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We are pleased to present the *full paper proceedings* of the **2nd International Conference on Fundamental and Applied Research (ICFAR)**, held under the theme *"Transforming Interdisciplinary Research for Sustainable Development: Challenges and Opportunities."* This volume brings together peer-reviewed full papers presented at the conference and serves as a platform for academic exchange, critical reflection, and the dissemination of interdisciplinary research findings across diverse fields of study.

The conference was designed to address the increasingly complex and interconnected challenges of sustainable development in contemporary global contexts. Accordingly, the contributions included in this volume reflect a wide range of disciplinary perspectives and methodological approaches. The main thematic areas encompass climate resilience and disaster risk, environmental sciences, policy and governance, gender equity and inclusive society, cultural sustainability, tourism and creative industries, eco-entrepreneurship and circular economy, education transformation and digital pedagogy, health, nutrition, and well-being, language and communication in societies in transition, as well as sustainable technologies and digital innovation.

This *full paper proceedings* is expected to serve as an important scholarly reference for academics, researchers, practitioners, and policymakers seeking to understand current research trends and theoretical as well as practical contributions related to sustainability-oriented interdisciplinary studies. By presenting diverse empirical findings and conceptual discussions, this publication aims to enrich academic discourse and support evidence-based decision-making in various sectors.

Beyond its academic function, this proceedings volume also reflects a collective commitment to fostering interdisciplinary collaboration and knowledge integration across institutional, national, and international boundaries. The exchange of ideas facilitated through ICFAR is expected to contribute to the development of innovative research agendas and collaborative networks that respond effectively to pressing societal and environmental challenges.

We would like to express our sincere appreciation to all authors for their valuable contributions, to the reviewers for their constructive evaluations, and to the organizing committee and supporting institutions for their dedication and professionalism. Their collective efforts have ensured the quality and successful publication of this proceedings volume. May this *full paper proceedings* provide meaningful insights and contribute to the advancement of knowledge and research-based practices for sustainable development.

We would like to express our sincere appreciation to all authors, reviewers, organizing committee members, and supporting institutions whose contributions made this conference and publication possible. May this *full paper of the proceedings* provide meaningful insights and contribute to the advancement of knowledge and research-based practices for sustainable development.

Committee

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The Impact of Physical Exercise Program on Functional Capacity in Patients with Hypertension

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ABSTRACT

Cardiac rehabilitation (CR)-based exercise is a therapeutic intervention that could reduce the mortality and morbidity rates of patients with hypertension by 40–55%. The purpose of this exercise program service is to improve the physiological and psychosocial status of patients with a history of hypertension. From several outpatient cardiac rehabilitation exercise programs in hospitals that refer to aerobic physical exercise, to date no research has implemented specific treadmill and stationary bike exercise programs. The two exercise programs are considered to be very effective and optimal for evaluating and measuring the impact of functional capacities such as blood pressure and pulse in patients with hypertension. The study measured blood pressure and pulse in 40 subjects using a sphygmomanometer. The data analysis technique used is ANOVA to determine the differences between groups and to compare which group has a significant impact. All treatment groups have the same optimal impact on the capacity of heart function in patients with hypertension. This study has proven that physical exercise programs in the form of treadmill and stationary bike exercises can increase the functional capacity of patients with hypertension. These 12 weeks research concludes that using treadmills and stationary bikes can optimize functional capacities. This research is the development of a physical exercise model to increase functional capacity safely and effectively. However, the combination of both exercises has the most optimal effect on blood pressure and pulse rate in patients with hypertension.

Keywords: functional capacity, hypertension, stationary bikes, treadmill

INTRODUCTION

Hypertension is a risk factor that has a high prevalence in the development of cardiovascular disease (Carlén et al., 2024). It is predicted that the prevalence of hypertension will increase by more than 30% during the next 20 years and result in an enormous disease burden for society (Crowley et al. 2022). In line with this ongoing development, the availability of suita-ble medicines and accurate measurements in the clinic and at home is crucial for patients with hypertension. An important factor in hypertension treatment is increasing the fitness of cardiac functional capacities, namely blood pressure (BP) and pulse or heart rate (HR) (Bruggisser et al., 2025). Previous studies have shown that imbalanced blood pressure and heart rate are the causes of hypertension (Spicuzza et al., 2025). Blood pressure and heart rate obtained in ambulatory monitoring reflect the daily activities of patients with hypertension. The UK guidelines explain the benefits of ambulatory monitoring that contradict the recommendations for ambulatory blood pressure and HR published by the 2016 European Society of Hypertension and European Society of Cardiology Guidelines (Correia et al., 2023).

Practitioners have made various efforts for patients with hypertension. However, overcoming hypertension problems still becomes an obstacle (Higashi, 2024). Historically, the debate about exercise management for hypertensive patients has been an obstacle, especially in finding the right solution. Interestingly, beneficial physical exercises have been suggested to deal with hypertension by optimizing the vascular wall (Lang et al., 2024). Besides conventional pharmacological treatment, physical exercise may therefore potentially prevent or treat hypertension (Alemayehu & Teferi, 2023). A review of various research journal articles on exercises for cardiovascular disease has found strong evidence that a structured exercise program is a safe recommendation and has tremendous beneficial effects to prevent cardiovascu-lar disease and manage diseases, especially hypertension (Romero et al., 2024). However,

the results of this review do not explain in detail what types of exercises are given, either aerobic exercise (functional capacity), stretching exercises (passive or active), or balance exercises (Safitri et al., 2025).

To date, no research has implemented a treadmill and stationary bike exercise program for the management of patients with hypertension (Leeyio et al., 2025). These programs are considered effective and optimal evaluating and measuring the impacts of functional ca-pacities, such as blood pressure and pulse in patients with hypertension (Sucipto et al., 2022). This study aims to evaluate the overall clinical impacts of the exercises and compare the exercise programs to discover which has the most significant impact on patients with hypertension. Thus, this study focuses on measuring the impacts of the tread-mill exercise program, the stationary bike, and the combination of both.

METHODS

Participants in this study were 40 patients diagnosed with hypertension in an in-dependent private clinical practice laboratory in Denpasar, Bali. The patients participated in the training twice a week for 12 weeks. Moreover, the patients were divided into four groups (10 patients per group). Group 1 received a treadmill exercise treatment (Low-bruce protocol). Group 2 received a stationary bike exercise (YCMA). Group 3 received a combination exercise between a treadmill and a stationary bike. Finally, group 4 was assigned as a control group. The patients were aged 50 to 65 years old according to the data of the Indonesian Hypertension Association Consensus (PERKI) and had no history of chronic comorbidities, such as post-stroke, diabetes mellitus, and chronic lung disease. All patients were educated about the risks and benefits of the training. During the follow-up period, they received the 6-minute walking test (6MWT) (D'Almeida et al., 2025). The informed consent had been obtained from the patients before they took part in the study. This research was tested through a proposal review involving human subjects and approved by the Research Ethics Committee of the Faculty of Medicine of Udayana University with number B/39401/UN38.8.1/PP.11.01/2025.

The measurement used the 6MWT, which was evaluated thoroughly and integrated all systems involved during the exercises, including the pulmonary and cardio-vascular systems, systemic circulation, peripheral circulation, blood, neuromuscular units, and muscle metabolism. The patients in each group received training for 24 meetings. Then, they were retested to evaluate the capacity of heart functions (blood pressure and pulse). In the next stage, the researcher collected data and coordinated with the persons in charge of PJT and cardiac rehabilitation. Afterward, they recommended physiotherapy actions in private clinical practice, especially in exercise laboratories. Furthermore, this study explained the research objectives, general characteristics of patients, research instruments, data collection procedures, and the usefulness of this research to the patients. If they had agreed, they would have become the research patients and signed the informed consent.

In the implementation phase, the researchers recruited field workers, such as competent physiotherapists in the cardiovascular field, to assist researchers to collect data. Furthermore, the researchers recruited instructor trainers to explain the research implementation process so that this implementation was uniform with the researchers' expectations. To obtain pre-test data, the patients would undergo the BP and pulse measurements. The next step was conducting physical exercise programs on a tread-mills and stationary bikes referring to the standard operating procedures. The final stage was collecting post-test data after conducting a series of training processes. Afterward, the research subjects were sorted into groups and trained to do treadmill and stationary bike exercises by considering a predetermined schedule and exercise program.

The data were analyzed using the statistical package for the social sciences (SPSS) for Windows. The normality test was conducted to assess continuous variables to fit normal distribution and normally distributed continuous variables. Moreover, one way ANOVA was performed to find out the difference between grups and followed by Duncan's post hoc test.

RESULTS AND DISCUSSION

The normality test of the data used the Shapiro Wilk-Test while the homogeneity test used the Lavene's Test. The results of the normality test (Shapiro Wilk-Test) have shown that the total value data (p-value) before and after the treatments is less than 0.05 ($p < 0.05$). However, the pulse rate before treatment is more than 0.05 ($p = 0.193$). Thus, the average values of the functional capacity in the heart before and after the treatments are not normally distributed. Meanwhile, the homogeneity test (Lavene's

Test) has obtained an average result of $p < 0.05$, which indicates the data are not homogeneous except for the value of the pulse before the treatments ($p = 0.614$), as presented in Table 1.

Table 1. Homogeneity and Normality Test Results pre and post Treatment of All Groups

Functional Capacity	P. Normality Test (Shapiro Wilk-Test)	P. Homogeneity (Levine's Test)
Blood pressure before treatment	0.001	0.320
Pulse before treatment	0.193	0.614
Blood pressure after treatment	0.006	0.002
Pulse after treatment	0.002	0.019

Table 2 demonstrates that the treadmill group has a blood pressure value of 136.7 and a pulse value of 81.8. The stationary bike group has a blood pressure value of 136.1 and a pulse with a value of 80.6. The combination of the treadmill and stationary bike group has the lowest blood pressure value of 125.9 and the lowest pulse rate value of 75.5. The control group has the highest blood pressure value of 153.3 and the highest pulse rate value of 91.4.

Duncan's test has proven that the treadmill and stationary bike groups have received an optimal impact on the functional capacity of blood pressure and pulse. Meanwhile, the group combining treadmills with stationary bike exercises has received the most effective and optimal impacts on the capacity of heart functions with a p-value = 0.000 ($p < 0.05$). This proves that the combination exercise program group has received the most significant impact on the capacity of heart functions in the form of blood pressure and pulse rate.

Table 2. Effect of 12-week treatment on blood pressure and pulse rate of patients with hypertension

Group	Variable	
	Blood pressure (mmHg)	Pulse rate (bpm)
Treadmill	136.7^{b}	81.8^{b}
Stationary bike	136.1^{b}	80.6^{b}
Treadmill and stationary bike	125.9^{a}	75.5^{a}
Control	153.3^{b}	91.4^{c}
Anova (p)	0.000	0.000

*Annotation:
1. p value < 0.05 is called significantly different or significant
2. Numbers followed by the same notation are in the same group
3. The notation “a” indicates the lowest average
4. The notation “c” indicates the highest average
5.Numbers followed by the same alphabet are the same group. If the alphabets are different, they are classified into different groups.

The preliminary evidence supporting this study shows that a structured and measurable physical exercise program can be used to improve hypertension patients heart functions against risk factors (Hisamoto et al., 2025). Several studies have proved that a 45% ejection fraction could optimize and lower the blood pressure of 133 patients aged 45 to 65 years old who have high blood pressure after receiving a physical exercise program (Lin, 2023). However, other studies have found that the clinical evidence of a physical exercise program in the form of aerobic exercise is still inconclusive because testing the effects of physical exercise on older adults for three months still shows an unclear health status and much lower pulse and blood pressure than conventional treatment (Galván et al., 2025). Patients with hypertension tend to experience complex cardiac function instability (Tamayo et al., 2022). The current study has proven that the impacts of aerobic exercise in the form of a treadmill are significantly beneficial to the aerobic fitness capacities, such as VO2max and pulse rate, and can reduce mortality of outpatients with hypertension. Generally, treadmills and stationary bike exercises provide similar benefits to heart function. Theoretically, treadmills and stationary bikes are included in the categories of aerobic exercises used to optimize the overall cardiac function capacities of patients with hypertension. Scientific literature evidence explains that treadmill and stationary bike exercises offer the most significant effects on blood pressure and VO2Max (Estévez-Caro et al., 2025).

Another study has proven that static cycling exercise can decrease systolic and diastolic blood pressure in patients with hypertension (Zhang et al., 2025). Thus, static bicycles are a safe modality to conduct physical exercise programs for hypertensive patients (Sli, 2022). Recent advances on physical exercises for cardiac function capacities and comprehensive treatment of exercise programs for hypertensive patients include aerobic exercises, such as treadmills and stationary bikes (Delgado-Floody et al., 2020). These exercises can increase the effectiveness of heart functions so that patients are able to improve their quality of life. This study shows that treadmill and stationary bike exercises impact heart functions. Treadmill and stationary bike exercise programs effectively improve the cardiovascular fitness of elderly patients and are easily used (Wang et al., 2025). The patients exercise intensity was measured during exercise on weeks 3, 9, and 12. The literature explains that treadmills and stationary bikes can optimize blood pressure, pulse, and vo2max of patients with hypertension. One mechanism that explains changes in heart functions is that treadmill and stationary bike exercises provide benefits to brain health and reduce anxiety or depression (Ren et al., 2022). Another study has discovered different impacts of a six minutes walk test on a controlled clinical trial sample evaluating 300 outpatients and proved that the test could improve functional capacities and quality of life of patients receiving treadmill and stationary bike exercises because they have stable blood pressure and a normal pulse (Li et al., 2022), (Dalton-Alves et al., 2024). The study also explains that most patients will die three years after the cardiac rehabilitation. These preliminary findings suggest that future studies should assess the efficacy of a community receiving the combined intervention of treadmill and stationary bike exercise programs that are believed to increase hypertensive patients' physical activities and proportion (150 minutes of moderate-intensity aerobic physical activities per week) (Helgerud et al., 2022). Other findings prove that treadmill and stationary bike exercises for 20 weeks have a significant 45% effect on pulse rates and VO2Max because treadmill and static bicycle exercises can maintain a balance of body performance by prioritizing concentration (Sahgal, 2024). Consequently, the VO2Max more optimally increases (Kim et al., 2025). The literature or previous research shows that treadmills and stationary bikes are potentially used as safe and effective exercise option to optimize blood pressure, pulse rate, and VO2Max (Lopes, 2024).

To date, no study has compared treadmill and stationary bike exercises (Pesova et al., 2023). Therefore, the results of this study can only be compared with those of similar studies. Furthermore, various previous studies still show different findings, and no similar studies have been published in Asia, especially in Indonesia. Thus, this study provides an introduction to the benefits of a combined exercise program and functions as a potential exercise for patients with hypertension who cannot or do not willingly take a conventional cardiac rehabilitation program, such as solely performing aerobic exercises.

CONCLUSION

Research study conducted over 12 weeks concludes that the physical exercise programs using treadmills and stationary bikes can optimize functional capacities. However, the com-bination of both exercises brings the most optimal effect on functional capacities of blood pressure and pulse rate of patients with hypertension.

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SURVIVING IN THE DIGITAL ERA: A PHENOMENOLOGICAL STUDY ON THE ADAPTATION STRATEGIES OF BALINESS LOCAL MSMES IN THE E-COMMERCE TRENDS

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ABSTRACT

Culturally, Bali's MSMEs operate within a strong creative economy ecosystem where craft, culinary, and art products often carry local cultural values as commodities. These cultural values become a comparative advantage if MSMEs are able to formalize product storytelling, quality, and packaging standards for the online market; but at the same time, they present a dilemma between maintaining the authenticity of tradition and meeting the demands of larger-scale production. This study aims to understand the adaptation strategies of local Bali Micro, Small, and Medium Enterprises (MSMEs) in facing the digital wave through the utilization of e-commerce. Using a phenomenological qualitative approach, the study involved ten MSME actors who have transitioned to digital platforms. Data were collected through in-depth interviews and analyzed thematically to reveal the experiences, challenges, and meanings of digital adaptation for business actors. The results indicate that e-commerce plays a significant role in the development of Bali MSMEs, not only as a survival strategy but also as an opportunity to expand market reach, improve operational efficiency, and strengthen product branding. Digital transformation encourages MSMEs to develop a more strategic long-term vision and create product innovations according to market demand. The findings also reveal that e-commerce becomes an important means of introducing Balinese cultural values through digital narratives that strengthen local identity in the global market. However, the digital adaptation of Balinese MSMEs still faces challenges, particularly related to limited digital skills, logistics costs, and service quality consistency. This emphasizes that the success of e-commerce utilization is determined not only by technology but also by the readiness of human resources and the support of the business ecosystem. This study concludes that the digital adaptation strategies of Bali SMEs are proactive in creating new growth opportunities and are not limited to survival efforts. The practical implications of these findings highlight the importance of collaboration between the government, e-commerce platform providers, financial institutions, and the community to create a digital ecosystem that supports the sustainability of local SMEs in the era of global competition.

Keywords: Bali SMEs, e-commerce, adaptation strategy, phenomenology, digital transformation

INTRODUCTION

Bali, as an island with a high dependence on the tourism sector, experienced a sharp shock when the flow of visitors stopped during the COVID-19 pandemic. The decline in tourists led to a decrease in demand for thousands of MSMEs based on experiences, crafts, and culinary products, forcing many business operators to seek alternative sales channels, particularly digital platforms and e-commerce. This situation makes Bali a natural laboratory for examining the adaptation processes of MSMEs in facing location-based demand disruptions.

The rapid shift to digital channels in Bali did not occur uniformly: some SMEs that already had social capital, technological skills, or access to online market networks were able to "upgrade," while others struggled due to limitations in digital literacy, capital for logistics/packaging, and price

competitiveness against imported products. Cross-national and national research has identified determinants of e-commerce adoption such as technological readiness, perceived benefits, external support, and business owner capabilities—factors that also appear relevant in the Indonesian and Balinese context.

From the perspective of infrastructure and supporting services, the penetration of electronic payments and the integration of e-commerce services have been proven to increase supply chain efficiency and market access for SMEs in Indonesia, with direct implications for Balinese SMEs that want to sell to domestic and international markets without full reliance on face-to-face tourism. However, this technical transformation requires changes in business practices (packaging, digital marketing, order management) and collaboration with platforms that provide logistics services and training.

Culturally, Bali's MSMEs operate within a strong creative economy ecosystem where craft, culinary, and art products often carry local cultural values as commodities. These cultural values become a comparative advantage if MSMEs are able to formalize product storytelling, quality, and packaging standards for the online market; but at the same time, they present a dilemma between maintaining the authenticity of tradition and meeting the demands of larger-scale production. Local phenomenological studies show how Balinese entrepreneurs interpret these changes in their life experiences and daily practices, making the phenomenological approach suitable for exploring the meaning of adaptation from the actors' perspective.

The most apparent gap lies in human capability aspects, such as digital training, mastery of social media marketing, and access to capital to improve product quality. Interventions that have proven effective in Bali include platform training programs, platform-based export initiatives, and collaborations within creative communities that help standardize products and distribution. However, empirical evidence on the most resilient adaptation strategies is still scattered; therefore, a phenomenological study focusing on the in-depth experiences of Bali's MSME actors would fill the understanding gap regarding how and why certain strategies succeed or fail in the local context.

THEORETICAL FRAMEWORK

Technology–Organization–Environment (TOE) emphasizes that technology adoption decisions are influenced by three domains: Technology characteristics (availability, compatibility, complexity), Organizational aspects (resources, leadership, structure), and Environmental factors (competitive pressure, government support, external infrastructure). In the context of Bali's SMEs, TOE helps explain why e-commerce adoption is not uniform: some actors have the infrastructure (connection, smartphones), organizational capital (personnel/knowledge), and access to environmental support (tourism office programs, training communities), so they tend to adopt the marketplace more quickly; conversely, SMEs with limitations in any of these domains will lag behind. Empirical studies on SMEs in developing countries (including Indonesia) consistently use TOE to map the determinants of e-commerce adoption.

Diffusion theory (Rogers) emphasizes the attributes of innovation (relative advantage, compatibility, complexity, trialability, observability) and the classification of adopters (innovators, early adopters, early majority, late majority, laggards). For SMEs in Bali, diffusion helps to understand why some artisans/SMEs become change agents (becoming examples that can be observed by others) while the majority will only adopt if they see evidence of success (observability). or experience mimetic pressure from competitors/communities. The implementation of training policies or pilot projects that highlight early adopters can accelerate diffusion in village/indigenous community clusters. (The application of Diffusion in e-commerce and SMEs has been widely reported in the e-business literature).

The Technology Acceptance Model (TAM) focuses on two main determinants of technology acceptance: Perceived Usefulness (PU) and Perceived Ease of Use (PEOU); the model is often extended with variables such as trust, perceived risk, and social norms (subjective norms) in the context of e-commerce. In Bali's SMEs, interventions that reduce perceived complexity and increase perceived usefulness will enhance owners' intention to use digital channels. The latest systematic review on TAM and e-commerce adoption confirms the relevance of these extensions in the SMEs context.

RBV emphasizes unique internal resources (brand, artisan skills, traditional designs) as sources of competitive advantage, while dynamic capabilities (sensing, seizing, reconfiguring) explain the organization's ability to modify resources as the environment changes. For Bali's SMEs, RBV explains competitive value: (a) intangible assets (cultural narratives, craftsmanship authenticity), (b) local

distribution networks; whereas dynamic capabilities explain the learning ability through studying digital marketing, collaborating with delivery services, or standardizing packaging that determines who survives post-tourism disruption. The dynamic capabilities theory (Teece) serves as the main reference in studies of digital transformation in SMEs.

METHOD

This study employs an interpretative phenomenological approach (phenomenology / Interpretative Phenomenological Analysis — IPA) to explore and describe the life experiences of Bali MSME owners/managers in the process of adapting to e-commerce. This approach is appropriate because it focuses on subjective meaning, everyday experiences, and how actors understand the process of digital adaptation within the context of the local ecosystem. The location is in Badung Regency and Denpasar City in Bali Province. Respondents come from various businesses that use at least one e-commerce channel or social media for their business, and have a minimum of 6 months experience using/experimenting with digital platforms OR have decided not to use them yet but are influenced by the digital flow. Data collection techniques include semi-structured in-depth interviews, participatory observation, documentation, field notes, and researcher reflections.

FINDINGS AND DISCUSSION

Research results indicate that e-commerce plays a central role in the development of local MSMEs in Bali in the digital era. Business actors interviewed stated that the presence of digital platforms is no longer seen merely as a means to withstand competitive pressures and changes in consumer behavior, but as a significant opportunity to expand market share. MSME products that previously circulated only in the local market can now penetrate national and even international markets. This phenomenon shows that e-commerce serves as an important bridge connecting local products with global consumers, while also elevating Balinese cultural identity to a broader realm. In addition to market expansion, e-commerce has also been proven to improve the operational efficiency of SMEs. Business actors emphasize that digital systems help them in recording transactions, managing stock, promotion, and direct communication with consumers. The analytical features available on e-commerce platforms provide better insights into customer behavior, enabling marketing strategies to be more targeted and effective.

Nevertheless, this study also found challenges still faced by SMEs in the process of digital adaptation, such as limited digital skills, logistics costs, and maintaining service quality consistently. These obstacles indicate that the success of digital transformation is determined not only by technology but also by human resource readiness and business ecosystem support. Overall, the findings of this study affirm that the transition of Bali's SMEs to e-commerce platforms is not only reactive to survive in the digital era but also proactive in creating new growth opportunities. Through digital adaptation strategies, SMEs are able to connect local wisdom with the global market, improve internal efficiency, and strengthen long-term business sustainability. Thus, e-commerce can be viewed as an integral transformation strategy for Bali's SMEs in facing the dynamics of competition and changes in the modern market structure.

The findings of this study also confirm that e-commerce has driven changes in consumer consumption patterns. Sources stated that consumers are now more likely to search for products online before making a purchase, even for local specialties from Bali. This creates both pressure and opportunities for MSMEs to offer products that are relevant, easily found on digital platforms, and have strong differentiation. From a phenomenological perspective, the experiences of business actors indicate a shift in the meaning of running a business. Previously, most MSMEs were only focused on the day-to-day survival of their businesses. However, after utilizing e-commerce, they began to develop a more strategic long-term vision, such as targeting export markets, enhancing branding, and expanding product variations according to market demand. This transformative meaning shows that digitalization not only changes the way of doing business but also shapes a new mindset regarding business sustainability.

Furthermore, the results of this study also show that e-commerce serves as a medium that strengthens local cultural identity. Bali's MSME products that contain cultural values, such as handicrafts and traditional cuisine, have become more recognized in the global market thanks to the digital narratives created by business actors. This strategy demonstrates that e-commerce is not only about transactions but also about building stories that connect consumers with local culture. Ultimately, this study implies that the digital adaptation strategies of Bali's SMEs must be understood within the context of a broader

ecosystem, involving the government, e-commerce platform providers, financial institutions, and consumers. Without adequate digital infrastructure support, skills training, and access to funding, SMEs' efforts to leverage e-commerce will not be optimal.

CONCLUSION

This study concludes that e-commerce plays a fundamental role in the development of local SMEs in Bali in the digital era. The findings indicate that digital platforms are no longer merely a survival strategy, but have evolved into strategic tools to expand markets, increase operational efficiency, and strengthen product branding. Digital transformation enables Bali's SMEs to penetrate national and even international markets, thereby opening growth opportunities that were previously difficult to reach through conventional channels.

In addition to market expansion, e-commerce also brings a change in the meaning of doing business for MSME actors. If previously business orientation only focused on daily survival, now business actors are beginning to build a more strategic long-term vision. This not only involves efficiency but also a transformation in mindset towards sustainability, innovation, and creativity. Thus, digitalization has proven to provide significant added value to the competitiveness of Bali's MSMEs.

E-commerce also serves as a medium for preserving and promoting local culture. Balinese products rich in cultural value are increasingly recognized through effective digital narratives, thereby not only expanding market access but also strengthening Balinese cultural identity in a global context. This phenomenon shows that digital adaptation has both economic and socio-cultural dimensions that complement each other.

The success of Bali's SMEs in navigating the digital wave is highly determined by the support of a broader business ecosystem. Factors such as digital infrastructure, skills training, funding, and collaboration between the government, platform providers, and the community are key to maximizing the potential of e-commerce. With such synergy, Bali's SMEs are not only able to survive in the digital era but also transform into significant players in a sustainable digital-based economy.

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SURVIVAL STRATEGIES IN THE DIGITAL LABOR MARKET: A QUALITATIVE STUDY ON THE RESILIENCE OF GIG ECONOMY WORKERS IN BALI

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ABSTRACT

The rapid growth of the digital labor market has driven the emergence of the gig economy, which offers both opportunities and challenges for workers, especially in developing regions. This study aims to explore the survival strategies and resilience of gig workers in Bali, Indonesia, within the context of a digital platform-based economy. The study employs a qualitative approach with in-depth interviews of six gig workers from various digital platforms. Data Collection Techniques: 1) Semi-structured in-depth interviews (primary method): duration: 30-60 minutes per respondent using audio recordings (with permission), and field notes in Indonesian, 2) Participant observation: observing daily work activities. Record actual practices, environmental context, and social interactions, 3) Data triangulation by combining interviews, observation, and documents to enhance credibility. The findings indicate that gig work is generally carried out to supplement household income, but its unpredictable and fluctuating nature makes it difficult for workers to plan for the future or save money. Work schedule flexibility is seen as a major advantage because it allows workers to balance economic activities with cultural and family obligations, but on the other hand, it demands high self-discipline and exposes workers to the instability of demand. In addition, workers also face serious challenges in the form of fictitious orders, which result in the financial risk being entirely borne by the workers and exacerbate job insecurity. This study concludes that the resilience of gig workers in Bali is shaped not only by individual adaptive capacity but also by socio-cultural support, such as community networks that play a role in reducing economic vulnerability. However, structural challenges remain, particularly concerning the lack of protection from digital platforms and the absence of adequate government regulation. These findings underscore the importance of comprehensive policies and platform accountability to create fairer working conditions and ensure economic security for gig workers within Indonesia's digital labor ecosystem.

Keywords: Digital Labor Market, Gig Economy, Resilience, Survival Strategies, Qualitative Study

INTRODUCTION

The shift in labor market structure towards digital platforms has accelerated the growth of gig workers, those who work on a task/short-term contract basis through applications and online platforms. Globally, this work model offers flexibility and quick income opportunities, but it also brings income uncertainty, minimal access to social protection, and algorithmic control mechanisms that limit worker autonomy. This phenomenon calls for an in-depth study of how workers develop adaptive strategies and resilience to sustain their economic continuity and well-being under such uncertain conditions.

In the Indonesian context and relevant to Bali as a region with a combination of a formal economy, tourism, and a strong informal sector, empirical research shows the complex experiences of gig workers: besides taking advantage of platform opportunities, workers experience unfairness in profit distribution, vulnerability to changes in platform incentives, and gaps in legal protection. Field studies in Indonesia

underscore the need for research that maps daily practices, multiple income strategies, social networks, and the use of digital skills as forms of resilience built by the workers themselves.

Bali has a unique digital labor market dynamic because it is heavily influenced by the tourism sector, which serves as the backbone of the local economy. When the COVID-19 pandemic hit, many formal workers in the tourism industry lost their jobs and shifted to the gig economy, such as online transportation, food delivery services, and digital freelance work. This shift demonstrates that the gig economy has become one of the primary survival strategies for the Balinese community affected by the crisis. However, gig workers in Bali face double challenges: dependence on fluctuations in tourist demand and regulatory uncertainty for platforms. In this context, the resilience strategies they develop are not only economic but also cultural, for example by leveraging the solidarity of traditional communities, social networks based on the *banjar* system, and diversifying other informal jobs to cover the risk of unstable income.

In addition to economic factors, the resilience of gig workers in Bali is also influenced by local social and cultural structures. The *banjar* system and strong communal bonds provide spaces for solidarity, moral support, and even informal economic networks that can help gig workers cope with financial and psychological pressures. This makes survival strategies in Bali not only reliant on the flexibility of digital platforms but also on deeply rooted social and cultural strength. This phenomenon shows that the resilience of gig workers in Bali cannot be separated from the local social context, unlike studies of the gig economy in Western countries, which focus more on aspects of individual resilience.

Furthermore, tourism, which is a characteristic of Bali, creates a pattern of gig work demand that is seasonal and highly sensitive to global fluctuations, such as pandemics and international economic instability. When the flow of tourists increases, gig workers gain greater earning opportunities through online transportation services, homestay management, and digital-based freelance services. However, when tourist visits drop sharply, many gig workers have to combine platform jobs with side businesses, such as family farming or small-scale trading, to maintain sustainable income. This situation shows that the survival strategies of gig workers in Bali are not only adaptive but also creative in leveraging the available local opportunities. A qualitative study on the resilience of gig workers in Bali is important because it can reveal how the combination of economic, social, and local cultural factors shapes distinctive adaptation patterns that differ from other regions.

THEORETICAL FRAMEWORK

The development of the digital economy has transformed the structure of the global labor market, particularly through the emergence of app-based platforms that connect service providers and consumers. The concept of digital labor platforms emphasizes flexibility and efficiency, but also creates vulnerable working conditions due to the absence of social security and long-term employment contracts. According to Vallas & Schor (2020), the digital economy produces new forms of temporary work that often fall outside formal labor regulations.

The gig economy is generally seen as a new job opportunity, especially in developing countries, but it is still accompanied by the challenge of uncertainty. Glavin & Schieman (2022) emphasize that dependence on platforms can lead to mental and economic vulnerability due to non-transparent algorithmic mechanisms. In the context of Bali, this is exacerbated by fluctuations in tourism demand, which make gig work highly seasonal.

Resilience in the context of employment refers to the ability of individuals or groups to adapt, endure, and recover from economic and social pressures. Bellesia (2023) shows that gig workers use various coping strategies, including income diversification and digital adaptation, to face the impacts of the pandemic. This theory is relevant for analyzing the strategies of gig workers in Bali who are dealing with the uncertainties of global tourism.

From the perspective of dependency theory, gig workers in developing countries are often trapped in a system that places them in a subordinate position within the global economic structure. Putri, Darmawan, & Heeks (2023) highlight the injustice felt by gig workers in Indonesia due to the uneven distribution of profits between platforms and workers. This shows that gig workers' survival strategies are not merely individual choices, but also a form of response to an exploitative economic structure.

The concept of social capital becomes important in understanding the resilience of gig workers. Coleman (1988) emphasizes that social networks can enhance economic opportunities through information support, solidarity, and collective resources. In the context of Bali, the existence of banjar

and traditional communities serves as social buffers that strengthen the resilience of gig workers in facing the uncertainties of the digital labor market. The study by Hafeez et al. (2022) also links social support to reduced stress among gig workers.

Becker (1993), through human capital theory, explains that skill enhancement is an important investment for individuals to improve their competitiveness. Fiers (2024) emphasizes that mastering digital skills becomes a vital element in gig workers' resilience, especially for those involved in online-based freelancing. For gig workers in Bali, digital skills not only open access to the global market but also serve as a survival strategy during periods of declining tourism.

Doeringer & Piore (1971) introduced the dual labor market theory, which distinguishes between the primary (formal, stable) and secondary (informal, unstable) sectors of employment. The gig economy is often placed in the secondary labor market due to the lack of certainty and protection. De Stefano's (2016) study shows that gig workers are often categorized as "independent contractors," thus remaining outside legal protection. This is relevant for explaining the position of gig workers in Bali, who exist between the formality of the tourism sector and the informality of digital labor.

The principle of justice (fairness theory) becomes important in evaluating the relationship between platforms and workers. According to Rawls (1971), distributive justice demands equal access to economic opportunities. However, research by Putri et al. (2023) shows that gig workers in Indonesia feel unfairly treated due to incentive systems that are unilaterally changed by platforms. In the context of Bali, this sense of injustice encourages workers to rely on local solidarity as a survival strategy.

Based on theory and empirical findings, the study of gig worker resilience in Bali can be seen as a combination of structural factors (platform and tourism uncertainty), individual factors (digital skills, agency), and socio-cultural factors (banjar social capital and local solidarity). Thus, the resilience of gig workers in Bali cannot be explained solely through digital economy theory, but requires a multidimensional framework that encompasses human capital theory, social capital, and agency. Qualitative studies will be able to capture this complexity more thoroughly.

METHOD

This study uses a qualitative approach with a multiple case study design on gig workers in Bali. The aim is to explore in depth the experiences, adaptive strategies, and resilience constructions from the participants' perspectives. The research locations include several areas in Bali, namely Denpasar and Badung. The population consists of gig workers who actively use the digital platforms Gojek and Grab in Bali. The sampling technique is snowball sampling. The sample size is 6 respondents selected to provide a variety of experiences. Data Collection Techniques: 1) Semi-structured in-depth interviews (primary method): duration: 30-60 minutes per respondent using audio recordings (with permission), and field notes in Indonesian, 2) Participant observation: observing daily work activities. Record actual practices, environmental context, and social interactions, 3) Data triangulation by combining interviews, observation, and documents to enhance credibility.

FINDINGS AND DISCUSSION

Research found that gig work is not merely viewed as a career, but rather as an adaptive strategy to expand economic opportunities and increase family income. Flexibility in working hours emerges as one of the main dimensions in gig workers' survival strategies in Bali. Based on interview results, respondents stated that they have complete freedom in determining their working hours, both in starting and ending activities on digital platforms. This contrasts with formal employment, which has a fixed time structure, thus gig work provides a wider space for autonomy for workers. Furthermore, work flexibility in the gig economy in Bali also contributes to the quality of life of workers. The freedom to manage their own time allows them to reduce stress levels caused by work pressures that typically arise in rigid formal work systems. On the other hand, flexibility also presents the challenge of requiring high self-discipline. Gig workers are expected to manage their own work schedules without direct supervision, making productivity highly dependent on individual discipline. Some respondents mentioned that the freedom to choose working hours sometimes causes them to postpone tasks, which in turn impacts their income.

One significant finding in this study is the emergence of fictitious order issues experienced by gig workers, particularly online drivers in Bali. Fictitious orders occur when workers receive orders from irresponsible users, but after the orders are picked up or executed, it turns out that the orders are invalid.

In such situations, gig workers have to bear all the losses, including fuel costs, time, and responsibility for the items that have been picked up. This phenomenon highlights the structural vulnerability in platform-based work systems, where risks are largely shifted to workers rather than the application-providing companies. From an employment perspective, the case of fictitious orders reflects the weak protection for gig workers. Unlike formal employees who have employment protection mechanisms such as work contracts and insurance, gig workers are in a position not fully recognized as employees. This situation causes losses from fictitious orders to be entirely borne by the worker without any compensation from the platform. In addition to material losses, the practice of fictitious orders also has psychological impacts on gig workers. Some respondents expressed feelings of frustration, stress, and loss of a sense of security at work due to the potential for recurring fraud. This situation adds to the mental burden of workers who are already facing uncertainty in daily income. In Bali, the phenomenon of fake orders has its own characteristics. With an economy still relying on the tourism sector, many gig workers compete fiercely to obtain limited orders, especially during periods of low tourist visits. In such conditions, the emergence of fake orders not only causes economic losses but also worsens the sense of job insecurity among workers. This indicates that their survival strategies not only face external challenges in the form of market demand fluctuations but also internal challenges in the form of unethical practices by platform users.

One of the important findings of this study is that gig workers' income in Bali tends to be unstable and fluctuating, making it difficult to be relied upon as a long-term source of livelihood. Respondents revealed that the amount of daily earnings is greatly influenced by the number of incoming orders, market conditions, as well as external factors such as the tourist season, fuel prices, and platform policies. This uncertainty makes gig work less likely to provide stable financial security, unlike formal employment which generally has a fixed salary. Income uncertainty also poses difficulties for gig workers in planning long-term finances, including efforts to save. Some respondents stated that the income they earn is mostly used for daily needs, while the ability to set aside funds is very limited. This condition indicates that although the gig economy offers flexible job opportunities, the nature of its income actually hinders workers from building financial security. In the context of Bali, the issue of income uncertainty is further complicated by the economy's dependence on the tourism sector. When the number of tourists decreases, the opportunities for online drivers and other gig workers to receive orders also decrease drastically. This situation makes workers' income highly dependent on external factors that they cannot control. Furthermore, income uncertainty also affects the long-term career prospects of gig workers. Most respondents expressed doubt about making gig work their future occupation due to the lack of income certainty and limited career development opportunities. This indicates that although the gig economy provides a short-term solution to earn additional income, in the long run, it cannot guarantee sustainability.

CONCLUSION

This study shows that gig workers in Bali develop various strategies to survive in the face of the dynamics of the digital labor market. The main findings indicate that gig work is primarily undertaken to supplement household income, whether as a primary or additional job, although the nature of the earnings tends to be uncertain. This income uncertainty causes workers to experience difficulties in financial planning, saving, and viewing gig work as a long-term career option.

In addition to income aspects, this study found that work-time flexibility is seen as a positive factor by gig workers. The freedom to set their own working hours allows them to balance economic demands with family activities and local culture. However, this flexibility also requires a high level of self-discipline, as productivity entirely depends on the individual's ability to manage their schedule.

On the other hand, gig workers face a number of serious challenges, especially fictitious orders that cause financial losses and create psychological pressure. These risks highlight the weak protection of workers in the platform-based work system, where losses are entirely borne by the workers without adequate compensation. This phenomenon underscores the vulnerable position of gig workers in the digital economy structure.

Overall, this study concludes that the resilience of gig workers in Bali is shaped not only by individual adaptive abilities but also by sociocultural support and creative strategies in leveraging local economic opportunities. However, to achieve sustainability, stronger policy interventions and structural protections are needed from both the government and platform companies to ensure that gig workers can

obtain more secure income and fair social guarantees.

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The Future of Traditional Markets: A Qualitative Analysis of Traders' Strategies in Facing Digital Disruption in Bali

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ABSTRACT

This study aims to analyze the strategies of traditional market traders in facing digital disruption and the increasing dominance of modern markets in Bali. The phenomena of digitalization and the expansion of modern retail have placed significant pressure on the sustainability of traditional markets, which have long been the backbone of family economies and social interaction spaces for the community. The research method used is qualitative with an exploratory approach, through in-depth interviews and participatory observation of 7 traders in several traditional markets in Bali. The results of the study indicate that all traders experience obstacles, such as fluctuations in commodity prices, vulnerability of perishable products, and intense competition with modern stores. However, the traders were still able to survive by implementing adaptation strategies, including maintaining the quality of their goods, offering affordable prices, keeping their stalls clean, and continuing to trade despite unstable income. These findings confirm that traditional markets still play an important role in supporting family economies and maintaining social functions within the community, even under the pressure of modern market developments and digital transformation. The future of traditional markets in Bali heavily depends on the traders' ability to preserve social and cultural values, as well as the quality of services that modern markets do not offer. Additionally, supportive policies and inclusive innovations are needed for traditional markets to continue surviving and thriving in the digital economic ecosystem.

Keywords: Adaptation, Bali, Digital Disruption, Merchant Strategy, Traditional Market

INTRODUCTION

Traditional markets in Bali are not merely spaces for economic transactions, but also centers of social interaction, cultural symbols, and integral parts of local identity. The presence of markets such as Ubud Market, Badung Market, and Gianyar Market has long supported the local economy, particularly micro and small business actors who rely on daily buying and selling activities for their livelihood. However, in recent years, traditional markets have faced serious challenges due to the wave of digitalization, which has given rise to new consumption patterns based on e-commerce platforms and online shopping services. Consumers, including local residents and tourists, are increasingly accustomed to the convenience of digital transactions, the availability of price information, and fast delivery services. This phenomenon pressures Bali's traditional market traders to change their business patterns in order to remain relevant.

The market revitalization initiated by the Bali Provincial Government, such as the major renovation of Pasar Badung following the fire in 2016, demonstrates a commitment to maintaining the functions of traditional markets. However, the revitalization, which has largely focused on improving physical infrastructure, has not been fully accompanied by adequate digital transformation. Traders still face limitations in digital literacy, minimal access to online marketing technology, and attachment to conventional buying and selling practices. This results in traditional markets remaining weak in competitiveness compared to modern retail and e-commerce platforms, even though their physical infrastructure has been renewed.

On the other hand, tourism, which is the backbone of Bali's economy, presents both opportunities and threats to traditional markets. Tourists seeking authentic experiences often visit traditional markets

to find local products, but their shopping patterns are also shifting towards purchases through digital platforms, both for souvenirs and daily needs. The COVID-19 pandemic has further accelerated this change, as consumers in Bali, whether local residents or domestic tourists, have begun to get accustomed to app-based delivery services. For traditional market vendors, this situation necessitates the development of diverse adaptation strategies, ranging from using social media for promotion, collaborating with online motorcycle taxi services, to developing hybrid selling models that combine face-to-face and online transactions.

However, academic studies on the adaptation strategies of traditional market traders in Bali in facing digital disruption are still very limited. Previous research has mostly focused on SMEs in general or on issues of market infrastructure revitalization, rather than on the specific adaptive strategies of traders. In fact, understanding how Balinese traders navigate digital transformation is crucial not only for the sustainability of traditional markets but also for the preservation of local culture and identity embedded in the market as a social institution. Therefore, this study seeks to qualitatively explore the strategies of Balinese traditional market traders in facing digital disruption and to analyze the social, economic, and cultural factors that influence the success or failure of such adaptation.

THEORETICAL FRAMEWORK

Digital transformation not only means the utilization of new technology, but a strategic process that changes the way organizations or market systems create value, interact with customers, and build sustainable business models. Verhoef et al. (2021) explain that digital transformation occurs through three main stages: digitization (conversion of analog processes to digital, for example using cashier apps or QR codes), digitalization (utilizing technology to improve operational efficiency, for example promotions via social media), and digital transformation (fundamental changes in business models and value logic, for example full integration into e-commerce platforms or development of a hybrid ecosystem connecting physical markets to digital markets). In the context of traditional Balinese markets, digital transformation has a special meaning. Traditional markets are not only economic spaces but also social and cultural spaces that serve as symbols of Balinese community identity. However, when digital technology enters, the function of the market experiences both expansion and shift. For example, digitization can be seen from vendors starting to use WhatsApp or Instagram to promote their goods. Digitalization occurs when vendors cooperate with online ride-hailing services to provide delivery services, or when market managers use applications for kiosk management. A more advanced stage, namely digital transformation, is evident in the integration of traditional markets into the digital tourism ecosystem: market products are promoted through tourism marketplaces, souvenir packages are sold online, and payments are made via e-wallet.

The Technology Acceptance Model (TAM) developed by Davis (1989) emphasizes that an individual's acceptance of technology is greatly influenced by two main constructs: Perceived Usefulness (PU) and Perceived Ease of Use (PEOU). PU refers to the extent to which an individual believes that using technology will improve their performance, while PEOU refers to the extent to which the technology is perceived as easy to learn and use. In the context of traditional market traders in Bali, these two constructs are key to explaining variations in responses to digitalization: 1) Perceived Usefulness (PU): Traders who see tangible benefits from technology (for example, increased sales through promotions on Instagram, or access to tourist customers via online marketplaces) are more likely to adopt it. Conversely, if traders feel that technology does not add value (for example, buyers still come directly to the market), adoption tends to be low. External factors such as the increased online shopping behavior post-pandemic reinforce this perceived benefit; 2) Perceived Ease of Use (PEOU): Many vendors in traditional markets face limitations in digital literacy. If buying and selling applications or digital payment methods are considered complicated, they tend to reject adoption. Support in the form of brief training, user-friendly application interfaces, and assistance from the vendor's children/family can enhance the perception of ease of use. The context of Bali, which still has a digital gap between urban areas (Denpasar) and rural areas, shows strong variation in this perception. In practice, TAM helps explain why some Balinese traders adapt relatively quickly to social media or e-wallets, while the majority continue to stick to face-to-face buying and selling. By using TAM, this study can explore traders' personal narratives: how they assess benefits, obstacles, and their direct experiences when trying technology.

The concept of organizational ecosystems originates from the ecological approach in business

studies. Organizations do not exist in isolation but are part of an ecosystem consisting of suppliers, consumers, regulators, competitors, and other interdependent actors. In this ecosystem, the survival of an organization is determined by its ability to adapt to environmental changes (technological shifts, regulations, consumer preferences). For the traditional Bali market, this means that merchants are not only interacting with local buyers but also with tourist communities, local government, digital platforms, and even online logistics (ride-hailing services, couriers). If one element changes (for example, an increase in consumer preference for shopping via apps), the entire market ecosystem is also affected. Merchants' adaptation to digital platforms is part of that ecosystem process. Adner (2017) emphasizes the importance of ecosystem positioning, which is how actors position themselves within the value network to remain relevant. Traditional markets in Bali should be understood as ecosystems, not merely physical locations. Merchants who previously relied only on direct interactions are now part of an expanded digital ecosystem, where the roles of e-commerce platforms, local influencers, and government regulations shape a new structure of market relationships.

METHOD

This study uses an exploratory qualitative approach with the aim of understanding the experiences, perceptions, and adaptive strategies of traditional market traders in Bali in response to digital disruption. The qualitative choice allows for an in-depth exploration of the narratives regarding how and why traders employ strategies to face digital disruption, which cannot be fully captured by quantitative surveys. The research locations are several markets in Denpasar City and Badung Regency. The selection of locations is based on variations in: (a) tourist visitation intensity, (b) level of physical revitalization, and (c) diversity of commodities (fresh food, crafts, souvenirs). The sampling technique used is purposive sampling involving 7 traders. Data collection methods consist of in-depth semi-structured interviews, participatory observation, and relevant local documents and archives.

FINDINGS AND DISCUSSION

The research findings indicate that trading activities in traditional markets remain a primary source of livelihood for traders. The majority of respondents stated that trading is not merely a temporary economic choice, but a long-term strategy to meet their families' daily needs. This shows that traditional markets continue to hold significant social and economic value amid digital disruption. In addition, these findings also confirm that traders' attachment to traditional markets is not solely due to economic factors but is also influenced by cultural, social, and intergenerational business sustainability aspects. Thus, the existence of traditional markets is seen not only as a space for commercial transactions but also as an economic foundation for families, providing stability amid changes in market structure due to technological advancements.

The research results indicate that all traders in traditional markets experience obstacles in carrying out their business activities. These obstacles appear in various forms, including the instability of merchandise prices, which makes it difficult for traders to predict their income. Price fluctuations make it challenging for traders to maintain stable profits, especially when the purchase prices from suppliers are not proportional to the selling prices in the market. In addition, traders also face challenges from the characteristics of perishable goods, especially fresh food products such as vegetables, fruits, and fish. This condition increases the risk of losses because the goods cannot always be sold within the targeted time frame. Another challenge perceived is competition with modern stores and large retail markets. The presence of modern retail, which offers more stable prices, more comfortable facilities, and technology-based marketing strategies, puts traditional market traders in an increasingly pressured position. Nevertheless, the traders continue to strive to survive with their own adaptation strategies, despite facing limitations in capital, resources, and digital access.

This study found that each traditional market trader has their own adaptation strategies to survive amid the dynamics of competition and pressures of the modern market. The dominant strategies include maintaining the quality of their goods, ensuring that the products sold remain fresh and suitable for consumption, thereby gaining customer trust. In addition, traders also strive to offer affordable and competitive prices as a form of differentiation to maintain buyer loyalty.

Another finding is maintaining the cleanliness of stalls and the surrounding selling environment, which is considered important in creating comfort for consumers and enhancing the competitiveness of traditional markets. Although the income earned is not always stable due to price fluctuations or people's

purchasing power, the traders remain consistent in continuing their business. This persistence demonstrates the existence of socio-economic resilience among traditional market traders.

Overall, the findings of this study indicate that traditional markets still play an important role in supporting family economies and the social life of the community, despite their existence being increasingly pressured by the growth of modern markets and digital transformation. Thus, traditional markets remain a vital economic and social space for local communities in Bali.

CONCLUSION

This study concludes that traditional markets in Bali still play a central role in supporting family economies and community social life, despite being under strong pressure from the development of modern markets and digital disruption. The research results show that traditional market traders face various obstacles, ranging from price fluctuations, the risk of perishable goods, to increasing competition with modern stores.

Nevertheless, traders are still able to demonstrate a variety of adaptive strategies, including maintaining the quality of their goods, offering affordable prices, keeping the selling environment clean, and maintaining consistency in trading activities. These strategies not only reflect the traders' resilience to market dynamics but also underscore the important role of traditional markets as both economic and social spaces for the local community.

Thus, the future of traditional markets in Bali does not solely depend on price competitiveness or technology, but also on the ability of traders to maintain social, cultural, and service quality values that distinguish them from modern markets. This indicates the need for inclusive policy support and innovation so that traditional markets can continue to thrive and contribute to the local economic ecosystem in the digital era.

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Legal Policy Reconstruction for Sustainable Development: Towards an Interdisciplinary Regulatory Model

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ABSTRACT

This study aims to analyze the urgency of reconstructing legal policy to achieve sustainable development through an interdisciplinary approach integrating law, science, and public policy. The research employs a normative-juridical approach, utilizing primary legal materials such as national legislation and international instruments related to the SDGs, as well as secondary legal materials including interdisciplinary academic literature. The findings reveal that the fragmentation of sectoral legal policies in Indonesia has led to inconsistency among regulations and ineffective implementation of sustainability principles. Therefore, a paradigm shift toward knowledge-based regulation and evidence-based policy is essential to enable law to function as an integrative instrument across disciplines. The proposed interdisciplinary regulatory model encompasses an integrative design linking law–science–policy, a robust mechanism for institutional coordination and accountability, and the application of adaptive and collaborative principles within the national legal framework. Through this model, law is expected not only to uphold legal certainty and justice but also to act as an enabler of sustainable social and economic transformation in Indonesia.

Keywords: Interdisciplinary Regulation, Legal Policy, Sustainable Development.

INTRODUCTION

Sustainable development is a concept that places the balance among economic, social, and environmental dimensions as the foundation of public policy and legal direction. The concept gained global legitimacy since the World Commission on Environment and Development released its report Our Common Future (1987), which introduced sustainable development as a process of meeting the needs of the present generation without compromising the ability of future generations to meet their own needs (Borowy, 2023). In the legal context, this principle has transcended its moral-normative nature and become an integral part of both international and national legal instruments governing development and natural resource management.

Indonesia, as a state based on the rule of law (Article 1 paragraph (3) of the 1945 Constitution of the Republic of Indonesia), affirms that all development activities must be grounded in law. Law serves as a steering instrument that guides development not only toward economic growth but also toward social justice and environmental sustainability. Indonesia's commitment to sustainable development is reflected in various legislative instruments, such as Law Number 32 of 2009 concerning Environmental Protection and Management (UUPPLH), which integrates ecological dimensions into development decision-making processes.

However, in practice, the national legal system continues to exhibit a sectoral and fragmented character. Each development sector, such as mining, forestry, energy, and housing is governed by its own statutory regime, often with conflicting policy orientations (Nugroho & Surono, 2018). For instance, Law Number 3 of 2020 concerning Mineral and Coal Mining emphasizes the economic exploitation of natural resources, while the UUPPLH stresses the precautionary principle. Such inconsistencies cause development policies to operate without an integrated and sustainable legal framework.

This legal fragmentation is further exacerbated by the command and control paradigm that still dominates Indonesia's legal policy. This approach positions the state as the principal actor in a top-down regulatory model, leaving limited room for public participation and cross-disciplinary interaction (Wijaya, 2021). Consequently, law often functions repressively rather than adaptively—regulating

behavior without providing space for innovation or for knowledge- and technology-based solutions. In an era of global disruption marked by rapid social and ecological change, this legal policy model has become increasingly inadequate.

Another prominent weakness lies in the absence of inter-sectoral coordination in policy implementation (Wati, 2018). Each ministry or agency performs its mandate under sectoral regulations without cross-sectoral integration. For example, spatial planning policy (Law No. 26 of 2007 on Spatial Planning) is often inconsistent with forestry or energy policies. This lack of harmony leads to overlapping authorities, licensing conflicts, and reduced effectiveness in environmental protection and community welfare.

These challenges signify the urgent need for a reconstruction of legal policy capable of addressing normative and institutional fragmentation. Reconstruction in this sense does not merely mean formal legal reform, but rather a paradigm shift in understanding the function of law as an enabler of sustainable development. Law should no longer serve solely as a tool of control but as an instrument for integrating diverse interests, disciplines, and sustainability values into a coherent and adaptive regulatory system (Mensah, 2019).

The reconstruction of legal policy toward sustainable development must be grounded in an interdisciplinary approach, one that combines legal perspectives with environmental science, economics, social studies, and technology to produce policies that are more contextual and responsive to multidimensional challenges. Within this framework, law must be viewed not as a closed system, but as an open system interacting with other subsystems, as articulated by Niklas Luhmann in his Systems Theory of Law (Nielsen, 2024).

In the context of national policy, the urgency of reconstructing legal policy aligns with Indonesia's long-term development agenda as stated in the National Long-Term Development Plan (RPJPN) 2025–2045. This document emphasizes the importance of legal transformation in supporting a sustainable, inclusive, and globally competitive Golden Indonesia 2045. Consequently, legal policy can no longer stand apart from social and economic dynamics; it must become the foundation of an integrated, knowledge-based development system (Rafiqi, 2021).

Furthermore, the interdisciplinary approach to law has direct relevance to the Sustainable Development Goals (SDGs), which Indonesia has adopted through Presidential Regulation Number 59 of 2017 on the Implementation of the Achievement of the SDGs. The SDGs promote synergy between legal, economic, and environmental policies to achieve a balance between progress and sustainability. Thus, an interdisciplinary legal policy framework will reinforce the driving force of SDG implementation at the national level.

The application of an interdisciplinary approach is also vital to address the epistemic deficit in the lawmaking process. Legislative processes in Indonesia have often focused excessively on legal drafting without adequate engagement with social or scientific research (Rahman et al., 2025). As a result, many regulations are not adaptive to shifts in social and technological contexts. For example, the policy on new and renewable energy management still faces obstacles due to regulations that inadequately accommodate green innovation and investment.

A similar weakness can be seen in environmental legal policy, which tends to be reactive rather than preventive. Government action is often limited to imposing administrative or criminal sanctions after environmental damage occurs, rather than constructing preventive legal mechanisms. Yet, the principle of prevention is better than cure has become a universal norm of sustainable development. Therefore, reconstructing legal policy that integrates the principles of prevention, precaution, and public participation has become an urgent necessity (Sembiring, 2023).

From an institutional perspective, legal policy reconstruction must also incorporate the principles of good governance. Transparency, accountability, participation, and the rule of law principles embedded in national regulations, must be internalized at every stage of policy formation and implementation (Putra et al., 2025). In this way, law functions not only as a normative product but also as an instrument for strengthening legitimacy and public trust in state policy.

The urgency of legal policy reconstruction is further reinforced by the challenges of global climate change and the escalating ecological crisis. Indonesia, as a megabiodiverse country, faces significant risks from uncontrolled natural resource exploitation. A legal policy that fails to respond to sustainability concerns will result in environmental degradation, threatening economic and social resilience. Therefore, the law must be designed to ensure intergenerational justice and ecological balance.

On the other hand, the proposed interdisciplinary regulatory model does not obscure the function of law; rather, it reinforces its role as an orchestrator among disciplines and interests. This model positions law as a framework for integration—where norms, policies, and knowledge work synergistically. Approaches such as adaptive governance and policy coherence should be adopted to ensure that law remains adaptive to social and ecological dynamics without sacrificing legal certainty.

In conclusion, the reconstruction of legal policy for sustainable development constitutes a fundamental necessity for Indonesia's modern legal system. Law must be transformed into an inclusive, integrative, and interdisciplinary instrument capable of addressing contemporary challenges and guiding development toward genuine sustainability. This effort holds not only theoretical significance for legal reform but also practical value in enhancing national competitiveness and resilience amidst the complexities of globalization and environmental change.

THEORETICAL FRAMEWORK

Legal policy, in essence, serves as a vehicle for transforming public objectives into a framework of norms and instruments capable of guiding collective behavior (Muhammad et al., 2023). In the context of development, the function of legal policy extends beyond merely setting prohibitions and obligations; it constitutes a mechanism for establishing a roadmap for resource allocation, rights protection, and the distribution of risks between public and private actors (Ghodoosi, 2015). The constitutional foundation for this function is embodied in the concept of the rule of law (Article 1 paragraph (3) of the 1945 Constitution), which affirms the role of law as the regulator of the national and state order, making legal policy a medium to realize national development goals in an orderly and just manner.

In the practice of public policy formation, law functions as an instrument of social engineering, capable of creating incentives, constraining negative externalities, and structuring decision-making processes. The tradition of law as social engineering requires policymakers to use legal norms consciously (Hidayat & Hainadri, 2021), integrating scientific evidence, economic analysis, and social assessment to ensure that regulation produces the intended outcomes. In Indonesia, legal instruments such as the Environmental Impact Assessment (AMDAL) regulated under Law Number 32 of 2009 concerning Environmental Protection and Management illustrate how normative mechanisms are designed to evaluate and control development impacts prior to final decision-making, positioning law as a tool for prevention and policy design, not merely for enforcement.

The theory of sustainable development situates the integration of economic, social, and environmental aspects as the primary criterion in formulating public policy. This framework requires legal norms that balance resource exploitation with the conservation of natural capital and the fulfillment of fundamental human rights, including those of future generations (Gupta & Vegelin, 2016). At the national policy level, Indonesia's commitment to the Sustainable Development Goals (SDGs), adopted through Presidential Regulation Number 59 of 2017, along with its long-term development vision, promotes the harmonization of sectoral norms so that economic, spatial, and environmental policies operate coherently rather than in isolated silos. This underscores the need for cross-sectoral and purpose-oriented legal policy.

Good governance complements sustainable development as a theoretical component, emphasizing that sound governance—encompassing transparency, participation, accountability, and the rule of law, determines the effectiveness of norm implementation. These principles are not merely normative but also practical within public administration processes. For example, transparent and participatory licensing processes reduce the risk of corruption and social conflict, while institutional accountability strengthens the enforcement of environmental regulations and the protection of vulnerable communities. The coherence between governance principles and legal instruments enables regulation to fulfill SDG objectives without compromising legitimacy and social sustainability (Butt, 2021).

An interdisciplinary approach to regulation has emerged in response to the limitations of traditional, sectoral, and fragmented legal frameworks (Disantara, 2024). The interaction of law with economics, ecology, engineering, and policy sciences enriches the design of legal norms with scientific data, impact modeling, and realistic cost–benefit analyses. Interdisciplinarity is not merely the addition of perspectives but a transformation of the entire policy input process, from problem identification and regulatory design to impact evaluation, to making law an evidence-based and adaptive medium responsive to advances in knowledge and technology.

An effective conceptual model of interdisciplinary regulation contains several key features: policy

coherence across sectors, regulatory adaptability mechanisms, and multi-stakeholder forums for policy deliberation. Coherence entails aligning spatial planning law (Law No. 26 of 2007), environmental management law (Law No. 32 of 2009), and other sectoral regulations such as those governing energy and mining, to prevent normative contradictions. Adaptability mechanisms enable legal norms to be revised or supplemented by flexible implementing rules in response to new evidence, while multi-stakeholder forums provide space for the participation of communities, scientists, and businesses, thereby enhancing the legitimacy and effectiveness of policy.

Theoretically, integrating the precautionary principle, prevention, and intergenerational justice into the legal framework signifies a shift from reactive to proactive law. These principles, which have become foundational to Indonesia's environmental law, must also be internalized in economic policy and resource governance. This requires regulations that adopt preventive legal instruments, such as minimum environmental standards, ecosystem restoration obligations, and incentives for green investment, so that development does not compromise the natural capacities underpinning long-term welfare.

The interaction between law and economics is equally essential in designing efficient policy instruments, such as green fiscal tools, payment for environmental services mechanisms, and incentive schemes for clean technologies. The economic approach provides a foundation for developing policies that minimize social costs and maximize shared benefits; however, its effectiveness depends on a legal framework that ensures certainty and enforcement. Therefore, interdisciplinary regulation must combine economic analysis with clear legal provisions on responsibility, compensation mechanisms, and dispute resolution procedures.

METHOD

This research employs a normative juridical approach to capture both the normative and contextual dimensions of legal policy reconstruction for sustainable development. The normative juridical approach is selected because the research focuses on the study of norms, institutional structures, and regulatory coherence ((Rizkia & Fardiansyah, 2023), namely how statutory regulations construct a framework for the implementation of the principles of sustainable development. The normative analysis examines the hierarchy of norms, legal constructions, and regulatory intents embodied in primary national legal sources (e.g., the 1945 Constitution of the Republic of Indonesia, Law No. 32 of 2009 concerning Environmental Protection and Management, Law No. 26 of 2007 concerning Spatial Planning, and other sectoral regulations) as well as international and national instruments that adopt the SDGs agenda (e.g., Presidential Regulation No. 59 of 2017 on the Implementation of the SDGs).

The sources of legal materials are divided into primary and secondary legal materials, analyzed using qualitative and interpretative techniques. Primary materials include statutory texts, implementing regulations, national policies, international treaties, and relevant government policy documents; secondary materials consist of interdisciplinary academic literature, policy reports, empirical studies, and research findings in the fields of environment, economy, and public governance. The analytical technique follows a qualitative-interpretative method, employing doctrinal exposition of legal norms, content analysis of policy documents, and hermeneutic interpretation to discern the objectives and implications of norms within the evolving socio-economic-ecological context. To ensure the validity of findings, the results of interpretation are triangulated through cross-source comparison (legal, academic, and policy-based).

FINDINGS AND DISCUSSION

Critique of Legal Policy Fragmentation and Sectoral Regulation

The fragmentation of legal policy has emerged as a significant structural issue in achieving sustainable development in Indonesia. On one hand, there exists a strong normative framework, such as spatial planning regulations (Law No. 26 of 2007), environmental protection and management (Law No. 32 of 2009), and sector-specific provisions in energy and mining laws—but on the other hand, the existence of these norms does not automatically ensure policy harmonization. This fragmentation is not merely a technical problem; it reflects an inconsistency of regulatory objectives between short-term economic growth and long-term ecosystem preservation. Consequently, policies that should ideally complement each other often compete or even negate one another in practical implementation.

In the environmental domain, fragmentation is evident when licensing procedures for large-scale

projects are conducted separately from holistic spatial planning and strategic assessments (Susanto et al., 2024). The Environmental Impact Assessment (EIA/AMDAL) functions to evaluate project-specific impacts; however, when licensing decisions stem from divergent sectoral mandates—such as those driven by energy or mining investment priorities—the EIA risks becoming a mere administrative formality rather than a tool aligning broader policy objectives (Sukananda & Nugraha, 2020). This condition results in poorly implemented mitigation measures and, ultimately, recurrent environmental degradation.

In the energy and mining sectors, sectoral regulatory models often promote resource exploitation without sufficient policy integration mechanisms. Sectoral regulations emphasizing production targets, investment incentives, or energy sovereignty may overlap with environmental protection norms and spatial planning requirements (Permana, 2020), allowing companies to obtain permits that operationally damage ecosystems or interfere with local community rights. The resulting impacts include social conflict, the loss of community livelihoods, and the degradation of ecosystem services that are not reflected in the economic valuation of projects.

Empirical cases—such as mining conflicts in production forest areas or plantation expansion encroaching upon protected zones—illustrate how regulatory fragmentation facilitates harmful trade-offs between short-term economic gains and long-term environmental loss (Rahim, 2017). Differences in the interpretation of authority between central and regional governments, combined with weak inter-ministerial coordination mechanisms, have caused slow and often biased problem resolution favoring actors with political access or strong capital. This phenomenon underscores the urgent need for legal policy reconstruction that places sustainability considerations at the core of governance.

Reforms in licensing administration intended to simplify investment procedures through integrated licensing mechanisms and also raise concerns if not accompanied by substantive policy harmonization. Centralization or procedural simplification without integrating environmental and spatial standards may weaken oversight and open the door to “permit shopping”, detrimental to the public and the environment (Bhamatika et al., 2025). Therefore, administrative reform must be designed to strengthen, not undermine, cross-sectoral policy integration.

Policy fragmentation also reveals gaps in distributive justice and public participation. Sectoral regulations that marginalize or exclude community participation in decision-making, such as through formal yet non-substantive public consultations, undermine the rights of indigenous peoples and local communities to engage meaningfully and to obtain fair compensation for development impacts (Mubarok et al., 2024). As a result, policy legitimacy declines and the potential for social disputes increases, ultimately disrupting project continuity and eroding the goals of sustainable development.

From an institutional perspective, fragmentation indicates the need for stronger coordination mechanisms, both horizontally among ministries and vertically between central and regional governments. Weak formal coordination leads to overlapping authorities and inconsistent implementation. Strengthening inter-agency coordination forums, mandating Strategic Environmental Assessments (KLHS) at the planning stage, and integrating planning outcomes into technical licensing processes are crucial instruments to reduce fragmentation and enhance policy coherence (Ulum & Ngindana, 2017).

Moreover, addressing fragmentation requires improving the analytical capacity of legislative and policy-making processes. Regulators must be equipped with interdisciplinary assessments that integrate scientific evidence, economic analysis, and social studies before adopting new legal norms. In this way, regulations are not merely derived from narrow sectoral perspectives but grounded in a comprehensive understanding of the interactions between natural systems and socio-economic systems affected by regulation.

Solutions to fragmentation are not only technical but also normative. It is essential to reaffirm the fundamental policy principles underlying all sectoral regulations—such as the principles of precaution, prevention, intergenerational equity, and transparency as hierarchical guidelines binding in the formulation of sectoral rules. Strengthening these principles at both the statutory and implementing regulation levels can help ensure that sustainability objectives are not subordinated to fiscal or investment priorities.

The critique of legal policy fragmentation in Indonesia thus highlights that without systematic reconstruction encompassing normative harmonization, strengthened coordination mechanisms, integration of interdisciplinary analysis in law-making, and the fulfillment of participatory rights—the

goals of sustainable development will remain difficult to achieve. The isolated sectoral approach must shift toward a coherent, adaptive, and just regulatory model, allowing law to truly function as a transformative instrument for managing interrelated environmental, social, and economic challenges.

The Urgency of Legal Policy Reconstruction in Sustainable Development

The reconstruction of the legal policy paradigm constitutes a strategic necessity if law is to play a role beyond that of a merely normative instrument reactive to conflict or market failure. Law must be positioned as an integrative instrument that unites various disciplines such as economics, ecology, sociology, and policy studies, so that the formulation of regulations no longer emerges from a purely sectoral logic (Rafalyuk, 2019)). In the Indonesian context, affirming the role of law as a regulator of sustainable development aligns with the Constitution (Article 1 paragraph (3) of the 1945 Constitution of the Republic of Indonesia) and various sectoral laws such as Law No. 32 of 2009 on Environmental Protection and Management and Law No. 26 of 2007 on Spatial Planning, which demand the harmonization of economic and environmental objectives in policy practice.

To make law an integrative instrument means transforming its traditional function from merely prescribing orders and sanctions into a vehicle for orchestrating cross-sectoral policy. In practice, this requires legal mechanisms that facilitate horizontal coordination among ministries and agencies, as well as vertical coordination between central and regional governments. Legal instruments such as the Strategic Environmental Assessment (KLHS) and Environmental Impact Assessment (AMDAL) demonstrate normative potential to synergize planning with impact assessment; however, their effectiveness depends on consistent integration between the outcomes of these assessments and technical licensing as well as other sectoral policies.

The knowledge-based regulation approach reinforces this integrative concept by positioning scientific evidence as the basis of normative legitimacy. Knowledge-based regulation requires a systematic process: data-driven problem identification, evidence-supported policy option selection, and rule evaluation and revision based on monitoring outcomes (Van Kerkhoff & Pilbeam, 2017)). In the context of environmental and green economy issues, scientific evidence concerning ecosystem capacity, environmental service valuation, and socio-economic impact projections must constitute essential inputs in norm formulation to prevent policies that generate substantial future externalities.

The concept of evidence-based policy complements knowledge-based regulation by emphasizing empirical methods and causal analysis in evaluating the effectiveness of policy choices (Andersen & Rocca, 2020). Legislation and regulations supported by empirical impact evaluation and cost-benefit analysis tend to be more efficient and equitable, as they reveal trade-offs, beneficiaries, and those adversely affected by policy interventions. For Indonesia's legal system, adopting such practices requires enhanced analytical capacity within policymaking bureaucracy and the availability of reliable data from environmental, social, and economic as operational prerequisites.

For law to effectively function as a disciplinary integrator, formal institutional mechanisms must be established to bind the rulemaking process. These mechanisms include the obligation to conduct regulatory impact analyses, involve cross-disciplinary experts at the drafting stage, and establish multi-stakeholder deliberative forums providing space for civil society, academia, and the private sector. Such legal instruments not only improve the substantive quality of norms but also strengthen social legitimacy and reduce implementation resistance.

Paradigm reconstruction must also address the methodological dimension of legislation. This involves a shift from mere text-based drafting toward a legislative process that incorporates documented scientific studies, the formulation of performance indicators, and periodic evaluation mechanisms. Law drafters and regulators must therefore design norms that not only satisfy formal legality but can also be measured in effectiveness through quantitative and qualitative indicators aligned with sustainability objectives. Consequently, regulation becomes more goal-oriented and can be systematically corrected when evidence shows that outcomes remain suboptimal.

A recurring pragmatic challenge is the capacity gap, as policymakers and supervisory institutions often lack the technical resources to conduct in-depth interdisciplinary analysis. Hence, paradigm reconstruction must be accompanied by investment in institutional capacity, such as strengthening policy analysis units within ministries, forming cross-disciplinary expert teams to support legislation, and establishing partnerships with universities and research institutions. This capacity is fundamental to ensuring that knowledge-based regulation evolves from mere rhetoric into a sustainable practice.

From the standpoint of democratic legitimacy, integrating scientific knowledge into legal processes must be combined with substantive public participation mechanisms. Evidence-based policy built without the involvement of affected communities risks neglecting local knowledge and social values crucial to implementation sustainability. Therefore, integrating scientific evidence with local wisdom through deliberative processes enriches the normative foundation and enhances compliance and public support for the resulting policies.

The proposed normative reform must also emphasize regulatory flexibility. Law should facilitate controlled policy experimentation (regulatory sandboxes), pilot projects, and adaptive management mechanisms that allow iterative policy learning (Baskoro, 2024). This adaptive framework enables legal norms to evolve in response to new knowledge without undermining the legal certainty required by economic actors. In the context of sustainable development, such an approach is vital for addressing scientific uncertainty and the dynamics of green technology.

In conclusion, the reconstruction of the legal policy paradigm entails both functional and institutional transformation: repositioning law as an integrative cross-disciplinary instrument, institutionalizing knowledge-based regulation and evidence-based policy, and building the capacity and mechanisms that allow legal norms to be adaptive and deliberative. This effort is not merely a technical clause within regulatory governance but a prerequisite for achieving equitable, effective, and sustainable development governance—a paradigm shift that must be reflected in legislative processes, public administrative practices, and policymaking culture in Indonesia.

Interdisciplinary Regulatory Model for Achieving Sustainable Development

The proposed interdisciplinary regulatory model positions the design of legal norms as a synthesis between law, science, and public policy, ensuring that every provision not only complies with formal legal standards but is also supported by scientific evidence and adequate policy analysis. In this model, statutes and implementing regulations serve as boundary-setting frameworks, while technical instruments and dynamic operational standards (Zhong & Shang, 2025) occupy the adaptive space of implementation. Scientific studies and policy evaluations subsequently inform and populate this operational domain. Such an approach prevents rigid sectoral regulation by promoting principle-based norms at the legislative level and rule-based mechanisms that are periodically updated at the implementation level.

Conceptually, the integrative design promotes a clear hierarchy of norms, in which principles such as sustainability, precaution, and intergenerational equity are positioned as foundational values guiding sectoral regulation (Mitrofanenko, 2016). These principles are then operationalized into performance indicators and technical standards jointly developed by policymakers, the scientific community, and relevant stakeholders. In Indonesia, mechanisms such as the Strategic Environmental Assessment (Kajian Lingkungan Hidup Strategis – KLHS) and the Environmental Impact Assessment (AMDAL) can be reconceptualized as integral components of this process to serving not merely as administrative requirements but as binding normative-scientific inputs in decision-making.

This model further requires the establishment of a coordinating institution vested with legal authority to harmonize cross-sectoral policies and to oversee the incorporation of scientific knowledge into regulatory processes (Saputra & Rahman, 2024). Such a coordinating body should be empowered to issue technical guidelines, mandate evidence-based reviews prior to licensing, and enforce inter-policy integration standards. The legal framework underpinning this coordination mechanism is essential to ensure that scientific and policy recommendations are not merely advisory in nature but carry binding administrative force that secures national policy coherence.

Coordination mechanisms should also include vertical coordination between central and regional governments. Ideally, the interdisciplinary model provides a national interoperable data platform that integrates environmental, social, and economic information, thereby enabling regional planning to align with national policies (Widijawan et al., 2023). Reliable data availability is a prerequisite for evidence-based regulation; likewise, data transparency strengthens accountability and enables public monitoring of policy implementation.

Institutional accountability within this model is operationalized through several instruments, such as mandatory periodic public reporting, independent audits of policy implementation, and administrative sanctions for agencies that disregard integrative guidelines. Public information disclosure, as guaranteed under Law No. 14 of 2008 on Public Information Disclosure, must be utilized to ensure that decision-

making processes combining scientific evidence and public consultation remain auditable by civil society and legislative bodies.

The adaptive principle constitutes the core of the proposed regulatory model, emphasizing that legal norms must be designed to evolve in response to advances in science and shifts in socio-economic dynamics (Yamani, 2024). Technically, this may be realized through provisions mandating periodic reviews, mechanisms for updating technical standards based on monitoring and evaluation, and controlled policy experimentation (regulatory sandboxes) allowing innovation to be tested prior to full-scale implementation. The legal framework for such adaptive mechanisms merges legal certainty with governance flexibility.

The collaborative principle necessitates procedures for multi-stakeholder engagement at every stage of the policy process—from formulation to implementation and evaluation. This participation includes dialogue with academics, the private sector, local communities, and civil society organizations, ensuring that resulting norms incorporate diverse forms of knowledge, including local and indigenous wisdom (Nonet et al., 2022). Properly designed participatory procedures enhance the legitimacy of decisions and mitigate implementation resistance, as stakeholders are engaged from the outset.

To ensure the practical integration of law, science, and policy, the model recommends institutional capacity-building measures. These include establishing research and policy analysis units within ministries, developing networks of research institutions capable of producing independent studies, and securing funding mechanisms for policy research (Ostrom, 2019). Investment in bureaucratic technical capacity is crucial to ensure that knowledge-based regulation becomes a genuine practice that yields measurable, high-quality, and evaluable regulations rather than a rhetorical aspiration.

Implementation of the interdisciplinary model also necessitates harmonization of legal instruments governing licensing, spatial planning, and environmental protection, ensuring that the licensing and impact assessment processes follow a single logical framework and avoid contradictory outcomes. This can be achieved through synchronization of implementing regulations, strengthening of joint technical guidelines, and legal requirements mandating the integration of KLHS/AMDAL results into licensing decisions—thereby making scientific and policy considerations a substantive prerequisite for the legitimacy of permits.

Ultimately, the proposed interdisciplinary regulatory model emphasizes not only structural reform in legal and institutional design but also a cultural transformation in policymaking—from a sectoral orientation toward a policy culture grounded in evidence integration, cross-disciplinary collaboration, and public accountability. If consistently implemented, this model can reinforce the role of law as an enabler of sustainable development—harmonizing legal certainty, adaptive flexibility, and social legitimacy so that national policies align with long-term socio-economic objectives and environmental sustainability.

CONCLUSION

The reconstruction of legal policy for sustainable development is an imperative necessity in addressing the complexity of intertwined social, economic, and environmental challenges in the modern era. Indonesia's legal system, which remains largely sectoral and grounded in a command-and-control paradigm, has not yet fully adapted to the dynamics of sustainable development that demand cross-disciplinary integration and the incorporation of scientific evidence into decision-making processes. Through an interdisciplinary approach, law is no longer perceived merely as a controlling mechanism but rather as an integrative instrument that unites scientific perspectives, public policy considerations, and social values. This transformation requires a paradigm shift in legal policy formulation from a reactive orientation toward knowledge-based regulation and evidence-based policy, where empirical and scientific knowledge constitutes the foundation of regulatory legitimacy.

The interdisciplinary regulatory model proposed in this study is built upon three main pillars: the integration of law, science, and public policy; the establishment of strong institutional coordination and accountability mechanisms; and the application of adaptive and collaborative principles within the national legal framework. Through these mechanisms, the law is expected to serve as an enabler of sustainable socio-economic transformation rather than a mere tool of administrative control. Implementation of this model necessitates the harmonization of legislation, the enhancement of institutional capacity, and the cultivation of an evidence-based and participatory legislative culture. Accordingly, the law can function as a dynamic foundation for governance that is just, inclusive, and

sustainable—consistent with the constitutional mandate and Indonesia's commitment to the Sustainable Development Goals (SDGs).

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The Urgency of Reorganizing Disaster Management Institutions in Indonesia

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ABSTRACT

A disaster management institutional system is always related to three main issues: power, justice, and legitimacy. In Indonesia, the main problems in disaster management institutions are: first, many institutions are directly involved and even act as leading actors, but do not cooperate; and second, because there are too many institutions involved, coordination problems arise among them. These issues have resulted in disaster management becoming fragmented and ineffective. To address this gap, this article introduces a structured analytical framework that classifies three alternative disaster management institutional arrangements – single-agency system, multi-agency system, and collaborative crisis management. This article advances the discourse by offering a normative and comparative legal analysis that has not been comprehensively applied in the Indonesian context. It analyzes the comparison of institutional systems in the United States and China to develop a new institutional perspective, providing actionable pathways for legal and organizational reform. This article argues that the historical involvement of numerous institutions shapes the dynamics of inter-institutional relations, leading to overlapping authority and heightened sectoral ego, thereby making coordination increasingly challenging. Therefore, this article provides a normative framework that serves as a foundation for enhancing coordination, strengthening institutional legitimacy, and improving the overall effectiveness of disaster management in Indonesia.

Keywords: Disaster Management Institution, Reorganization, Single-Agency System, Multi-Agency System, Collaborative Crisis Governance.

INTRODUCTION

The implementation of disaster management in Indonesia, whether natural, non-natural, or social, cannot be separated from 3 (three) main issues: *power, justice, and legitimacy* (Wignyo, 2018, p. 12). These 3 (three) things are very relevant if contextualized with the disaster management institution, where *power* is related to the organizing institution as a state representative in responding to disaster; then *justice* is related to how the institution functions to reduce the suffering of disaster victims; lastly, *legitimacy* is related to public trust and the legal basis or regulations underlying the institution's duties, authorities, and functions (Wignyo, 2018, p. 12).

When looking at how disaster management has been carried out in Indonesia so far, the author identifies 2 (two) main problems, namely, problems related to authority and those related to coordination. These two problems are closely related and are the main reasons why disaster management in Indonesia often encounters obstacles and ultimately operates ineffectively.

First, based on Law Number 24 of 2007 on Disaster Management (DMR), which is still the legal umbrella for the implementation of disaster management in Indonesia (Hizbaron et al., 2018, p. 79), the Central Government and Local Governments hold the primary responsibility for the implementation of disaster management as stated in Article 5, through the *Badan Nasional Penanggulangan Bencana (BNPB)* at the national level as indicated in Article 10 paragraph (10). As stated in Article 18 paragraph (1), the *Badan Penanggulangan Bencana Daerah (BPBD)* is responsible at the regional level. In addition to these institutions, DMR does not explicitly regulate other institutions' involvement in disaster management implementation. Still, in reality, many institutions are either directly or indirectly involved, for example, the *Badan Nasional Pencarian dan Pertolongan (BASARNAS)*, the *Pusat Vulkanologi dan Mitigasi Bencana Geologi (PVMBG)*, the *Badan Nasional Penanggulangan Terorisme (BNPT)*, and the

Palang Merah Indonesia (PMI), and various ministries such as the Ministry of Social Affairs, the Ministry of Home Affairs, and the Ministry of Transportation, took a role in disaster management (Pratama & Gischa, 2020). What is more intriguing about this matter is that many of those institutions taking on the leading actor role ultimately degrade BNPS's role, especially in handling non-natural and social or man-made disasters.

Basically, the DMR does not differentiate between handling natural, non-natural, and social disasters. Thus, there is a tendency for all provisions in the DMR to apply to all types of disasters. However, for a social disaster, such as social conflicts, they are handled by an *ad hoc* institution of the Social Conflict Resolution Task Force based on Law Number 7 of 2012 on Social Conflict Handling, with the Coordinating Ministry for Political, Legal, and Security Affairs as the leading actor (Arsil & Ayuni, 2020, p. 439). Another type of social disaster that another institution handles is the act of terrorism based on Law Number 5 of 2018 on Amendments to Law Number 15 of 2003 on the Stipulation of Government Regulation in Lieu of Law Number 1 of 2002 on the Eradication of the Criminal Acts of Terrorism into Law (Terrorism Law), that mandates the *Badan Nasional Penanggulangan Terorisme (BNPT)* as the leading actor. Furthermore, non-natural disasters, such as pandemics, are explicitly regulated in Law Number 6 of 2018 on Health Quarantine, in which the Ministry of Health leads operations (Arsil & Ayuni, 2020, p. 439).

At this point, the author understands that the specialization related to the handling of social and non-natural disasters is a result of the characteristics and complexity of the events classified into these types of disasters, so that if separated, it can reduce the workload of BNPB, which throughout the year deals with natural disasters, which have a higher frequency compared to other types of disasters. For example, according to BNPB's annual report, 3.472 natural disasters occurred through 2024 (Rosyida et al., 2025, p. vi). However, in the handling of natural disasters itself, other institutions have a central role whose authority overlaps with BNPB, one of which is related to the implementation of disaster mitigation and policy-making, namely the *Pusat Vulkanologi dan Mitigasi Bencana Geologi (PVMBG)*, which is an agency under the auspices of the Ministry of Energy and Mineral Resources based on Presidential Regulation Number 97 of 2021 on the Ministry of Energy and Mineral Resources. The number of institutions that are actively involved and even play a unique and central role raises questions about the position and function of BNPN, as stipulated in the DMR, in implementing disaster management in Indonesia.

Second, the consequences of the many institutions involved in implementing disaster management, as described above, stem from the coordination problems they create. This problem is clearly seen in the early days of handling the Coronavirus Disease 2019 (COVID-19) pandemic, where the Ministry of Health, which became the leading actor in managing that situation, experienced miscoordination with BNPB as a leading actor in disaster management as a whole regarding data synchronization and the development of COVID-19 cases in Indonesia, which indirectly caused the government to take the wrong policy (Biro Komunikasi dan Informasi Publik, 2020) in controlling the spread of the virus (Santia, 2020; Wadhana, 2020).

According to Article 13 paragraph (1) DMR, as an institution that coordinates in a planned, integrated, and comprehensive manner in implementing disaster management, BNPB should ideally be able to lead and guide the handling of disasters not only during a pandemic but also when any disaster strikes Indonesia. This function is challenging to implement due to the unclear relationship between the BNPB and other institutions within the institutional system (hierarchy), and the absence of solid legitimacy for the BNPB to lead these institutions in disaster response. Therefore, it is necessary to review Indonesia's disaster management system, from its institutional structure to its coordination mechanisms, so that disaster management can be implemented effectively and adaptively.

To address these issues, this paper will explain, *first*, how the legal reality of the many institutions involved and the potential overlapping authority in the implementation of disaster management in Indonesia, to illustrate the urgency of reorganizing clearly; *second*, the choices of institutional systems that can be considered for use, namely single-agency system, multi-agency system, and collaborative crisis governance; and *third*, which among the options that more feasible to apply in Indonesia's disaster management institutional system.

THEORETICAL FRAMEWORK

Before elaborating on the study's findings, the author should provide prior studies and theoretical

frameworks to clarify key terminology, synthesize major theoretical perspectives, and identify gaps or tensions in the existing literature.

Key Terms

Disaster

Early scholars, such as Charles Fritz, defined a disaster as a localized, time-bound event that disrupts the essential operations of society (Fritz, 1957, p. 6). Quarantelli further elaborated on disasters as unexpected, socially disruptive events that require unplanned, adaptive responses (Borgatta & Montgomery, 2000, p. 682). More recently, the United Nations Office for Disaster Risk Reduction (UNDRR) defines a disaster as a severe disruption of the functioning of a community or society due to hazardous events interacting with conditions of exposure, vulnerability, and capacity (Secretary-General, 2016). This definition emphasizes the multidimensional impacts on human, material, economic, and environmental systems and recognizes that disasters often exceed local capacities, necessitating broader coordination across jurisdictions (Secretary-General, 2016).

The term disaster is sometimes used interchangeably with: crisis, which means a sudden, abnormal situation with limited scope (Darling, 1994, pp. 3–8); and emergency that denotes a broader and potentially escalating situation requiring coordinated action (Alexander, 2017, p. 158), even though each carries distinct implications for public policy and legal regulation (Al-Dahash et al., 2016, pp. 1191–1200). In Indonesia, these terminologies are inconsistently used in legal and policy instruments, leading to interpretative ambiguities that may affect institutional responses (Adhari, 2019, p. 43). This paper will focus only on the "disaster" term as stated in DMR.

Disaster Management

Disaster management constitutes a continuous and cyclical process encompassing four interrelated stages: *first*, mitigation that aims to reduce or eliminate the potential consequences of hazards; *second*, preparedness that involves equipping communities and institutions to minimize losses and enhance survival; *third*, response that focuses on immediate actions to mitigate the impact of ongoing disasters; and *fourth*, recovery that aim to restores social and economic systems to customary conditions, often requiring extended periods and inter-institutional coordination (Haddow et al., 2007, p. 8).

These stages illustrate the multi-dimensional nature of disaster management and highlight the necessity for well-defined institutional roles and coordination mechanisms. The involvement of multiple agencies often leads to fragmentation, overlapping authorities, and coordination failures that require study through the lens of institutional theory.

Theoretical Foundations

Legal Politics

Legal politics refers to the state's policy choices concerning which laws are enacted, implemented, or reformed to achieve national objectives (Rahardjo, 1991, p. 352). This perspective enables the analysis of how political, social, and economic contexts shape the institutional architecture of disaster management.

Separation of Powers and Inter-Institutional Relations

The separation of powers, both horizontal (legislative, executive, and judicial) and vertical (central and local), forms the backbone of Indonesia's constitutional framework (Hamja, 2020, p. 986). Within this system, five forms of inter-institutional relations exist, namely functional, supervisory, dispute-resolution, accountability, and membership relations (Arifin et al., 2004, pp. 70–72). These relationships illustrate the complexity of institutional interaction, particularly in disaster management, where multiple agencies overlap in authority.

Reorganizing Theory

According to Shukrullaev, reorganization refers to structural changes that alter institutional forms and legal status (Rakhmonov, 2022, pp. 248–253). Scholars such as Ingraham and Peters differentiate reorganization (structural change) from reform (procedural change), though both involve adaptation to new political and administrative environments (Ingraham & Peters, 1988, p. 10).

There are three models of reorganization: *first*, purposive models that emphasize political motivations; *second*, environmental models that highlight adaptive responses to external pressures; and *third*, institutional models that integrate both by focusing on organizational values and legitimacy (Peters, 1992, pp. 199–217). In Indonesia, persistent institutional proliferation and resistance to reform reflect the political and bureaucratic constraints inherent in the reorganization process. (Peters, 1992)

Existing studies on disaster management in Indonesia predominantly focus on operational

challenges or community-based resilience, but rarely integrate institutional analysis with legal and political perspectives. The current literature often treats coordination failures as administrative or technical problems rather than as symptoms of deeper institutional design issues. This study seeks to fill this gap by applying theories of legal politics and institutional reorganization to examine how institutional relationships shape the effectiveness and legitimacy of disaster governance in Indonesia.

By situating the research within these theoretical frameworks, this chapter not only clarifies conceptual boundaries and synthesizes prior scholarship but also positions the study as a contribution to the development of a more coherent, adaptive, and accountable institutional design for disaster management.

METHOD

This study adopts a normative legal research method to analyze legal theories, principles, and structures while also exploring the dynamics of disaster management regulation in Indonesia. The research is descriptive, aiming to assess the level of synchronization and consistency among laws and regulations related to disaster management, particularly regarding the forms of institutional relationships and coordination mechanisms, and how these factors influence disaster response and management processes. At the same time, it is prescriptive, offering insights and recommendations on ideal institutional arrangements and coordination models that could be considered or implemented in Indonesia.

FINDINGS AND DISCUSSION

Indonesia is highly prone to disasters. According to the World Risk Index (WRI), Indonesia ranks second among countries most at risk of disasters (Frege et al., 2023, p. 6), including natural disasters such as hydrometeorological (such as floods, hurricane, droughts etc. are the most frequent disasters with the highest number of affected victims) and geophysical (such as earthquakes and tsunami that have higher intensity, causing the highest number of casualties) events, as well as volcanic eruptions (Djalante, 2017, p. 447). And social disasters such as social conflict and terrorism, or non-natural disasters such as pandemics. Therefore, the state is responsible for reducing the risks and impacts of these threats to people's lives and livelihoods by systematically and thoroughly organizing disaster management functions.

Disaster management is a conceptual framework encompassing several aspects, namely regulation, planning, institutional arrangements, budgeting, capacity building, and disaster management implementation (Shalih & Nugroho, 2021, p. 127). In Indonesia itself, problems related to regulations and institutions are urgent issues that the author believes should be discussed, especially regarding the forms of institutions used and the mechanisms for coordinating among institutions.

The Legal Reality of The Many Institutions Involved in Disaster Management in Indonesia

Disaster affairs are the business of all parties (multi-stakeholders), as exemplified by the Penta helix approach, which involves the government, academics, the business world, the community, and the media (Shalih & Nugroho, 2021, p. 127). Because of this large number of parties, a command and coordination system is needed, even though it does not guarantee smooth implementation, especially if the paradigm regarding the implementation of disaster management is viewed as a sectoral aspect and fragmented, which, unfortunately, is also one of the main problems in Indonesia's disaster management institutions.

The number of institutions involved in the implementation of disaster management results in complexity and overlapping, which can lead to 3 (three) main impacts: *First*, it creates ambiguity and potential "legal inconsistencies" between the norms and rules of different institutions that can hinder compliance by those who are the object of the regulations; *second*, it blurs the lines of responsibility for actions and outcomes and increase the likelihood of unintended consequences that ultimately make it burdensome to control the governance process and difficult to determine which relevant parties are responsible, and this can undermine the legitimacy of existing arrangements; and *third*, it opens up opportunities for power holders to adjust which institutions they prioritize to administer a particular affair as their strategic priorities, vision and mission, and policy direction change (Haftel & Lenz, 2022, p. 324). If the institution previously designated to administer the matter feels undercut, the effectiveness of governance may be reduced, and the *status quo* of the institution's arrangements may be changed.

One example of a case that shows the weakness of the current institutional system for organizing

disaster management is at the beginning of handling the COVID-19 pandemic, where there was a difference in understanding between BNPB and the Ministry of Health, which, based on Law Number 6 of 2018 on Health Quarantine, became the leading actor in handling the pandemic. There were differences in the data on the development of COVID-19 pandemic cases reported by both parties, because the BNPB considered the Ministry of Health had withheld the data (Wadhana, 2020). This situation ultimately led to inappropriate decision-making and policies. The lack of coordination and synergy between institutions was also prominent again when the Ministry of Health issued a Large-Scale Social Restriction (Pembatasan Sosial Berskala Besar or PSBB) policy whose guidelines were contained in Minister of Health Regulation Number 9 of 2020 on Guidelines for Large-Scale Social Restriction in the Context of Accelerating the Handling of Corona Virus Disease 2019 (COVID-19), where gradual easing was carried out after seeing the impact on people's welfare which continued decline (Faturahman, 2021, pp. 77–78). However, the Ministry of Home Affairs views that the PSBB policy is still too early because, until early 2021, there has been no decrease in the number of cases, so it issued a policy of Enforcing Restrictions on Community Activities (Pemberlakuan Pembatasan Kegiatan Masyarakat or PPKM) to replace PSBB through Home Affairs Ministerial Instruction Number 1 of 2021 on the Enforcement of Restrictions on Activities to Control the Spread of Corona Virus Disease 2019 (COVID-19) (Faturahman, 2021, p. 78).

There are several more situations in which inter-agency coordination during disaster management implementation fails. There is no synergy or integration among the institutions involved, and some even undermine BNPB's role as the leading actor in disaster management. For example, the Social Conflict Resolution Task Force, which is based on Article 98 paragraph (1) Government Regulation Number 2 of 2015 on Implementing Regulations of Law Number 7 of 2012 on Social Conflict Handling, appoints the Coordinating Ministry for Political, Legal, and Security Affairs as the leading actor (coordinator and initiator) meanwhile BNPB only act as the regular member of the task force. Then, the involvement of the Indonesian Red Cross (Palang Merah Indonesia or PMI), which often operates independently with its own facilities and logistical support without coordination, leads to an unbalanced distribution of aid (oversupply or undersupply) (Kusumastuti et al., 2010).

Adding to the list, the Ministry of Social Affairs' idea to concretize the content material on counter-terrorism in the DMR, considering the nature of the act of terrorism, which is part of a social disaster, raises questions about the competence, authority, and limitation of the BNPB in countering terrorism, which already has its specialized agency, the National Counterterrorism Agency (Badan Nasional Penanggulangan Terorism or BNPT), as stated in Article 1 number 1 and 2 of Presidential Regulation Number 46 of 2010 on the National Counterterrorism Agency (Farisa & Meiliana, 2021). Moreover, according to Article 35B paragraph (1) of the Terrorism Law, regarding the handling of victims, they have been handled by the Witness and Victim Protection Agency (Lembaga Perlindungan Saksi dan Korban or LPSK), therefore, if this suggestion is approved, without proper harmonization, the potential for overlapping authority between agencies will be high.

Based on the realities mentioned above, the author argues that institutional reorganization of disaster management is needed to minimize the impact of the large number of institutions involved and, most importantly, to ensure that disaster management is carried out promptly.

Institutional Options for Disaster Management in Indonesia

One factor that can determine the effective implementation of disaster management is the institutional system used. In general, three System models can be used: single-agency, multi-agency, and collaborative crisis governance (CCG). Each system has advantages, disadvantages, and consequences when applied in Indonesia, so it is necessary to understand how these systems work and provide factual examples of their application before deciding whether to use or adopt them.

Single-Agency System

The single-agency system integrates various functions related to a single affair into a specialized agency to provide intensive, high-quality services at low cost (Goiana-da-Silva et al., 2024, p. 2). This system creates a clear "identity" and produces coherent policy and program priorities that can be easily communicated to the agency. Decision-making mechanisms can be carried out relatively quickly because, on the one hand, implementation is faster when coordination is easier, as it tends to be within the same agency (Kovacic & Hyman, n.d., p. 534). A simple example of a single-agency institutional system is shown in Figure 1.

One example of implementing a single-agency system in disaster management is the United States.

Initially, disaster management in the United States involved more than 100 agencies, ranging from federal agencies to the military and private sectors (McNabb & Swenson, 2022, p. 12). Finally, on 1 April 1979, the Federal Emergency Management Agency (FEMA) was formed by combining various federal agencies and their disaster management functions (Pinkowski, n.d., p. 39). Since FEMA's first reorganization in 1992, which elevated its status to cabinet level with direct links to both the President and Congress, and implemented the "*all hazard, all phases*" concept (Roberts, 2006, p. 21). However, since the 9/11 incident in 2001, the institutional paradigm for organizing disaster management in the United States has changed.

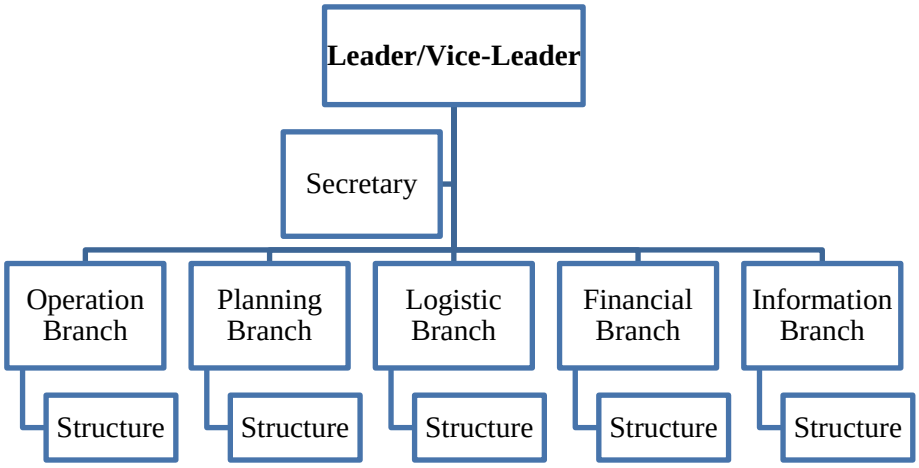


Figure 1. Example of a Single Scheme of Disaster Management Organizing Institution with Single-Agency System

After the 9/11 incident in 2003, the Department of Homeland Security (DHS) was created, combining 22 agencies and more than 180.000 employees, including FEMA (Roberts, 2006, pp. 46–47). However, this reorganization created a new problem for disaster management institutions in the United States: DHS was overly focused on terrorism, neglecting other disaster management (Roberts, 2006, p. 60). In addition, FEMA staff's response to the reorganization, which saw it no longer occupy a cabinet-level position and lose its authority to deal directly with the President and Congress, led to many senior and experienced staff deciding to retire early, taking their resources with them and ultimately hampering the delivery of disaster management, particularly natural disaster responses (Roberts, 2006, p. 60).

FEMA had to bear the most significant institutional consequences after merging with DHS, including competing with 21 other federal agencies for departmental funding and sharing, and even transferring resources to other agencies, ultimately eroding FEMA's role in organizing disaster management (Hall, 2012, p. 39). As a result, when Hurricane Katrina hit the states of Louisiana and Mississippi in 2005, communication between the states and FEMA became stretched and confusing due to additional layers of bureaucracy (Hall, 2012, p. 39). Learning from the response to Hurricane Katrina, DHS restored FEMA's previously degraded authority, including the authority to communicate directly with the President and Congress and manage its resources, but still under DHS (Haddow et al., 2007, p. 24).

What FEMA experienced after merging with DHS illustrates the shortcomings and consequences agencies face in the single-agency system. Although it has many shortcomings, it is effective in mobilizing competent personnel in the emergency response period, and distributing large amounts of relief supplies evenly in a short time is also a success and an advantage in this system because it is under one command, so that control and coordination are more accessible (Miskel, 2006, p. 123). Based on this discussion, the author has conducted a Strengths, Weaknesses, Opportunities, and Threats (SWOT) Analysis as a basis for consideration of whether this system should be adopted or implemented, as shown in Table 1.

Table 1. SWOT Analysis of The Possible Implementation of the Single-Agency System

STRENGHT	WEAKNESS	OPPORTUNITIES	THREATS

1. Budget efficiency; 2. Easier control and coordination; 3. Very low potential overlap; 4. High stability and adaptability; **5.** No confusion regarding who is responsible or the leading actor in handling the situation, resulting in a rapid response.	1. The burden on the institution is enormous because the scope of its functions and authority is vast; 2. There are bound to be one or two functions that receive less attention. 3. Bureaucracy and administration are bloated or multi-layered.	1. A strong legal basis or mandate to carry out its duties and functions; 2. Sufficient authority and capacity to control and oversee matters related to its functions; 3. High-quality resources (including budget and staff/employees).	1. Resistance from institutions; 2. Uneven focus on handling each type of disaster; 3. Higher potential for abuse of authority and criminal acts, like corruption.

Multi-Agency System

Unlike the single-agency system, which centralizes disaster management functions within a single agency, the multi-agency system involves two or more agencies, each focusing on a single function or expertise (Wibawa et al., 2021, p. 6). Thus, various functions in disaster management can be explicitly assigned to institutions based on their capacities, resources, and expertise, thereby enhancing the system's legitimacy and resilience. Especially those related to the transfer of power, because making a decision or policy requires the involvement of many parties (Kovacic & Hyman, n.d., p. 531).

Four schemes are commonly used to describe inter-agency relationships in multi-agency systems: centralization, closure, brokerage, and core/periphery (Nowell et al., 2018, p. 702). The details of the schemes are shown in Figure 2.

A multi-agency system in disaster management organizations exists in China. Their emphasis is on organizing disaster management, namely, a coordination system led by the most experienced institution that has already handled the disaster, for example, for flood disasters coordinated by the Ministry of Water Resources, or for industrial accidents coordinated by the State Administration of Work Safety (Lu & Han, 2019, p. 1429). If the disaster is more complex or caused by two or more agents, the organization will be led by the National Management Office (NEMO) under the State Council (Lu & Han, 2019, p. 1429). Another exciting thing about how the multi-agency is implemented in China is that it is accompanied by the application of the “One Planning Plus Three Systems” concept, namely: *First*, one emergency response plan prepared by the Central Government and coordinating various ministries and departments to make derivative emergency response plans following their respective functions and capacities; *second*, standardizing the governance of emergency management; *third*, create an institutional management system by taking into account elements, namely centralized leadership, integrated coordination, categorized governance, multilevel responsibility and governance at the local level; and *fourt*, a regulatory system or mechanism that includes prevention/mitigation and preparedness, monitoring and warning, response and rescue, rehabilitation and reconstruction, and evaluation phases (Zhe et al., 2016, pp. 3–4).

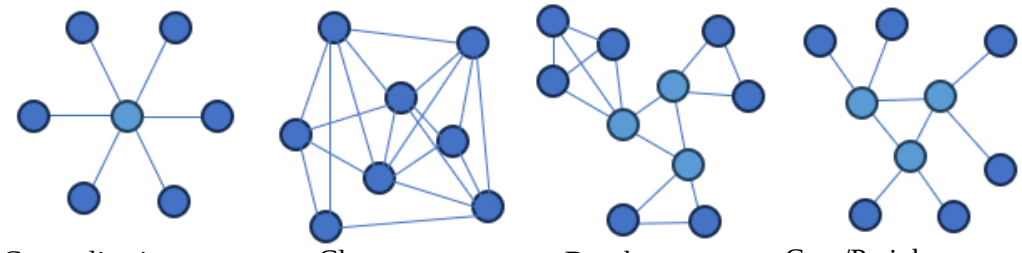


Figure 2. Schematic of Inter-Agency Relationships in a Multi-Agency System

Although the multi-agency system is said to be an ideal system for organizing disaster management, it should be noted that with the many tasks that must be carried out in the governance of disaster management, there is the potential for overlapping policies that can lead to conflicts between institutions due to the sectoral ego of each institution (Kovacic & Hyman, n.d., p. 532). Therefore, the hierarchical relationship and coordination between institutions are important elements for the multi-agency system to run optimally. In addition, because the budget will not be as effective as a single-agency system, each agency developed its own budget system or planning process.

Based on this discussion, the author has conducted a Strengths, Weaknesses, Opportunities, and Threats (SWOT) Analysis as a basis for consideration of whether this system should be adopted or implemented, as shown in Table 2.

Table 2. SWOT Analysis of The Possible Implementation of the Multi-Agency System

STRENGHT	WEAKNESS	OPPORTUNITIES	THREATS
1. Each institution has higher-quality expertise, knowledge, and resources because it focuses on one function, resulting in a more accurate response; 2. greater legitimacy and resistance to charge or transfer of power; **3.** disaster management is carried out holistically.	1. Inefficient budget; 2. greater potential for conflict, overlapping authority, and/or policies between institutions; 3. more difficult coordination and communication; 4. *ad hoc* institutions, resulting in disaster management not being carried out on a sustainable basis.	1. Clarifying the hierarchy, position, duties, functions, and limits of authority between the institutions involved; 2. establishing a clear and focused coordination system and process.	1. The sectoral egos of each large institution; 2. conflict between institutions due to a lack of unity of purpose and understanding between them; 3. competing interest or shifting responsibility.

Collaborative Crisis Governance

Rather than calling it a separate system, Collaborative Crisis Governance (CCG) is more suitable for optimizing the multi-agency system used by a country's disaster management institutions, as CCG almost certainly involves many agencies, so that the multi-agency system and CCG cannot be separated. CCG is the key to starting a multi-agency system.

There are four variables in the CCG concept that can affect the outcome of the collaboration: *first*, starting conditions or initial conditions that can affect the course of the collaboration, namely unequal positions or resources (power/resource imbalance) between the institutions involved, then the contributions made, and the incentives obtained by each (incentive to participate), and the history of conflict and cooperation that has been carried out between institution before; *second*, facilitative

leadership, leadership variables are needed to facilitate all parties in the work area, establish and maintain ground rules, build trust, and mediate when conflict occurs, to explore mutual benefits. This variable is crucial, especially if the initial conditions of each institution are problematic or not ideal; *third*, Institutional Design, which refers to the protocol or legal basis as legitimacy in carrying out collaboration; and *fourth*, collaborative process or collaboration process carried out in a cycle, starting from direct face-to-face dialogue, building trust between each other, building commitment to collaboration, and building understanding and common goals (Ansell & Gash, 2008, pp. 549–4560).

In the collaboration process, if in the process of building understanding, the institutions have different goals or forget their original purpose to collaborate, which ultimately creates potential conflict and hinders collaboration, then the dialogue process, which is the first process described, will be essential to do, and so on until each party in the collaboration can work together and get the desired results. In more detail, the entire CCG concept is shown in Figure 3.

Based on the description above, the author can conclude that the SWOT analysis shown in Table 3 applies.

Table 3. SWOT Analysis of The Possible Implementation of the Multi-Agency System

STRENGHT	WEAKNESS	OPPORTUNITIES	THREATS
1. Optimizing the multi-agency system; 2. synergizing various agencies involved in policy-making or decision-making; 3. facilitating the various interests of the agencies involved; 4. suppressing the egos of each agency involved.	1. The process cannot be carried out briefly and must be continuous; 2. susceptibility to manipulation by parties in higher positions or with greater authority; 3. the level of participation is highly dependent on the benefits that each party can obtain.	1. Building trust, commitment, and understanding among the institutions involved; 2. equalizing positions and breaking down stereotypes that can hinder the collaboration process; 3. inter-institutional dialogue is conducted in good faith and regularly.	1. There is a history of conflict between institutions, making collaboration difficult; 2. each institution has too much ego; 3. When a disaster occurs, collaboration may not work well.

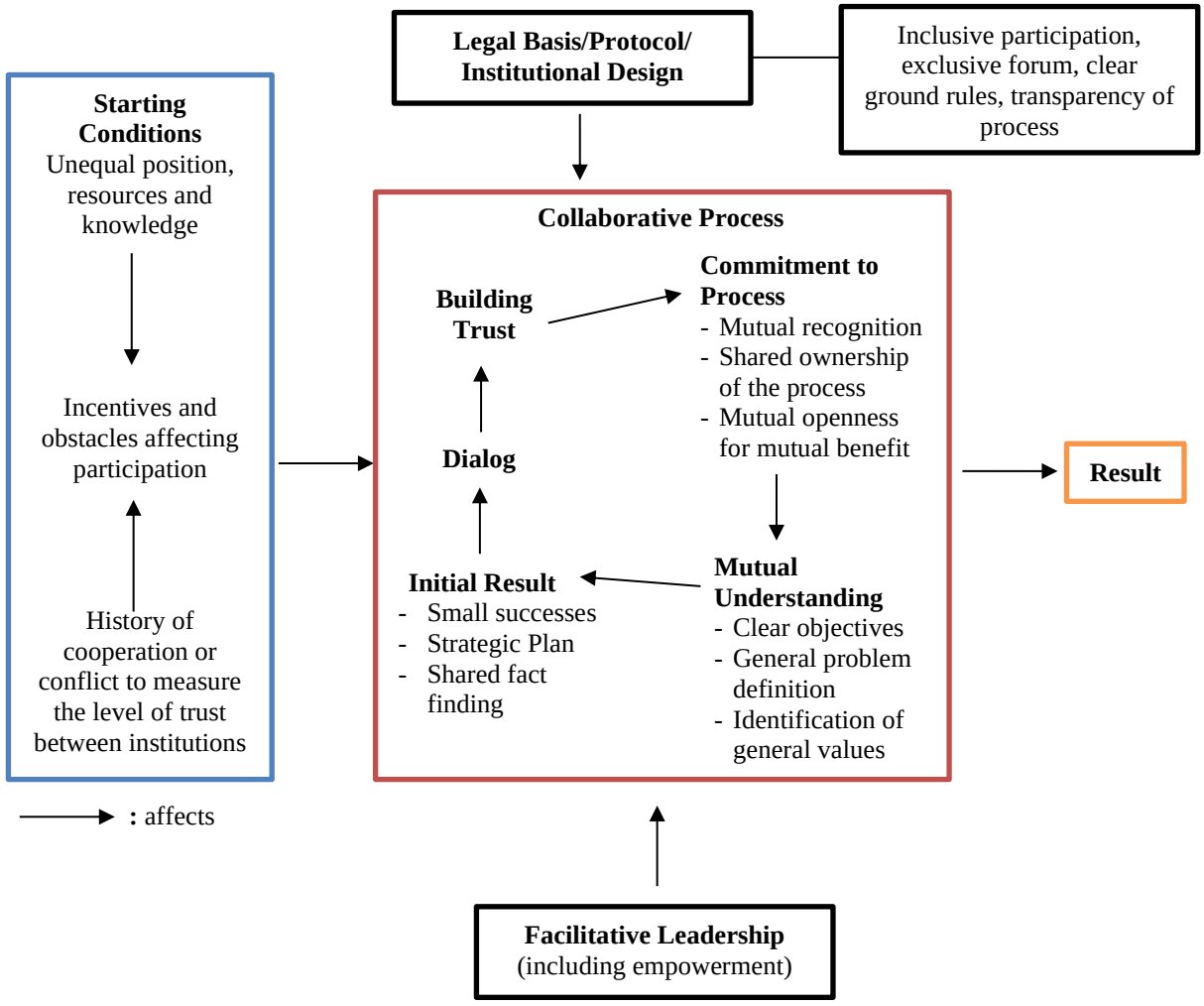


Figure 3. Schematic for Running the Collaborative Crisis Governance System

The Most Feasible Option to Use or Adopt in Indonesia

Before deciding which institutional system is most feasible to adapt in Indonesia, several indicators assessing an institution's adaptability and effectiveness should be considered. *First*, persistence, which means institutional structures are not prone to rapid or continuous change; *second*, purposefulness means having an understanding of the mandate given in accordance with the objectives and principles of the core policy; *third*, information, richness, and sensitivity related to storing and updating information from time to time, including in the distribution of appropriate use of information; *forth*, inclusiveness, referring to access to relevant stakeholders, which is achieved by maintaining public participation in policies ranging from operational management to national policy; and *fifth*, flexibility, that implies clear goals, flexible, and continuous to adapt and learn (Goodin, 1996, pp. 39–43).

Based on those indicators and the options above, also paying attention to the institutional condition in Indonesia as a whole, and specifically related to the implementation of disaster management, the author argues that the government should consider implementing a multi-agency system more firmly, and more specifically, with a mixed scheme between the centralization scheme and the intermediary scheme, and during the governance of disaster management implementation must apply the CCG concept to reduce the sectoral ego of each agency involved (see Figure 4).

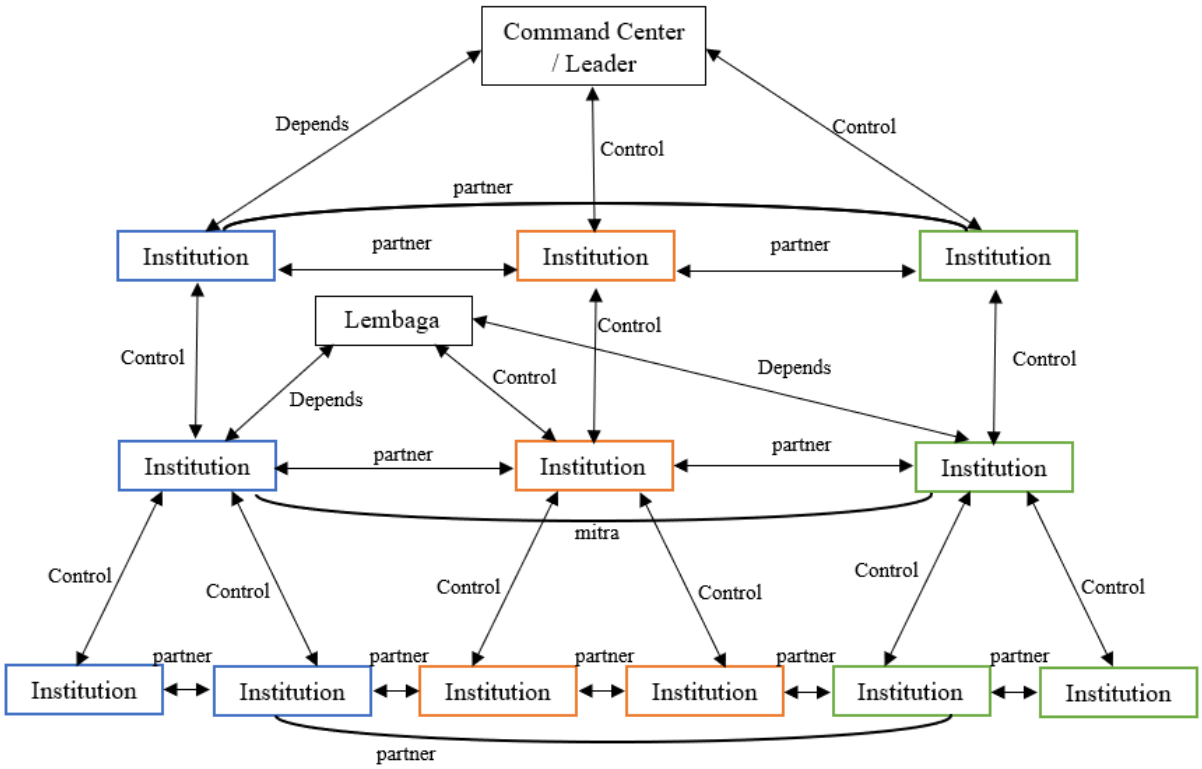


Figure 4. Alternative Scheme for Organizing Disaster Management Institutions with Multi-Agency System and Collaborative Crisis Governance

This option is wiser than forcing the unification of various institutions and disaster management functions scattered across multiple institutions into a single institution, which seems very difficult given strong institutional resistance and the many interests involved.

With that scheme, the government can organize and adjust the position of each institution according to its functions, duties, and desired hierarchy and relationship. Although there is no guarantee that the scheme will perform better than other schemes or the current system, the government must be careful in determining which steps to take to improve Indonesia's disaster management organization's governance and institutional framework, because whatever choice is made has consequences.

The government cannot wait until extraordinary events, disasters, or other emergencies occur to test the systems it has in place to uncover existing shortcomings, then form *ad hoc* institutions or issue policies that negate existing rules on the grounds of emergencies. Although this is most likely inevitable, at least the government can adopt a more adaptive system so that, if faced with a situation never encountered before, it is no longer confused and only needs to make minor adjustments. Disaster management is highly dependent on the speed of response to reduce the more severe impacts. The speed at which handling is provided depends on the institutional system established by the government.

CONCLUSION

The number of institutions involved, both directly and indirectly, in Indonesia's Disaster Management Implementation creates coordination and communication issues between institutions, making it more challenging to carry out, so that overlapping authorities and policies, miscommunication, and miscoordination often occur, as happened during the handling of the COVID-19 pandemic, which ultimately confused the public. Therefore, reorganization is needed to create an institutional system that is adaptive and effective in responding to all types of disasters.

In general, three system options can be considered: single-agency systems, multi-agency systems, and collaborative crisis governance. Of these three options, the most likely to be implemented in Indonesia is a multi-agency system combined with collaborative crisis governance, as the institutional framework for implementing disaster management has already been established and involves many parties. Suppose it is merged, combined, or united into a single extraordinary institution (a single-agency

system). In that case, various new problems will arise, primarily related to the budget for filling employee formations, which are definitely full of conflicts of interest that further hamper the implementation of disaster management.

Because of that, for the institutional system of disaster management organizers in Indonesia to run effectively and adaptively, the Government, both the DPR– in this case, Commission VIII– together with other relevant ministries and institutions, especially BNPB, ministries that are included in the steering committee of BNPB, BNPT, BMKG, Basarnas, PMI, to the TNI and Polri, must carry out dialogues and studies, especially those related to institutional forms, coordination flow, to limit the authority and role of each party to reduce the potential for overlap and sectoral ego.

Not only the Government but the community is also expected to encourage increased effectiveness in the implementation of disaster management and adaption in the face of all types of threats by increasing studies, public discussions, and issuing critical notes related to the current institutional system for organizing disaster management, with the hope of raising awareness about the urgency and importance of this issue throughout the community. If awareness in the community has been built, the issue becomes familiar. Finally, the urgency of changes in the institutional system for organizing disaster management is also increasing. They can increase the pressure on the Government to immediately re-discuss the DRM Bill, which was stopped.

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The Role of MSMEs Galeri Jawet Niang Palangka Raya as An Economic Driver for Rattan Artisan

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ABSTRACT

Galeri Jawet Niang is one of well-known MSMEs based local wisdom in Palangka Raya that has been operated for almost 10 years. It successfully produces all products made from *uwei* or rattan and *jawet* or woven by local Dayak people. This research aims to analyze the role of MSMEs Galeri Jawet Niang in preserving local culture and increasing the income of the local community. This study uses a descriptive qualitative approach with data collection methods through direct observation, semi-structured interviews with the owner and gallery staffs, and also documentation studies. Data analysis was carried out thematically to identify key themes such as the role of MSMEs, challenges, economic impacts, and empowerment strategies. This study finds that (i) the gallery combines the local wisdom of rattan weaving Dayak Ngaju culture with modern designs that follow current market trends, digital design and marketing technology; (ii) the gallery creates jobs for local artisans that can increase their income and also has sent some products to abroad; and (iii) the gallery promotes Dayak Ngaju culture, through its handicraft products and also develops human resources in the field of handicrafts. From the results, this research concludes Galeri Jawet Niang has big roles for preserving local culture and supporting to increase the income of local people. This study contributes to the understanding of how MSMEs based on local wisdom can compete in global market through innovation and effective marketing strategies. These findings can be a reference for other MSMEs actors in developing culture-based businesses as well as for the government in designing supporting policies.

Keywords: Economic Driver, Galeri Jawet Niang, MSMEs, Rattan Artisan, Role

INTRODUCTION

Micro, Small, and Medium Enterprises (MSMEs) play a very significant role in a nation's economy. MSMEs are businesses managed by individuals or small groups that have fewer than 250 employees. In Indonesia, there are around 65.4 million MSMEs that absorb around 56% of the total workforce and contribute more than 60% to the country's Gross Domestic Product (GDP). However, during the pandemic, the contribution of MSMEs to GDP fell to 37.3%. To survive in increasingly fierce competition, especially since the pandemic, as many as 83.8% of MSME actors have switched to digitalization or use technology in running their business activities. In addition, MSMEs have great potential to develop, especially by utilizing natural resources in Indonesia (Firdausya, 2023).

MSMEs are productive businesses owned by individuals and/or individual business entities that meet the criteria for Micro Enterprises as regulated in the Law (Hasri, 2014). Indonesia has vast forests and various types of natural resources that can be used to meet the needs of the humans (Indahsari, 2024). All of this can be used as a creative economy, where people have their own habits in managing nature and the environment. These habits form local wisdom that has an influence on economic and social life for generations. The creative economy has a positive impact on society, such as improving the quality of life and equitable distribution of welfare, as a concrete example is the use of natural resources for handicrafts (Eriawaty, 2024).

Seeing how important this natural potential is, especially in terms of preserving culture and improving the local economy, a number of regions in Indonesia have created a creative economy rooted in local wisdom. One example is rattan processing. The people of Kalimantan also use rattan to produce handicrafts, especially soft rattan weaving. The webbing is used to produce bags, mats, hats, and various other tools that are useful in daily life (Berliani, 2020).

Almost most people in Indonesia are familiar with rattan plants, which are easy to find along the Kalimantan River (Indahsari, 2024). One example is in Palangka Raya, the capital city of Central Kalimantan, where there are a variety of products from small and medium-sized businesses run by local residents, usually using materials of natural origin. For example, rattan crafts that can be processed into fashion items such as bags, shoes, wallets, and belts. This craft not only reflects local wisdom but also has the ability to improve the economy of the people in the area. Therefore, micro, small, and medium enterprises that focus on the creative economy like this can make a great contribution to regional economic growth (Peridawaty, 2020).

In Dayak culture, rattan or *uwei* is not only used for functional needs, but also has symbolic value in social and customary life (Lastaria, 2018). Weaving or *jawet* reflects traditional skills that have been passed down from generation to generation. The weaving process itself is often carried out collectively in the community, so that it contains strong social values and mutual cooperation.

Galeri Jawet Niang which is located on RTA. Milono Street, Kilometers 8, Perum Kereng Indah Permai 2 Number 26, Sabaru, Sabangau District, Palangka Raya City, Central Kalimantan, is an example of a micro, small and medium business in Central Kalimantan that has succeeded in introducing local wisdom through fashion products made of rattan or *uwei*. The term *uwei* comes from Dayak Ngaju language which means rattan. The name *jawet*, which means weaving in Dayak Ngaju language, along with the name Niang, which refers to the owner of the gallery, reflects a skill that has been passed down from generation to generation to her since childhood era. In 2015, Mrs. Niang started a business in the field of weaving from *uwei* raw materials. With a small team committed, Galeri Jawet Niang innovates in creating new designs that follow current trends, making *uwei* one of the hallmarks of Central Kalimantan.

Therefore, through this research, the authors analyze the role of Galeri Jawet Niang in the development of a creative economy based on local wisdom. The focus of this study includes how this business is able to combine elements of culture, creativity, and innovation strategies in increasing the competitiveness of local products, while making a real contribution to the economic empowerment of the surrounding community in the current digital era. This research also highlights how Galeri Jawet Niang is not only a producer of rattan crafts, but also an economic driver for local *uwei* artisans in Palangka Raya. Through the empowerment of the artisan community, training, and the creation of a wider market, the gallery plays a strategic role in supporting the sustainability of the local culture-based economy.

METHODS

Approaches and Types of Research

This study uses a descriptive qualitative approach to analyze and explain in detail the role of MSMEs of Galeri Jawet Niang Palangka Raya as economic driver of *uwei* artisans. This approach was chosen because it aims to describe social phenomena in a systematic, factual, and accurate manner (Sugiyono, 2019). This method allows researchers to capture the meaning, views, and experiences of the subject directly in its social and economic context (Moleong, 2018).

Research Location

This research was carried out directly at Galeri Jawet Niang located on RTA. Milono Street Kilometers 8, Perum Kereng Indah Permai 2 Number 26, Sabaru, Sabangau District, Palangka Raya City, Central Kalimantan.

Data Source

The data sources for this study include primary and secondary data, which were obtained through direct observation of the activities and circumstances of the gallery, telephone interviews with business owner (Mrs. Niang), interaction with two gallery staff, documentation in the form of photos to strengthen the explanation and obtain data from scientific journal articles, MSME profiles, and other supporting documents.

Data Collection Techniques

The data was collected by doing direct observation, visiting the gallery to meet and interview the owner, staff and also take photo of the products in detail. The interviews were conducted with a semi-structured approach to obtain in-depth information about the gallery's background, marketing strategies, interactions with *uwei* artisans, and its role to local economy. The semi-structured interview technique

was chosen because it provides flexibility in digging into in-depth information, and allows researchers to adjust the direction of the questions according to the informant's response (Moleong, 2018).

Data Analysis

Data analysis was carried out with a thematic approach as explained by Rozali (2022), namely through the process of grouping data based on the main themes that emerged repeatedly from the results interviews and observations. Then the existing information will be classified into main themes such as the role of MSMEs, existing challenges, economic impact on artisans, and empowerment strategies implemented.

RESULTS AND DISCUSSION

Based on the interview with the owner of Jawet Niang, the interviewee revealed that Galeri Jawet Niang is a handicraft business pioneered by Mrs. Niang, started in 2015. Starting from a home scale with her husband, now Galeri Jawet Niang has grown rapidly, with artisans from various regions in Central Kalimantan. Complex production processes, from raw material processing to final finishing, require specialized expertise at every stage. The selection of raw materials is a key factor in success, because mistakes in this process can cause problems such as color fading or materials that break easily.



Figure 1. Jawet Niang Gallery


Figure 2. Researchers doing visitation

Despite these challenges, Galeri Jawet Niang has managed to meet the increasing market demand, both from within and outside the country. Superior products such as bags, shoes, suitcases, hats, traditional clothing, accessories, and rattan woven handbags, with prices starting from IDR 150,000, have successfully penetrated the global market. The price of this product varies, depending on the difficulty of manufacturing and the materials used.


Figure 3. Galery Jawet Niang's Bag Products


Figure 4. Galery Jawet Niang's Bag Products

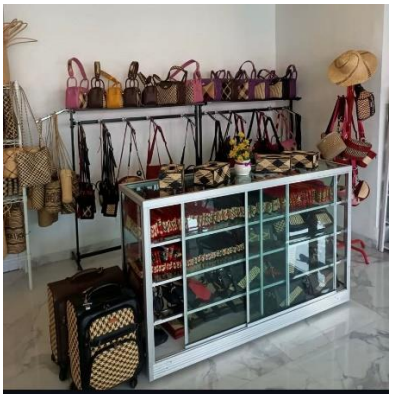


Figure 5. Bags Products

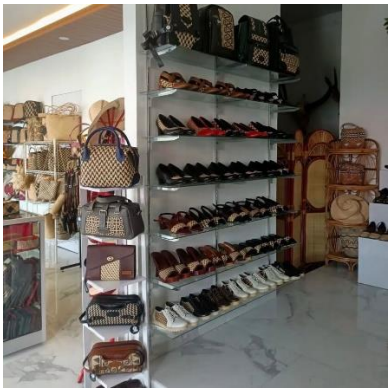


Figure 6. Shoes Products

Here are some roles of Micro, Small, and Medium Enterprises (MSMEs) Galeri Jawet Niang as a driver of the creative economy.

The Role of Galeri Jawet Niang in Advancing Cultural Aspects Related to Technology

Galeri Jawet Niang combines the local wisdom of rattan weaving Dayak Ngaju culture with modern designs that follow current market trends, digital design and marketing technology as well as testimonials of satisfied customers that also strengthen word-of-mouth marketing. This combination of strategies has succeeded in bringing Jawet Niang's products to be widely known. Galeri Jawet Niang not only preserves traditional culture but also adapts it to be relevant to the tastes of modern consumers. The use of social media such as Instagram, Facebook, TikTok, and YouTube for promotion is a concrete example of how technology is used to advance economic and cultural aspects simultaneously. This strategy is always done by Galeri Jawet Niang to reach a wider market, including the younger generation who are more interested in products with a modern touch.

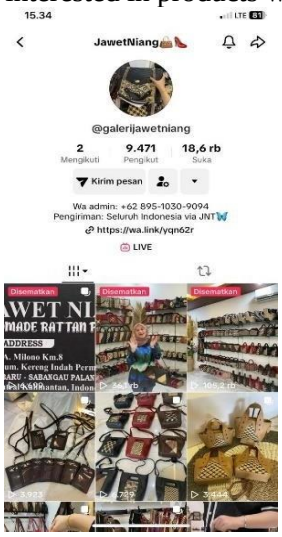


Figure 7. Tik Tok Account

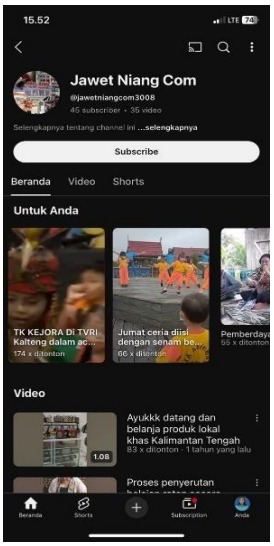


Figure 8. YouTube Account



Figure 9. IG Account



Figure 10. FB Account

The Role of Galeri Jawet Niang in Creating Jobs and Exporting Income

Galeri Jawet Niang has 21 employees and local artisans from various regions in Central Kalimantan. By involving local craftsmen in the production process, the gallery has 19 permanent employees with various specialties. They have different roles, including roles in production such as weaving, marketing and promotion, as well as other support roles. In addition, there are 2 permanent employees who are on duty at the gallery and non-permanent employees who are employed as needed, bringing the total number of employees to 21 people. So, Galeri Jawet Niang has succeeded in creating jobs and increasing the income of the surrounding community. Its products have also been exported to Australia and Malaysia. The success of exports shows that local handicraft products have competitiveness in the global market. Participation in international exhibitions also opens up opportunities to expand marketing networks and increase exports. This proves that the creative economy can be a driver of regional economic growth through increasing export income and job creation.



Figure 11. The employees



Figure 12. The employees



Figure 13. The employees



Figure 14. The employees

The Role of Galeri Jawet Niang in Promoting Cultural Diversity and Human Resource Development

Galeri Jawet Niang introduces rattan weaving or *uwei* crafts as a characteristic of Central Kalimantan. Galeri Jawet Niang plays an active role in promoting Indonesian culture, especially Dayak Ngaju culture, through its handicraft products. Galeri Jawet Niang also provides training to craftsmen. The training provided to the artisans not only improves their skills but also ensures the sustainability of the tradition of rattan weaving from generation to generation. Thus, Galeri Jawet Niang not only develops the creative economy but also preserves cultural heritage and develops human resources in the field of handicrafts.


Figure 15. The employees in training class



Figure 16. The employees in training class

Overall, Galeri Jawet Niang is a successful example of how MSMEs based on local wisdom can play an important role in advancing the creative economy, creating jobs, increasing export income, promoting cultural diversity, and developing human resources. The business model implemented by Galeri Jawet Niang can be an inspiration for other MSMEs in Indonesia to develop culture-based businesses by utilizing technology and effective marketing strategies.

CONCLUSION

Galeri Jawet Niang, as an MSMEs in Palangka Raya, plays a significant role in preserving local culture and increasing the income of the local community. Through innovation and effective marketing strategies, this gallery has successfully developed rattan weaving products that not only preserve the cultural values of Dayak Ngaju people, but also adapt to market trends. Marketing strategies that combine traditional and digital approaches, as well as participation in international exhibitions, have opened up export opportunities to Australia and Malaysia. In addition, the gallery also empowers local employees

and artisans, contributing to the economic improvement of the community. This study demonstrates how MSMEs based on local wisdom can compete in the global market through innovation and effective marketing strategies.

Galeri Jawet Niang has successfully advanced cultural aspects related to technology by combining local rattan weaving wisdom with modern design and digital marketing technology. The gallery also plays a role in creating jobs and increasing export revenues by employing local workers and craftsmen and participating in international exhibitions. In addition, Galeri Jawet Niang promotes cultural diversity and human resource development through training for artisans and the preservation of rattan weaving traditions. The business model implemented by the Jawet Niang Gallery can inspire other MSMEs to develop culture-based businesses by utilizing technology and effective marketing strategies.

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Chitosan As a Bone Graft Biomaterial Enhance Osteogenesis After Tooth Extraction: A Systematic Literature Review

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ABSTRACT

Tooth extraction often results in changes to the dimensions of the alveolar ridge due to resorption, which can affect the stability and comfort of dental prostheses. Socket preservation efforts are crucial to prevent bone resorption and support the regeneration of soft and hard tissues. Chitosan, a biomaterial derived from crustacean exoskeletons, has shown potential as a scaffold and graft material for bone regeneration. With its biocompatible, biodegradable, and antibacterial properties, chitosan supports osteogenesis through its osteoconductive, osteoinductive, and osteogenic capabilities. Additionally, the cationic nature of chitosan allows interaction with bacterial cell membranes, preventing infection and facilitating the transformation of macrophages from pro-inflammatory to anti-inflammatory types. This systematic literature review evaluates the benefits of chitosan in bone regeneration after tooth extraction. The study employed a PRISMA flow diagram to select relevant literature, resulting in 15 studies meeting the inclusion criteria. The findings indicate that chitosan significantly enhances osteoblast activity, accelerates new bone formation, and supports bone healing during the inflammatory, reparative, and remodeling phases without toxicity or risk of disease transmission. Thus, chitosan presents an innovative solution for bone regeneration in clinical dental practice. This study shows that chitosan is an effective natural material to support bone healing after tooth extraction. It helps increase bone cell activity, speeds up new bone growth, and prevents infection. These findings support the use of chitosan as a safe and promising option for improving dental bone regeneration.

Keywords: chitosan, bone regeneration, osteogenesis, scaffold, tooth extraction

INTRODUCTION

Tooth extraction is a dental treatment procedure that can cause significant changes in the dimensions of the alveolar ridge. The tooth socket is made of cortical bone leaving a post-extraction wound where the periodontal ligament is severed. Tooth extraction aims to remove the tooth from the socket without or with opening the soft and hard tissues. Ideally, tooth extraction causes minimal trauma to the supporting tissues of the tooth, but is not accompanied by pain. Post-extraction wounds generally heal well without causing prosthetic problems.[1]

Tooth extraction can cause loss of the alveolar ridge due to resorption. Several studies have shown that, within three months after tooth extraction, two-thirds of the hard and soft tissues will undergo resorption. Most of this bone loss occurs in the first six months after tooth extraction. After that, the average resorption rate increases by 0.5-1% per year. It is estimated that there will be a loss of alveolar bone width of up to 50% within 12 months after tooth extraction. This loss of alveolar bone will affect the stability, retention, and support of dental prostheses, thereby reducing patient comfort. The best time to prepare the alveolar ridge is at the time of tooth extraction, namely by performing a socket preservation procedure. The use of graft material in the tooth extraction socket is expected to slow down the resorption process of the socket walls and regenerate soft and hard tissues.[2,3]

Chitosan is a biomaterial scaffold and bone graft for bone regeneration. Chitosan, produced from exoskeletons, has biocompatible, biodegradable, and antibacterial properties. As a natural material, chitosan is often used to reduce the side effects of synthetic materials. Chitosan has antibacterial properties that support the inflammatory phase of the bone healing process by preventing infection,

accelerating the transformation of macrophages from pro-inflammatory to anti-inflammatory types, which supports osteoblastogenesis.[4]

Chitosan exhibits osteoconductive, osteoinductive, and osteogenic properties, allowing the deposition and mineralization of extracellular matrix to form osteocytes in the ossification process. In addition, the antibacterial ability of chitosan is based on its cationic nature, which allows interaction with bacterial cell membranes, causing disruption of material transfer processes, bacterial lysis, and inhibition of protein synthesis. Chitosan is also used in nanocomposite scaffolds with hydroxyapatite to support bone regeneration in the inflammatory, reparative, and remodeling phases. This article emphasizes the benefits of chitosan as a bone scaffold material that supports regeneration and healing without causing toxicity or risk of disease transmission.[4]

METHODS

Search strategy

A literature search is based on the scientific findings derived from the literature review conducted in 2015 to 2025 using electronic databases (PubMed, Scopus, ScienceDirect, Google Scholar) to obtain some information related to the use of chitosan in the relationship with bone regeneration. This study searched each of the databases using the combination of several keywords including Chitosan AND bone regeneration AND bone graft AND scaffold.

Screening process using PRISMA flowchart diagram

Figure 1 shows the process of writing an article review through the Prisma flow chart. The article screening process was carried out based on journal selection criteria, including publications (original articles or review articles) published within the last 5 years, including free journals, journals that have discussions on increasing osteoblasts in bone graft material, Indonesian language journals and or in English. The article screening strategy is carried out through three stages: looking at the article title, abstract article, and full-text article.

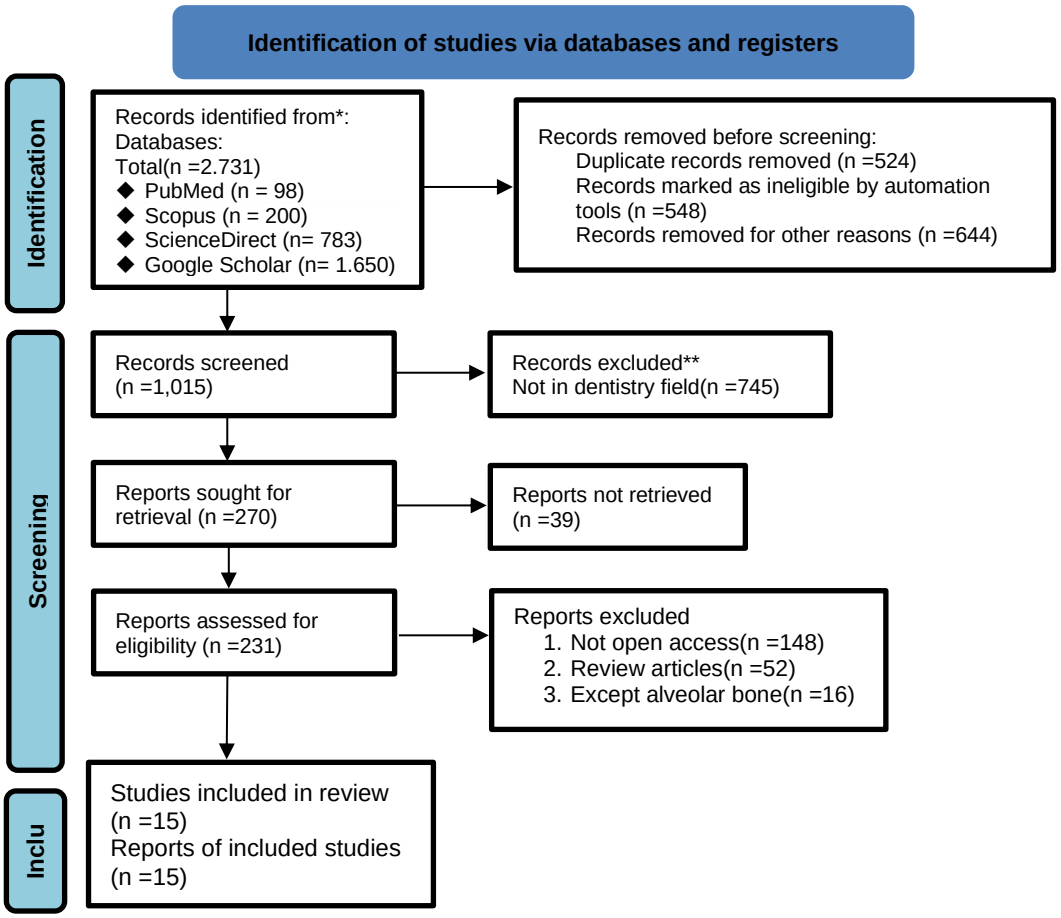


Figure 1. Flow diagram of study identification.

RESULTS AND DISCUSSION

Experimental Studies Discussing the Efficacy of Chitosan in Dental Socket Preservation

Various experimental studies using animal models have investigated the effectiveness of chitosan in preserving dental sockets after tooth extraction (Tabel 1). In these studies, chitosan was applied to extraction sockets in animals such as Wistar rats or guinea pigs (Cavia cobaya) to observe its ability to reduce alveolar bone volume loss and accelerate new bone regeneration. The results showed that chitosan has significant pro-osteogenic properties, stimulating osteoblast proliferation and enhancing faster bone matrix formation compared to untreated controls. Chitosan also plays a role in reducing local inflammation and accelerating wound closure in the dental socket. Studies using chitosan scaffolds combined with biphasic calcium phosphate and additives like trichostatin A in rat models demonstrated improved bone fill and better preservation of alveolar shape. Additionally, chitosan gels derived from various sources, including crab shells and fish scales, proved effective in promoting biological responses in bone tissue of animal dental sockets. Overall, these animal model experimental studies provide strong evidence that chitosan is a promising biomaterial for dental socket preservation and could be further developed for clinical applications in humans.[16-30]

Table 1. Experimental Study Summary

Research Name and Year	Research Title	Research Design	Data Sources and Data Collection Methods	Number of Samples or Informants	Key Findings
Sularsih and Endah Wahjuningsih (2015); [16]	*Expression of BMP-2 after Using Chitosan Gel with Different Molecular Weight on Wound Healing Process of Dental Extraction*	Experimental	Experimental laboratory study using Wistar rats with 3 treatment groups. 1. Use of immunohistochemistry to assess BMP-2 expression. 2. Time-based research (7, 14, 21 days).	21 Wistar rat	High molecular weight chitosan gel is more effective in increasing BMP-2 expression and accelerating bone healing.
Gani A., et al (2022); [17]	*Effectiveness of Chitosan Gel and Hydroxyapatite as Bone Graft on Periodontal Regeneration*	Experimental	Laboratory experiment with 3 groups (negative control, positive control, chitosan and HA combination). Immunohistochemical analysis for IL-1 and BMP-2.	27 Wistar rats	The combination of chitosan and HA increased BMP-2 expression and reduced IL-1 compared to control, supporting regeneration.
Lopes MS., et al (2020); [18]	*Bone Regeneration Driven by Nano-Hydroxyapatite/Chitosan Composite Bioaerogel for Periodontal Regeneration*	Experimental	In vitro evaluation on human dental follicle mesenchymal cells (DFMSCs) and in vivo rat bone defect model. n-depth biological mechanism evaluation via genetic and histological analysis.	12 Wistar rats	Nano-hydroxyapatite/chitosan bioaerogel increased DFMSC proliferation, osteogenic differentiation, and new bone formation significantly.
Dewi RK., et al (2024); [19]	*Potential of Chitosan Black Soldier Flies Pupae on Post-Extraction Wound Healing Process*	Experimental	Histological measurements of macrophages and fibroblasts.	18 Male Cavia cobaya	The application of chitosan BSF pupae accelerates the post-extraction wound healing process in Cavia cobaya by increasing the number of macrophages and also increasing the number of fibroblasts which may be good for accelerate wound healing process.
Maula N., et al (2025); [20]	*The impact of chitosan derived from black soldier fly (Hermetia illucens) pupae on bone remodeling post-tooth extraction: an in vivo study*	Experimental	This study employed a true experimental design. The left mandibular incisor of guinea pigs was extracted. In the control group (n=9), the socket was filled with polyethylene glycol (PEG) gel as a placebo, while in the treatment group (n=9), the socket was filled with BSF pupae chitosan gel.	18 guinea pigs	The application of chitosan BSF pupae gel can increase osteoblast numbers and decrease osteoclast numbers after tooth extraction, potentially accelerating bone formation and offering benefits for future bone regeneration.
Rusdy H., et al (2024); [21]	*Effect of Black Crab (Scylla Serrata) Chitosan Gel on the Three-Dimensional Socket Response and Fibroblasts after*	Experimental	This research is an experimental study with a post-test only with a controlled group design.	30 Wistar rats	Black crab (*Scylla serrata*) chitosan gel is effective in accelerating socket wound closure and stimulating fibroblasts in

	Tooth Extraction in Rattus Norvegicus		Observations were made by measuring the mesial-distal, lingual-buccal, and socket depths using calipers and the UNC15 probe and observing the number of fibroblasts histologically on Days 1, 3, and 7.		socket wounds after tooth extraction.
Hendrijantini N., et al (2019); [22]	*The Effect of a combination of 12% spirulina and 20% chitosan on macrophage, PMN, and lymphocyte cell expressions in post extraction wound*	Experimental	Determine macrophage, PMN and lymphocyte cells of animal models treated with a combination of 12% spirulina and 20% chitosan on the 1st, 2nd and 3rd post-extraction day	42 Cavia cobaya	Combination of 12% spirulina and 20% chitosan decrease PMN cells, also increase macrophage and lymphocyte cells on day 1, 2 and 3 after tooth extraction.
Siti Rochmah, Y. (2018); [23]	*Analisa Gel Kombinasi Platelet Rich Plasma Dan Chitosan Terhadap Peningkatan Jumlah Osteoblas Sebagai Bone Regeneration Pada Luka Pasca Ekstraksi Gigi Tikus Wistar.*	Experimental	Analyze the combination of PRP and Chitosan gel to increase the number of osteoblast in post extraction wound of wistar rat teeth	28 wistar rats	The combination of PRP and chitosan gel had a more optimal and effective effect in increasing the number of osteoblasts in post-extraction socket bone regeneration compared to PRP gel and chitosan gel.
Ragab M., et al (2025); [24]	*Evaluation of the Healing Potential of Silicon Carbide/Bioactive Glass/Carboxymethyl Chitosan Nanocomposites on Extraction Socket in Albino Rats*	Experimental	Healing efficacy of the materials were evaluated histologically, histomorphometricaly and by using real time polymerase chain reaction (qRT-PCR) for quantitative analysis of osteopontin (OPN) gene expression.	36 male Albino rats	SiC/BG/CMC group can have superior results as more mature bone formation with a more regularly arranged osteocytes as compared to other groups
Gharib HS., et al (2023); [25]	*Histological And Immunohistochemical Evaluation Of Chitosan–Nanohydroxyapatite Scaffold On Regenerative Bone Healing In Osteoporotic Rabbits*	Experimental	The effect of CS/nHA was evaluated histologically and immunohistochemically using ALP, OP, and BMP-2 markers.	40 New Zealand white rabbits	CS/nHA scaffolds could be used to augment bone healing and improve the quality of newly formed bone after extraction in patients with osteoporosis required for future surgical procedures such as dental implantation.
Dewi RK., et al (2025); [26]	*Chitosan Black Soldier Fly (Hermetia Illucens) Pupae Improves Osteoblasts and Decreases Osteoclasts Post-Tooth Extraction: In Vivo Studies*	Experimental	Expression of the number of osteoblasts and osteoclasts.	18 Cavia cobaya	BSF chitosan pupae can potentially accelerate bone formation Through increasing the number of osteoblasts and decreasing the number of osteoclasts posttooth extraction which may be good for bone regeneration
Putranto, R., et al (2022); [27]	*Effects Of Clamshell (Amusium Pleuronectes) Chitosan Extract On The Increase Number Of*	Experimental	The increase in the number of osteoblasts was compared and analyzed.	30 Wistar rats	An increasing effect of alveolar bone osteoblasts from chitosan in scallop shell extract (*Amusium Pleuronecte*)

	Osteoblast Of The Alveolar Bone Under Periodontitis				in Wistar rats with periodontitis
Sukpaita T., et al (2023); [28]	*Alveolar ridge preservation in rat tooth extraction model by chitosan-derived epigenetic modulation scaffold*	Experimental	Micro-Computed Tomography (micro-CT), polyfluorochrome labeling, and histological analysis were used to evaluate the ridge-preservation ability	16 male Wistar	Chitosan biphasic calcium phosphate loaded with trichostatin A showed a significantly higher potential to induce bone formation and complete healing in the extraction socket than the other groups
Hendrijantini N., et al (2018); [29]	*The Effect of Combination Spirulina–chitosan on Angiogenesis, Osteoclast, and Osteoblast Cells in Socket Models of Hyperglycemic Rattus norvegicus*	Experimental	The capillary lumen, osteoblasts, and osteoclast cells were counted in tooth socket models of type 1 diabetes.	36 Wistar rats	Significant increment in the number of capillary lumen, osteoblast cells, and a decrease in osteoclasts in all three treated groups
Salim S., et al (2015); [30]	*Effect Spirulina Chitosan Combination as A Socket Preservation to Osteoblast, Osteoclast, and Collagen Density*	Experimental	Histopathology examination on the amount of osteoblast, osteoclast and collagen density.	28 Cavia cobayas	Combination spirulina 12% chitosan 20% can increase the amount of osteoblas and collagen density also reduce the amount of osteoclast on day 14th.

Bone Wound Healing

The wound healing process in bones includes several phases: the inflammatory phase, the reparative phase and the bone remodeling phase. In the reparative phase, bone callus formation occurs due to the differentiation of progenitor cells into chondrocyte and osteoblast cells, vascular growth and deposition of fibrous bone. Pro-inflammatory cytokines and chemokines produced in the reparative phase are Transforming Growth Factor-β (TGFβ1, TGFβ2, TGFβ3), Bone Morphogenic Protein (BMP), Vascular Endothelial Growth Factor (VEGF), Platelet Derived Growth Factor (PDGF), and Fibroblast Growth Factor-2 (FGF-2) which are the main mediators of the reparative and bone remodeling processes. Bone Morphogenic Protein (BMP) is a pro-inflammatory cytokine that has osteoinductive properties so that it stimulates osteoprogenitor cells to proliferate and differentiate to form new bone.[4]

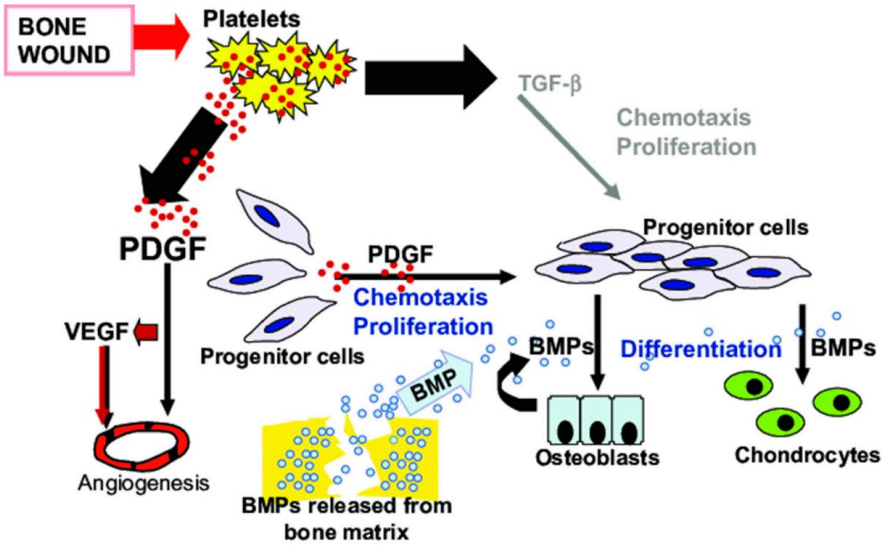


Figure 2. Growth factors expressed in bone wound healing. (PDGF, platelet-derived growth factor; VEGF, Vascular endothelial growth factor; BMPs, bone morphogenetic proteins; TGF-β, Transforming growth factor beta) (Park et al., 2019).[7]

Biomaterials used in socket preservation after tooth extraction will enhance bone growth induced by their osteoconductive activity. New bone formation can differ significantly depending on the osteoconductive material used as graft material in the socket.[5] Bone tissue engineering innovations in socket preservation procedures include biomaterial selection and bone scaffold design. The requirements for making an ideal scaffold include osteoconductive, osteoinductive, osteogenic, biodegradable, good microstructure and proper mechanical properties. Chitosan (poly-β-1,4-glucosamine) is a biomaterial that is still being developed to date, because it has been proven to be non-toxic, has excellent biocompatibility and biodegradability compared to other polymers, so chitosan is very useful in bone regeneration.[5,6] Chitosan has a remarkable effect on bone regeneration and healing. Several studies have shown that spongy chitosan increases osteoblast activity, enhances osteogenesis and helps bone formation.[6]

Chitosan as Scaffold and Graft Material for Bone Regeneration

Chitosan, a natural polymer derived from the exoskeleton of crustaceans such as shrimp and crab, has attracted attention as a multifunctional biomaterial. With its biodegradability, biocompatibility, and antibacterial properties, chitosan has great potential in the field of regenerative medicine, especially in applications as scaffolds and graft materials for bone regeneration.[4]

Chitosan has several unique characteristics that make it ideal as a biomaterial. Its non-toxic, biodegradable nature and low inflammatory response make it safe for use in the human body. The chitosan production process involves partial deacetylation of chitin using chemical or biological methods, which determines its molecular weight and solubility in traditional solvents. In addition, the metabolites resulting from the degradation of chitosan are easily absorbed by the body without any harmful side effects.[5]

The Role of Chitosan in the Bone Healing Process

In cases of bone damage, chitosan acts as a scaffold that supports the regeneration process through osteoconductive, osteoinductive, and osteogenic properties. As a natural material, chitosan can encourage the formation of new osteoblast cells and accelerate the deposition and mineralization of the extracellular matrix until mature osteocytes are formed through the ossification process.[4]

One of the important mechanisms of chitosan is its ability to control the inflammatory phase, the first phase in bone healing. The cationic nature of chitosan allows electrostatic interaction with the bacterial cell membrane, thereby disrupting membrane permeability and causing bacterial lysis. In addition, chitosan can inhibit bacterial protein synthesis by binding to bacterial DNA. This process helps reduce the risk of infection and supports the change of macrophages from the pro-inflammatory type to the anti-inflammatory type, which is important in supporting osteoblastogenesis and accelerating healing.[4,5]

Chitosan is often used in combination with other materials such as hydroxyapatite to form nanocomposite scaffolds. This combination produces a structure that supports adhesion, proliferation, differentiation, and mineralization of osteoblast cells. In its application, this nanocomposite scaffold is able to support all phases of bone regeneration, from inflammation, repair, to remodeling, by improving bone structure and function as a whole.[4]

Regenerative Benefits of Chitosan

As an antibacterial agent and biomaterial scaffold, chitosan not only prevents infection but also accelerates the bone regeneration process through a mechanism that supports the balance between bone resorption by osteoclasts and new bone formation by osteoblasts. Thus, chitosan is a superior alternative compared to traditional graft materials such as autograft or allograft which have higher risks of complications and disease transmission.[4]

CONCLUSION

Chitosan offers an innovative solution for bone regeneration with its multiple regenerative benefits, including antibacterial properties and the ability to support osteoblastogenesis. The combination of its safety in the human body and efficiency in accelerating the bone healing process makes chitosan a superior choice for clinical applications in regenerative medicine.

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THE EFFECT OF FINANCIAL LITERACY AND MATHEMATICAL KNOWLEDGE ON THE INVESTMENT INTEREST OF JAKARTA HIGH SCHOOL STUDENTS MODERATED BY RISK PERCEPTION

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ABSTRACT

This study examines the influence of financial literacy and mathematical knowledge on investment interest among high school students in Jakarta, moderated by risk perception . The sampling method used was probability random sampling. The study involved 489 high school students from Jakarta. To obtain primary data, questionnaires were distributed online to both public and private high schools in five areas of Jakarta. This study used a quantitative approach, and the data obtained were processed. by using the Smart PLS program with a 5% significance level. Empirical evidence shows that financial literacy, mathematical knowledge, and risk perception partially influence the investment interest of Jakarta high school students. Furthermore, it was found that risk perception does not moderate the relationship between financial literacy and investment interest, nor does it moderate the relationship between mathematical knowledge and investment interest. The results show that as financial literacy, mathematical knowledge, and risk perception increase , the investment interest of Jakarta high school students also increases. Conversely, risk perception does not moderate the influence of financial literacy and mathematical knowledge on investment interest of Jakarta high school students. This study provides important insights for the government and schools that by strengthening financial literacy and mathematical knowledge, students' interest in investing increases.

Keywords: Financial literacy, investment interest mathematical understanding, and risk perception

INTRODUCTION

Social media users in Indonesia have reached 185 million people (66.5%) out of a total population of 287 million. Meanwhile, 130 million, or approximately 48 percent of the population, use (Katadata.Co.Id, 2024)gadgets (mobile phones). The most frequently used social media platforms in Indonesia are WhatsApp, Instagram, Facebook, and TikTok. This data demonstrates the widespread use of social media among the public. High school students in Jakarta, as part of this generation, are increasingly familiar with technology and the internet, which indirectly expands their access to various information, including investment. The number of high school students in Jakarta is 194,210, consisting of 92,199 males and 97,391 females (Kemendikbud, 2024). These 194,210 students are spread across both private and public high schools in Jakarta. This number has the potential to become novice investors if they develop an interest in investing during high school and eventually pursue it.

Number of investors and SID (Single Investor Identification) At the end of 2019 increased from 1,619,372 to 2,409,075, or 48.77%. The latest data from the Indonesian Central Securities Depository (KSEI) shows that by the end of December 2024, the number of Indonesian capital market investors reached 14.84 million SID. increased from 12.16 million SIDs at the end of 2023 (KSEI, 2024). Investment growth in Indonesia is increasing annually, as evidenced by the increase in the number of individual investors or single investor identification numbers.

In the context of high school students, understanding investment is becoming increasingly important as technological advances facilitate access to investment platforms. Students are taught financial literacy since high school. Financial literacy is the ability to make informed judgments and take effective actions regarding current and future money management (Purwidianti, 2019). Besides that, mathematical concepts are also important. Mathematics offers a strong analytical framework for understanding financial market behavior, identifying investment risks, and developing effective investment strategies using mathematical tools and strategies such as probability models, statistical analysis, and portfolio optimization, so that investors obtain accurate information in making investment decisions and minimize the risks that occur with unstable economic conditions (Hidayat, 2024). Researchers Gracia (2024) state that learning mathematics helps students in decision-making, especially in financial matters. Mathematical skills are the foundation for sound decision-making, effective problem-solving, and innovation in various sectors, including science, technology, economics, and engineering (Arafu, 2023).

Investment interest is an interest that can be linked to financial behavior, which explains how people treat, manage, and use their financial resources (Suryanto, 2017). This student's interest is also influenced by risk perception. No investment is safe in business practices and there is always risk. is an individual's point of view when estimating potential losses in investing (Azmi, 2022). Research on investment interest is still focused on students who have invested (Sumaiya, 2022), focusing on the millennial generation (Berliana, 2022), (Setyorini, 2020)and (Cuandra, 2020)focusing on the younger generation (Nurmalia, 2021). There has been no research that focuses on high school students even though high school students today are already familiar with investment because the Economics curriculum has introduced financial literacy, digital economics and financial technology.

Research by Sumaiya (2022) shows that financial literacy has a significant influence on students' investment intentions. This research aligns with (Fadli, 2020), (Gultom, 2024), and (Gunawan, 2021). When financial literacy was used as a mediating variable, the same results were obtained: a very positive and significant effect on stock investment intention. (Sembel, 2024). Likewise, financial literacy is positioned as a moderating variable between heuristics and herding behavior. Financial literacy does not weaken, but rather strengthens (Wijaya, 2023). Meanwhile, Mutawaly (2029) said that financial literacy does not affect investment interest. This is supported by(Ady, 2019) (Taufiqoh, 2019) (Wardana, 2023)

When risk perception is used as an independent variable, research Hikmah (2024) indicates that risk perception significantly influences investment interest. This is supported by (Ramadhani, 2024), (Ardiana, 2020)and (Nadhila, 2024). This contrasts with (Ro'fati, 2023)the statement that risk perception does not influence investment interest. Similarly, when risk perception is used as a mediating variable, (Chen, 2022)it is shown that risk perception mediates emotional intelligence and investment decision-making. Based on the explanation above, financial literacy and risk perception still need to be studied with a different target group, namely high school students.

. Research on mathematics in life has been carried out by several researchers, including Telambuana (2021) the conclusion of this study is that by studying mathematics, humans develop the skills to make sound decisions in entrepreneurship. Similarly, (Barus, 2020) mathematical research is applied to economics. Furthermore, (Novita Sari, 2022) the study examines the relationship between mathematics and educational philosophy, both of which essentially seek truth based on reason and rationality. These studies conclude that mathematics can serve as a foundation for critical thinking, linking it to other subjects, including investment.

Many have previously studied the influence of financial literacy on investment interest. Similarly, some have studied risk perception as an independent variable on investment interest, but the use of risk perception as a moderating variable is still limited, and there is no evidence of the influence of mathematics on investment interest. This is the urgency of the study the author proposes, entitled "The Effect of Financial Literacy and Mathematical Knowledge on Investment Interest of High School Students in Jakarta, Moderated by Risk Perception."

Based on the explanation above, the problem is formulated: How does financial literacy influence the investment interests of high school students in Jakarta? How does mathematical knowledge influence investment interest of high school students in Jakarta? How does risk perception influence the investment interest of high school students in Jakarta? How does financial literacy influence the investment interest of Jakarta students moderated by risk perception? How does mathematical

knowledge influence the investment interest of Jakarta high school students moderated by risk perception? Based on the formulated research problems, this research aims to analyzing the influence of financial literacy on investment interest of high school students in Jakarta, analyzing the influence of mathematical knowledge on investment interest of high school students in Jakarta, analyzing the influence of risk perception on investment interest of high school students in Jakarta, analyzing the influence of financial literacy on investment interest of Jakarta students moderated by risk perception, and analyzing the influence of mathematical knowledge on investment interest of Jakarta high school students moderated by risk perception.

THEORETICAL FRAMEWORK

Planned Behavior Theory (TBP)

TPB explains that an individual's decision to adopt a particular behavior can be predicted by the intention to form that behavior (Ajzen, 1991). In his latest journal, AiZen (2020) proposed 3 determinants of intention, namely (1) attitude toward the behavior (2) subjective norm and (3) perceived behavioral control. In TPB, attitude toward behavior is one of the key factors that influence a person's intention to perform an action. This attitude reflects an individual's evaluation of a particular behavior, which can be positive or negative, based on personal beliefs and experiences. Attitudes toward behavior are formed from an individual's beliefs about the consequences of that action. If someone believes that the behavior will produce positive results, then their attitude tends to be positive, and vice versa. Therefore, understanding this attitude is very important in predicting individual intentions and behavior in various contexts, such as health, environment, and social behavior.

Subjective norms in the TPB refer to an individual's perception of the social pressure they feel to perform or not perform a particular behavior. These norms encompass an individual's beliefs about what is considered right or wrong by those around them, such as family, friends, or coworkers. If individuals perceive that those closest to them support a behavior, they are likely to have a stronger intention to perform it. Conversely, if they perceive that social norms oppose the behavior, their intention to perform it may be reduced, even if they personally believe the behavior is beneficial.

Perceived behavioral control in the TPB refers to an individual's belief in their ability to perform a particular behavior. This component encompasses two main aspects: the individual's ability to perform the behavior and external factors that may influence its implementation. If an individual perceives sufficient control over the situation and the resources necessary to perform an action, their intention to perform it tends to be stronger.

Investment and Investment Interest

Before explaining the concept of investment interest, let's first explain the definition of investment. In today's economic era, many Indonesians are managing their income to gain future profits through various means, such as investing, investing capital, and so on. Investing is increasingly popular in today's culture. This is evidenced by the presence of several types of investments, such as savings, gold, land, property rights certificates (stocks and bonds), and so on (Tri Cahya, 2019). According to Boughton (2019), Investment is a crucial instrument needed by a country to improve the welfare of its people. There are two prevailing paradigms regarding investment in society: first, investment is viewed as a desire, and second, investment is viewed as a need. When investment is seen as a desire, this happens when someone has excess money, then the money will be saved as savings rather than used for investment (Turley, 2019). In investing a certain amount of funds at a certain planned time with the hope of generating profits or returns, investors need important information to make the right investment choices (Blankespoor, 2020). From the definition above, it can be concluded that investment is the activity of increasing one's assets by investing them in various instruments. Investment is beneficial for the country because it stimulates the economy, and also for investors because it generates profits.

Investment interest is an affective tendency that encourages someone to undertake investment activities and tends to enjoy the differences that arise from these activities after seeing, observing and comparing them, then considering their needs along with the planned efforts and feelings of pleasure (Hasan, 2022), (Siswanti, 2023). Interest indicates a person's intrinsic desire for something, regardless of external influences. On the other hand, investment involves allocating resources with the expectation of future benefits and profits (Wardani, 2020). According to Darmawan (2022) the statement, a person's knowledge of investing tends to increase their confidence and, therefore, their self-confidence in their

investment choices. From this definition, it can be concluded that investment interest is a strong desire for their money to increase in the future.

Financial Literacy

The results of the 2024 SNLIK (National Survey of Financial Literacy and Inclusion) show that the financial literacy index of the Indonesian population is 65.43 percent, while the financial inclusion index is 75.02 percent. The 2024 SNLIK also measures the level of Islamic financial literacy and inclusion. The results show a financial literacy index of 39.11 percent, while financial inclusion is 12.88 percent (OJK, 2024)**.**The data above shows that the financial literacy index and financial inclusion index are quite high. Why is it necessary to study financial literacy? Many individuals invest, but many fail to achieve profits, this occurs due to their lack of investment knowledge (Sun, 2022). Meanwhile Brigham (2019) states that financial literacy occurs when individuals can utilize existing resources to achieve desired goals. Financial literacy can help provide an understanding of how to manage finances to achieve a prosperous life in the future.

Definition of financial literacy according to Yamori (2022**)** Financial literacy is an important skill: it is associated with higher participation in the stock market. Financial literacy is often defined as the knowledge, skills, and attitudes needed to make effective financial decisions. According to the Organization for Economic Co-operation and Development (OECD), financial literacy is a combination of awareness, knowledge, skills, attitudes, and behaviors needed to make good financial decisions and achieve individual financial well-being (Klapper, 2020). Meanwhile Kumar (2022) defines financial literacy as (1) an individual's knowledge and understanding of financial concepts and (2) their skills and abilities to utilize their financial resources optimally by making appropriate decisions based on that knowledge (3) to improve their long-term financial well-being.

Financial literacy is an individual's ability to understand and use financial information. Students with good financial literacy tend to have a better understanding of investment concepts, such as money management, interest, and risk. Improved financial knowledge can increase students' confidence in investing. Research, Rafli (2025) suggests that financial literacy influences investment interest. This is consistent with research (Grace, 2024), (Isnaini, 2023)**,** (Berliana, 2022)and (Sukarno, 2023)**.**

H1: Financial literacy influences investment interest of high school students in Jakarta

Mathematical Knowledge

Mathematics instruction should be provided to all students, starting from elementary school, to equip them with logical, analytical, systematic, critical, creative, and collaborative thinking skills (Nurfadilah, 2022). Through mathematical understanding, decision-making becomes easier. Mathematical understanding **is** a student's ability to grasp and apply mathematical concepts. A strong grasp of mathematics enables students to analyze financial data and make better investment decisions.

Students who are proficient in mathematics are better able to calculate the potential profits and risks of investments. Researchers, Garcia (2024) have found that learning mathematics helps students make decisions, especially financial ones. Their research found a positive correlation between men's mathematical abilities and their ability to calculate interest. Interest is one indicator in calculating investment returns. Research, Ozkale (2022) suggests that mathematics is a tool for financial literacy.

H2. Mathematical understanding influences investment interest of Jakarta high school students

Risk Perception

Risk perception is a concept that emphasizes an individual's subjective assessment of the characteristics and intensity of risk and is widely used (An S-H, 2016). Risk perception also includes a person's subjective evaluation and assessment of the likelihood and consequences of an event, which influences their attitudes and decision-making tendencies (Ma Z, 2023). In relation to investment, risk perception is an individual's point of view when estimating potential losses in investing (Azmi, 2022) and (Anisah, 2023). In the research by Aini (2019) stated that the risk measurement indicators include the existence of certain risks, high risks, experiencing losses, not guaranteeing that needs will be met, risky investment decisions, and the belief that investing in the capital market is high risk.

Risk perception is **how** individuals understand and evaluate the risks associated with investment decisions. Risk perception can strengthen or weaken the relationship between financial literacy, mathematical understanding, and investment interest. Students with good risk perception will be better able to assess the risks and rewards of investments, thus influencing their investment decisions. If students have a positive risk perception, the relationship between financial literacy and investment

interest will be stronger, and vice versa. If students have a positive risk perception, the relationship between mathematical knowledge and investment interest will be stronger, and vice versa.

Risk perception positively influences investment decisions (Nadhila, 2024).This is in line with the statement (Rafli, 2025). Other researchers, Natahadi (2023) say that indirectly, increasing the level of financial literacy will increase risk perception. and confidence in financial influence, and vice versa. The decline risk perception will encourage millennial investors to herd (follow what the majority does) and increasing risk perception will make investors more cautious in investing

H3. Risk perception influences investment interest of high school students in Jakarta

H4. Financial literacy influences investment interest of Jakarta high school students, moderated by risk perception.

H5. Mathematical knowledge influences investment interest of Jakarta high school students, moderated by risk perception.

Financial Literacy and Mathematical Knowledge

As described above, there has been research on the relationship between financial literacy and investment interest. However, there is no research examining mathematical knowledge and investment interest. The only research that (Sakinah, 2024)addresses the impact of literacy and numeracy on savings activity is numeracy literacy. Numeracy literacy (Husna, 2023)is "the fundamental ability to understand, use, and apply mathematical concepts in everyday life." This concept can be the foundation for making financial decisions. Saving and investing have almost the same goal: increasing the value of assets in the future. Recent research, Lusardi (2023) has incorporated mathematical calculations into measuring financial literacy. This means that a person's understanding of financial literacy is also supported by an understanding of mathematics.

METHOD

This research is quantitative with a survey method to obtain primary data. The purpose of quantitative research is to test the extent to which one or more independent variables influence the dependent variable with the measuring instrument used having been tested for reliability and validity (Karim, 2021). If associated with the objectives, this research is of a verification nature (Muhaimin, 2022). According to the title of the research, it will be known how much influence financial literacy and mathematical knowledge have on the investment interest of Jakarta high school students and how much influence the moderating risk perception has. Through a quantitative approach, researchers can conduct in-depth statistical analysis so that the results can be generalized to the population. The population of this study is Jakarta high school students, both public and private schools. According to *Dapodik* data in 2024, (Kemendikbud, 2024) the number of students was 194,210 people. Because the number is large, a representative sample is needed so that the research results are accurate. The sample is calculated using the Cochran formula (Sugiyono, 2017) (n = (Z^2 * p * q) / e^2) and this formula is suitable for large populations. n = sample, Z = 1.96 (95% confidence level), p = population proportion 0.5, q = 1-p, e = margin of error 5% (0.05). So n = (1.96^2 x 0.5x0.5) / 0.05^2 = 384, rounded up to 385 people. The sample size is 385 people, and this is considered representative of the population with a 5% confidence level. This practice is common in research. The operational definitions of the variables can be seen in the following table.

Table 1: Operational Definitions of Variables

Variables	Dimensions	Indicator	Measurement Scale	Source
Financial literacy	Time value of money & Inflation	1. I understand the concept of time value of money . 2. I understand the concept of inflation ..	Interval scale	(Wijaya, 2023)
	Risk diversification	3. I understand the concept of risk diversification on my investment		
	Risk and return	4. I understand the concept of risk and p return my investment .		

		5. I don't understand the concept of risk and return on my investment.		
Risk Perception	Risk perception and opportunity risk Acceptance and personal gain Long-term growth orientation High income opportunities	1. I associate the word "risk" with the idea of "opportunity" 2. The risk seems more acceptable if I can get the potential personal gain I expect. 3. I want to earn more than my current personal income in the long term. 4. I am looking for a business and job with higher income. 5. I avoid businesses and jobs with higher incomes.	Interval scale	(Nadhila, 2024)

Variables	Dimensions	Indicator	Measurement Scale	Source
Mathematical Knowledge	Critical thinking Benefits and Risks Financial problems	1. With my understanding of mathematic I can think critically. 2. With my understanding of mathematic I can calculate the profit or loss if I invest. 3. With an understanding of mathematics, I understand financial matters, including investments, better. 4. Understanding mathematics does not help me in understanding financial and investment issues.	Interval scale	(Nufadillah, 2022) (Garcia, 2024) (Ozkale, 2022)
Investment interest	Investment Planning Investment Intention Possibility of investment implementation	1. I plan to invest in the future. 2. I want to invest in the future. 3. I may make investments in the future. 4. I probably won't make any investments in the future.	Interval Scale	(Thai, 2017)

The research variables are as follows: The independent variables include financial literacy and mathematical understanding, while the dependent variable is investment interest. In addition, a moderating variable, namely risk perception, is also used. The research data is primary data. Data were obtained directly from respondents through a questionnaire. The questionnaire was compiled based on indicators (Sekaran, 2016). The questionnaire was created in the form of a Google form and distributed to high school students in Jakarta through the Jakarta Economics Teachers' Forum (MGMP Ekonomi). This data collection will support the quality and credibility of the research because the data is primary.

The data was processed using SEM PLS (Structural Equation Modeling) with a Partial Least Squares approach. SEM PLS was chosen for three reasons: First, this study uses multivariate analysis with four variables. Second, these variables do not have to be normally distributed. Third, SEM-PLS

can distinguish between measurement and structural models and account for erro (Henseler, 2015). Another reason is that the study used a moderating effect. (Hair, 2017). Reliability and validity are tested with the outer model, while the determinant coefficient and hypothesis test are tested with the inner model (Wilson, 2019). The analysis stages include: Outer model: Measurement to see validity and reliability and Inner model: Testing the coefficient of determination, path coefficient, hypothesis test, T test, F test and analysis of moderation effects.

FINDINGS AND DISCUSSION

Respondent Demographics

Data for this study was collected through a structured questionnaire. A total of 489 high school students in Jakarta responded to the questionnaire . All students answered the questions completely . If someone answered two options, the first option was used. The following are the demographics of the respondents:

Table 2. Respondent Demographics

No	Information	Differentiator	%
1	Gender	Man	37.42
		Woman	62.58
2	Age	15 years	9.41
		16 years	19.02
		27 years old	36.40
		18 years	32.72
		Over 18 years old	2.45
3	High School Origin	Country	80.98
		Private	19.02
4	Region	Central Jakarta	28.22
		North Jakarta	7.16
		East Jakarta	18.81
		West Jakarta	33.74
		South Jakarta	12.07
5	Class	X	25.77
		XI	30.88
		XII	43.35
6	Monthly pocket money	0-500,000	75.20
		500,000-1,000,000	18.03
		Above 1,000,000	6.76
7	Major	Science	7.98
		Social Studies	25.21
		Subjects (optional)	66.87

Table 3. Descriptive Statistics

Variables	Obs	Mean	Std. Dev	Min	Max
LK1	489	3,742	1,003	1	5
LK2	489	3,865	0.971	1	5
LK3	489	3,562	1,034	1	5
LK4	489	3,489	1,031	1	5
LK5	489	3,088	1,206	1	5
PM1	489	3,804	0.988	1	5
PM2	489	3,965	0.970	1	5
PM3	489	3,847	0.982	1	5
PM4	489	3,278	1,222	1	5
RP1	489	3,650	0.952	1	5

RP2	489	3,746	0.919	1	5
RP3	489	4,227	0.870	1	5
RP4	489	4,194	0.884	1	5
RP5	489	3,292	1,381	1	5
MI1	489	3,202	1,463	1	5
MI2	489	4.127	0.962	1	5
MI3	489	4,176	0.928	1	5
MI4	489	4,061	0.991	1	5

In analyzing the data, this study used a two-step approach to test the measurable variables that describe four variables. The first step The first step involves analyzing the measurement model, while the second step tests the hypothesis of structural relationships among the variable constructs . The purpose of this two-step approach is to assess the reliability and validity of the constructs before they are used in the full model (Demir, 2015). After processing the data with Smart PLS 3.0, the following results were obtained:

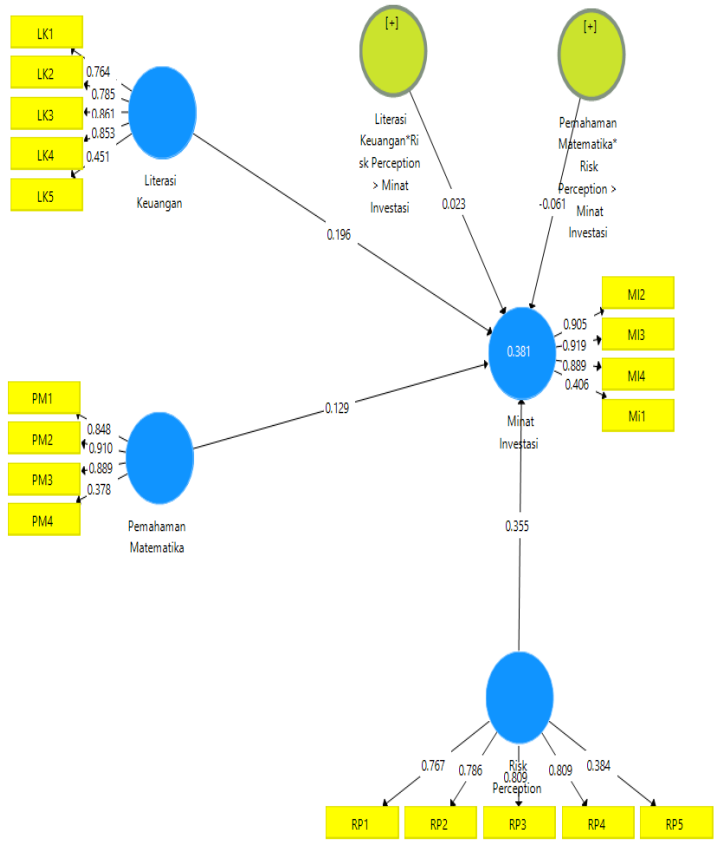


Figure 1. PLS Test Model Results

Reliability and Validity Measurement

Table 4. Loading Factor

Construct	Items	Loadings
Financial Literacy	LK1	0.764
	LK2	0.785
	LK3	0.861
	LK4	0.853
	LK5	0.451
Mathematical Understanding	PM1	0.848
	PM2	0.910
	PM3	0.889
	PM4	0.378
Risk Perception	RP1	0.767
	RP2	0.786
	RP3	0.809
	RP4	0.809
	RP5	0.384
Investment Interest	MI1	0.905
	MI2	0.919
	MI3	0.889
	MI4	0.406

LK: Financial Literacy PM: Mathematical Knowledge RP: Risk Perception MI: Invesment Interest

Figure 1 shows that the loading factors for Lk5, PM4, RP5, and MI4 are below 0.50. Convergent validity, discriminant validity, and reliability are calculated below. Convergent validity is also assessed using the Average Variance Extracted (AVE) value. with minimum limit from 0.50. Based on Table 5, all AVE values > 0.50 so it can be concluded that the measurement has met the convergent validity criteria. and declared ideal.

Table 5. Average Variance Extracted Value (AVE)

Variables	Average Variance Extracted (AVE)
Financial Literacy	0.574
Mathematical Understanding	0.620
Risk Perception	0.532
Investment Interest	0.655

The second validity test was carried out through the t - discriminant validity test. Validity fulfilled If square root coefficient track or Fornell Lacker Ideally, it is greater than the correlation coefficient between the independent variables. Validity of the discriminant said to be good If he owns coefficient mark > 0.70. Based on Table 6, It is known that all Fornell Larcker values are > 0.70. Thus, it can be concluded that discriminant validity is met.

Table 6: Discriminant Validity

	Financial literacy	Mathematical understanding	Risk Perception	Interest investment
Financial Literacy	**0.758**			
Mathematical Understanding	0.575	**0.787**		
Risk Perception	0.586	0.623	**0.730**	
Investment Interest	0.494	0.477	0.576	**0.809**

Questionnaire reliable If meets Construct Reliability and Validity: Cronbach's Alpha and Composite Reliability > 0.70. Reliability testing was conducted to measure the consistency of respondents' answers. Table 7 shows Construct Reliability and Validity: Cronbach's Alpha and Composite Reliability have all coefficients above 0.70. Respondents' answers are said to be consistent and the research questionnaire was declared reliable.

Table 7. Reliability Test

Variables	Cronbach Alpha	Composite Reliability
Financial literacy	0.805	0.866
Mathematical Understanding	0.776	0.857
Risk Perception	0.764	0.844
Investment Interest	0.795	0.876

If we look at Tables 5, 6, and 7, all measuring instruments used to obtain data are valid and reliable, but because the LK5, PM4, RP5, and MI 4 indicators are below 0.50, they must be removed from the research instrument (Ghozali, 2015). After removing the four indicators, the image of the PLS test model results is as follows:

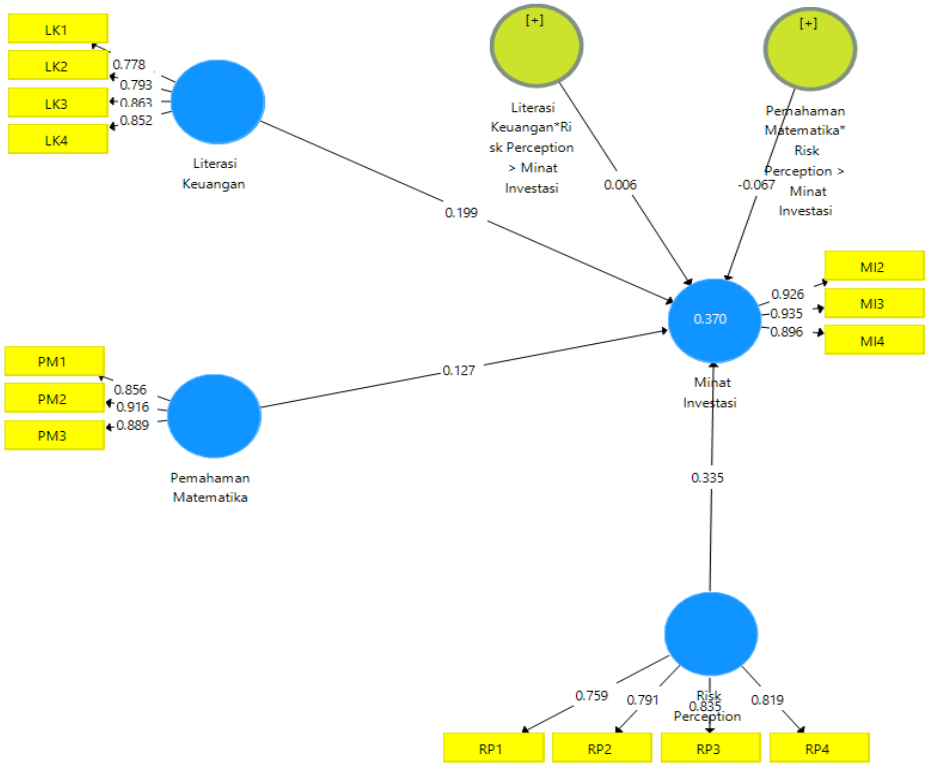


Figure 2: PLS Test Model Results (after elimination)

Next, the Average Variance Extracted (AVE), Discriminant Validity, and Reliability Test will be displayed successively:

Table 8: Average Variance Extracted (AVE)

Variables	Average Variance Extracted (AVE)
Financial Literacy	0.676
Mathematical Understanding	0.787
Risk Perception	0.642
Investment Interest	0.845

Table 9. Discriminant Validity

	Financial literacy	Mathematical understanding	Risk Perception	Interest investment
Financial Literacy	**0.822**			
Mathematical Understanding	0.575	**0.877**		
Risk Perception	0.569	0.616	**0.801**	
Investment Interest	0.484	0.468	0.562	**0.919**

Table 10. Reliability Test

Variables	Cronbach Alpha	Composite Realibility
Financial literacy	0.839	0.893
Mathematical Understanding	0.865	0.917
Risk Perception	0.816	0.878
Investment Interest	0.908	0.942

From Table 8, all AVE figures are above 0.5, which means they are valid. Likewise, from Table 9, all Fornell Larcker values are > 0.70, which means discriminant validity is met. From Table 10, all Construct Reliability and Validity coefficient figures: Cronbach's Alpha and Composite Reliability above 0.70, it is said to be reliable. It can be concluded that the measurement tool in this study is valid and reliable (Ghozali, 2016).

Table 11. R Square and R. Square Adjusted

Investment Interest	R Square	R Square Adjusted
	0.370	0.364

Based on Table 11, the adjusted R2 value of 0.364 or 36.4 % shows that the independent variables together, namely financial literacy, mathematical understanding and risk perception contributes approximately 36.4% of the variation in investment interest while the remaining 63.6 % is contributed by other variables not included in the research model.

Hypothesis Testing

Table 12. Path Coefficient

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (|O/STDEV|)	P Values	Decision
Financial Literacy -> Investment Interest	0.199	0.201	0.048	4,115	**0,000**	**Accepted**
Mathematical Understanding -> Investment Interest	0.127	0.125	0.057	2,232	**0.026**	**Accepted**
Risk Perception -> Investment Interest	0.335	0.335	0.062	5,366	**0,000**	**Accepted**
Financial Literacy*Risk Perception > Investment Interest -> Investment Interest	0.006	0.010	0.046	0.138	**0.890**	**Rejected**
Mathematical Understanding*Risk Perception > Investment Interest -> Investment Interest	-0.067	-0.067	0.044	1,544	**0.123**	**Rejected**

Discussion

The results of the study indicate that three of the five formulated hypotheses were accepted, while two were rejected. Based on Table 12, the hypotheses are explained below:

Hypothesis 1: In Table 12, the coefficient value for financial literacy is 0.199, while the p-value is 0.000 at a significance level of 5%. Because the p-value is less than 0.005 , the research hypothesis is accepted, namely that financial literacy has a positive and significant effect on investment interest. A one percent increase in financial literacy levels will result in an increase of approximately 0.199, or 19.9 %, in investment interest among Jakarta high school students. This means that when Jakarta high school students have information about financial literacy, such as stock prices, high returns , and macroeconomic variables like inflation , they will be interested in investing , and vice versa. The results of this study are in line with(Tri Utari, 2022) (Auliana, 2024) (Gunawan W. K., 2021).(Ratnawati, 2022)

Hypothesis 2: From Table 12, it is known that the coefficient of 0.127 for mathematical knowledge with a p-value of 0.026 at a significance level of 5%. Because the P-value of 0.026 is smaller than 0.05, the research hypothesis is accepted, namely that there is a positive and significant influence on the investment interest of Jakarta high school students. A 1% increase in mathematical knowledge will increase the investment interest of Jakarta high school students by 12.7%. From this, it can be understood that every increase in mathematical knowledge , especially related to finance (interest, net present value, future value) and investment, student interest will increase. This is in line with the statement that certain real-life situations can be used as objects of mathematical learning (Darhim, 2004). Likewise, the statement Nurhaswinda (2025) that in financial management, mathematical logic helps budget planning, investment decision making, and risk management.

Hypothesis 3: Table 12 shows a coefficient of 0.355 for risk perception with a p-value of 0.000 at a significance level of 5%. Since the p-value of 0.000 is less than 0.05, the research hypothesis is accepted, namely that risk perception has a positive and significant effect on investment interest among high school students in Jakarta. A 1% increase in risk perception will increase investment interest among Jakarta students by 35.5%. This research result is in line with (Handini, 2020), (Titin Eka Ardian, 2020),(Yanti, 2024) (Anggraeni C. A., 2024) (Rafli Y. A., 2025),And (Teker, 2023)

Hypothesis 4: In Table 12, the risk perception coefficient is 0.06 and the p-value is 0.890 at a significance level of 5%. The p-value of 0.890 exceeds 0.005, so the research hypothesis is rejected, meaning that risk perception is does not moderate the influence of financial literacy on investment interest . If students are interested in investing due to financial literacy, risk perception does not hinder their interest in investing. The study Nurmala (2021) found that risk perception had no significant effect on interest in investing (stocks), which is consistent with research (Arshad, 2019). Regarding moderation, the study Haryanto (2022) stated that risk perception did not moderate the independent variable and investment decisions. Likewise, it stated that risk perception played no role between financial literacy and investment interest (Nauman sadiq, 2018).

Hypothesis 5: In Table 12, the risk perception coefficient is -0.067 with a p-value of 0.123 at a significance level of 5%. The p-value of 0.123 is greater than 0.05, so the research hypothesis is rejected, meaning that risk perception is does not moderate influence mathematical knowledge on investment interest . If students are attracted to investing because of their understanding of mathematics, risk perception doesn't hinder their interest in investing. A strong understanding of mathematics makes students confident in their decisions and interests, preventing risk perception from influencing them.

So it can be said that financial literacy, mathematical knowledge and risk perception partially influence investment interest of Jakarta high school students and risk perception does not moderate the effect of financial literacy on investment interest and also does not moderate the effect of mathematical knowledge on investment interest. This study further tests the effect of exogenous variables on endogenous variables using f2. According to (Cohen, 1988), the f2 values of 0.02, 0.15, and 0.35 represent small, medium, and large effects, respectively. The effect of financial literacy on investment interest is 0.199 . This means that financial literacy has a moderate effect on investment interest of Jakarta high school students . Similarly, mathematical knowledge has a moderate influence on investment decisions with an influence of 0.122 moderate, risk perception has a large influence on the investment interest of Jakarta high school students, namely 0.355.

Conclusion

Financial literacy influences the investment interest of Jakarta high school students. Mathematical knowledge also influences the investment interest of Jakarta high school students. In addition, risk perception influences the investment interest of high school students in Jakarta. However, risk perception does not moderate the influence of financial literacy on the investment interest of Jakarta high school students, and risk perception also does not moderate the influence of mathematical knowledge on the investment interest of Jakarta high school students.

However, this research has several limitations. First, the result of the R square is 34.4%, while other factors account for 65.6%, meaning that more than 50% of the influence on investment interest comes from variables outside this research. Second, this study only uses a few variables, namely two independent variables, one moderating variable, and one dependent variable, even though there are still many variables that need to be studied. Third, the respondents were homogeneous and came from one youth community, namely high school students; therefore, the results cannot be generalized to other age groups.

The suggestions in this research are aimed at several parties. For educational institutions, it is recommended that financial literacy and the application of mathematics to business concepts be continuously improved so that Jakarta high school students in the coming years will be interested in investing and realize it in real life. For application development companies, entrepreneurs in the app industry can design investment simulation models specifically to help high school students become accustomed to investing. App companies can then create investment applications tailored to high school students. For next researchers, future research could examine the implications of investment interest, including whether students with strong investment interest directly implement it in the real world. Furthermore, research could be expanded to include vocational high schools (SMK) or high schools across Indonesia and incorporate new variables.

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Title: The Title Should be Short, Clear, and Informative, but Does not Exceed 12 Words (Has Not yet Included Conjunctions, Prepositions, and Articles)

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ABSTRACT

This study aims to describe the level of happiness of tourists after participating in yoga activities in Ubud, Bali, which is known as a spiritual and health-based tourist destination. The method used is quantitative descriptive involving 100 respondents aged 18-30 years who were selected using purposive sampling techniques. The data collection instrument used the Oxford Happiness Questionnaire (OHQ), which has a high level of reliability. The results showed that the level of happiness of tourists was in the high category, with an average of 105.36, a median of 106.5, and a mode of 108. The standard deviation of 7.39 indicates a small variation, while the range of happiness values ranged from 84 to 125. The Shapiro-Wilk normality test produced a p-value of 0.307, so the data distribution can be considered normal. Most respondents were female (65%) with an average age of 24.82 years. These findings reinforce the view that yoga contributes significantly to increasing happiness, emotional balance, and reducing stress in tourists. Yoga activities in Ubud not only promote physical health but also support overall mental well-being. Based on the research results, it is recommended that tourism operators expand yoga programs with variations that suit the needs of tourists, improve comfortable supporting facilities, and promote the benefits of yoga more widely to attract more visitors. Further research can explore the long-term impact of yoga and identify additional factors that influence happiness levels.

Keywords: Ubud, Happiness, Tourism, Yoga

INTRODUCTION

The island of Bali is one of Indonesia's leading tourist destinations, globally recognized for its distinctive combination of natural beauty and rich cultural heritage (Wesnawa, 2022). The deep-rooted Hindu traditions and cultural tourism practices have made Bali a unique and meaningful center for spiritual tourism, offering experiences that go beyond recreation to encompass self-discovery, inner balance, and the pursuit of happiness through religious and spiritual practices.

Bali itself has been promoted as a center for wellness tourism, combining natural approaches with scientific knowledge, while still embracing its local wisdom and cultural heritage. In relation to this, one of the most popular wellness destinations in Bali is Ubud. Ubud offers a unique blend of serene natural beauty and well-developed infrastructure that supports wellness tourism, including world-class yoga centers and various forms of alternative healing experiences.

Following the post–Covid-19 recovery phase, Bali's tourism sector has shown a significant resurgence. According to data from the Central Bureau of Statistics (BPS, 2024), the average number of international tourist arrivals to Bali in 2023 exceeded 9,000 visitors per day, reflecting a nearly 120% increase from the previous year. This growth illustrates that Bali remains one of the most desirable global destinations, particularly in the wellness and spiritual tourism segment. The Global Wellness Institute (2023) reported that wellness and spiritual tourism grew at a global rate of 12.8% annually, with Bali ranked among the top five destinations in Asia for yoga and meditation practices.

Previous studies have shown that spiritual activities such as *Tirta Yatra*, *Ratha Yatra*, *Yoga*, *Harinama*, and *Japa* are integral to the spiritual tourism experience practiced by communities such as

The International Society for Krishna Consciousness (ISKCON) (Devi et al., 2020). These activities are believed to provide profound spiritual experiences and enhance psychological well-being. Among them, yoga is the most popular practice among spiritual tourists, particularly in Ubud, which has long been recognized as Bali's center for retreats and healing (Setiawan & Manurung, 2023).

Conceptually, yoga derives from the Sanskrit term *"yuj"*, meaning *to yoke* or *to unite*, referring to the union between human consciousness and a higher, divine, and transcendent awareness (Satri Adnyani, 2019). Empirical evidence has shown that yoga brings multiple physiological and psychological benefits, such as improving concentration, emotional stability, and positive mood through increased brain oxygenation and activation of the parasympathetic nervous system (Sivaramakrishnan et al., 2022; Tang & Liu, 2023). Moreover, a study by Putra and Suryani (2024) in Ubud revealed that 78% of regular yoga participants reported higher levels of happiness and inner calm after attending yoga sessions for at least four consecutive weeks.

Field data obtained from a survey conducted among 120 tourists visiting Ubud between January and November 2024 revealed that 83 respondents (69.2%) visited Ubud to experience both natural and spiritual tourism, particularly through participating in yoga activities. Furthermore, the survey showed that 20 respondents (16.7%) stated that yoga provided them with a sense of inner calm, while 13 respondents (10.8%) found yoga highly engaging because it enhanced their mindfulness and sensitivity toward themselves and their surroundings through silence and introspection. Additionally, 20 participants (16.7%) reported that yoga helped them better understand and manage their emotions, both positive and negative. Interestingly, 30 respondents (25%) mentioned that they had participated in yoga multiple times in Ubud because it effectively helped them recover from fatigue, sleep disturbances, and other psychological difficulties, complementing professional and medical treatments.

From both previous research and preliminary field findings, it can be inferred that yoga plays a significant role in shaping the emotional and psychological well-being of tourists engaging in spiritual tourism in Ubud. However, limited empirical studies have quantitatively examined the level of happiness experienced by tourists after participating in yoga activities in this region. Therefore, this study aims to measure and analyze the level of happiness among tourists following yoga activities in Ubud, Bali, and to explore the psychological factors that may influence this experience.

METHODS

This study employed a quantitative descriptive design. The primary objective of this research was to examine and describe the level of happiness among tourists after participating in yoga activities in Ubud, Bali. A total of 100 participants were involved in this study. Participants were selected using a purposive sampling technique, with inclusion criteria comprising individuals aged 18 to 30 years, who were domestic tourists and had participated in yoga sessions in Ubud.

The reason for selecting participants aged between 18 and 30 years is that individuals within this age range are generally considered capable of traveling independently. Moreover, this age group represents the productive stage of life, during which people tend to engage in various demanding activities that may lead to negative residual effects, such as fatigue, stress, exhaustion, and other negative emotions. In addition, individuals aged 18 to 30 are typically in good physical condition, making them well-suited to participate in different types of physical activities, including yoga.

The data collection instrument used to measure the tourists' level of happiness after participating in yoga activities was the Oxford Happiness Questionnaire (OHQ). Responses were rated using a Likert Scale. The OHQ, originally developed in English, consists of 29 items, including 17 favorable and 12 unfavorable statements. The scale has demonstrated a high level of reliability, with a Cronbach's Alpha coefficient of 0.91. A reliability test conducted on 100 participants in this study produced a coefficient value of 0.874, indicating that the instrument was reliable and valid for measuring the happiness variable (Devi et al., 2020). The collected data were analyzed using frequency analysis with the assistance of JASP software.

RESULTS AND DISCUSSION

Table 1. Happiness Level

	Low	Moderate	High
Valid	2	75	23
Missing	0	0	0
Mean	86.00	106.5	127.9
Std. Deviation	0.000	7.393	9.737
Minimum	86.00	88.00	117.0
Maximum	86.00	116.0	148.0

The result from this research indicate that respondents exhibit a moderate or satisfactory level of happiness, suggesting that they tend to experience a balanced proportion of positive and negative emotions in daily life.The predominance of the moderate happiness category implies that the participants still has potential for improvement in subjective well-being, possibly through practices that foster self-awareness, relaxation, and emotional regulation, such as yoga, which is the central activity of this research.

Yoga enhances happiness because it integrates the body, mind, and emotions. Physiologically, it reduces stress by lowering cortisol and increasing calming neurotransmitters like GABA, which promotes relaxation (Streeter et al., 2018). Psychologically, yoga cultivates mindfulness helping individuals stay present, regulate emotions, and accept themselves without judgment. Research by Gaiswinkler & Unterrainer (2021) also shows that regular yoga practice increases well-being and reduces anxiety and depression. In essence, yoga supports happiness by promoting relaxation, emotional balance, self-awareness, and a sense of inner peace and connection.

Table 2. Cross-Tabulation Between Happiness Level and Age Groups

	Happiness level catagories			
Age groups	**Low**	**Moderate**	**High**	**Total**
Young Adults	1	44	18	63
Late Adolescents	1	29	4	34
Early Adolescents	0	2	1	3
Total	2	75	23	100

The data indicate that happiness levels vary across age groups, showing a developmental pattern consistent with psychological theories of emotional maturation. Young adults (ages 20–40) demonstrate higher levels of happiness, with the majority reporting moderate to high well-being. This pattern reflects greater emotional regulation and life satisfaction typically associated with adulthood, when individuals have developed more stable self-concepts and coping mechanisms. Late adolescents (ages 17–19) predominantly report moderate happiness, suggesting an ongoing process of identity exploration and emotional adjustment. Meanwhile, early adolescents (ages 13–16) show the lowest representation and slightly lower happiness, which aligns with the transitional instability of early developmental stages.

From a psychological perspective, this trend supports the notion that subjective well-being increases with age as individuals gain autonomy, establish social roles, and integrate emotional experiences more effectively (Diener et al., 2018; Orben et al., 2022). According to Erikson's psychosocial theory, young adults are typically in the stage of *intimacy vs. isolation*, where successful relationship formation enhances life satisfaction and happiness (Erikson, 1968). In contrast, adolescents—particularly early adolescents—are in the *identity vs. role confusion* stage, characterized by emotional fluctuation and self-exploration, which may explain lower happiness levels. These findings are also in line with recent empirical studies showing that emotional regulation and subjective well-being improve with age, largely due to neurological and psychosocial maturation (Blanchflower, 2021; Charles & Luong, 2022).

Tabel 3. Cross-tabulation between happiness level and gender

Gender	Happiness level catagories			
	Low	Moderate	High	Total
Male	1	23	11	35
Female	1	52	12	65
Total	2	75	23	100

Consistent with previous research (Zheng et al., 2022; Stevenson & Wolfers, 2019), the data reveal that female participants tend to exhibit higher levels of happiness and subjective well-being compared to males, although they are also more sensitive to emotional stress. In this dataset, women predominantly occupy the moderate happiness category. This finding can be interpreted through the lens of *Social Role Theory* (Eagly, 2019), which suggests that gender differences in well-being are shaped by social and cultural expectations. Women are often encouraged to express empathy, maintain emotional openness, and prioritize interpersonal harmony—factors that serve as protective mechanisms for their psychological well-being.

Moreover, while women appear to experience relatively higher subjective well-being, balancing social roles, occupational demands, and personal responsibilities remains a significant challenge. Empirical studies emphasize that social support and a positive emotional environment function as moderating factors that enhance well-being (Lyubomirsky & Layous, 2022).

From all the findings, it can be concluded that participation in yoga-based wellness tourism activities contributes positively to the psychological well-being and overall happiness of tourists visiting Ubud. These activities not only provide relaxation and stress reduction but also enhance self-awareness, emotional balance, and a sense of inner peace, which are essential components of sustained happiness.

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Innovation in Early Childhood Education Assessment: Gamification as a Contemporary Literacy-Based Evaluation Tool

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ABSTRACT

Early Childhood Education (PAUD) requires innovative assessment approaches to holistically and interactively evaluate children's development. This article explores gamification as a contemporary literacy-based assessment tool in PAUD through a literature review. Research findings indicate that gamification, incorporating elements such as badges, leaderboards, and story-based challenges, enhances children's intrinsic motivation, literacy skills, and provides dynamic feedback for teachers. The implementation of gamification in game-based learning has proven effective in stimulating critical thinking, language mastery, and peer collaboration. However, challenges such as insufficient teacher training and limited access to technology remain barriers. This study recommends integrating gamification into the PAUD curriculum through adaptive approaches, teacher training, and developmentally appropriate content. The findings highlight gamification's transformative potential in creating an engaging and meaningful learning environment. With policy support and stakeholder collaboration, gamification can serve as an innovative solution to improve the quality of assessment and learning in PAUD.

Keywords: Assessment, Early Childhood Education, Gamification

INTRODUCTION

Early Childhood Education (PAUD) is a critical foundation for children's cognitive, social, emotional, and language development (NAEYC, 2020). Stimulation through various activities and play needs to be designed so that learning in PAUD becomes enjoyable and meaningful in achieving optimal child growth and development. Play is one way children work and learn. Through play, many of a child's potentials can be actualized and enhanced. Traditional assessment in PAUD often relies on conventional methods like observation and paper-based assessments, which are considered less interactive and less capable of capturing children's holistic development (Pyle & DeLuca, 2013). In this digital era, innovative approaches are needed that not only evaluate learning but also motivate children through enjoyable and meaningful experiences.

Gamification has become a trending topic in various fields, including education. Gamification can be adopted in various contexts and for various purposes. It can be used to promote fundamental aspects of learning and increase student engagement in learning. The appeal of gamification lies in its potential to strengthen bonds, change behavior, and support innovation. The impact of gamification on learning has empirical evidence, finding that gamification has a positive effect on learning outcomes and student engagement. Research results state that gamification has the potential to enhance student motivation, participation, and social influence (Mei & Surat, 2021). The implementation of gamification in education has also proven effective in increasing students' interest in learning and providing challenges in improving the quality of learning materials (Permata & Kristanto, 2020). The goal of gamification is to engage and motivate students in learning by incorporating game elements as its characteristic.

Gamification, or the application of game elements in non-game contexts, emerges as a potential solution to enhance engagement and the effectiveness of assessment in PAUD (Deterding et al., 2011). Research shows that gamification can increase children's intrinsic motivation, strengthen literacy skills, and provide more dynamic feedback (Hamari et al., 2016). For example, Annuar et al. (2024) found that

game-based learning encourages critical and strategic thinking in early childhood, while Nurhayati et al. (2022) proved that interactive digital games significantly improve language mastery.

Assessment is an activity to collect information on the results of activities obtained from various types of assessed activities and processed into information as student development outcomes. Information collection uses tests, which consist of a set of planned questions or tasks in the form of items that have answers. In its development, assessment and technology are two very important components in education (Pitoyo, Sumardi, & Asib, 2020). Technology as an assessment tool helps achieve learning objectives more easily. Teachers can utilize the integration of technology and assessment to obtain accurate and comprehensive information about children's learning progress and development, which can then be used to create good teaching processes in the future. Therefore, gamification-based assessment is needed in education. Gamification in assessment involves designing assessment instrument development methods that have game elements. Its design links game elements, game mechanics, and game dynamics into one constituent. These three are the core of gamification-based assessment that meets the criteria. One example of a gamification design for assessment was developed by Werbach and Hunter in Pitoyo, Sumardi, & Asib (2020). It is explained that to design gamification-based assessment, there are three steps. The first process is selecting the dynamics of the test, and the second process is selecting the appropriate mechanics, considering that the dynamics and mechanics of the test must match. Lastly, selecting components that fit the mechanics.

Literacy, as a basic competency, requires adaptive and comprehensive assessment approaches. Gamification offers a new way to assess literacy development through mechanisms like badges, leaderboards, and story-based challenges that are appropriate for the child's developmental stage (Behnamnia et al., 2022). However, its implementation in PAUD still faces challenges, such as a lack of teacher training and limited access to technology (Alotaibi, 2024).

Therefore, this research aims to explore the role of gamification as a contemporary literacy assessment tool in PAUD through a literature review. By analyzing relevant empirical findings and theoretical frameworks, this study is expected to provide recommendations for educators and policymakers in effectively integrating gamification into the PAUD curriculum.

THEORETICAL FRAMEWORK

Early Childhood Education (PAUD) plays a crucial role in laying the foundation for a child's development, including literacy development. Assessment in ECE has unique characteristics; it must be holistic, authentic, and continuous, and should not create pressure on the child. However, conventional assessment practices are often considered boring and fail to accurately reflect children's actual abilities. In the digital era, the demand to integrate new literacies (digital, data, and technological) is increasingly urgent. Therefore, this study explores assessment innovation through a gamification approach linked to contemporary literacy as an effective, engaging, and relevant solution for ECE.

a. ECE (PAUD) Assessment

Assessment in ECE should not be equated with formal testing at higher educational levels. According to Wortham (2014), the appropriate assessment for young children is authentic assessment conducted through observation, portfolios, and anecdotal records within the context of play and daily activities. This aligns with the perspective of the Indonesian Ministry of Education and Culture Regulation No. 137 of 2014, which emphasizes the principle of continuous assessment to understand children's development and progress. The concept of "assessment as learning" proposed by Earl (2012) is also relevant, where assessment becomes an integral part of the learning process itself. In this context, children do not feel like they are being assessed but are engaged in an activity that encourages self-reflection. Gamification, with its enjoyable nature, has great potential to realize these principles of authentic assessment.

b. The Theory and Concept of Gamification in Education

Gamification is defined as the application of game elements and game design in non-game contexts (Deterding et al., 2011). Key elements of gamification include: points, badges, leaderboards, challenges, and immediate feedback. In education, gamification has been proven to increase students' intrinsic motivation and engagement (Sailer & Homner, 2020). The Self-Determination Theory (SDT) by Deci & Ryan (2000) provides a strong foundation for why gamification is effective, as it fulfills three basic psychological needs: competence (the feeling of capability when overcoming challenges), autonomy (freedom of choice), and relatedness (interacting and competing healthily). For ECE children, the

application of gamification must be adapted, for instance, by reducing excessive competitive elements and placing greater emphasis on personal achievement and exploration.

c. Literacy Development in ECE and Contemporary Literacy

Literacy in ECE is not limited to early reading and writing (emergent literacy). UNESCO (2004) defines literacy as the ability to identify, understand, interpret, create, and communicate something within a changing context. This concept has expanded into contemporary literacy, which includes digital literacy, data literacy, financial literacy, and critical literacy. Research by Neumann & Neumann (2014) shows that the early introduction of digital literacy, through interaction with appropriate technology, can support children's cognitive and social development. Assessment based on contemporary literacy aims to evaluate not only knowledge of letters and numbers but also children's abilities in problem-solving, critical thinking, and using symbols (including digital icons) in meaningful contexts.

d. The Convergence of Gamification and Literacy Assessment in ECE

The intersection between gamification and literacy assessment lies in their ability to create an authentic and contextual evaluation environment. Some application examples are:

1) Interactive Quizzes with Stories: Applications like Quizizz or Kahoot!, modified with bright visuals and simple stories, can be used to assess story comprehension (language literacy) and the ability to follow instructions (digital literacy).
2) Literacy Mission Games: Children are given a "mission" to sort images based on color, shape, or category (assessment of data literacy and categorization). Mission accomplishments are rewarded with digital badges or stickers.
3) Real-World Simulations: Simple simulation games like "shopping at the market" can assess financial literacy (the concept of exchange) and social literacy.

A study by Nicolson & Gray (2019) found that children involved in gamified assessments showed higher levels of persistence in completing complex literacy tasks compared to the group using worksheets. Gamification successfully transformed the perception of assessment from something intimidating into an enjoyable adventure.

e. Challenges and Implementation Considerations

Although promising, the integration of gamification as an assessment tool in ECE is not without challenges. Plowman & McPake (2013) remind us of the importance of adult guidance (teacher/parent) while children interact with technology to ensure the experience is educationally meaningful. Furthermore, unequal access to technological devices and internet connectivity is a practical obstacle (Zaranis et al., 2013). Another primary consideration is the user interface design (UI/UX), which must be suited to ECE children's development—simple, intuitive, minimal in text, and rich in visual and audio cues. Gamified assessment must also adhere to the basic principle of ECE, which is learning through play, and must not displace direct social interaction, which remains vital for child development.

Based on the literature review, it can be concluded that gamification offers a new paradigm in ECE assessment that aligns with the demands of contemporary literacy. This approach not only makes the evaluation process more engaging and less threatening for children but is also capable of authentically assessing complex 21st-century skills. Further research is needed to develop specific, measurable, and easily adoptable gamified assessment models and instruments for ECE teachers with diverse technological backgrounds. This innovation is expected to strengthen children's literacy foundation from an early age while simultaneously preparing them for an increasingly digital world.Provide a structured overview of previous studies and theoretical concepts relevant to your topic. Consider defining key terms and concepts, identifying and evaluating existing studies, highlighting any gaps or tensions in the literature, and concluding this part by positioning your chapter in relation to these gaps.

METHOD

This research uses the literature review method by applying the following steps: collecting reading materials, taking notes, and processing the reading results (Melfianora, 2017). The data required for the research were obtained from literary sources or documents. Library research, literature search is not only the initial step in preparing the research design but also utilizes library sources to obtain research data (Zed, 2014). The data sources used come from secondary data collected in the form of scientific works, both published and unpublished (Embun, 2012), textbooks, scientific journals, periodicals, websites, and other sources relevant to the research problem. The collected data were then analyzed descriptively and qualitatively.

FINDINGS AND DISCUSSION

Several research findings reveal that gamification in learning for early childhood has proven effective to implement. Gamification has a positive impact on the learning process and is effective in teaching science material. Children become more confident to participate in the learning process, while collaboration among peers increases, creating a suitable foundation for the implementation of collaborative learning. Furthermore, the feedback provided can offer immediate information for teachers regarding the child's level of understanding (Xezonaki, 2022).

The use of Serious Games, leveraging their specific advantages (entertainment, enjoyment, and interactivity) both in formal and informal curricula, shows promising results (Lamrani et al., 2020). Gamification features can become an engaging problem-based learning approach for children by using familiar and easily understood symbols (Syafi‟udin et al, 2019). Various game materials can be used to guide children to independently explore within a gamified environment, while also stimulating children's creative thinking. Through themed game activities, children can be guided to choose game methods for independently learning thematic knowledge, encouraging individual child development, and enhancing their overall abilities (Tao Zhang, 2022).

Assessment is an important component in analyzing children's learning and play processes because through assessment, educators and parents can obtain information about children's developmental achievements after undergoing learning and play activities. PAUD assessment should not focus solely on the results achieved by the child, causing educators to pay less attention to how the child learns or what the child needs in relation to their environmental context. Evaluating PAUD programs is certainly not a simple matter, as many factors need to be considered, and it requires seriousness in collecting facts, understanding the developments and indicators arising from children's play behavior, careful observation without mixing it with assumptions, and objective management of facts so that they become data that describes who and how the child truly is (Handayani, 2021).

In the context of modern early childhood education (PAUD), innovation in assessment methodologies is crucial, especially with the integration of gamification strategies to enhance literacy development. Gamification, when applied in educational settings, transforms traditional assessment into an interactive and engaging experience, which can foster various cognitive and social skills in early learners. This paper synthesizes recent literature on the use of gamification as a literacy assessment tool in PAUD, while highlighting its implications for cognitive development and pedagogical practices.

Gamification in PAUD has shown great potential in enhancing cognitive abilities and language skills. Annuar et al. emphasize that game-based learning (GBL) encourages children's critical and strategic thinking, as they must make mature decisions while navigating game scenarios, which can enhance cognitive development (Annuar et al., 2024). Furthermore, Alotaibi highlights the need for educators to adapt to game-based learning strategies, considering that traditional assessment methods may be less capable of capturing the multidimensional competencies developed through such interactive platforms (Alotaibi, 2024). This challenge underscores the role of gamification not only in actively engaging children but also in providing a holistic picture of their learning progress.

Additionally, research shows that educational games can specifically target language development in early childhood. Nurhayati et al. proved that digital educational games can stimulate language skills through rich interactive media, going beyond mere memorization (Nurhayati et al., 2022). Similarly, Rahnang et al. provide insights into how traditional games used in educational contexts can enhance language skills along with children's motor-physical development, thereby encouraging the achievement of various developmental aspects (Rahnang et al., 2023). This is closely related to the educational philosophy that places play as the foundation of effective pedagogy in PAUD.

The methodological framework for assessing children's learning through gamification is essential to ensure the effective achievement of learning objectives. The findings of Hidayat et al. show that various educational game tools can be used not only to stimulate interest and enthusiasm in PAUD but also to create pathways for assessing science learning outcomes (Hidayat et al., 2023). This is reinforced by the research of Maulida et al., which demonstrates the effectiveness of the gamification approach in teaching disaster preparedness, with an increase in children's understanding of complex concepts (Maulida et al., 2023). These examples affirm the potential of gamification to transcend traditional barriers in assessment, making learning both enjoyable and effective.

Furthermore, the continuous development and adaptation of gamification content is crucial for its

implementation. Behnamnia et al. assert that for digital games to be successful in educational settings, the content must be tailored and easily understood, maintaining children's engagement while encouraging learning outcomes (Behnamnia et al., 2022). The importance of professional development in this field cannot be overlooked, as educators require training to integrate these tools into their teaching practices, ensuring that they not only encourage engagement but also meaningful learning assessment (Alotaibi, 2024).

CONCLUSION

Gamification offers a revolutionary approach in PAUD assessment by combining game elements into learning evaluation. Based on the literature review, gamification not only increases children's engagement but also provides an effective tool for holistically assessing literacy and cognitive development. For example, digital and traditional educational games have been proven to encourage strategic thinking, language skills, and disaster preparedness. However, successful implementation requires support such as teacher training, content adaptation, and adequate technological infrastructure. Moving forward, the development of flexible and sustainable gamification-based assessment systems will be key to building a strong foundation for lifelong learning in early childhood. This study recommends collaboration among stakeholders to address challenges and maximize the potential of gamification in PAUD.

Gamification provides a transformative approach in PAUD assessment. The incorporation of educational games designed to enhance literacy and cognitive development opens new avenues for engaging young learners and assessing their progress in enjoyable and meaningful ways. As the educational landscape continues to evolve, leveraging this innovative method will be key to building a solid foundation for lifelong learning.

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Effect of Goji Berry (*Lycium barbarum*) Serum Extract on The Expression of Pro-Inflammatory Cytokines and Anti-Inflammatory Cytokines During Wound Healing in Wistar Rats: A Systematic Literature Review

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ABSTRACT

Wound healing is a complex biological process involving the phases of hemostasis, inflammation, proliferation, and remodeling, in which cytokines and growth factors play an important role. This study aimed to evaluate the effect of administration of Goji Berry (*Lycium barbarum*) serum extract on the main molecular markers involved in wound healing in Wistar rats. This study was a systematic literature review that assessed the effect of administration of Goji Berry (*Lycium barbarum*) serum extract on the expression of mRNA pro-inflammatory cytokines (TNF and IL-1), anti-inflammatory cytokines (IL-10 and TGF-β), as well as matrix metalloproteinase enzyme MMP-9 and its inhibitor TIMP-1 in the wound healing process in Wistar rats. The findings of the review show that Goji Berry extract is able to suppress pro-inflammatory molecules while increasing anti-inflammatory molecules, thereby accelerating the transition from the inflammatory phase to the proliferative phase as well as supporting tissue regeneration. This extract also plays a role in regulating the degradation balance and repair of the extracellular matrix through increased expression of MMP-9 and TIMP-1, which ensures optimal tissue remodeling. Goji Berry extract has the potential to be an effective natural therapeutic agent in supporting wound healing with minimal side effects. Further research is needed to optimize doses, administration methods, and validate their application in humans for wider clinical use. This study highlights the potential of Goji Berry (Lycium barbarum) serum extract in modulating key molecular markers of wound healing. The results demonstrate the extract's ability to balance pro- and anti-inflammatory mRNA expression and regulate extracellular matrix remodeling, thereby supporting faster and better tissue repair. These findings provide the basis for the development of effective natural wound therapies and guide further research into optimal clinical applications.

Keywords: Goji berry, pro-inflammatory cytokines, anti-inflammatory cytokines, wound healing

INTRODUCTION

The skin is the largest organ in the human body with three main layers: epidermis, dermis, and hypodermis. The epidermis, as the outermost layer, is made up of layered squamous epithelium that serves as a protective barrier against various environmental stressors (Kabashima et al., 2019). The dermis, which is located below the epidermis, is a layer of collagen and elastin-rich connective tissue that supports the skin's structure while also housing hair follicles, sweat glands, and blood vessels (Blair et al., 2020). The hypodermis, the innermost layer, is mainly composed of adipose tissue that acts as an insulator and energy reserve (Chen et al., 2019). This anatomical complexity allows the skin to carry out a variety of vital functions, such as thermoregulation, sensory perception, and immune defense (Kabashima et al., 2019).

When a wound occurs, the skin begins a complex healing process that includes a series of physiological and biochemical events. This process begins from hemostasis and inflammation, followed by the proliferation phase to tissue remodeling. Platelets initiate the process of blood clotting

while inflammatory cells, such as neutrophils and macrophages, clear debris and bacteria, while secreting growth factors to stimulate angiogenesis and fibroblast proliferation (Larouche et al., 2018). This process is closed with keratinocyte migration and ECM remodeling to repair and regenerate tissues (Tottoli et al., 2020).

However, several factors can hinder wound healing, including circulatory disorders, chronic inflammation, infections, and systemic conditions such as diabetes. Chronic inflammation characterized by an increase in pro-inflammatory cytokines (IL-1β, TNF-α) can prolong the inflammatory phase and inhibit the proliferation phase (Schilrreff & Alexiev, 2022). Other factors, such as microorganism biofilms and nutrient deficiencies, contribute to exacerbating this condition (Rodrigues et al., 2019). This disorder can lead to complications such as chronic wounds, infections, and the formation of abnormal scars such as keloids characterized by excessive collagen deposition and dysregulation of TGF-β signals (Ogawa, 2017).

Wound healing management is currently evolving, with a focus on inflammation control. Approaches such as advanced dressings, negative pressure wound therapy, to the use of growth factors and stem cells have shown promising results (Kolimi et al., 2022). However, this approach has limitations, such as high cost, inconsistent results, and the risk of side effects such as pain or infection (Frykberg & Banks, 2015).

In this context, attention is now focused on natural agents such as goji berries (Lycium barbarum), which are known to have significant anti-inflammatory and antioxidant properties. The polysaccharides and carotenoids in goji berries have been shown to suppress pro-inflammatory cytokines and enhance anti-inflammatory mediators through modulation of the NF-κB pathway (Cheng et al., 2015). This effect makes goji berry a potential candidate to support wound healing. However, to date, research on the effects of goji berries in the context of wound healing, especially on molecular expressions such as TNF-α, IL-1, IL-10, TGF-β, MMP-9, and TIMP-1, is still very limited. This study aims to compare the effect of administering goji berry serum extract with NaCl 0.9% on the expression of these molecules in the wound healing model of Wistar rats, in order to evaluate the therapeutic potential of goji berry in improving the quality of wound healing.

METHODS

This study is a systematic literature review (SLR) designed to evaluate the effect of giving goji berry serum extract (Lycium barbarum) on the expression of TNF-α, IL-1, IL-10, TGF-β, MMP-9, and TIMP-1 mRNA on wound healing processes using a Wistar mouse model. The research design follows the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) 2020 guidelines to ensure transparency and reproducibility. The main objective is to identify, assess, and synthesize evidence from the relevant literature regarding the molecular effects of such extracts in the context of wound healing. The literature search was conducted comprehensively in the period January 2015 to September 2025, with a focus on experimental studies in animals.

The search strategy was developed using a combination of keywords and Boolean operators, including "goji berry" OR "Lycium barbarum" AND "wound healing" AND "mRNA expression" AND ("TNF-α" OR "IL-1" OR "IL-10" OR "TGF-β" OR "MMP-9" OR "TIMP-1") AND "Wistar rat". Electronic databases used include PubMed, Scopus, Web of Science, Embase, and the Cochrane Library, as well as manual searches on reference lists of selected articles and grey literature such as theses or conference proceedings via Google Scholar. There are no language restrictions, but priority is given to English and Indonesian articles. Duplication is eliminated using the EndNote X9 software, and the search process is documented in detail to allow replication.

Inclusion criteria include in vivo experimental studies in Wistar mice evaluating the effect of goji berry serum extract on the mRNA expression of target genes in excision or incision wound models, with measurements using techniques such as RT-qPCR. Exclusion criteria include in vitro studies, animal studies other than Wistar mice, narrative reviews, or articles without primary data on mRNA expression. The selection process was carried out by two independent reviewers: the first stage involved screening of titles and abstracts, followed by a complete text assessment in the second stage. Disagreements are resolved through discussion or consultation with third reviewers. The PRISMA flowchart is used to report the number of studies screened, excluded, and included.

Data extraction was performed using a standard form that included study characteristics (author, year of publication, study design), methodology (extract dose, duration of treatment, mRNA

measurement method), main outcome (fold change of mRNA expression), and effect size if available. Study quality assessments were evaluated using SYRCLE's risk of bias tool for animal studies, which included aspects such as randomization, blinding, and full reporting. The risk of bias score is categorized as low, moderate, or high.

The synthesis of data in this study was carried out narratively by considering the heterogeneity between studies, so that the results obtained were presented in the form of an integrated descriptive description. The entire process is carried out while still referring to the ethical principles of secondary research, where there is no direct involvement of living subjects so that new ethical approval is not required.

RESULTS AND DISCUSSION

Study Characteristics

Table 1. Thematic Matrix Based on Cytokines

Marker	Author & Year	Type	Intervention	Key Findings
TNF-α	Zhu (2019), de Oliveira (2020), Liu (2022), Amaglo (2025), Wang (2019), Potterat (2024), Zhang (2022), Li (2021), Cai (2023), Zhang (2018), Chen (2023)	Wistar rats & models of inflammation/colitis/wounds	Goji Berry Extract/LBP/Combination	Consistently downgraded, via NF-κB pathway, p38 MAPK, TLRs
IL-1 / IL-1β	Zhu (2019), Liu (2022), Wang (2019), Zhang (2022), Stoyanova (2023), Cai (2023), Zhang (2018)	Inflammation/wound model mice	LBP, extract, fraction	Consistently decreases, favors the initial inflammatory phase
IL-10	Zhu (2019), de Oliveira	Wistar rats & inflammatory models	Goji Berry Extract / LBP	Consistently improved, anti-inflammatory

	(2020), Liu (2022), Potterat (2024)			effect
TGF-β	Amaglo (2025), Xiao (2019), Xiao (2013)	Wistar & NASH Rats	LBP, extract	Downgrade, relevant for remodeling/fibrosis
MMP-9	Lee (2021), Chen (2023)	Wistar rats, high-fat diet & wound models	Goji berry juice, LBP topical	Consistently degrading, supporting ECM stability
TIMP-1	Chen (2023)	Wistar Rats	Topical LBP	Increases, maintains ECM balance

The synthesis of results from various studies showed a relatively consistent pattern in the regulation of cytokine mRNA expression and extracellular matrix markers (ECM) in animal models after being given interventions in the form of *Goji berry* extract and its fractions such as Lycium barbarum polysaccharides (LBP), juice, or other combinations.

Most studies focused on TNF-α, where as many as eleven studies reported a consistent decline in expression. This decline is mediated through key molecular pathways, including NF-κB, p38 MAPK, and TLRs, which are important regulators in the inflammatory response. These findings confirm the role of *Goji berry* as an effective anti-inflammatory agent especially in the acute inflammatory phase.

In addition to TNF-α, seven studies also showed consistent declines in IL-1/IL-1β expression. These cytokines are known to play a role in triggering and maintaining the initial inflammatory response. Thus, the decrease in IL-1β through the administration of *Goji berries* can be interpreted as a protective mechanism that helps reduce tissue damage due to over-inflammation.

Different results are demonstrated by IL-10, where four studies reported a consistent increase in expression. IL-10 is known as an anti-inflammatory cytokine that regulates the immune balance by suppressing pro-inflammatory cytokines while strengthening inflammatory resolution mechanisms. This increase in IL-10 describes a balanced immune modulation, thus supporting faster tissue recovery.
Three other studies reported a decrease in TGF-β, a cytokine associated with fibrosis and tissue remodeling. These findings are important because decreased TGF-β may have implications for preventing excessive scar tissue formation after the inflammatory phase, although the available evidence is still relatively limited when compared to TNF-α and IL-1β.

On extracellular matrix markers, two studies (Lee 2021 and Chen 2023) reported a decrease in MMP-9 expression. Given that this enzyme plays a role in matrix degradation, its degradation can support tissue structural stability while accelerating wound healing. This finding is further strengthened by the report of Chen (2023) which shows an increase in TIMP-1, which is a natural inhibitor of MMP. The combination pattern of decreased MMP-9 accompanied by an increase in TIMP-1 indicates a better mechanism of ECM homeostasis, so that the healing process takes place more controlled.

Table 2. Key Findings Heatmap

Cytokines/mRNA	Number of Studies	Regulation	Heatmap Representation (Intensity by Number of Studies)
TNF-α	11	↓ Consistent	■■■■■■■■■■■ (Highest)
IL-1 / IL-1β	7	↓ Consistent	■■■■■■■ (High)
IL-10	4	↑ Consistent	■■■■ (Medium)
TGF-β	3	↓ Consistent	■■■ (Medium)

MMP-9	2	↓	■■ (Low)
TIMP-1	1	↑	■ (Lowest)

The heatmap results showed that TNF-α was the most studied cytokine, with eleven studies reporting consistent declines. The intensity of these findings is a strong indicator that *Goji berries* have a major anti-inflammatory effect through the suppression of the TNF-α pathway. The cytokine IL-1/IL-1β also occupies a high position with seven studies consistently showing a decrease, confirming the role of Goji berry in reducing proinflammatory activity in the early phases of the immune response. In contrast to the two cytokines, IL-10 actually increased in four studies. This improvement suggests that Goji berry interventions not only suppress inflammation, but also promote resolution mechanisms by strengthening anti-inflammatory cytokines. In the fibrosis and tissue remodeling pathways, TGF-β was found to decrease in three studies. Although the number is relatively small, this regulatory direction is still important because it relates to the prevention of excess fibrosis and the formation of scarring. Extracellular matrix markers showed a more limited trend, with MMP-9 reported to decrease in two studies, while TIMP-1 increased in one study. The combination of decreased MMP-9 with an increase in TIMP-1 describes a tissue protection mechanism through extracellular matrix stabilization.

Effect of Goji Berry Serum Extract

Various studies reviewed showed that the administration of *Goji Berry* (*Lycium barbarum) serum extract* had a significant positive impact in supporting the wound healing process in the Wistar mouse model. One of the key findings is the ability of these extracts to increase the expression of anti-inflammatory cytokine mRNAs, such as IL-10 and TGF-β, which play an important role in reducing inflammation and accelerating the transition to the proliferation phase. Increased expression of IL-10 and TGF-β suggests that *Goji Berry extract* can strengthen tissue regeneration by reducing the effects of excessive inflammation. In addition, a significant decrease in the expression of pro-inflammatory cytokine mRNA such as TNF-α and IL-1 indicates the ability of these extracts to regulate the balance of the inflammatory response, thereby preventing chronic inflammation that can inhibit wound healing (Zhu et al., 2019; de Oliveira et al., 2020; Liu et al., 2022).

This effect confirms that *Goji Berry* not only serves as a natural anti-inflammatory agent, but also creates a molecular environment that favors optimal tissue healing. By suppressing the activity of pro-inflammatory molecules through pathways such as NF-κB and p38 MAPK and promoting the production of anti-inflammatory molecules, these extracts contribute to a more efficient wound healing process. These findings indicate the great potential *of Goji Berry* as an herbal-based therapeutic intervention to support wound healing, both in experimental contexts and future clinical applications (Amaglo et al., 2025; Potterat, 2024).

The Role of Pro-Inflammatory and Anti-Inflammatory Molecules

The studies reviewed show that pro-inflammatory molecules such as TNF-α and IL-1 play an important role in the early phases of wound healing. These molecules act as the primary mediator to trigger an inflammatory response, which is necessary to cleanse the wound area of pathogens, debris, and dead cells. However, excessive or prolonged expression of TNF-α and IL-1 can prolong the inflammatory phase, causing additional tissue damage and inhibiting regeneration (Zhang et al., 2022; Cai et al., 2023).

In contrast, the increased expression of anti-inflammatory molecules such as IL-10 and TGF-β induced by *Goji Berry extract* accelerates the transition from the inflammatory phase to the proliferation phase. IL-10 is known as a regulatory cytokine that suppresses excess inflammation, while TGF-β supports fibroblast proliferation and collagen synthesis, which is essential for the formation of new tissues (Liu et al., 2022; Xiao et al., 2019). Regulating the balance between these pro-inflammatory and anti-inflammatory molecules is essential to prevent chronic wounds, which are often difficult to heal. Thus, *Goji Berry* has the potential to provide therapeutic benefits by minimizing the risk of complications due to uncontrolled inflammation (Wang et al., 2019; Stoyanova et al., 2023).

Affected Wound Healing Phase

Goji Berry *serum extract* has a significant impact on various phases of wound healing, especially inflammation, proliferation, and remodeling. In the inflammatory phase, this extract suppresses the excessive inflammatory response by increasing the mRNA IL-10 and TGF-β, while also lowering the mRNA TNF-α and IL-1, creating micro-conditions that favor the transition to the proliferation phase

(de Oliveira et al., 2020; Li et al., 2021).

In the proliferation phase, *Goji Berry extract* promotes the migration of fibroblasts and keratinocytes to the wound area. Fibroblasts produce new collagen and extracellular matrix (ECM), while keratinocytes support re-epithelialization to cover wounds (Xiao et al., 2013; Amaglo et al., 2025). In the remodeling phase, this extract regulates the expression of MMP-9 and TIMP-1 mRNA. MMP-9 facilitates degradation of damaged ECM, while TIMP-1 maintains balance to prevent excessive degradation, ensuring the integrity of new tissues (Lee et al., 2021; Chen et al., 2023). With the effect on these three phases, *Goji Berry* accelerates wound healing and ensures organized tissue regeneration (Zhu et al., 2019; Potterat, 2024).

Clinical Potency of Goji Berry

Goji *Berry's clinical potential* as a therapeutic agent for wound healing is very promising due to its ability to regulate the expression of pro-inflammatory (TNF-α, IL-1), anti-inflammatory (IL-10, TGF-β), and remodeling (MMP-9, TIMP-1) molecules. This effect accelerates tissue regeneration, reduces the duration of inflammation, and prevents complications such as chronic wounds (Zhang et al., 2018; Liu et al., 2022). This extract has the potential to be a therapeutic supplement for chronic wounds, severe infections, or wounds in patients with diabetes and immune disorders, thanks to its immunomodulatory properties (Cai et al., 2023; Stoyanova et al., 2023).

Nonetheless, more research is needed to optimize effective doses, methods of administration (topical, oral, or injectable), and specific molecular mechanisms. Large-scale clinical studies in humans are also needed to validate the findings from the Wistar mouse model, ensuring safety and effectiveness in the human population. With further development, *Goji Berry* can become an integral part of modern wound therapy, offering a natural alternative with minimal side effects compared to synthetic drugs, making it an innovative choice in molecular-based wound management (Chen et al., 2023; Amaglo et al., 2025).

CONCLUSION

Goji Berry serum extract (*Lycium barbarum*) showed significant therapeutic potential in supporting wound healing in Wistar mouse models through regulation of pro-inflammatory (TNF-α, IL-1) and anti-inflammatory (IL-10, TGF-β) cytokine mRNA expression, as well as remodeling molecules such as MMP-9 and TIMP-1. By suppressing excessive inflammation, increasing the migration of fibroblast and keratinocyte cells, and maintaining the balance of degradation and extracellular matrix synthesis, this extract accelerates the transition from the inflammatory phase to proliferation and remodeling, resulting in more efficient and organized wound healing. Although these findings are promising, further clinical research in humans is needed to optimize dosage, administration methods, and safety validation, making Goji Berry a strong candidate for herbal wound therapy with minimal side effects.

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PLANNING FOR DETERMINING THE LOCATION OF INTEGRATED WASTE PROCESSING SITE (TPST) USING A GEOGRAPHIC INFORMATION SYSTEM (GIS) AND THE SIMPLE ADDITIVE WEIGHTING (SAW) METHOD IN DENPASAR CITY, BALI

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ABSTRACT

The waste problem in big cities in Indonesia is still an environmental issue that never ends. By increasing the population, land conversion in several areas, lack of waste processing facilities and lack of awareness are factors contributing to the waste problem. In 2020, waste services in Denpasar only reached 67.5%, so management of the waste produced is not yet optimal. An integrated waste processing method from upstream to downstream is needed before the waste ends up in the landfill. By functioning optimally, the quality and quantity of waste processing at the TPST in Denpasar, the presence of an overcapacity landfill in Suwung can reduce the burden of waste in the landfill. The existence of a TPST is very necessary in Denpasar, which so far has not been optimal, so a decision is needed to determine the location of the TPST in the Denpasar area. There are 2 methods used in the research method, the first is the use of the SAW method of decision making system (DSS) and the second is digitization of mapping using GIS. Analysis of the decision making system (DSS) using the SAW method using mathematical analysis, decision matrices and priority scales. The results of the research show that the priorities for determining TPST locations were obtained by areas that were priority I for TPST development using the SAW method, namely Kesiman and Padang Sambian with a value of 80-100. Priority I area is also included in the low rainfall area category according to rainfall data for the Denpasar city area. There are 10 priority II regions and 25 priority III regions. So the Kesiman and Padang Sambian areas have the highest priority compared to other areas in Denpasar Bali for TPST development.

Keywords: GIS, SAW, TPA, TPST, waste management

INTRODUCTION

Bali Province is a world-class tourist destination favored by both domestic and international tourists. This has undoubtedly had a positive impact on the regional economy and the development of supporting infrastructure. Furthermore, it has led to high consumption activity among local residents and tourists, resulting in significant waste generation.

According to data from the Ministry of Environment and Forestry (KLHK), Bali Province generated 915,500 tons of waste in 2021. This makes Bali the eighth-largest waste-producing province in Indonesia. When broken down by region, the highest waste generation in Bali came from Denpasar City, with 349,500 tons in 2021. Next in line are Gianyar Regency with 141,400 tons of waste, Buleleng Regency with 123,700 tons, Badung Regency with 116,700 tons, and Tabanan Regency with 84,200 tons. Based on its source, the majority of waste in Bali comes from household activities, accounting for 40.58% of the province's total waste. Followed by waste from commercial activities 18.22% and from markets 17%.

The waste collection system in Denpasar City generally utilizes temporary storage sites (TPS), where household waste is collected at the TPS and then transported to the final disposal site (TPA). The number and capacity of TPS in Denpasar City still do not meet the city's waste management needs. This

limited number and capacity are also influenced by the limited land available for TPS placement in the central urban area. The lack of clear direction and strategy for determining the location and distribution of TPS, coupled with the limited land in urban areas and the difficulty of constructing adequate TPS that meet standards, has led to serious problems such as waste being scattered around the TPS, which has reduced the aesthetics of the environment (Achmad, 2015). According to data from the Ministry of Environment and Forestry (DKLH), as of July 2023, the Suwung TPA received an average of 690 tons of waste per day from the Denpasar City Environment Agency (DLHK), the Badung Regency Environment Agency (DLHK), and private entities in Denpasar and Badung. Ten to 12 garbage trucks transport waste to the TPA daily. This indicates that the landfill is overcapacity, leading to serious environmental problems. This problem is exacerbated by, in addition to the increasing daily waste volume, management at smaller levels, such as the waste disposal sites (TPS) and waste disposal sites (TPST), which are sometimes suboptimal, leading to waste being sent directly to the landfill. This is inconsistent with the proper waste management process from upstream to downstream. The number of TPS and TPST is considered insufficient and disproportionate to the increasing daily waste volume. This is due to the constraints of policy, land use, and a lack of technical and scientific analysis.

Based on this background, a study is needed to determine the ideal TPST location using scientific methods, such as "Planning for Determining the Location of Integrated Waste Processing Sites (TPST) Using Geographic Information Systems (GIS) and the Simple Additive Weighting (SAW) Method in Denpasar City, Bali."

METHODS

Research Design

The research plan design can be seen in Figure 1 below. As can be seen in the picture, the concept of this research begins with conducting field observations to be able to analyze the main problem, equate perceptions with research members, and design problem-solving ideas according to the researcher's expertise.

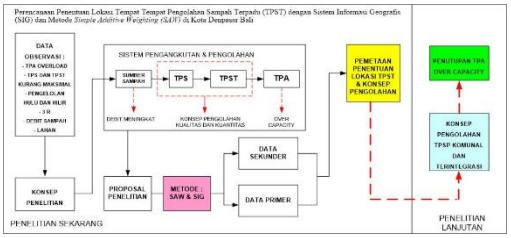


Figure 1. Research Design Chart

The research plan is divided into two parts: current research and follow-up research. These two stages are expected to provide short-, medium-, and long-term solutions to waste management issues in Denpasar in particular and Bali in general.

The current research focuses on determining the location criteria for waste disposal sites (yellow block diagram) using two methods (purple block): SAW and GIS. These two methods are expected to complement each other in scientific analysis to determine the ideal location for waste disposal sites.

The next stage of research, after determining the location criteria and the scientific study, is expected to continue with technical studies for the construction phase. The establishment of these waste disposal sites will facilitate optimal waste processing and oxidation, thereby reducing the burden on the landfill (TPA). Furthermore, in the long term, if all TPS and TPST function properly, the existence of landfills (TPA) can be reduced or even eliminated.

Research Location and Timeline

The research location is in the Denpasar area of Bali, and the research period is six months, from September 2023 to February 2024. In addition to data from field observations and literature studies, two data sources were used in this study.

The primary data used in this study consist of data processed using the SAW method, including matrices, matrix normalization, and mathematical calculations. In addition, primary data also include data obtained from digitization, map overlay, and analysis using ArcView software. Meanwhile, the secondary data used in this study include spatial data such as administrative map data for the City of

Denpasar, topographic data of each sub-district, land use map data for the City of Denpasar, rainfall map data for the City of Denpasar, and population density data for the City of Denpasar. Secondary data also include data related to weighting criteria, matrices, and calculation formulas used in SAW analysis.

Research implementation

The implementation stages of this research are divided into four stages:

Preparation Stage

This stage focuses on the initial phases before the research begins, including research preparation, literature review, and research observations. Research observations include field visits to polling stations (TPS), TPST, and landfills (TPA). In addition, this stage includes discussions between team members and the lead researcher to establish a shared understanding of the research objectives, benefits, and other supporting factors.

Data Collection Stage

The data collection stage is divided into two parts: primary data collection and secondary data collection. Primary data collection is obtained from direct research using two methods: SAW and GIS digitization, while secondary data is obtained from literature studies, literature, and other supporting data such as maps and the topology of Denpasar.

Data Processing Stage

At this stage, data processing is carried out using two methods, one of which is a Decision Support System (DSS) using the SAW method. This method emphasizes mathematical analysis through the use of matrices, normalization, and prioritization based on several calculation formulas aimed at determining values that serve as supporting decision-making criteria for a given problem, such as determining the criteria for selecting an integrated temporary waste processing (TPST) location. The steps in applying the SAW method begin with determining the criteria (Ci) that will be used as references in decision-making. Next, the suitability rating of each alternative is determined for each criterion. A decision matrix is then constructed based on the criteria (Ci) and normalized using equations adjusted to the attribute type, whether benefit attributes or cost attributes, to produce a normalized matrix R. Finally, the ranking process is conducted by summing the results of multiplying the normalized matrix R by the preference weight vector to obtain the highest value. This highest value, for example alternative A1, is selected as the best alternative and serves as the decision-making solution in the SPK (Survey Planning and Decision Making) method.

Location mapping using spatial analysis with GIS

To further deepen the analysis and refine the results of the first method, spatial analysis was continued using ArcView software with GIS. This software analysis emphasizes digitizing overlays supported by secondary maps, such as land use maps, population density, rainfall, natural disaster vulnerability levels of a region, and other supporting map data. All analysis steps are performed using ArcView GIS software.

The results of this analysis are expected to support decision-making in the first method (SAW) to be more accurate and scientifically measurable, supported by primary and secondary data.

RESULTS AND DISCUSSION

Data Analysis Using SAW

The criteria used in this study to calculate the priority values for determining the location of the TPST are: C1 = Population density, C2 = Availability of road access, C3 = Number of TPS (landfill sites), C4 = Availability of land, and C5 = Disaster-prone area. When adjusted for the number of attributes, these criteria include C1, C2, C3, and C4 as benefit attributes, and C5 as cost attributes.

The population density criterion is directly proportional to the amount of waste generated in the area, therefore, the population density criterion is a priority in determining the location of the TPST. Similarly, the availability of road access that will serve as a transportation route to the location, the number of TPS (landfill sites) supporting the TPST, and the availability of land sufficient to meet the ideal needs for an integrated waste sorting location are factors in the priority scale for TPST development (benefit). Meanwhile, the criteria for disaster-prone areas are a factor in considering a location for a landfill (TPST).

Based on data on the population of sub-districts and villages in Denpasar City, with four population density classifications (Kingma, 1991), the following data were obtained:

Table 1. Population Density Classification of Denpasar City

Population/km^2	Classification	Rating
< 8.842	Low	1
8843 - 17.685	Moderate	2
17.686 -26.528	High	3
> 26.529	Very High	4

The criteria for the availability of polling stations are categorized into 3 groups, namely Priority 1, 2, and 3. Priority 1 indicates that the area does not have a polling station or only 1 polling station for one sub-district, Priority 2 indicates that there are 2 to 3 polling stations for 1 sub-district, Priority 3 indicates that there are more than 3 polling stations in 1 sub-district. Determining the range of the number of polling stations utilizes a statistical formula which can be seen in Table 2. below.

Table 2**.** Priority scale Number of TPA

Number of polling stations	Priority	Rating
>3	Priority 1	1
2-3	Priority 2	2
<=1	Priority 3	3

The results of the SAW analysis of each of the criteria used, such as C1 = Population density, C2 = Availability of road access, C3 = Number of polling stations, C4 = Availability of land, C5 = Disaster-prone areas, are obtained in the following table:

Table 3. Research data based on each criteria

ALTERNATIVE	C1	C2	C3	C4	C5
K1	4029	1	3	There is	disaster-prone
K2	24603	1	3	There is	not prone to disasters
K3	39397	1	3	There is	not prone to disasters
K4	23228	1	3	There is	not prone to disasters
K5	11434	1	3	There is	not prone to disasters
K6	9509	1	3	There is	disaster-prone
K7	17078	1	3	There is	not prone to disasters
K8	30297	1	3	There is	not prone to disasters
K9	7685	1	3	There is	disaster-prone
K10	11111	1	2	There is	disaster-prone
K11	13202	1	3	There is	not prone to disasters
K12	7840	1	3	There is	not prone to disasters

K13	9271	1	3	There is	not prone to disasters
K14	10187	1	3	There is	not prone to disasters
K15	14101	1	2	There is	not prone to disasters
K16	12761	1	3	There is	not prone to disasters
K17	10733	1	3	There is	not prone to disasters
K18	18523	1	3	There is	not prone to disasters
K19	8104	1	3	There is	not prone to disasters
K20	7069	1	3	There is	not prone to disasters
K21	7531	1	3	There is	not prone to disasters
K22	9229	1	3	There is	not prone to disasters
K23	20962	1	3	There is	not prone to disasters
K24	28525	1	3	There is	not prone to disasters
K25	20100	1	3	There is	not prone to disasters
K26	32647	1	3	There is	not prone to disasters
K27	14143	1	3	There is	not prone to disasters
K28	11822	1	2	There is	not prone to disasters
K29	4312	1	3	There is	not prone to disasters
K30	12637	1	3	There is	not prone to disasters
K31	16920	1	3	There is	not prone to disasters
K32	16809	1	3	There is	not prone to disasters
K33	15019	1	3	There is	not prone to disasters
K34	10074	1	3	There is	not prone to disasters
K35	14354	1	3	There is	not prone to disasters
K36	9369	1	3	There is	not prone to disasters

K37	7098	1	3	There is	not prone to disasters
K38	13670	1	3	There is	not prone to disasters
K39	28114	1	3	There is	not prone to disasters
K40	18637	1	3	There is	not prone to disasters
K41	22671	1	3	There is	not prone to disasters
K42	8711	1	3	There is	not prone to disasters
K43	18085	1	3	There is	not prone to disasters

The results of processing the data in the table above, in accordance with the ranking criteria, are:

Table 4. Data Processing Results

ALTERNATIVE	C1	C2	C3	C4	C5
K1	1	1	3	1	1
K2	3	1	3	1	2
K3	4	1	3	1	2
K4	3	1	3	1	2
K5	2	1	3	1	2
K6	2	1	3	1	1
K7	2	1	3	1	2
K8	4	1	3	1	2
K9	1	1	3	1	1
K10	2	1	2	1	1
K11	2	1	3	1	2
K12	1	1	3	1	2
K13	2	1	3	1	2
K14	2	1	3	1	2
K15	2	1	2	1	2
K16	2	1	3	1	2
K17	2	1	3	1	2
K18	3	1	3	1	2
K19	1	1	3	1	2

K20	1	1	3	1	2
K21	1	1	3	1	2
K22	2	1	3	1	2
K23	3	1	3	1	2
K24	4	1	3	1	2
K25	3	1	3	1	2
K26	4	1	3	1	2
K27	2	1	3	1	2
K28	2	1	2	1	2
K29	1	1	3	1	2
K30	2	1	3	1	2
K31	2	1	3	1	2
K32	2	1	3	1	2
K33	2	1	3	1	2
K34	2	1	3	1	2
K35	2	1	3	1	2
K36	2	1	3	1	2
K37	1	1	3	1	2
K38	2	1	3	1	2
K39	4	1	3	1	2
K40	3	1	3	1	2
K41	3	1	3	1	2
K42	1	1	3	1	2
K43	3	1	3	1	2

From the table above, the following decision matrix X is obtained:

$$X = \begin{bmatrix} 1 & 1 & 3 & 1 & 0 \\ 3 & 1 & 3 & 1 & 1 \\ 4 & 1 & 3 & 1 & 1 \\ 3 & 1 & 3 & 1 & 1 \\ \dots & \dots & \dots & \dots & \dots \\ 3 & 1 & 3 & 1 & 1 \end{bmatrix}$$

Next, the above matrix will be normalized based on the equations according to the predetermined criteria types. The results of the normalization process can be seen below:

$$R11 = \frac{1}{Max(A1;\dots A43)} = \frac{1}{4} = 0.25$$
$$R21 = \frac{3}{Max(A1;\dots A43)} = \frac{3}{4} = 0.75$$
$$R31 = \frac{4}{Max(A1;\dots A43)} = \frac{4}{4} = 1$$
$$R41 = \frac{3}{Max(A1;\dots A43)} = \frac{3}{4} = 0.75$$
$$R12 = \frac{1}{Max(A1;\dots A43)} = \frac{1}{1} = 1$$
$$R22 = \frac{1}{Max(A1;\dots A43)} = \frac{1}{1} = 1$$
$$R32 = \frac{1}{Max(A1;\dots A43)} = \frac{1}{1} = 1$$
$$R42 = \frac{1}{Max(A1;\dots A43)} = \frac{1}{1} = 1$$

$$R13 = \frac{3}{Max(A1;\dots A43)} = \frac{3}{3} = 1$$
$$R23 = \frac{3}{Max(A1;\dots A43)} = \frac{3}{3} = 1$$
$$R33 = \frac{1}{Max(A1;\dots A43)} = \frac{1}{1} = 1$$
$$R43 = \frac{1}{Max(A1;\dots A43)} = \frac{1}{1} = 1$$
$$R14 = \frac{Min\ (A1;\dots A43)}{1} = \frac{1}{1} = 1$$
$$R24 = \frac{Min\ (A1;\dots A43)}{1} = \frac{1}{1} = 1$$
$$R34 = \frac{Min\ (A1;\dots A43)}{1} = \frac{1}{1} = 1$$
$$R44 = \frac{Min\ (A1;\dots A43)}{1} = \frac{1}{1} = 1$$
$$R15 = \frac{Min\ (A1;\dots A43)}{1} = \frac{1}{1} = 1$$
$$R25 = \frac{Min\ (A1;\dots A43)}{2} = \frac{1}{2} = 0.5$$
$$R35 = \frac{Min\ (A1;\dots A43)}{2} = \frac{1}{2} = 0.5$$
$$R45 = \frac{Min\ (A1;\dots A43)}{2} = \frac{1}{2} = 0.5$$

From the normalization results above, the following values are obtained :

$R11 = 0.25$
$R12 = 1$
$R13 = 1$
$R14 = 1$
$R15 = 0.5$

Normalize the x-matrix to R using alternative 1, Serangan, as an example. Then, assign a weight based on its importance level, according to the technical guidelines for the establishment of a waste treatment plant (TPST) from Cipta Karya, at 20%. This yields:
V1 = (20 x 0.25) + (20 x 1) + (20 x 1) + (20 x 1) + (20 x 0.5)
= 5 + 20 + 20 + 20 + 10 = 75
Continuing the calculation using the same method, the values of V1 – V43 are as follows:

Table 5. Tabel Priority Locations for TPST in Denpasar City

No	Alternative	% match	Priority
1	SERANGAN	75	Priority II
2	PEDUNGAN	80	Priority II
3	SESETAN	80	Priority II
4	PANJER	75	Priority II
5	RENON	70	Priority III
6	SANUR	60	Priority III
7	SIDAKARYA	70	Priority III
8	PEMOGAN	80	Priority II
9	SANUR KAJA	70	Priority III
10	SANUR KAUH	72	Priority III
11	KESIMAN	100	Priority I
12	SUMERTA	80	Priority II
13	DANGIN PURI	75	Priority III
14	PENATIH	75	Priority III
15	DANGIN PURI KELOD	80	Priority II
16	SUMERTA KELOD	78	Priority III
17	KESIMAN PETILAN	90	Priority I
18	KESIMAN KERTALANGU	95	Priority II
19	SUMERTA KAJA	75	Priority III
20	SUMERTA KAUH	80	Priority II
21	PENATIH DANGIN PURI	77	Priority III
22	DAUH PURI	78	Priority III
23	PEMECUTAN	75	Priority III
24	PADANGSAMBIAN	80	Priority II
25	PADANGSAMBIAN KELOD	84	Priority II
26	PEMECUTAN KELOD	78	Priority III
27	DAUH PURI KAUH	75	Priority III
28	DAUH PURI KELOD	75	Priority III
29	DAUH PURI KANGIN	78	Priority III
30	TEGAL HARUM	80	Priority II
31	TEGAL KERTHA	78	Priority III
32	PADANG SAMBIAN KAJA	85	Priority I
33	TONJA	75	Priority III
34	UBUNG	80	Priority II
35	PEGUYANGAN	75	Priority III
36	DANGIN PURI KANGIN	78	Priority III
37	DANGIN PURI KAUH	75	Priority III
38	DANGIN PURI KAJA	78	Priority III

39	PEMECUTAN KAJA	75	Priority III
40	DAUH PURI KAJA	75	Priority III
41	UBUNG KAJA	80	Priority II
42	PEGUYANGAN KAJA	75	Priority III
43	PEGUYANGAN KANGIN	75	Priority III

As seen in the table above, the Kesiman and Padang Sambian areas are the priority I areas for the TPST development planning area.

CONCLUSION

The conclusions and recommendations derived from this study indicate that the determination of TPST locations was conducted using two complementary methods, namely the SPK SAW method and Geographic Information Systems (GIS) analysis using ArcView software. The results of the SAW method show that the Priority I areas for TPST development are Kesiman and Padang Sambian, which obtained scores ranging from 80 to 100. In addition, the analysis identifies 10 areas classified as Priority II and 25 areas classified as Priority III.

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PHYSIOLOGICAL MECHANISMS OF RED BLOOD CELLS IN SUPPORTING MUSCLE PERFORMANCE DURING EXERCISE

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ABSTRACT

Red blood cells play a crucial role in supporting muscle performance during exercise through complex physiological mechanisms, particularly oxygen transport, blood pH regulation, and adaptation to exercise. This study aimed to examine in-depth the physiological mechanisms of red blood cells in supporting muscle function during exercise. A systematic literature review of various international scientific publications from 2000–2024 that discussed the relationship between red blood cell physiology and exercise performance was used as the method. The results of the study indicate that endurance training and hypoxic training can increase red blood cell count, hemoglobin levels, and cell membrane deformability, which directly impact oxygen transport capacity and muscle work efficiency. Furthermore, these hematological system adaptations also help delay muscle fatigue by increasing oxygen supply and regulating acid-base balance. In conclusion, understanding the physiological mechanisms of red blood cells is crucial in developing training programs and strategies to improve athlete performance.

Keywords: athlete performance, exercise physiology, hemoglobin, muscle oxygenation, red blood cells

INTRODUCTION

Muscle performance during exercise is highly dependent on oxygen availability and the body's ability to transport it to active tissues. Red blood cells, or erythrocytes, serve as the primary component of the oxygen transport system, playing a vital role in supporting muscle aerobic metabolism during physical activity. According to Mairbäurl (2013), increased energy requirements during exercise drive hematological adaptations in the form of increased erythrocyte count, hemoglobin levels, and changes in blood viscosity. In the context of physical exercise, these changes are part of the body's physiological adaptations to improve muscle metabolic efficiency. Endurance training has been shown to trigger increased production of erythropoietin (EPO), a hormone that stimulates erythropoiesis in the bone marrow (Schmidt & Prommer, 2008). Furthermore, changes in erythrocyte membrane deformability allow for more efficient blood flow to muscle capillaries. This study is important because understanding the role of erythrocytes in supporting muscle performance can provide a scientific basis for coaches and sports physiologists in designing blood physiology-based training programs.

METHODS

This study used a systematic literature review approach. Relevant scientific articles were collected from PubMed, Scopus, ScienceDirect, and Google Scholar databases using the keywords "red blood cell," "exercise physiology," "oxygen transport," and "athlete performance." Inclusion and Exclusion Criteria 1. Articles published between 2000 and 2024. 2. Experimental research or reviews related to red blood cell adaptation to exercise. 3. Studies explaining the relationship between erythrocyte function and muscle performance. A total of 62 articles were retrieved, and 28 of them met the criteria for thematic analysis. The analysis was conducted using a descriptive thematic approach covering four main themes: (1) oxygen transport, (2) pH regulation and the Bohr effect, (3) adaptation to exercise, and (4) erythrocyte deformability.

RESULTS AND DISCUSSION

Oxygen Transport by Erythrocytes

Erythrocytes function to carry oxygen from the lungs to muscle tissue via hemoglobin. During intense exercise, oxygen demand increases 15–20 times above resting levels. Adaptation to prolonged exercise increases the number of erythrocytes and hemoglobin levels, thereby increasing oxygen-carrying capacity. This has direct implications for increasing VO_2 max and endurance (Sawka & Coyle, 1999). Exercise at high altitudes or in hypoxic environments stimulates the secretion of EPO, which stimulates the formation of new erythrocytes. This adaptation, known as the "live high–train low" (live high–train low), has been shown to improve athletic performance due to increased blood oxygenation capacity (Gore & Hopkins, 2005).

Blood pH Regulation and the Bohr Effect

During intense activity, anaerobic metabolism produces lactic acid, which lowers blood pH. Erythrocytes play a crucial role in maintaining pH homeostasis through the hemoglobin buffer system and the enzyme carbonic anhydrase. The Bohr Effect explains that a decrease in pH and an increase in CO_2 decrease hemoglobin's affinity for oxygen, thereby accelerating oxygen release to active tissues (Mairbäurl, 2013). Long-term endurance training increases the buffering capacity of red blood cells, thus offsetting the decrease in pH and delaying muscle fatigue.

Physiological Adaptations to Exercise

Repeated physical exercise triggers increased erythropoiesis and increases total red blood cell mass. These adaptations improve tissue oxygenation capacity and decrease the rate of hemolysis. According to Connes et al. (2013), moderate-intensity exercise also increases intracellular antioxidant levels in red blood cells, protecting membranes from oxidative damage. Athletes with optimal hematological adaptations demonstrate physiological increases in hematocrit and hemoglobin without compromising blood viscosity. However, extreme increases can increase blood flow resistance and cardiovascular load.

Erythrocyte Deformability and Blood Rheology

The ability of red blood cells to change shape as they pass through narrow capillaries is called deformability. Aerobic exercise increases deformability by increasing intracellular ATP and lipid membrane integrity. This improves muscle perfusion and oxygen supply (Connes et al., 2013). Conversely, oxidative stress, dehydration, and heat exposure decrease red blood cell deformability, thereby decreasing muscle perfusion efficiency. Therefore, fluid and antioxidant balance are important factors in maintaining erythrocyte function during strenuous exercise.

Implications for Muscle Performance and Endurance

Increased red blood cell mass and hemoglobin levels enhance aerobic capacity and delay fatigue. Athletes with optimal hematological values have a longer time to exhaustion and faster post-exercise recovery due to increased CO_2 and metabolite transport. Monitoring hematological parameters (hematocrit, hemoglobin, reticulocyte count) is an important indicator in evaluating an athlete's physiological condition and adaptation to training loads (Schmidt & Prommer, 2008).

CONCLUSION

Red blood cells play a central role in supporting muscle performance during exercise through complex physiological mechanisms that include oxygen transport, blood pH regulation, and hematological adaptations to exercise. Endurance training and exposure to hypoxia have been shown to improve red blood cell function, oxygenation capacity, and muscle efficiency. This understanding is crucial for developing physiology-based training programs to enhance athlete performance and prevent fatigue.

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The Influence of Bioactive Compounds in Arabica Coffee Extract on TNF-Alpha Regulation in Animal Models: A Systematic Literature Review

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ABSTRACT

Arabica coffee (Coffea arabica) contains bioactive compounds such as caffeine and chlorogenic acid, known for their anti-inflammatory potential through the regulation of tumor necrosis factor-alpha (TNF-α), a key pro-inflammatory cytokine involved in metabolic and neurodegenerative diseases. This systematic literature review aims to synthesize evidence from post-2020 studies on the effects of Arabica coffee bioactive compounds on TNF-α regulation in animal models. This review adheres to the PRISMA 2020 guidelines, including experimental studies (2021–2025) from PubMed, Scopus, Web of Science, and Google Scholar. Inclusion criteria encompassed studies using animal models, focusing on Arabica coffee bioactive compounds, and employing quantitative TNF-α measurements (ELISA, RT-PCR, Western Blot). Data were extracted on study characteristics, animal models, bioactive compounds, measurement methods, outcomes, and molecular mechanisms, with quality assessed using SYRCLE's Risk of Bias Tool. From 900 articles, 20 met inclusion criteria after rigorous screening. Wistar rats (30%) were the dominant animal model, followed by BALB/c mice and Sprague-Dawley rats (10% each). Compounds like caffeine (6 mg/kg) and chlorogenic acid reduced TNF-α via oxidative stress modulation and NF-κB suppression. Green coffee bean extract (200 mg/kg) showed dose-dependent effects, with higher doses increasing TNF-α. ELISA (55%) was the primary measurement method. Mechanisms included antioxidant activity, inhibition of gut inflammation, and immunomodulation. Arabica coffee bioactive compounds consistently reduce TNF-α, supporting their therapeutic potential for chronic inflammation. Variability in doses and animal models underscores the need for standardized protocols to enhance clinical translation.

Keywords: Arabica coffee, bioactive compounds, TNF-α, animal model, anti-inflammatory, systematic review.

INTRODUCTION

Arabica coffee (*Coffea arabica*) is one of the the most coffee varieties consumed globally , containing various compound bioactive like caffeine , acid chlorogenic acid (CGA), trigonelline , and diterpenes such as kahweol and cafestol , which has been proven own potential antioxidant and anti-inflammatory (Rebollo-Hernanz et al. , 2022) . Compounds This play a role in modulation response inflammation body , including regulations factor tumor necrosis factor alpha (TNF-alpha), which is a pro- inflammatory cytokines the main involved in various condition pathological like disease metabolic , neurodegenerative, and inflammatory chronic (Socała et al. , 2021) . Regulation of TNF-alpha through intervention experience like Arabica coffee extract become focus study Because its potential in reduce risk disease related inflammation without effect side significant from drug synthetic (Vats, 2022) .

Recent studies show that compound bioactive in Arabica coffee extract can influence TNF-alpha regulation in animal models. Administration caffeine from coffee at a dose of 6 mg/kg in Swiss mice was able to lower TNF-alpha expression in condition inflammation induced by lipopolysaccharide (LPS), so that promote anti- inflammatory effect (Makiso et al. , 2024) . Additionally , acid chlorogenic acid from green coffee beans Arabica has proven reduce TNF-alpha secretion in cells stimulated hepatocytes sour palmitate , with activate FGF21 pathway and suppress NF- κB pathway , although studies This more Lots done in vitro (Jiménez-Gutiérrez et al. , 2025) .

In animal models , extracts green coffee beans Arabica at a dose of 200 mg/kg significant lower TNF-alpha levels in affected male Wistar rats exercise physique excessive , while dose more high (400-800 mg/kg) instead increase level said , shows effect dose-dependent (Koníčková et al. , 2024) . Another study in 2024 found that green coffee supplement (800 mg/ day) reduces TNF-alpha levels in subjects obesity with syndrome metabolic , although this is in the human model , which supports potential translation from animal models (Dewi et al. , 2024) . The neuroprotective effect of compound coffee bioactives , such as sour chlorogenic acid , also involves reduction of TNF-alpha through modulation stress oxidative and apoptosis in mouse models with condition like ischemia or toxicity , although proof more post-2020 specifics emphasizing the mTOR/TFEB mechanism (Artusa et al. , 2022a) .

Combination Arabica coffee extract with other materials, such as turmeric and chili, indicating effect synergistic in hinder TNF-alpha secretion up to 39.85% in cells murine macrophages, although not yet tested on animal models intact. Thus, literature show variability results, including difference between in vitro and in vivo studies, as well as lack of consistency in doses and animal models used. This highlight importance synthesis more evidence deep For understand dynamics influence compound bioactive the (Naeem et al. , 2022) .

Therefore, a systematic literature review is necessary. For synthesize proof from post-2020 study on influence compound bioactive in Arabica coffee extract to regulation of TNF-alpha in animal models, in order to identify research gaps, mechanisms dominant molecular, and implications therapeutic potential. Approach This will ensure comprehensive and data -based evaluation evidence, support development intervention based natural for management inflammation.

METHODS

Research Design

Systematic literature review This will done in accordance with guidelines Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 for ensure transparency and consistency in the process of data collection and analysis. Approach This was chosen for synthesize proof from studies experimental research influence compound bioactive in Arabica coffee extract to TNF-alpha regulation in animal models, with focus on post-2020 publications.

Criteria Inclusion and Exclusion

The study that will be entered in review This must fulfil criteria inclusion following : (1) published between January 2021 to September 2025 in Language English or Indonesia; (2) is studies experimental studies using animal models (e.g. , rats , mice); (3) research effect compound bioactive from Arabica coffee extract (such as caffeine , acid chlorogenic acid , kahweol, or cafestol) against level or TNF-alpha expression ; (4) has design clear research , including group control and measurement of TNF - alpha quantitative (e.g. , ELISA, RT-PCR, or Western Blot). Criteria exclusion includes: (1) in vitro studies without in vivo data; (2) reviews, opinions, or non- experimental studies; (3) studies that do not specific discussing Arabica coffee or TNF-alpha; (4) publication before 2021; and (5) studies without access text complete.

Search Strategy Literature

Search literature was conducted in an electronic database such as PubMed, Scopus, Web of Science, and Google Scholar. The keywords used covers combination term such as: "Arabica coffee extract", "bioactive compounds", "TNF-alpha", "tumor necrosis factor-alpha", "animal model", "inflammation", "caffeine", "chlorogenic acid", and variations other using Boolean operators (AND, OR). Search was limited to published articles from January 2021 to September 2025. In addition, the bibliography from relevant articles was checked manually to identify studies possible additions No detected through search electronics.

Data Selection and Extraction Process

Selection process will done in three stage: (1) filtering beginning based on title and abstract by two reviewers independent For identify relevant articles ; (2) assessment text complete For ensure compliance to criteria inclusion ; and (3) resolution mismatch through discussion with reviewer third If required . Extracted data includes : (1) characteristics study (author , year publication , country); (2) animal model (species , strain, condition experimental); (3) type compound bioactive and dosage ; (4) method TNF-alpha measurement ; (5) results main (decrease / increase) TNF-alpha levels); and (6) mechanisms reported molecular pathways (e.g. , NF - κB pathway , FGF21). Data will be saved in table standard use device soft like Microsoft Excel for analysis more carry on .

Evaluation Data Quality and Analysis

Quality methodology studies will assessed use designed SYRCLE's Risk of Bias Tool special For studies preclinical in animal models , with consider aspect like randomization , blinding, and reporting results . The data will be analyzed in a way narrative For identify pattern , consistency , and variability in results , including effect dose-dependent , type compound bioactive , and the animal models used .

RESULTS AND DISCUSSION

Search process article For review literature systematic This started with found 900 articles , consisting of of 850 articles from databases such as PubMed, Scopus, Web of Science, and Google Scholar, as well as 50 articles from manual search through the bibliography or other sources . After duplication deleted as many as 150 articles , the remaining 750 articles which then filtered based on title and abstract . At stage this , 600 articles No fulfil criteria beginning so that only 150 articles searched For accessible text complete .

Of the 150 articles , 20 articles No can taken Because constraint access , up to 130 articles assessed its feasibility . From the number of said , 110 articles issued Because various reasons , including : not studies experimental or animal models (30 articles), no researching Arabica coffee or TNF-α (25 articles), in vitro studies without in vivo data (15 articles), in the form of reviews , opinions , or non-experimental studies (10 articles), published before January 2021 (20 articles), or use Language besides English and Indonesian (10 articles). Finally 20 articles fulfil criteria inclusion and analyzed more carry on For evaluate influence compound bioactive in Arabica coffee extract to TNF-α regulation in animal models. Full results depicted as following :

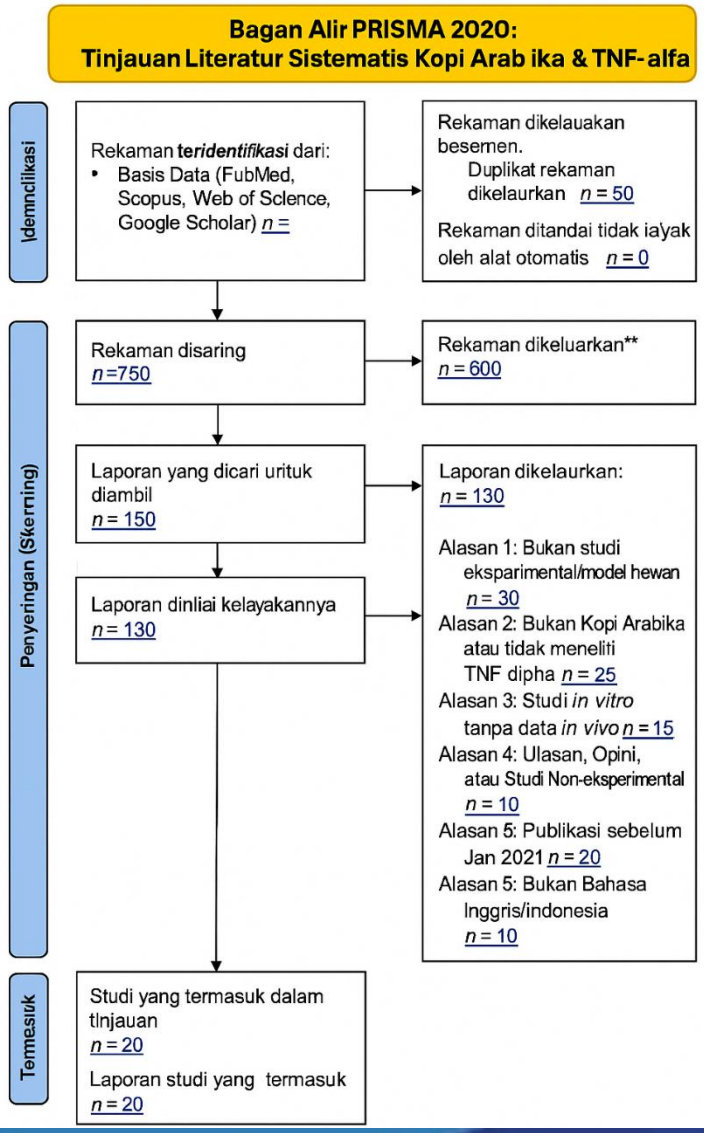


Figure 1Research Flowchart

Articles created source in study This show distribution sufficient geographical extensive , covering countries in Asia, Europe , America, and Africa. Most of study done in a number of year lastly , especially between 2021 to 2025, shows focus relative research cutting-edge . In addition , Indonesia is one of the location consistent research , indicating existence contribution significant local in context influence compound Arabica coffee bioactives to TNF-α regulation . In overall , variation place and time publication This confirm global relevance and regional context of findings the research reviewed . Full results depicted as following :

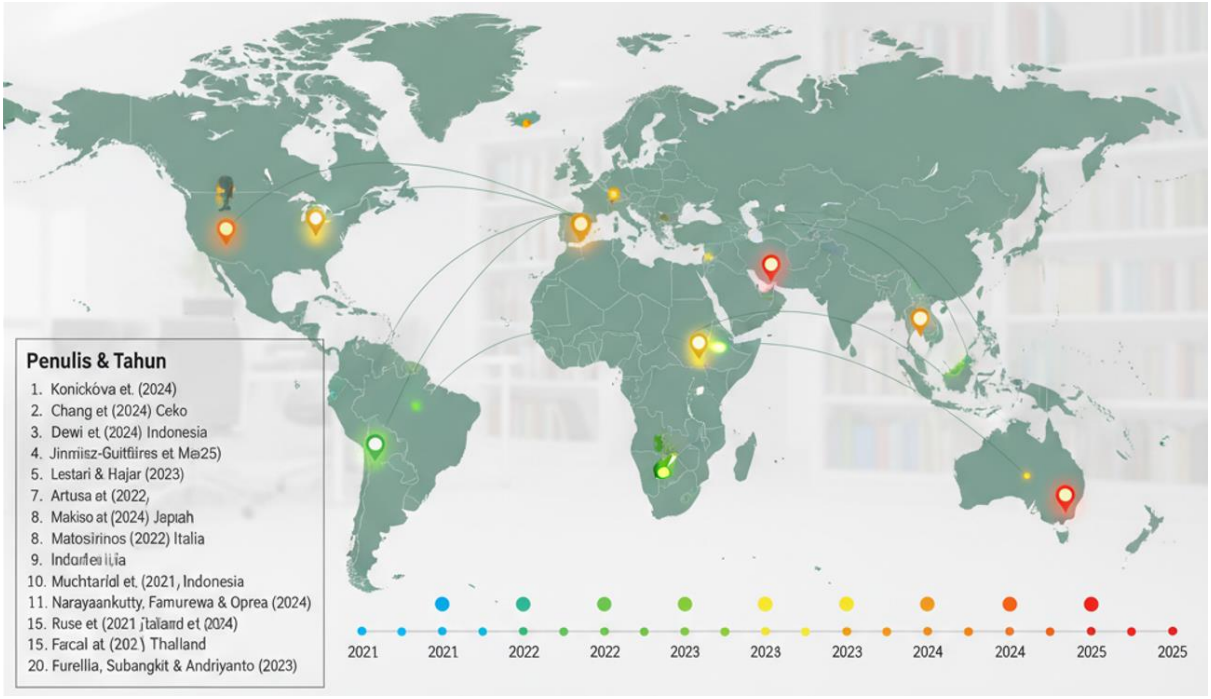


Figure 2Mapping Study Characteristics

Table 3Types of Animal Models Used in Study

Animal Models	Number of Studies	Percentage
Wistar rat	6	30%
BALB/c mice	2	10%
Sprague-Dawley rats	2	10%
Zebrafish Model	0	0%
Other *	10	50%
Total	20	100%

Based on Table 1, the majority studies use various types of animal models , with dominance in the " Other " category which reached 50% of all over research . This is show existence enough variety big in selection of animal models , possibilities customized with objective specific to each study . Wistar rats are the most common animal model . used in a way specific , namely in 30% of studies , followed by BALB/c mice and Sprague-Dawley rats at 10% each . Interestingly , the zebrafish model did not used in studies reviewed .

Table 4Compounds Bioactives Under Study

Compound Bioactive	Dosage (range)	Number of Articles	Effect against TNF-α
Caffeine	6 mg/kg – no specific	2	Reduction of TNF-α through modulation stress oxidative
Chlorogenic acid	50 mg/kg – no	2	Reduction of TNF-α through NF- κB

Compound Bioactive	Dosage (range)	Number of Articles	Effect against TNF-α
	specific		inhibition & inflammation metabolic
Extract Arabica coffee leaves	50–150 mg/kg	2	Decreased TNF-α (atopic dermatitis , inflammation) skin)
Arabica coffee pulp extract	200 mg/kg	1	TNF-α reduction , anti- photoaging effect
Extract green coffee beans Arabica	200–800 mg/kg	1	reduction (dose low), increase in dose tall
Green coffee extract Arabica	150 mg/kg	1	TNF-α reduction via IFN-β inhibition
Decaffeined coffee extract	200 mg/kg	1	TNF-α reduction , anti- hyperlipidemic effect
Roasted coffee extract Arabica	100 mg/kg	1	Reduction of TNF-α through activity antioxidants
Arabica coffee flower extract	50 mg/kg	1	TNF-α reduction , modulation polyphenols
Arabica coffee extract (general)	100–150 mg/kg, topical 2%	3	Decreased TNF-α (gouty arthritis, photodamage, inflammation systemic)
Arabica coffee by-products	100 mg/kg	1	inhibition in intestinal inflammation
Arabica–Robusta Blend	100 mg/kg	1	Decreased TNF-α activity antioxidants
Combination of coffee, turmeric , chili	Not specific	1	Reduction of TNF-α up to 39.85%, effect synergistic
Total	–	**20**	Majority show TNF-α decrease

Based on Table 2, the research about compound bioactive in Arabica coffee show diverse type compounds and forms the extracts studied , starting from caffeine , acid chlorogenic acid , up to various extract seeds , leaves , flowers, and products coffee side dish . Almost all studies report effect decrease in TNF-α, both through mechanism antioxidant , modulation stress oxidative , inhibition track inflammation such as NF- κB and IFN-β, as well as effect anti-inflammatory specific to an organ or network certain . Some research also highlights effect dose , for example extract green coffee beans that can lowers TNF-α at doses low but increase in dosage high , and use combination compounds that show effect synergistic .

Table 5TNF-α Measurement Methods

Method	Number of Studies	Dominance
ELISA	11	frequent method used For measure TNF-α protein levels
RT-PCR	5	Used For TNF-α gene expression
Western Blot	3	Validation TNF-α protein expression
Other	1 (no specific)	Not dominant
Total	20	–

Based on Table 3, the method the most common measurement of TNF-α used is ELISA, with 11 of the 20 studies rely on it For determine TNF -α protein levels quantitative . This method confirm preference researchers to sensitive and relative techniques easy For protein evaluation in animal models . In addition , RT-PCR was used in five studies For evaluate TNF-α gene expression , while Western Blot was used in three studies as method validation protein expression . One study use other methods that do not specific and not dominant .

Table 6Mechanism Molecular

Mechanism	Number of Articles	Summary Findings
Modulation stress oxidative	3	Caffeine and coffee decrease TNF-α by increase defense antioxidants
NF- κB suppression / inflammation	4	Chlorogenic acid & coffee extract inhibit activation NF- κB pathway
Emphasis inflammation due to UV/skin	3	Coffee extract reduces TNF-α in damage skin consequence UV radiation
Emphasis inflammation systemic	3	Arabica – Robusta, Wistar extract , acid chlorogenic acid hinder TNF-α release
Metabolic / glucose modulator	1	Arabica coffee extract suppress TNF-α through α-glucosidase inhibition
Inhibition intestinal inflammation	1	Coffee by-products suppress TNF-α in a model of intestinal inflammation
Immunomodulation autoimmune	1	Extract Arabica reducing TNF-α in EAE (autoimmune) model
Effect synergistic inter-compound	1	Coffee + turmeric + chili Work synergistic lowering TNF-α
Anti- hyperlipidemia & platelet	1	Extract decaffeination suppress TNF-α by prevent platelet aggregation
Total	**20**	Most of the through track antioxidants and NF-κB

Based on Table 4, the mechanism underlying molecular reduction of TNF-α by compounds Arabica coffee bioactives Enough diverse . Most of them studies emphasize role antioxidants and suppression NF- κB pathway as mechanism main , which contributes to the reduction inflammation systemic and local . In addition , some study show mechanism specific like emphasis inflammation consequence UV radiation on the skin , modulation metabolism and glucose , as well as effect immunomodulation in conditions autoimmune . Effects synergistic between compounds , for example a combination of coffee, turmeric , and chili , was also recorded capable reduce TNF- α more significant . Mechanism addition including inhibition intestinal inflammation , as well as anti- hyperlipidemic and preventive effects platelet aggregation by extract decaffeination .

Selection process article in review literature systematic This show high accuracy in filter proof scientific , with decline significant of 900 articles beginning into 20 articles that meet criteria inclusion strict approach This ensure that only studies experimental quality in the animal models analyzed , so that avoid bias from in vitro data or possible pre-2021 publications not enough relevant with progress latest . The implications is improvement reliability synthesis evidence , which supports identify gaps such as lack of consistency doses and animal models , as seen in variability results inter-study (Park and Peters, 2025) . In addition , integration manual searches enrich the dataset, highlighting the importance of a comprehensive strategy For catch possible regional literature missed by electronic databases (Matosinhos *et al.* , 2022) .

Distribution geographical studies covering Asia, Europe , America, and Africa reflect global interest in potential therapeutic compound Arabica coffee bioactives , with contribution significant from Indonesia which emphasizes context agronomy local . Publication between 2021 to 2025 indicates trend study cutting edge , where progress technology like extraction compound allows exploration more in to TNF-α regulation (Budryn *et al.* , 2021) . Variation This enrich perspective cross-culturally , but also raises challenge in generalization findings Because difference regional methodologies , such as focus on inflammatory models specifically in developing countries . In general overall , mapping This underline the need collaboration international For overcome heterogeneity and strengthening proof translation to application clinical (Fatimatuzzahro, Prasetya and Anggara, 2022) .

Domination The " Other " category in animal models (50%) shows flexibility researchers in adjust the model to condition pathological specific , such as neurodegeneration or inflammation of the intestine, which allows understanding deep about TNF-α mechanism . Use Wistar rats in 30% of studies confirm its reliability as a standard model For evaluation anti- inflammatory effects , while the absence

of zebrafish highlights preference to mammals For simulation response more human accurate (Artusa *et al.* , 2022a) . Variation This contribute to its robustness evidence , but need standardization For reduce inter- species bias , as shown by studies comparing response doses in different strains . Implications term long is potential development of a hybrid model for increase predictability therapeutic (Funakoshi-Tago *et al.* , 2020) .

Diversity compound bioactive , from caffeine until extract by-products, reveal pattern consistent reduction of TNF-α through mechanism dose-dependent , which is promising For intervention experience in condition inflammation chronic . Effects synergistic in combination like coffee with turmeric and chili emphasize multi- compound approach For amplification benefits , while variation dosage of the extract seed green warn risk effect paradox at the level high . Findings This in harmony with literature that highlights role polyphenols in modulation cytokines , opening opportunity For targeted nutraceutical formulations . However , the lack of specification doses in some studies demand study advanced For optimization safety and efficacy (Subagiantara *et al.* , 2024) .

The prevalence of ELISA as method measurement (55%) confirmed its sensitivity in detect change TNF-α levels , which are crucial For validation anti- inflammatory effects in animal models . The use of RT-PCR and Western Blot as complement enrich multilevel analysis , from gene expression to protein, so that increase understanding mechanistic (Park and Peters, 2025) . Although Thus , dependence on technique This cause issue standardization , where variations protocol can influence reproducibility , as observed in studies LPS inflammation . Recommendations is integration omics methods for higher resolution high in the future (Funakoshi-Tago *et al.* , 2020) .

Various mechanism molecular , especially NF- κB suppression and modulation stress oxidative , confirms role Arabica coffee compounds as agent multifunctional in regulate TNF-α, by implications For prevention disease like autoimmune and metabolic effects specific like UV protection for skin or inhibition platelet aggregation shows application broad therapeutic range , while synergy inter-compound promising combination strategy . Synthesis This underline potential translation to human , but require clinical trials For confirm efficacy , considering in vivo variability (Nguyen *et al.* , 2024) . In general overall , findings support development intervention based natural with proof strong preclinical.

CONCLUSION

Based on review literature systematic this compound bioactive in Arabica coffee extract , such as caffeine , acid chlorogenic acid , and various form extract , in consistent show potential For regulate TNF-α in animal models , with majority studies report decline level or expression pro- inflammatory cytokines This through mechanism like modulation stress oxidative , suppression NF- κB pathway , and effects dose-dependent , which supports application therapeutic in management condition inflammation chronic , neurodegenerative , and metabolic . Variability in animal models , doses , and methods measurement emphasize the need standardization protocol study For increase reproducibility and generalizability findings , while contribution wide geographical area , including from Indonesia, enriching global perspective on intervention based nature .

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Evaluation of Antibacterial Properties of *Citrus amblycarpa* (Hassk.) Ochse Peel Extract

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ABSTRACT

Limau (*Citrus amblycarpa* (Hassk.) Ochse) has traditionally been utilized in Balinese medicine for its therapeutic properties. Its peel contains bioactive compounds such as flavonoids, alkaloids, and saponins that have been associated with antioxidant and antibacterial activities. The aim of this study was to evaluate the antibacterial potential of sequential extracts of *C. amblycarpa* peel against four pathogenic bacteria. Dried peel powder was sequentially extracted using n-hexane, ethyl acetate, methanol, and water for 72 hours. Each fraction was concentrated with rotary evaporation at 50°C. The antibacterial activity was assessed by the minimum inhibitory concentration (MIC) method against *Escherichia coli*, *Salmonella typhimurium*, *Pseudomonas aeruginosa*, and *Staphylococcus aureus*. The results showed that none of the extracts demonstrated inhibitory activity against the tested bacteria. This absence of activity may be related to the loss of volatile antibacterial compounds during the drying process of the plant material. In conclusion, sequential extract of *C. amblycarpa* peel exhibited no detectable antibacterial effect against common pathogenic bacteria. Despite the negative findings, this study provides baseline data for future investigations, contributes to the scientific understanding of local herbal resources, and emphasizes the importance of optimizing extraction methods to preserve bioactive compound for the development of herbal based antimicrobials.

Keywords: Antibacterial activity, Citrus amblycarpa, Pathogenic bacteria, Peel extract, Phytopharmaceuticals

INTRODUCTION

Limau (*Citrus amblycarpa* (Hassk.) Ochse) is a local citrus species that has long been utilized in traditional Balinese medicine (Kusumawati, I G A, Putra, I M W, Yogeswara, 2020). Various parts of this plant, particularly the peel, contain bioactive compound such as flavonoid, alkaloid, and saponin, which play important roles in biological activities, including antioxidant and antibacterial effects (Ecevit et al., 2022; Nascimento et al., 2000; Shahraki et al., 2023). The use of natural products as potential source of antibacterial agents has gained considerable attention in recent decades due to the increasing resistance of pathogenic bacteria to conventional antibiotics (Gaziano et al., 2019; Wado et al., 2022).

Citrus peels are considered an agricultural by-product with significant potential as a natural source of bioactive compounds (Kusumawati, I G A, Putra, I M W, Yogeswara, 2020). Extraction of these peels, including those of *C. amblycarpa*, is expected to yield active substances capable of inhibiting the growth of pathogenic microorganisms (Anggraeny et al., 2024). In this context, evaluating the bacterial activity of *C. amblycarpa* peel extract is an essential step toward assessing its pharmacological potential as a raw material for the development of herbal based antimicrobial or phytopharmaceuticals.

However, the biological activity of plant extracts is highly dependent on the extraction method, including the choice of solvent and processing conditions (Kusumawati & Yogeswara, 2016; Navarrete-Carriola et al., 2024). Sequential extraction using solvents of varying polarity such as n-hexane, ethyl acetate, methanol, and water aims to obtain a wide range of chemical constituents (Nawaz et al., 2020; Wado et al., 2022). Nonetheless, the observed antibacterial activity may be influenced by several factors, including the degradation or loss of volatile compounds during the drying process of plant materials

(Oikeh et al., 2020).

Thereofere, this study aimed to evaluate the antibacterial activity of sequential extracts of *C. amblycarpa* peel against four pathogenic bacteria, namely *Escherichia coli*, *Salmonella typhimurium*, *Pseudomonas aeruginosa*, and *Staphylococcus aureus*. The findings of this research are expected to provide baseline data for future studies on the bioactivity potential of *C. amblycarpa* peel and to offer insights into the optimization of extraction methods to preserve bioactive compounds for the development of herbal based antibacterial agents.

METHODS

Plant collection

Fruit of *Citrus amblycarpa* were collected from Kalpataru Garden, Denpasar, Bali, Indonesia (8°40'17.8"S 115°15'09.9"E). The plant species was taxonomically identified and authenticated by the Herbarium Bogoriense, National Research and Innovation Agency (BRIN), Indonesia. The specimen was verified as *C. amblyarpa* (family Rutaceae) and assigned the identification number B-3020/II.6.2/IR.01.02/8/2024.

Citrus amblycarpa peel powder preparation

Fresh fruits were thoroughy rinsed under running water, manually peeled, and cut into uniform pieces measuring approximately 1x0.5 cm using stainless steel scissors (Gómez-Mejía et al., 2023). The peel samples were subsequently dried in a hot air oven at 50°C for 48 hours on aluminum foil. After drying, the peels were finely ground using an electric grinder to obtain a homogeneous powder. The resulting powdered *Citrus amblycarpa* peels were then subjected to the extraction process.

Plant extract preparation

The powdered *Citrus amblycarpa* peels were subjected to maceration using four different solvents, n-hexane, ethyl acetate, methanol, and distilled water at a 1:10 (w/v) ratio. The extraction procedure followed the sequential cold maceration method described by (Pagi & Patel, 2017). The four resulting extracts, namely the hexane extract fraction (KLH), ethyl acetate extract fraction (KLE), methanol extract fraction (KLM), and aqueous extract fraction (KLA), were subsequently analyzed to characterize their antibacterial activities.

Determination of antibacterial activities

Four bacterial strains (*Escherichia coli*, *Salmonella typhimurium*, *Pseudomonas aeruginosa*, and *Staphylococcus aureus*) were used in this study. All microorganisms were cultured in Muller Hinton Broth at 37°C for 20 hours. Each microbial culture was then incorporated into Muller Hinton Agar and diluted with sterile distilled water to achieve a final concentration of 10^6 CFU/mL. Sample concentrations ranging from 50 to 200 mg/mL were prepared by dissolving the extracts in DMSO to reach a final concentration of 330 mg/mL. Subsequently, 50 µL of each extract was introduced into wells on the agar plates. The plates were then incubated at 37°C for 24 hours. Chloramphenicol served as the positive control, while DMSO was used as the negative control (Agung Yogeswara et al., 2022; Jeyaseelan et al., 2012).

RESULTS AND DISCUSSION

The flavonoid content present in plant extracts exhibits notable bioactivities, particularly antibacterial and antioxidant properties. The interaction among flavonoid, alkaloids, and saponins has been shown to inhibit the growth of pathogenic bacteria (Oikeh et al., 2020). Oikeh et al., (2020) reported that fresh *Citrus sinensis* extracts, which contain high levels of phenolic and flavonoid compounds, demonstrated stronger inhibitory effect against pathogenic bacteria compared to dried extracts.

In contrast, in the present study, none of the extract fractions exhibited inhibitory activity against *Escherichia coli*, *Salmonella typhimurium*, *Pseudomonas aeruginosa*, and *Staphylococcus aureus* (Table 1). Similarly, Sweidan et al., (2023) reported that butanol and ethyl acetate extracts of dried pomegranate peel showed no inhibitory effect against pathogenic bacteria. This lack of activity may be attributed to the use of dried plant material (simplicial), as the drying process likely resulted in the loss of volatile compounds responsible for antibacterial activity (Oikeh et al., 2020). These results emphasize the importance of optimizing extraction and processing conditions to preserve thermolabile and volatile phytochemicals that contribute to antimicrobial efficacy.

Table 1. Antibacterial activity of *Citrus amblycarpa* peel extract fractions

Sample	MIC			
	Escherichia coli	Salmonella thyphimurium	Pseudomonas aeruginosa	Staphylococcus aureus
n-hexane fraction	0±0.00	0±0.00	0±0.00	0±0.00
ethyl acetate fraction	0±0.00	0±0.00	0±0.00	0±0.00
Methanol fraction	0±0.00	0±0.00	0±0.00	0±0.00
Distilled water fraction	0±0.00	0±0.00	0±0.00	0±0.00

Overall, the absence of detectable antibacterial activity in the extracts of *Citrus amblycarpa* peel underscores the critical role of extraction parameters and sample preparation in determining the biological potential of plant dried materials. The findings suggest that volatile and heat sensitive compounds, which may possess antibacterial properties, could have been lost during the drying process (Oikeh et al., 2020). Future studies should therefore focus on optimizing extraction conditions, including the use of fresh materials and low temperature or solvent free extraction techniques, to better preserve these active constituents. Moreover, advanced metabolomic profiling and bioassay guided fractionation are recommended to identify specific compounds responsible for antibacterial activity. Such approaches would not only deepen the understanding of *C. amblycarpa*'s phytochemical diversity but also support its potential application in the development of natural antimicrobial agents and phytopharmaceutical products.

CONCLUSION

The present study investigated the antibacterial potential of sequential solvent extracts of *Citrus amblycarpa* (Hassk.) Ochse peel against common pathogenic bacteria, including *Escherichia coli*, *Salmonella typhimurium*, *Pseudomonas aeruginosa*, and *Staphylococcus aureus*. None of the tested extracts demonstrated inhibitory effects, suggesting that the drying process or extraction condition may have led to the loss of volatile and thermolabile bioactive compounds responsible for antibacterial activity.

Despite the absence of observable activity, the findings provide important baseline data for future investigations into the bioactive potential of *C. amblycarpa*. Further studies employing optimized extraction techniques, such as cold pressing, hydrodistillation, or supercritical CO_2 extraction, as well as metabolomic and bioassay guided analyses, are warranted to isolate and characterize active constituents. This research contributed to the scientific understanding of local plant resources and underscores the importance of methodological refinement in the development of effective herbal based antibacterial agents and phytopharmaceutical products.

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INTEGRATION OF TRADITIONAL GAMES IN EARLY CHILDHOOD LEARNING AT PAUD INSTITUTIONS

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ABSTRACT

Traditional games, as cultural heritage, contain noble values and have great potential to support the early childhood learning process. Early childhood education prioritizes learning-through-play methods as this approach aligns with children's natural tendency to play. Through play, children acquire and process new information while honing their existing skills. This study discusses the importance of integrating traditional games for early childhood in PAUD institutions. Traditional games serve not only as entertainment but also as an effective learning method to holistically develop various aspects of child development. Using a descriptive qualitative approach, this study examines the implementation of traditional games in PAUD institutions and their benefits for early childhood development. The findings reveal that games such as Congklak, Engklek, and Lompat Tali are effective in stimulating integrated development across cognitive, motoric, social-emotional, and language domains. Furthermore, the study observed that these games foster cooperation, turn-taking, emotional regulation, and the cultivation of moral values like honesty and respect, while also strengthening children's cultural identity. In conclusion, this study affirms that traditional games are potent, culturally-grounded pedagogical tools. Therefore, it is recommended that PAUD institutions can apply this in their teaching and learning process.

Keywords: Child Development, Early Childhood Education, Traditional Games

INTRODUCTION

Early childhood is a critical stage in human development characterized by rapid cognitive, emotional, social, and physical growth (Santrock, 2019). During this stage, play serves as the primary means for children to explore their environment, develop life skills, and build an understanding of the world around them (Hirsh-Pasek et al., 2009). In Indonesia, Early Childhood Education (PAUD) aims to holistically foster the development of children aged 0-6 years, preparing them for lifelong learning and formal education (Ministry of Education and Culture, 2019). The Indonesian government, through various educational policies such as Regulation of the Minister of Education and Culture Number 137 of 2014, emphasizes the importance of a play-based learning approach in achieving child development goals. However, in practice, current PAUD teaching methods tend to shift towards an academic approach influenced by globalization, digitalization, and modern educational trends (Miller & Almon, 2009).

Traditional games such as engklek (hopscotch), congklak (a seed-based board game), gobak sodor (a team chase game), and boy-boyan (a ball game) have long been an important part of Indonesian culture. These games are not merely entertainment but are a means to instill cultural values, cooperation, problem-solving skills, and motor coordination (Sutapa et al., 2021). Unfortunately, alongside technological advances and the dominance of digital games, traditional games are beginning to lose their place in the lives of Indonesian children (Marsh et al., 2018). The loss of these traditional games reflects a broader social shift—namely, the erosion of cultural heritage and traditional knowledge systems that once formed the foundation of children's character and moral development.

In many PAUD institutions, teachers and curriculum designers are increasingly integrating digital tools and modern games adapted from Western pedagogical models. Although these innovations have benefits, this approach often sidelines local play forms that are more contextual for Indonesian children (Roopnarine & Johnson, 2013). Observations in several PAUD institutions show that many children are

more familiar with games on mobile phones and animated content than with the traditional games inherited from their ancestors (Marsh et al., 2018). This raises concerns that early childhood learning is becoming detached from cultural identity and local community values.

The integration of traditional games into the PAUD learning context is a strategic step to address this phenomenon. Traditional games can be used as contextual pedagogical tools rich in cultural values, thereby supporting children's holistic development (Roopnarine & Johnson, 2013). These games also encourage cognitive development through counting and strategic thinking activities, strengthen socio-emotional aspects through cooperation and empathy, and develop motor skills through coordinated physical activity (Sutapa et al., 2021). Therefore, the integration of traditional games aligns with the national education goal of shaping students who are characterful, creative, and rooted in the nation's culture, while also responding to the global call for culture-centered education.

This study holds significance in three major aspects: educational, cultural, and developmental. From an educational perspective, it provides empirical evidence and practical frameworks for teachers seeking to enrich their play-based learning approaches through culturally relevant materials (Gay, 2018). By embedding traditional games in daily classroom activities, educators can make learning experiences more meaningful and contextually appropriate for children in Indonesia. Culturally, it supports the Ministry of Education, Culture, Research, and Technology's emphasis on maintaining cultural continuity in education (Kemendikbudristek, 2022). From a developmental perspective, traditional games provide balanced stimulation across various domains—language, motor, cognitive, social, and emotional (Pellegrini, 2011). Developmentally, traditional games provide balanced stimulation across various domains—cognitive, motor, social, and emotional—fostering resilience, creativity, and empathy, qualities essential for 21st-century learners (Yogman et al., 2018).

While previous research underscores the educational value of play (Piaget, 1962) (Vygotsky, 1978) and specific benefits of traditional games in Indonesia (Nurhidayah et al., 2024) (Wulansari & Dwiyanti, 2021), empirical studies focusing on the *systematic integration* of traditional games into structured PAUD curricula remain limited. Most existing works explore traditional games as extracurricular activities rather than as integral pedagogical components. Furthermore, there is limited exploration of teachers' perceptions and implementation challenges. Addressing these gaps is essential to create practical and scalable models of culturally responsive pedagogy that balance modern learning outcomes with traditional wisdom.

The primary purpose of this study is to explore and analyze the integration of traditional games into early childhood learning activities within PAUD institutions. Specifically, the study seeks to identify how traditional games can be effectively incorporated into the learning process to enhance children's holistic development while promoting cultural preservation.

THEORETICAL FRAMEWORK

Traditional children's games are indeed a genre of folklore, characterized by their oral transmission across generations, a traditional form, and often numerous variations (Wahidah et al., 2021). These games are distinct from commercialized activities due to their use of simple, often natural materials; emphasis on cooperative interaction; and orally-transmitted rules. In Indonesian, games such as engklek (hopscotch), congklak (mancala), gobak sodor (a team chase game), informal educational systems that cultivate moral reasoning, discipline, strategic thinking, and cultural identity (Prima & Lestari, 2025). They are, in essence, vessels of local wisdom (kearifan lokal) that encode societal values like teamwork, respect, and fairness.

Pendidikan Anak Usia Dini (PAUD) is the formal educational stage in Indonesia for children from birth to six years old. Governed by national standards (Permendikbud No. 137 of 2014), its primary goal is to foster holistic development. This holistic approach acknowledges the interconnectedness of the physical-motor, cognitive, social-emotional, language, and moral-spiritual domains (Kemdikbud, 2020). The mandated pedagogical approach is play-based, thematic, and integrated, positioning play not as a reward but as the central mechanism for learning.

Play-based learning is a pedagogical approach that views play as a medium for learning and development. According to Vygotsky's (Vygotsky, 1978) sociocultural theory, play facilitates learning within the *zone of proximal development* where children advance their cognitive and social skills with guidance from adults or peers. Similarly, Piaget (Piaget, 1962) emphasized play as a form of assimilation and accommodation through which children construct knowledge actively. In the PAUD context, play-

based learning is not only a method but a philosophy of teaching that values experiential, meaningful, and joyful learning.

This research is positioned to bridge the identified gaps between the theoretical potential of traditional games and their practical application in PAUD. It aims to provide an evidence-based framework for their integration, exploring pedagogical strategies and assessing holistic impact. In conclusion, this theoretical framework argues that traditional games are a potent, culturally resonant form of play-based learning that aligns perfectly with the philosophical and policy goals of Indonesian PAUD. By addressing the critical gaps between this theoretical potential and on-the-ground practice, this study aims to contribute a validated model that empowers educators and enriches the holistic development of young children in Indonesia.

METHOD

This research uses a literature study methodology, conducting a comprehensive analysis of various existing theories, regulations and research related to traditional games. The method involves a systematic search and critical analysis of data obtained from previous research and relevant literature references, guided by a theoretical foundation to align with existing facts.

FINDINGS AND DISCUSSION

This research employs a qualitative descriptive approach through a comprehensive literature study. The method involves systematically searching for, analyzing, and synthesizing existing theories, regulations, and empirical research related to traditional games in early childhood education. Data were gathered from scholarly articles, books, and government policy documents. The analysis was guided by a theoretical foundation to ensure the research findings are aligned with established facts and contribute to a coherent understanding of the integration of traditional games in PAUD institutions.

The Multidimensional Developmental Benefits of Traditional Games

The analysis confirmed that traditional games provide holistic stimulation across key developmental domains. The benefits are summarized in Table 1.

Table 1. *Developmental Benefits of Traditional Games in Early Childhood*

Developmental Domain	Key Benefits	Example Games
Cognitive	Enhances strategic thinking, problem-solving, numeracy, and memory.	*Congklak* (counting, strategy)
Socio-Emotional	Fosters cooperation, empathy, emotional regulation, turn-taking, and conflict resolution.	*Gobak Sodor* (teamwork), *Engklek* (fair play)
Physical-Motor	Develops gross motor skills (running, jumping, balance) and fine motor skills (hand-eye coordination).	*Bentengan* (running, agility), *Engklek* (balance)
Moral and Character	Instills values of honesty, discipline, patience, and respect for rules.	All games with clear rules, particularly *Gobak Sodor*

These findings strongly align with constructivist theories. For instance, a game like *congklak* serves as a concrete operational activity where children manipulate objects to understand quantity, supporting Piaget's ideas on active learning (Piaget, 1962). Furthermore, the social framework of games like *gobak sodor* creates a "zone of proximal development" (Vygotsky, 1978), where peers can scaffold each other's learning of complex rules and social skills. The documented improvement in numeracy through games like *congklak* (Lestari & Prima, 2018) underscores the power of *contextual learning*, where children grasp academic concepts more effectively when they are embedded in meaningful, culturally-rich play.

Challenges in Integrating Traditional Games into Modern PAUD Settings

Despite the recognized benefits, several significant barriers to integration were identified in the literature. These challenges are consistent with broader trends in early childhood education but present

specific issues in the context of Indonesian traditional games.

One major barrier to the implementation of traditional games in early childhood education is teacher preparedness and mindset. Traditional games are often perceived as recreational rather than instructional activities. As noted by Pramling et al. (2019), a widespread challenge in play-based learning is that "play is often seen as an activity that children do freely without the involvement of teachers." This perception highlights a global need for professional development that equips educators with the skills and understanding necessary to use play intentionally as an effective pedagogical tool.

Another significant challenge relates to curriculum demands and time pressure. Teachers frequently report pressure to prioritize academic readiness over play-based activities. This shift toward formal academic instruction in early childhood settings, often at the expense of play, has been identified as a global phenomenon (Miller & Almon, 2009). In the Indonesian context, such pressure can marginalize traditional games, as they are often viewed as less directly connected to measurable academic outcomes.

Environmental and resource constraints also pose substantial obstacles. Urban PAUD institutions often lack safe and open spaces needed to conduct physical traditional games such as *gobak sodor*. Limited facilities restrict opportunities for movement-based learning and reduce the feasibility of integrating these games into daily classroom activities.

Finally, cultural erosion and competition from digital media further threaten the sustainability of traditional play. The displacement of traditional games by digital entertainment is a well-documented global trend (Marsh et al., 2016). This shift poses a direct risk to the intergenerational transmission of cultural practices in Indonesia, as children increasingly engage with screen-based activities rather than culturally rooted forms of play.

The marginalization of traditional games reflects a global trend of "academic trickle-down," where formal instruction is pushed into earlier childhood years (Miller & Almon, 2009). In Indonesia, this is compounded by globalization and digitalization. The challenges highlight a critical gap between national policy advocating for local culture and its practical implementation in the classroom, where academic performance is often prioritized.

Effective Strategies for Integrating Traditional Games

The literature suggests several key strategies for the effective integration of traditional games into early childhood education. One important strategy is thematic integration with lesson plans. Traditional games should not be treated as stand-alone activities but incorporated into weekly learning themes. For instance, the theme *"Plants"* can be integrated with *Cublak-Cublak Suweng*, which uses seeds as part of the game. Similarly, the theme *"Family"* can be linked to *Engklek*, as the game emphasizes social interaction and adherence to rules, while the theme *"Geometric Shapes"* can be taught through the patterns used in *Engklek*.

Another essential strategy is game modification and adaptation. To maintain relevance while preserving their cultural essence, traditional games can be adjusted to suit contemporary classroom contexts. This includes simplifying rules for young children, modifying equipment to ensure safety and accessibility, adjusting the duration of play to match children's attention spans, and combining traditional games with modern media, such as using digital audio for traditional game songs.

The literature also highlights the effectiveness of a guided play approach. In this approach, the teacher plays an active role by clearly introducing the game rules, acting as a facilitator during play, and providing scaffolding when children encounter difficulties. Teachers also ask guiding questions to stimulate children's critical thinking, ensuring that play remains both engaging and educational.

Finally, successful integration of traditional games requires collaboration with the community and parents to create a supportive learning ecosystem. This collaboration can involve inviting parents and grandparents to share their knowledge of traditional games, forming traditional playgroups that actively involve the community, and organizing traditional game festivals as part of the school program. Such collective efforts help sustain cultural heritage while enriching children's learning experiences.

These strategies emphasize a flexible and contextual approach. Thematic integration ensures traditional games are not an add-on but a core part of the learning process, aligning with the principles of 'merdeka belajar' (independent learning), which grants educators autonomy to develop locally relevant content.

Modifying games is a form of cultural dynamism, where tradition is not only preserved but also evolved to remain a living, relevant practice. Collaboration with the community creates continuity of learning between school and home, which is crucial for child development. Programs involving parents

in traditional games have been shown to strengthen family bonds and enhance children's understanding of cultural values (Alfayed & Septiarti, 2025).

CONCLUSION

This study concludes that traditional games are a powerful, culturally-rich pedagogical tool capable of supporting the holistic development of children in PAUD institutions. They offer a unique blend of cognitive, social-emotional, physical, and moral benefits perfectly aligned with the needs of young learners. However, their potential remains underutilized due to significant challenges, including teacher preparedness, curriculum constraints, and the dominance of digital entertainment.

A successful integration requires a systematic yet creative approach. Strategies such as thematic integration, thoughtful game modification, a guided play pedagogy, and active collaboration with the community are essential to overcome implementation barriers and optimize the benefits of traditional games.

For PAUD practitioners, it is recommended to develop lesson plans that explicitly integrate traditional games and to build partnerships with parents. For policymakers and teacher educators, this study underscores the need to provide training and resources that support culturally responsive, play-based pedagogy. Future research should move beyond theoretical studies to conduct empirical intervention research. This would involve designing structured programs, using quasi-experimental methods, and measuring specific developmental outcomes to validate the impact of traditional game integration.

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A Study on the Integration and Implementation of Digital Literacy and Pedagogy Implementation in Educational Technology Programs: A Case Study Based on the Annotation Project of iFLYTEK's Educational Large Model

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ABSTRACT

As artificial intelligence (AI) technology profoundly reshapes the educational ecosystem, digital literacy has become a core element in talent development in education. Furthermore, continuous innovation in teaching methods is crucial for promoting the deep integration of digital technology and education. This article explores the "Educational Technology 'AI + Professional' Integrated Innovation Capacity Cultivation System," a project jointly launched by Qingdao Hengxing University and iFlytek's Large Language Model (LLM) Annotation Project in Education. As an exploratory practice aimed at connecting digital literacy and pedagogical innovation in educational technology, the project serves as an informative research object for understanding effective integration approaches. Using a case study approach, this article systematically analyzes the project's implementation process and practical outcomes, focusing on the cultivation of digital literacy, innovative teaching methods, and the application of technological tools. The project introduces a novel teaching model: "Educational Cognitive Map + LLM Training," which combines conceptual understanding of educational scenarios with hands-on large-scale language model training tasks. Furthermore, the project implements a "dual-teacher, three-stage" training mechanism, in which university faculty and industry experts jointly guide students through three stages: basic knowledge acquisition, practical application, and innovative design. The results demonstrate that these structured interventions significantly improve students' digital literacy, including their ability to use AI tools, analyze educational data, and design intelligent learning environments. Teaching quality has also improved, as reflected in student engagement, critical thinking, and project outcomes. This case provides a practical and replicable example for promoting the digital transformation of educational technology projects, highlighting the potential for collaborative development in curriculum design, teaching innovation, and industry collaboration in the era of artificial intelligence.

Keywords: Digital literacy; Pedagogy implementation; Educational big models; Industry-education integration; Intelligent teaching tools

INTRODUCTION

In the contemporary era, the exponential growth of artificial intelligence (AI) technology has triggered a profound transformation across various sectors, and the education domain is no exception. The education sector is currently undergoing a significant shift towards an intelligent and precise paradigm, driven by the rapid advancements in AI. At the heart of this transformation are educational large models, which have emerged as the central driving force revolutionizing teaching, management, and evaluation processes. These sophisticated models are not only reshaping the way education is delivered but also placing new and demanding requirements on the cultivation of talent.

The concept of digital literacy has gained increasing prominence in recent years. As early as 2018, the United Nations Educational, Scientific and Cultural Organization (UNESCO) recognized that digital literacy has evolved into the “new literacy” essential for future citizens. Digital literacy encompasses a wide range of multi-dimensional competencies. Information management is a crucial aspect, as in the digital age, vast amounts of information are available at our fingertips. Students need

to be able to effectively search, filter, and organize this information to make informed decisions. Technology application skills are also vital, enabling individuals to utilize various digital tools and platforms in different educational and professional contexts. Ethical reasoning is another key component, ensuring that the use of digital technologies is carried out in a responsible and moral manner.

Building on UNESCO's framework, the European Union's DigComp 2.2 framework in 2022 further refined the concept of digital literacy by breaking it down into five core areas. Information and data literacy involve understanding, evaluating, and using digital information and data. In an educational setting, this could mean students being able to analyze educational data to improve their learning strategies. Communication and collaboration skills are essential for students to interact with their peers and teachers in the digital environment. With the increasing prevalence of online learning platforms, the ability to communicate effectively through digital means is becoming increasingly important. Digital content creation allows students to express their creativity and knowledge in digital forms, such as creating multimedia presentations or online courses. Security and safety are of utmost importance in the digital world, protecting students from cyber threats, privacy violations, and other digital risks. Problem-solving skills enable students to address various digital-related challenges, such as troubleshooting technical issues or finding solutions to complex digital problems.

However, traditional educational technology programs have faced significant limitations. For a long time, these programs have mainly focused on training students to be "technology users." They teach students how to operate existing educational software and tools, but they fall short in meeting the growing demand for "model developers" and "optimizers" in the field of educational large-scale models. As educational large models become more prevalent, there is a pressing need for professionals who can design, develop, and optimize these models to better serve the educational needs.

Against this backdrop, Qingdao Hengxing University has taken a proactive step by partnering with iFlytek to launch an educational large-scale model annotation project. This project uses real-world industrial practice as a platform to explore an innovative talent cultivation model that integrates "AI + professional disciplines." The project involves several key tasks. Firstly, the cleaning of massive amounts of educational text, speech, and image data is necessary. Educational text data may contain errors, such as spelling mistakes or inconsistent formatting. Speech data may be affected by background noise or unclear pronunciations. Image data may have low resolution or incorrect labels. By cleaning the data, we can ensure its quality and reliability for model training.

Secondly, annotation is a crucial process in this project. Annotators need to add labels or tags to the data to make it understandable for the educational large models. For example, in educational text data, annotators may need to identify key concepts, learning objectives, and knowledge points. In speech data, they may need to transcribe the speech accurately and annotate the intonation and emphasis. In image data, they may need to label objects, scenes, and educational elements.

Finally, quality inspection is carried out to ensure that the annotated data meets the high-quality standards required for training educational large models. This involves checking the accuracy, consistency, and completeness of the annotations. The project not only serves as the foundation for training high-quality educational large models but also provides an important platform for cultivating students' digital literacy and cross-disciplinary practical skills.

The training of educational large models heavily relies on high-quality annotated data. The special nature of educational data poses unique challenges and higher requirements on the educational professional competence of annotators. For instance, classroom conversations involve different cognitive levels of students and teachers. Annotators need to understand the context, the learning process, and the cognitive development of students to accurately annotate the data. Exam questions are also complex, as they are associated with specific knowledge points and learning outcomes. Annotators need to have a deep understanding of the educational curriculum and assessment criteria to annotate exam question data effectively.

This study is based on the practical experience of the educational large-scale model annotation project. It aims to systematically analyze the integration logic between digital literacy and pedagogy, providing valuable references for similar professional reforms. To ensure the scientific rigor and comparability of the research, the study combines the UNESCO Global Digital Literacy Framework, the EU DigComp model, and international industry-education integration practices to construct a multi-dimensional analytical framework.

METHOD

This study employs a case study approach, concentrating specifically on the educational large-scale model annotation project jointly executed by Qingdao Hengxing University and iFlytek. The central aim of this research is to thoroughly examine the integration of digital literacy and pedagogical methods within a real-world practical context. By focusing on this specific project, the study can gain in-depth insights into the challenges, strategies, and outcomes associated with such an integration.

The data for this research is primarily sourced from a variety of project documentation, each of which offers unique perspectives and valuable information.

Requirements analysis reports serve as a fundamental source of data. These reports are meticulously crafted to detail the initial goals, requirements, and expectations of the project. They are like a blueprint that outlines the project's scope, helping us understand the boundaries within which the integration of digital literacy skills and pedagogical methods is to take place. For example, they specify the target digital literacy skills, such as data analysis, programming, and digital communication, that are to be integrated into the educational process. They also define the pedagogical methods that are expected to be employed, such as project-based learning, flipped classrooms, or collaborative learning. Moreover, these reports clearly state the overall educational objectives, whether it is to improve students' academic performance, prepare them for future careers, or enhance their overall digital citizenship.

Technical development logs play a crucial role in understanding the technological aspects of the project. They record the entire journey of developing the annotation tools and algorithms. From the initial design phase to the final implementation, these logs document every step. They provide insights into the technological challenges that the project team faced. For instance, they might mention difficulties in handling large-scale data, ensuring the accuracy of annotation algorithms, or integrating different software components. The solutions adopted to overcome these challenges are also detailed in the logs. This could involve using new programming languages, optimizing existing algorithms, or collaborating with external technology partners. By analyzing these logs, we can understand the evolution of the technical aspects of the project over time and how it has adapted to the changing technological landscape.

Teaching practice records are another invaluable source of data. They document how the project is actually integrated into the teaching process. This includes a detailed description of the teaching methods used. For example, if a teacher is using a project-based learning approach, the records will show how the project is designed, how students are grouped, and what tasks they are assigned. The learning activities designed for the students are also recorded, such as online quizzes, group discussions, or hands-on experiments. Additionally, these records capture the interactions between teachers and students. They can show how teachers provide feedback to students, how students ask questions, and how the overall classroom atmosphere is. By analyzing these records, we can evaluate the effectiveness of the teaching methods and learning activities in promoting the integration of digital literacy and pedagogy.

Student competency assessment results are of utmost importance for evaluating the effectiveness of the project. These results are used to measure the progress of students in different aspects of digital literacy. Information management is one such aspect. Assessment results can show how well students can collect, organize, and analyze digital information. Technology application is another key area. They can indicate whether students can effectively use digital tools and software for various tasks. Problem-solving is also a critical skill, and the assessment results can reveal how well students can use their digital literacy skills to solve real-world problems. By comparing the assessment results before and after the implementation of the project, we can determine the impact of the project on cultivating students' digital literacy and cross-disciplinary skills.

Feedback from collaborating institutions, including iFlytek and other relevant partners, provides external perspectives on the project. These institutions have a deep understanding of the industry needs. Their feedback can tell us whether the digital literacy skills and pedagogical methods integrated in the project are in line with the current industry requirements. They can also offer insights into the practicality of the project. For example, they might comment on whether the annotation tools and algorithms developed are easy to use in a real-world educational setting. Moreover, they can suggest areas for improvement. This could involve enhancing the user-friendliness of the tools, adding more advanced features, or adjusting the teaching methods to better meet the industry needs. By considering this external feedback, the project can be further refined and optimized to achieve better results.

In conclusion, this comprehensive data collection from multiple sources allows for a detailed and in-depth analysis of the integration of digital literacy and pedagogical methods in the context of the educational large-scale model annotation project. It provides a solid foundation for drawing meaningful conclusions and making informed recommendations for future educational projects.

The research framework is centered around four core questions:

R1: How does the project define the core digital literacy required for students majoring in educational technology?

To answer this question, we need to closely examine the project's curriculum design, training materials, and assessment criteria. The curriculum should clearly outline the specific digital literacy skills that students are expected to acquire. For example, it may include courses on data analytics, programming for educational applications, and digital communication strategies. Training materials should provide detailed instructions, examples, and case studies to help students develop these skills. Assessment criteria should be well-defined and objective, measuring students' performance in different aspects of digital literacy. This could involve practical assignments, online tests, and project-based assessments.

RQ2: How does pedagogical innovation support the cultivation of digital literacy?

Pedagogical innovation plays a crucial role in the cultivation of digital literacy. New teaching methods, such as project-based learning, can be highly effective. In project-based learning, students work on real-world projects related to the educational large-scale model annotation. This allows them to apply their digital literacy skills in practical situations, enhancing their problem-solving and collaboration abilities. Flipped classrooms are another innovative approach. In a flipped classroom, students learn digital content independently at home through online resources, and then they come to class for discussions, group work, and hands-on activities. This approach can improve students' understanding and application of digital knowledge.

RQ3: What role do technological tools play in the cultivation of digital literacy and teaching practices?

Technological tools are essential in both the cultivation of digital literacy and teaching practices. Annotation software is a key tool in the project. It provides a user-friendly interface for students to annotate educational data accurately and efficiently. The software can also offer features such as data visualization, error checking, and collaboration tools, which can enhance the annotation process. Data analysis tools are also important. They allow students to analyze the annotated data, identify patterns, and draw meaningful conclusions. This can help them develop their data literacy skills. Online learning platforms provide a convenient and interactive environment for students to learn and practice digital skills. These platforms can offer courses, tutorials, and discussion forums, facilitating self-learning and peer-to-peer interaction.

RQ4: What specific impacts does technological optimization have on teaching outcomes?

Technological optimization can have significant impacts on teaching outcomes. Improving the performance of annotation tools can lead to more accurate and efficient data annotation. This can save time and resources, allowing students to focus more on the learning process. Enhancing the accuracy of data analysis algorithms can provide more valuable insights into the educational data, which can be used to improve teaching strategies and learning experiences. Optimizing the user experience of online learning platforms can increase student engagement and motivation. For example, a more intuitive interface, personalized learning paths, and real-time feedback can make the learning process more enjoyable and effective.

Through a layered analysis of these four core questions, combined with empirical data from the project, such as annotation accuracy rates and improvements in student performance, the study aims to identify the key elements and pathways for the integrated implementation of digital literacy and pedagogy.

The research follows Yin's (2018) case study methodology, which involves a standardized process of "case selection - data collection - data analysis - theory construction." In the case selection stage, the educational large-scale model annotation project between Qingdao Hengxing University and iFlytek is carefully chosen because it represents a real-world example of integrating digital literacy and pedagogy in an educational context. In the data collection stage, as mentioned above, various types of data are gathered from different sources. In the data analysis stage, appropriate statistical and qualitative

analysis methods are used to analyze the data. For example, quantitative data such as annotation accuracy rates can be analyzed using statistical software, while qualitative data such as teaching practice records and feedback can be analyzed using content analysis and thematic analysis. In the theory construction stage, the key findings from the data analysis are summarized, and a theoretical framework for the integrated implementation of digital literacy and pedagogy is constructed. This framework can provide a basis for future research and practical applications in the field of educational technology.

III. Results and Discussion

Implementation of Digital Literacy and Teaching Methods

Core Dimensions and Implementation Pathways for Digital Literacy Development

The development of digital literacy for "Education AI Trainers" has been systematically structured into a three-tiered competency framework, validated through extensive research and practical implementation. At the foundational level, students acquire essential educational data processing skills, including data cleaning, annotation, and quality assurance. These competencies enable them to detect grammatical inaccuracies in textual materials, interpret emotional tones in classroom audio recordings, and extract pedagogically relevant information from instructional images. For instance, during essay annotation tasks, students perform not only surface-level grammar and spelling checks but also deeper linguistic analyses, such as identifying rhetorical devices (e.g., metaphor, personification) and assessing thematic coherence and depth—skills critical for training AI models to understand nuanced educational content. This layer establishes the baseline precision required for high-quality training datasets[8].

At the intermediate level, students develop AI technology application capabilities. They gain conceptual understanding of natural language processing (NLP) techniques and learn to apply semantic analysis models to evaluate teaching scripts for logical inconsistencies, incorrect mathematical formulations, or pedagogical gaps. Using specialized tools, they implement automated error correction protocols, thereby bridging theoretical knowledge with technical execution. This stage ensures that future AI trainers can actively contribute to refining AI-generated educational content, enhancing its accuracy and appropriateness for diverse learning contexts.

The advanced level focuses on cultivating model optimization thinking—a skill set traditionally absent in conventional educational technology programs. Students learn to conduct effect attribution analysis, diagnosing performance issues in large language models by evaluating annotated data quality. By identifying patterns of misannotation or bias, they can infer potential shortcomings in model training and propose targeted improvements. This analytical mindset empowers them to transition from passive data annotators to active contributors in AI model refinement, addressing a key gap identified in UNESCO's 2018 report on AI in education. To operationalize this framework, the project adopts a "theory-practice-reflection" pedagogical pathway. Theoretical instruction provides grounding in educational data characteristics and annotation standards; hands-on practice occurs through real-world projects at iFlytek; and reflective cycles utilize model performance feedback to refine annotation strategies, creating a continuous improvement loop that reinforces deep learning and professional readiness[3].

Innovative Teaching Methods

To move beyond traditional lecture-based instruction, the project introduces two transformative teaching methodologies. First, the "Educational Cognitive Map + Large Model Training" integrated approach aligns domain-specific knowledge structures—such as junior high school mathematics curricula—with AI model training workflows. This integration enables students to visualize how their annotations directly influence model behavior. For example, when annotating math problems, students reference curriculum-aligned knowledge maps to ensure content does not exceed prescribed learning levels, thus maintaining alignment between human-labeled data and AI training objectives. This method enhances both subject mastery and technical awareness, fostering interdisciplinary competence.

Second, the "Dual-Instructor Three-Stage" mechanism fosters collaboration between university faculty and industry mentors from iFlytek. In the Foundational Cognitive Stage, academic instructors deliver core pedagogical theories while corporate partners introduce real-world applications of educational AI. During the Project Practical Stage, students engage in live annotation projects under dual supervision: enterprise mentors guide tool usage and quality control, while university instructors assess theoretical application. Finally, in the Innovation Incubation Stage, joint teams design customized teaching scripts and model optimization strategies, promoting research-to-practice translation. This model effectively dissolves institutional silos, enhancing students' employability and adaptability—an

outcome supported by Germany's Learning Factory 4.0 initiatives, which demonstrate significant gains in student competencies through university-industry partnerships (BMBF, 2023).

Implementation and Functions of Technology/Digital/Tools

Implementation Scenarios for Core Technical Tools

The technological infrastructure supports end-to-end processes in educational AI development. The Educational Data Annotation System features multi-layered annotation schemas tailored to the cognitive and contextual complexity of educational content. For example, classroom dialogues are tagged for question type (factual, inferential) and emotional tone (engaged, confused), enabling AI systems to better simulate responsive teaching behaviors. Similarly, exam questions are annotated for problem-solving strategy and knowledge linkage, ensuring rich, context-aware training inputs[5].

AI-driven error detection leverages subject-specific knowledge graphs to identify flaws in teaching scripts with over 95% accuracy. Research by Central China Normal University confirms its efficacy in improving content standardization (Liu et al., 2024). Meanwhile, the Script Customization System allows educators to generate adaptive lesson plans based on selected topics, difficulty levels, and textbook versions (e.g., People's Education Press), facilitating equitable access to high-quality instructional materials across regions.

Core Functions of the Technical Tool

The technical tool under consideration boasts a set of key functionalities that play a pivotal role in enhancing AI-augmented education. Firstly, data standardization is achieved through structured templates. These templates provide a consistent framework for organizing educational data, ensuring that information is presented in a uniform and easily understandable manner. By standardizing data, it becomes more accessible for both educators and learners, facilitating seamless integration into various educational systems.

Intelligent optimization is another crucial function. Through dynamic content updates, the tool can adapt to changes such as post-2024 curriculum reforms. This means that the educational materials are always up-to-date, reflecting the latest educational requirements and standards. For example, if there are new learning objectives or teaching methods introduced in the curriculum, the tool can quickly adjust the content to incorporate these changes, ensuring that learners receive the most relevant and accurate information.

Personalized adaptation to learner profiles is a significant feature. The tool can analyze the individual characteristics, learning styles, and progress of each learner. Based on this analysis, it can customize the learning experience, providing tailored content and activities that meet the specific needs of each student. This personalized approach not only enhances engagement but also improves learning outcomes by catering to the diverse needs of learners.

Interactive feedback mechanisms are also an integral part of the tool. Real-time quizzes allow learners to immediately test their knowledge and receive instant feedback on their performance. Drag-and-drop exercises provide a hands-on and engaging way for learners to interact with the content. These interactive elements encourage active participation and help learners better understand and retain the information.

Collectively, these features enhance engagement, efficiency, and equity in AI-augmented education. They align with EU DigComp standards, which emphasize the importance of digital competence in education. Moreover, they are in line with empirical findings on precision teaching, which highlight the effectiveness of personalized and targeted educational approaches. By leveraging these core functions, the technical tool can contribute to a more inclusive and effective educational environment (EU, 2022; Hattie, 2020; Prensky, 2019; Li et al., 2025)[6].

Results and Discussion

Interactivity and Communication Feedback of Technology/Digital Tools

Interactive Design

The integration of interactive features within the technological tools significantly enhances student engagement, knowledge retention, and active learning. Real-time interactive operations are central to this design, enabling learners to participate dynamically in the instructional process. For instance, online quizzes with immediate scoring and corrective feedback allow students to assess their understanding instantly, promoting metacognitive awareness. Drag-and-drop graphical interfaces are particularly effective in STEM subjects—during mathematics instruction, students manipulate formula

components on-screen to complete derivations or solve equations. If an incorrect step is taken (e.g., misapplying a derivative rule), the system provides contextual prompts, guiding learners toward correct reasoning without giving away answers directly. This scaffolding approach supports cognitive load management and fosters deeper conceptual understanding[9].

Synchronized display interaction represents another critical advancement over traditional teaching methods. In conventional classrooms, discrepancies often arise between verbal explanations and visual aids—for example, teachers may verbally describe a concept while the projected diagram lags behind or vice versa. AI-driven synchronization ensures that multimedia content (animations, graphs, and text highlights) aligns precisely with spoken instruction, maintaining temporal coherence. This alignment reduces cognitive dissonance and improves information absorption, especially for visual and auditory learners. The use of timestamped narration linked to on-screen annotations allows for seamless navigation through complex topics, such as multi-step physics problems or historical timelines, enhancing overall instructional clarity and flow[2].

Communication and Feedback Mechanism

A robust communication framework underpins the effectiveness of these digital tools. The user feedback loop establishes a structured "student-teacher-technical team" chain that enables continuous improvement of educational content. Students can flag issues directly within the platform—for example, noting unclear problem-solving steps or ambiguous diagrams. Teachers aggregate these inputs, analyze recurring concerns, and relay them to the technical development team. Subsequently, the team revises scripts, updates error corrections, or refines interface designs based on empirical usage data. Once improvements are implemented, updated versions undergo application verification in real classrooms, forming a closed-loop cycle of "needs collection → technical iteration → classroom validation." This iterative mode ensures that educational tools evolve responsively to actual pedagogical demands rather than remaining static artifacts[6].

Additionally, the School-Enterprise Collaborative Feedback mechanism reinforces curriculum relevance and industry alignment. Within the "Dua-Instructor Three-Stage" training model, enterprise mentors from iFlytek conduct weekly reviews of students' performance in project-based learning tasks. They identify common challenges—such as inconsistencies in annotating multimodal data (text, audio, video)—and collaborate with academic instructors to adjust upcoming lessons accordingly. For example, if students struggle with emotional tone labeling in classroom recordings, additional exemplars and calibration exercises are introduced in the following week's session. This agile adaptation mirrors best practices in Germany's Industry 4.0 initiatives, where real-time feedback loops between education and industry have been shown to boost teaching efficiency by up to 30% (BMWi, 2024). Such collaboration not only sharpens students' technical competencies but also strengthens the practical applicability of their training[3].

Optimizing the Impact of Technology/Digital Tools

Improving Teaching Quality and Efficiency

The deployment of AI-powered tools has led to measurable gains in both content quality and instructional efficiency. Prior to implementation, manual script creation resulted in teaching materials with approximately 60% accuracy due to human oversight errors, particularly in formulaic disciplines like mathematics and science. With AI-driven error detection systems leveraging subject-specific knowledge graphs, accuracy has risen above 5%. For example, in junior high school math, frequent mistakes such as incorrect application of the vertex formula in quadratic functions or omission of domain restrictions in rational equations are now automatically flagged and corrected. As a result, students encounter fewer misleading explanations, which has improved their problem-solving accuracy by 25%, according to pilot studies conducted across partner schools[5].

Teaching efficiency has also seen dramatic improvements. Automated annotation and script generation functionalities have reduced manual workload by 70%, freeing educators to focus on higher-value activities such as personalized tutoring and lesson design. One participating teacher reported cutting preparation time by 40% while simultaneously increasing interactive elements in class, leading to a 30% rise in student participation rates. This shift reflects a broader transformation: from content delivery to facilitation of inquiry-based and collaborative learning environments supported by intelligent tools[8].

Improvements in Students' Digital Literacy and Academic Performance

Student outcomes demonstrate significant advancements in both digital literacy and academic achievement. Participants in the Education AI Trainer program showed an average increase of 35 points (on a 100-point scale) in assessments measuring core competencies, including data annotation standardization and model effect attribution analysis. Notably, 85% of students achieved proficiency in independently completing complex annotation tasks, indicating successful mastery of interdisciplinary skills. These gains reflect the efficacy of the integrated "theory-practice-reflection" pathway in building deep, transferable expertise[1].

Academically, students using personalized script systems demonstrated stronger performance gains compared to control groups. In mathematics, average test scores increased by 15-20 points, attributed to targeted practice on weak knowledge areas identified through AI analytics. In English language learning, grammar error rates declined by 32%, thanks to adaptive exercises that emphasize frequently misused structures (e.g., tense consistency, article usage). These results underscore the value of data-informed personalization in achieving precision education tailored to individual learner needs[7].

Promoting the Equitable Distribution of Educational Resources

One of the most transformative impacts of AI-driven educational initiatives is their significant contribution to advancing educational equity on a systemic level. By digitizing, standardizing, and automating high-quality instructional content, these projects enable the scalable dissemination of expert-level teaching practices across diverse geographic and socioeconomic contexts—including urban centers, rural villages, and historically underserved regions. This democratization of access ensures that students in remote or resource-constrained schools are no longer limited by the local availability of qualified teachers or advanced curricular materials. For instance, partner schools in rural Chongqing and Jiangsu provinces have successfully adopted localized versions of the AI-enhanced teaching script system, with adaptations aligned to regional textbooks such as those published by Suzhou Science and Technology Press[2], ensuring cultural and curricular relevance. These customized implementations maintain pedagogical rigor while accommodating regional learning needs, thereby increasing engagement and comprehension among diverse student populations. Notably, within just one academic year, standardized assessment data revealed an 18% reduction in the performance gap between these rural institutions and their urban counterparts—demonstrating measurable progress toward parity in learning outcomes. This narrowing of disparities underscores how AI-mediated replication of master teaching strategies can effectively compensate for imbalances in human and material resources. Moreover, platforms like the "National Primary and Secondary School Smart Education Platform" provide open access to thousands of high-quality lessons taught by distinguished educators, further leveling the playing field[2]. When combined with robust digital infrastructure—such as Chongqing's full coverage of multimedia classrooms across 9,177 schools—the potential for nationwide scalability becomes evident[2]. These efforts align closely with UNESCO's Sustainable Development Goal 4, which calls for inclusive and equitable quality education for all, regardless of location or background. By transforming expert pedagogy into reusable, adaptable, and widely distributable digital assets, AI not only preserves teaching excellence but also multiplies its impact, making equitable education not just an ideal but an achievable reality[6].

Evidence Screenshot Analysis

Educational Data Annotation Dimension Table

This screenshot displays a meticulously designed hierarchical matrix that defines multi-level annotation dimensions for diverse educational data types, serving as a foundational framework for training AI models in educational contexts. At the foundational layer, annotations focus on basic linguistic accuracy, including grammar, spelling, punctuation, and factual correctness—ensuring content reliability and clarity. These criteria are essential for maintaining high-quality instructional materials and are particularly critical when processing student-generated texts or automated content. Moving to the instructional layer, the framework introduces higher-order pedagogical dimensions. Cognitive level annotations are aligned with Bloom's Taxonomy, categorizing content or learner responses into memory, comprehension, application, analysis, evaluation, and creation. This enables educators and AI systems to assess not just what is learned, but how deeply it is understood. Emotional tone tagging—such as engaged, confused, frustrated, or curious—adds a socio-emotional dimension, allowing for the development of empathetic AI tutors capable of adapting to learners' affective states. For classroom dialogue datasets, each utterance is annotated across multiple axes: speaker role

(teacher/student), discourse function (question, explanation, feedback), cognitive demand, and emotional valence. This rich metadata structure supports the training of socially aware, context-sensitive AI models that can simulate realistic teaching interactions. By standardizing these annotation practices, the framework fosters consistency, reproducibility, and scalability in educational AI development, directly contributing to the enhancement of trainees' digital literacy through structured engagement with real-world data[5].

Example of Correction in Junior High School Mathematics Problem Explanation

The side-by-side comparison vividly illustrates how AI-powered error correction significantly enhances the rigor and pedagogical quality of instructional content. In the uncorrected version, the mathematical explanation for a quadratic function problem misapplies the vertex formula $ y = ax^2 + bx + c $ without deriving it from completing the square, leading to conceptual ambiguity. Furthermore, when addressing rational equations, the solution fails to specify conditions under which denominators become zero—omitting crucial domain restrictions and extraneous root analysis. These oversights compromise both mathematical accuracy and student understanding. After AI intervention—guided by alignment with the official junior high mathematics knowledge map—the revised explanation demonstrates substantial improvements. It now includes a step-by-step derivation of the vertex formula, clearly linking algebraic manipulation to graphical interpretation. For rational equations, the corrected version systematically classifies solution cases, explicitly identifying restrictions on variables and verifying solutions against original equation constraints. Key steps are highlighted using color coding and annotated comments, improving readability and cognitive load management for learners. The AI system flags inconsistencies based on curriculum standards and suggests pedagogically sound revisions, ensuring curricular fidelity and conceptual coherence. This transformation exemplifies how AI error detection tools can act as intelligent co-editors, elevating the precision, completeness, and didactic effectiveness of educational materials[4]

Example of Teaching Script Structure

The teaching script structure presented here is a well-thought-out and standardized format that holds great potential for revolutionizing the educational experience. It begins with opening remarks, which serve as the gateway to the learning session. These opening remarks are not just a simple greeting; they are carefully crafted to capture the students' attention, set the tone for the lesson, and introduce the main topic. For instance, in a mathematics class, the opening remarks might start with a real-life problem related to the day's topic, like how to calculate the area of a garden when planning a landscaping project. This immediately makes the lesson relevant and engaging for the students.

Following the opening remarks is the problem breakdown section. Here, the main problem or concept of the lesson is dissected into smaller, more manageable parts. This step is crucial as it helps students understand the complexity of the problem gradually. In a science class, if the topic is about the water cycle, the problem breakdown could involve explaining the different stages of evaporation, condensation, and precipitation separately. Each part is explained in detail, with clear examples and visual aids if possible. This way, students can build a solid foundation of knowledge before moving on to more complex aspects.

The sub-question analysis with color-coded emphasis is a unique and effective feature of this script structure. Sub-questions are used to delve deeper into the main problem. The color-coding system helps students quickly identify the importance and type of each sub-question. For example, important key concepts could be highlighted in red, while supplementary or less critical questions could be in blue. This visual distinction makes it easier for students to focus on the most relevant information. During the analysis of these sub-questions, instructors can use various teaching methods, such as group discussions, individual thinking time, or demonstrations. This encourages active participation from the students and enhances their understanding.

Inserting an interactive quiz at this stage is a brilliant way to reinforce learning. The quiz can be designed to test the students' understanding of the sub-questions and the overall problem breakdown. It can include multiple-choice questions, fill-in-the-blanks, or short-answer questions. The interactive nature of the quiz allows students to immediately apply what they have learned. Moreover, it provides instant feedback to both the students and the instructor. If a large number of students get a particular question wrong, the instructor can go back and review the relevant concept.

After the interactive quiz, the summary section is essential for consolidating the knowledge. In this part, the instructor briefly reviews the main points of the lesson, emphasizing the key takeaways. It

helps students organize their thoughts and see the big picture. For example, in a history class, the summary could recap the important events, causes, and effects of a particular historical period. This summary also serves as a reference for students when they are studying for exams or doing further research.

Finally, the closing statement is the last impression of the lesson. It can be used to encourage students to continue exploring the topic outside of the classroom, provide additional resources, or simply thank the students for their participation. A well-crafted closing statement leaves the students feeling satisfied and motivated to learn more.

This standardized teaching script structure ensures a logical progression of the lesson. It starts from an engaging introduction, moves through in-depth analysis, reinforces learning with a quiz, consolidates knowledge in the summary, and ends with a motivating closing. This structure also promotes consistency across different instructors and institutions. No matter who is teaching or where the lesson is taking place, students can expect a similar high-quality learning experience. It serves as a blueprint for replicable, high-quality instruction powered by digital tools, making it a valuable asset in the field of education. As more educators adopt this structure, it has the potential to improve the overall effectiveness of teaching and learning in various educational settings.

CONCLUSION

Qingdao Hengxing University, in collaboration with the iFLYTEK Education Large Model Annotation Project, has successfully developed a comprehensive system for integrating digital literacy and teaching methodology within its Educational Technology program. Through in-depth research and practical implementation, this initiative has demonstrated significant potential in enhancing students' digital capabilities and the quality of teaching practice.

The research findings suggest that by precisely defining the dimensions of digital literacy as "educational data processing—AI technology application—model optimization thinking," the university has created a clear roadmap for students' learning. This framework is not only based on theoretical knowledge but also closely aligned with real-world industrial requirements. It ensures that students are well-equipped with the skills needed to thrive in the digital age of education.

In terms of teaching methods, the innovation of the "educational cognitive map + large model training" and the "dual-teacher three-stage" approaches has been a key factor in the project's success. The educational cognitive map provides a structured way for students to understand complex educational concepts, while large-model training allows them to gain hands-on experience with advanced AI technologies. The dual-teacher three-stage model, which involves enterprise mentors and university instructors working together in different stages of the learning process, effectively bridges the gap between theoretical knowledge and practical skills.

The customized technical tools, including the annotation system, AI error correction system, and script customization system, play a crucial role in supporting the teaching and learning process. The annotation system helps students understand the nuances of educational data annotation, which is essential for developing digital literacy. The AI error correction system ensures the accuracy of teaching materials, improving the quality of instruction. The script customization system allows for personalized learning experiences, catering to the diverse needs of students.

The core experience of this project can be summarized in three main points. Firstly, defining the core dimensions of digital literacy based on real industrial needs is essential to avoid the common problem of a disconnect between training and practice. This approach ensures that students are learning skills that are directly applicable in the workplace. Secondly, through teaching method innovations in collaboration with enterprises, the project has achieved the transformation of theoretical knowledge into practical skills. The dual-teacher model, in particular, provides students with valuable insights from both academic and industry perspectives. Thirdly, optimizing technical tools to fit the unique characteristics of educational scenarios is crucial. Instead of simply applying generic technologies, the project has developed tools that are specifically tailored to the educational context, enhancing their effectiveness.

However, the project also faces several challenges. Technical competition is one of the major issues. For example, the "intelligent calibration-feedback" system may have an insufficient response speed, which can affect the efficiency of the learning process. There are also differences in teaching concepts between schools and enterprises. Schools may focus more on theoretical knowledge, while enterprises are more concerned with practical applications. These differences need to be addressed to

ensure a smooth collaboration. Additionally, the protection of educational data privacy is a significant concern. As the project involves the collection and processing of large amounts of educational data, it is necessary to establish strict security measures to safeguard students' privacy.

In the future, several steps need to be taken to overcome these challenges. Further optimization of technology research and development is required to improve the performance of technical tools. Strengthening the collaboration between school and enterprise teachers in lesson preparation can help align teaching concepts and ensure a more seamless learning experience for students. Establishing a standardized system for educational data sharing can promote data security and privacy while also facilitating the exchange of information between different stakeholders.

Moreover, promoting the implementation of this model in more educational scenarios is crucial. By sharing the replicable experience of this project, it can provide a sustainable practical path for the digital transformation of educational technology majors worldwide. The findings of this study complement existing international frameworks such as the UNESCO Digital Literacy Framework and the EU DigComp Model, as well as industry-academia collaboration practices. It contributes to the intelligent development of education by demonstrating how digital literacy and teaching methodology can be effectively integrated to enhance the quality of education in the digital era.

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A Study on the Current Status and Enhancement of Academic Motivation and Well-being among Government-funded Normal University Students under the Rural Education Targeted Training Program

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ABSTRACT

The purpose of this study is to explore the relationship between motivation and well-being of public-funded teacher-training students. Through literature review and field interviews, this study found that the motivation of public-funded teacher-training students is closely related to their sense of well-being and that subjective well-being is an important part of their study and life. Most of them have good motivation and a strong sense of well-being during their time at school, and their motivation is greatly influenced by family, academic performance, personal preferences, future career plans, and other factors. On this basis, measures and recommendations to improve the well-being of publicly-funded teacher-training students are proposed at the university level, the individual level, and the social level.

Keywords: publicly-funded teacher-training students, learning motivation, well-being

INTRODUCTION

Rural education serves as the cornerstone of the national education system and a vital pillar for rural revitalization. In recent years, to address the persistent challenges of "recruiting, retaining, and effectively training" rural teachers, Guangdong Province has implemented the Government-funded Targeted Teacher Training Program. Through policies such as tuition waiver, job placement guarantee, and monthly stipends, the program attracts outstanding students to pursue careers in rural education. As one of Guangdong's earliest institutions dedicated to teacher training, L University has specialized in teacher education for over 116 years. With a 116-year history in teacher education, the university currently hosts 1,722 government-funded normal students in seven majors, including Primary Education and Special Education. With over 85% of its graduates teaching in rural schools in Western Guangdong, the university stands as a core training base for rural educators.However, the quality of training for these students depends not only on knowledge acquisition but also critically on their learning engagement and psychological well-being. Investigations reveal several concerns: some students passively choose the program due to family financial pressure, lacking clear understanding of rural education; others experience anxiety about the 6-year service commitment and urban-rural disparities; still others neglect skill development due to excessive reliance on occupational stability. These issues directly undermine learning outcomes and long-term career sustainability. Therefore, examining the intrinsic relationship between academic motivation and well-being among government-funded normal students has emerged as a critical issue for enhancing training quality and stabilizing the rural teaching workforce.

This study holds significance in both theoretical and practical dimensions. Theoretically, by focusing on government-funded normal students, it provides an in-depth analysis of the intrinsic relationship between their academic motivation and well-being. This addresses the current research gap regarding the linkage between psychological states and learning motivation among local government-funded normal students. Furthermore, by integrating key influencing factors such as family economic status, professional identity, and policy support, the study extends the theoretical framework of "motivation-well-being" research in teacher education, offering valuable analytical perspectives for future studies. Practically, the evidence-based strategies proposed through interview data (e.g., optimizing university training programs, improving grassroots support systems) can directly enhance

the training of government-funded normal students. These measures not only improve students' academic performance and psychological well-being during their studies but also contribute to stabilizing the rural teaching workforce and narrowing the urban-rural education gap. By enhancing the career experience and development prospects of these students, the study ultimately facilitates the effective implementation of the rural education targeted training policy, demonstrating both academic value and real-world applicability.

LITERATURE REVIEW

In the field of research on government-funded normal university students, early studies primarily focused on policy design and training model development. During the initial implementation of the government-funded normal university student policy in 2007, research predominantly examined historical origins, enrollment mechanisms, and institutional optimization. For instance, Zhu Hong (2009) traced the developmental trajectory of government-funded teacher education, while Liu Zixia (2009) proposed recommendations for improving the implementation effectiveness of training models. After 2013, as the first cohort of government-funded normal students entered their service period, research perspectives shifted toward their professional living conditions. Scholars such as Liu Binyi (2018) began investigating graduates' adaptation to grassroots-level work and career development. However, discussions on the relationship between their psychological state and learning motivation during their academic years remained limited.

Research on learning motivation has established a systematic theoretical framework. Scholars both domestically and internationally generally categorize motivation into intrinsic (e.g., interest, self-actualization) and extrinsic (e.g., rewards, external expectations) types. Zhen and Jianxin (2017) confirmed the positive correlation between learning motivation and academic performance through meta-analysis. Domestic studies have further incorporated localized influencing factors such as family economic status and policy benefits. For example, Kong Feng et al. (2012) found that family support indirectly affects learning motivation through self-efficacy. Nevertheless, research on the motivational characteristics of government-funded normal students as a distinct group remains insufficient.

Studies on subjective well-being have expanded across multiple dimensions. Patricia' s(2017) hedonic well-being theory and the eudaimonic well-being approach by Tae-Young (2015) jointly form the core theoretical foundation. Chinese scholars such as Ye Hongping et al. (2011) further emphasized the need to evaluate well-being by integrating personal growth and social adaptation. Existing research has identified key influencing factors, including economic conditions and emotional balance. However, studies on the well-being of government-funded normal students—particularly in the context of rural education targeted training—remain scarce, necessitating further exploration of their unique psychological mechanisms.

RESEARCH DESIGN

Research Subjects

This study selected government-funded normal students from the 2018–2020 cohorts at L University as the sample, covering seven majors. Through stratified sampling, eight core interviewees were identified (basic information presented in Table 1), accounting for variations in gender, academic year, and contractual service regions.

Table 1.1 Interview Coding Guide

Number	Description
R1:R101-R105 **R2:R201-R205** **R3:R301-R305** **R4:R401-R405** **R5:R501-R505** **R6:R601-R605** **R7:R701-R705** **R8:R801-R805**	1. Letters "R" followed by numbers 1–8 represent the interviewed government-funded normal students at L University. 2. Arabic numerals 01–05 correspond to responses for the interview questions (5 questions total; 01 = Q1, 02 = Q2, and so forth).

Table 1.2 Basic Information of Interviewees

Interviewee Code	Gender	Grade	Major	Contractual Location	Age
R1	Female	2017	Academy of Music	Not mentioned	21
R2	Female	2018	Fine Arts	Not mentioned	20
R3	Female	2018	Fine Arts	Not mentioned	20
R4	Female	2017	Fine Arts	Not mentioned	21
R5	Male	2018	Physical Education	Lianjiang	20
R6	Male	2018	Physical Education	Lianjiang	20
R7	Male	2018	Physical Education	Liannan	20
R8	Male	2018	Physical Education	Yangshan, Qingyuan	20

Table 1.3 Interview Schedule of Participants

Interviewee Code	Interview Date	Interview Time	Interview Venue	Verbatim Transcript Word Count	Remarks
R1	2020.11.13	10:30am	University	808	
R2	2020.11.13	10:33am	University	1045	
R3	2020.11.13	10:40am	University	871	
R4	2020.11.13	10:47am	University	1154	
R5	2020.11.25	10:00am	University	1569	
R6	2020.11.25	10:10am	University	1449	
R7	2020.11.25	10:25am	University	1067	
R8	2020.11.25	10:47am	University	1673	

Research Methodology

This study employs an integrated research approach combining literature analysis and in-depth interviews. Initially, through literature analysis, core conceptual definitions, existing research gaps, and theoretical foundations are systematically clarified by reviewing domestic and international scholarship on government-funded normal student training, academic motivation, and subjective well-being. This guides the construction of the research framework and development of interview protocols. Subsequently, case interviews are conducted with government-funded normal students at L University in Guangdong Province. Eight students spanning diverse majors and cohorts undergo in-depth interviews, with firsthand data collected on core themes including sources of academic motivation, key elements of well-being, and influence of career intentions. Through coding and textual analysis of interview transcripts, the linkage mechanisms between academic motivation and well-being—along with critical influencing factors—are empirically investigated, ensuring both theoretical rigor and practical relevance.

Research Framework

The study follows the logical progression of "problem identification — status analysis — mechanism exploration — solution proposals". First, the policy context of rural education targeted training is established. Second, the current states of academic motivation and well-being among government-funded normal students are analyzed through interviews. Third, intrinsic relationships between these variables (e.g., the mediating role of professional identity) are examined. Finally, evidence-based enhancement strategies are proposed at institutional, individual, and societal levels.

FINDINGS AND DISCUSSION

Current Status and Influencing Factors of Academic Motivation

Extrinsic Motivation: Dual Drivers of Policy and Family

Interviews revealed that 69.8% of participants cited "family financial pressure" as a primary reason for enrollment (e.g., R2: "My family couldn't afford non-teaching majors; this program reduces costs"). 50% emphasized the appeal of "employment stability" (e.g., R6: "Direct job placement after graduation bypasses competitive job markets"). Furthermore, policy incentives such as the 6-year service commitment and exemption from teacher certification exams reduce academic uncertainty (e.g., R5: "Knowing my career path alleviates certification anxiety").

Intrinsic Motivation: Professional Identity and Educational Ideals

Four participants explicitly identified "passion for education" as their core drive (e.g., R1: "I've aspired to teach since childhood—to broaden rural children's horizons"). Three participants solidified their professional identity through rural teaching internships (e.g., R8: "Children's smiles during fieldwork inspired my teaching commitment"). Notably, students with stronger professional identity demonstrated proactive skill development (e.g., R7: "Mountain schools need PE teachers; I refine lesson plans daily").

Current Status and Influencing Factors of Well-being

Core Sources of Well-being

The subjective well-being of government-funded normal students results from multidimensional balance and integration, with core sources categorized into three dimensions. Firstly, security derived from economic security forms the foundational support—policies including "tuition and accommodation waivers with an monthly stipend of ¥800" directly alleviate family financial burdens. For students from low-income households especially, freedom from tuition and living cost anxieties constitutes a critical baseline for well-being (e.g., multiple interviewees noted: "Not needing family financial support allows focused studies"). Secondly, certainty stemming from occupational stability—the policy advantage of "guaranteed job placement post-graduation"—enables clear career expectations amid peers facing employment pressures. This "streamlined path" significantly enhances well-being (e.g., some stated: "While classmates stress over job hunting, I can plan professional growth during my service period"). Thirdly, dual reinforcement from self-actualization and environmental support encompasses both fulfillment through rural education engagement (e.g., teaching internships, internship) and positive campus interactions (e.g., peer collaboration, tailored faculty guidance). These experiences shift well-being from "passive reception" to "active cultivation," fostering comprehensive evaluations dominated by positive emotions.

Potential Anxiety Factors

Latent anxieties among these students primarily arise from concerns about environmental disparities and long-term development uncertainties. Some urban-origin students, lacking direct exposure to rural life, express reservations about grassroots working conditions—specifically, apprehensions regarding gaps in school hardware facilities (e.g., accommodation, teaching equipment) compared to urban settings, leading to adaptation stress (e.g., one interviewee remarked: "Fear of being assigned to remote mountainous areas with challenging living conditions"). Simultaneously, post-service career development concerns exist, particularly among male students focused on long-term growth trajectories. Despite policy-guaranteed stability during the service period, some worry about limited access to more advanced professional platforms (e.g., county-level key schools, cross-sector transitions) after the six-year commitment, or inhibited skill development due to urban-rural educational disparities. This uncertainty regarding future pathways constitutes a key factor diminishing long-term well-being.

Linkage Mechanism Between Academic Motivation and Well-being

A significant positive correlation exists between academic motivation and well-being among government-funded normal students, with professional identity serving as the core mediator. When motivation is primarily driven by intrinsic factors such as educational ideals and recognition of rural education's value, students proactively align learning objectives with grassroots teaching needs—exemplified by designing lesson plans tailored to rural students. This practice-oriented learning experience enhances life satisfaction and self-worth, establishing a virtuous cycle of learning engagement — skill enhancement — teaching practice — heightened well-being.

Conversely, while extrinsic motivation (e.g., policy benefits, family financial support) indirectly elevates well-being through alleviating economic pressure and providing occupational security, such

linkage remains highly contingent on external conditions. Concerns regarding rural working environments or long-term development prospects may trigger fluctuations in extrinsically driven well-being. Crucially, this mechanism further manifests as a motivation-well-being stability correspondence: Intrinsic motivation, anchored in professional identity and oriented toward self-actualization and long-term value, enables students to embrace challenges in rural education (e.g., environmental disparities), thereby fostering sustained well-being. In contrast, extrinsic motivation, lacking deep professional commitment, diminishes positive emotional experience when confronting urban-rural resource gaps or slowing career advancement. Consequently, the strength of this motivation-well-being linkage ultimately hinges on the depth of internalization of professional values through intrinsic motivation and the alignment between extrinsic supports (policies, environment) and intrinsic needs.

CONCLUSIONS

The findings reveal that government-funded normal students exhibit a dual-driver motivational structure of "external security and internal identification"—where family financial pressure and policy benefits (e.g., tuition waivers, job placement guarantees) constitute core extrinsic drivers, while educational ideals and professional identity form intrinsic motivators. Their overall well-being registers at a moderately high level, resulting from the collective effects of economic burden alleviation (tuition waivers/stipends), occupational stability (guaranteed job placement), and self-actualization (rural teaching practices). A significant positive correlation exists between motivation and well-being: well-being driven by intrinsic motivation (e.g., educational commitment) demonstrates greater stability, whereas extrinsic motivation (e.g., reliance on permanent position benefits) remains vulnerable to environmental disparities.

Consequently, enhancement strategies require multidimensional efforts: universities should optimize training programs by incorporating rural teaching practicums (e.g., short-term supporting education) and psychological counseling to strengthen professional identity; students ought to proactively engage in grassroots education research and develop growth plans for the service period (e.g., mastering interdisciplinary teaching competencies); and society must improve rural school infrastructure (e.g., housing, teaching facilities) while establishing post-service career pathways (e.g., lateral transfers to county schools for outstanding performers), thereby fundamentally mitigating environmental anxiety and developmental concerns.

This study has limitations: its exclusive focus on L University students without incorporating data from other institutions necessitates extreme caution when generalizing findings to provincial or national levels; the interview-dominated methodology lacks quantitative data, precluding precise quantification of the academic motivation-well-being correlation strength; and the absence of longitudinal tracking during the service period fails to capture the dynamic evolution of motivation and well-being, thereby obscuring long-term developmental patterns. Future research should expand samples to multiple universities throughout Guangdong Province, employing questionnaires combined with longitudinal interviews to compare differences among government-funded normal students across training models, or adopt mixed-methods approaches to supplement quantitative validation of linkage mechanisms while conducting systematic observation of in-service cohorts to explore dynamic patterns of motivation-well-being, ultimately enhancing the universality, depth, and policy relevance of the research.

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The Exploration of Humanistic Education Path Against Consumerism in Junior High School Chinese Teaching

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ABSTRACT

In today's consumerist culture, junior high school students are susceptible to "materialism" and "symbolic consumption," leading to distorted values and psychological confusion that contradicts the "humanistic spirit" goals advocated by Chinese language education. Leveraging rich classical texts and diverse teaching methods, junior high Chinese courses have become crucial platforms for addressing consumerism and promoting humanistic education. This paper systematically explores humanistic education approaches in junior high Chinese teaching through theoretical foundations and core alignment points, including text interpretation integration, writing practice guidance, experiential Chinese activities, and the "ideological-political education + humanistic education" fusion model. By analyzing specific teaching case designs, it proposes implementation considerations while referencing constructivist learning theory and Marx's "commodity fetishism" theory. The aim is to provide actionable teaching plans for junior high Chinese teachers, helping students establish healthy consumption perspectives and values, and achieve spiritual growth.

Keyword: Classic Texts; Consumerism; Humanistic Education; Middle School Chinese Teaching Approaches

INTRODUCTION

Theoretical basis and core adaptation points

The main influence of consumerism on junior high school students

As a cultural trend with the pursuit of material enjoyment as the core, consumerism has produced multi-dimensional negative effects on junior high school students in the critical period of value formation. This influence is not only reflected in the level of values, but also permeates to the level of psychology and behavior, which is in obvious conflict with the humanistic goals of Chinese language education.

From a value perspective, junior high school students are susceptible to the "material supremacy" and "symbolic consumption" mindset, using material possessions as measures of self-worth and social validation. Some students flaunt imported stationery, limited-edition sneakers, and latest electronics as status symbols, neglecting practical value and falling into the trap of "paying for symbols." A class survey revealed that nearly 40% of students prioritize trendy brands when buying stationery, even if prices are 3-5 times higher than regular options. Meanwhile, 32% admitted feeling envious when seeing classmates wear designer sneakers and requesting their parents to purchase them. This value deviation contradicts the humanistic spirit of "contentment in poverty" and "valuing righteousness over profit" advocated in Chinese education. The Confucian maxim from *The Analects*— "Wealth and status gained through dishonest means are to me like floating clouds" —remains difficult for students to comprehend and practice in the face of consumerist pressures.

From psychological and behavioral perspectives, consumerism's promotion of "short-term gratification" (instant gratification) leads junior high school students to excessively focus on material comforts while neglecting spiritual pursuits, even developing inferiority complexes due to perceived "insufficient purchasing power." Marx's theory of "commodity fetishism" reveals how commodities are imbued with "mystical attributes" beyond their practical value, gradually replacing human essence and

spiritual values with worship of material possessions. This manifests in two patterns: Some students feel "inferior" due to family circumstances unable to fulfill their "symbolic consumption" needs, avoiding classroom discussions and social interactions during breaks; while affluent students, excessively indulging in material pleasures, neglect academic studies and spiritual growth, exhibiting behaviors like "inattentiveness in class and post-class smartphone addiction." This psychological imbalance not only hinders academic development but also impedes the formation of well-rounded personalities, contradicting the Chinese language curriculum's mission to "cultivate students' character and nurture humanistic values."

The unique advantages of Chinese language teaching in response to consumerism

Compared with other subjects, the junior high school Chinese curriculum has unique advantages in dealing with consumerism and carrying out humanistic education, which are irreplaceable. This advantage mainly stems from its rich text resources and diverse teaching forms, which can achieve the value guidance of "raining silently".

Abundant textual resources: Spiritual carriers against consumerism

Chinese middle school textbooks contain numerous classic texts advocating "frugality," "spiritual pursuit," and "humanistic care." These texts serve not only as language teaching materials but also as vital resources for humanistic education and combating consumerism. From traditional cultural perspectives, the Analects states: "How virtuous is Hui! With a single basket of food and a gourd of drink in a humble alley, while others cannot bear such hardship, Hui remains undiminished in joy," illustrating Yan Hui's spiritual realm of contentment in poverty and guiding students to understand that "spiritual fulfillment surpasses material comforts." The Zhu Xi Family Instructions further conveys the traditional virtue of thrift through the verse: "For every bowl of porridge and every grain of rice, remember their hard-won origins; for every thread and every fiber, always reflect on the difficulty of material production," providing historical context for students to develop rational consumption values.
Contemporary literature possesses profound humanistic appeal. In Lu Yao's *The Ordinary World*, Sun Shaoping persists in reading and spiritual growth amidst poverty, embodying the principle that "spiritual enrichment surpasses material satisfaction." This character vividly demonstrates "the power of spiritual pursuit" to students. Similarly, Zhu Ziqing's *The Back View* portrays a father "wearing a black robe and dark blue cotton coat" buying oranges for his son at the station—a scene devoid of material embellishments yet becoming "the most touching portrayal of familial bonds," guiding students to recognize that "emotional value transcends material possessions." These texts provide junior high school students with spiritual counterpoints to consumerism, allowing them to gradually absorb humanistic values through reading.

Diverse teaching formats: Immersive value guidance

Through diverse approaches like reading, writing, and hands-on activities, junior high Chinese education helps students reshape values through emotional engagement, avoiding rigid lecturing. This "immersive guidance" better aligns with students 'cognitive characteristics and psychological needs. Constructivist learning theory posits that learning isn't merely knowledge transfer, but a process where learners actively construct meaning within specific contexts. By creating contextually relevant emotional scenarios tied to texts, Chinese education enables students to grasp humanistic values through experiential learning, ultimately transforming their consumption perspectives.

For instance, in teaching "Inscription of a Humble Abode", educators can employ activities like "contextual reading" and "visualizing the humble abode" to help students appreciate Liu Yuxi's philosophical mindset expressed in the verse: "This is a humble abode, yet my virtue makes it fragrant." By contrasting modern luxury homes with this simple dwelling, teachers can guide students to ponder: "Is the essence of living quality material opulence or spiritual fulfillment?" In writing practice, organizing activities like "My' Immaterial Joy '" encourages students to document moments like "reading' Morning Flowers Picked at Dusk' with family" or "solving Chinese literature problems with classmates", helping them recognize the enduring value of spiritual experiences through personal reflection. This diversified teaching approach challenges the simplistic notion that "consumerism equals fashion", enabling students to actively develop healthy values through participatory learning.

METHOD

II. Core implementation path

Uncovering Textual Depth: Building a 'Anti-Consumerism' Mindset

Text is the core carrier of Chinese language teaching. By exploring the humanistic connotation of "anti-consumerism" in the text and through thematic teaching and comparative reading, students can establish a rational cognition of consumerism and understand the humanistic concept of "spiritual value is superior to material enjoyment".

Specialized instruction in classical texts

The thematic teaching of classical texts adopts the approach of 'theme integration', integrating texts of different genres and eras around core themes such as 'diligence and thrift' and 'spiritual pursuit'. Through in-depth interpretation and discussion, students can form a systematic humanistic cognition.

Case Study Design for Traditional Culture Text Teaching: The Analects of Confucius: 'Diligence, Frugality, and Spiritual Pursuit'

instructional objectives ：

To comprehend the core teachings of 'diligence and frugality' and 'valuing righteousness over profit' in the Analects, such as 'to economize and cherish others' well-being 'and' wealth and honor gained through unjust means are to me like passing clouds.' By drawing on real-life experiences, we analyze the clash between consumerism and traditional virtues, and foster the concept of 'rational consumption'. To cultivate students' ability to draw wisdom from traditional culture and solve practical problems.

teaching process ：

Text Interpretation: The teacher guides students to read aloud from "Xue Er" in The Analects of Confucius: "Practice frugality and love others, and ensure the people are well-fed and clothed." Through annotations, students explore the meaning of "frugality" — thrift and opposition to waste. In the activity "Imagining Confucius' Life Scenes," students describe "Confucius traveling across states, persisting in teaching despite material scarcity," experiencing his philosophy of "spiritual pursuit surpassing material needs."

Real-world connections: Present cases of 'blind consumption' among junior high students, such as 'a student spending 500 yuan monthly on trendy stationery that they rarely use' and 'classmates competing over sports shoe brands priced from 1,000 to thousands of yuan.' Organize group discussions: 'How do these behaviors conflict with the' frugality 'principle in The Analects? How can we practice this traditional virtue of frugality?'

Through historical comparisons, we introduce modern concepts like the 'Clean Plate Campaign' and 'low-carbon living' to guide students in analyzing the connection between the Clean Plate Campaign and the traditional Chinese ethos of 'cherishing every grain of rice and every drop of soup.' Students are then encouraged to discuss whether thriftiness remains essential in today's material abundance and why. Teaching Extension: Assign the 'My Frugal Plan' homework, where students create a weekly 'rational spending plan' based on quotes from The Analects of Confucius. Examples include 'avoid non-essential stationery' and 'prioritize reusing items,' with a requirement to document their reflections and experiences during implementation.

Contemporary Text Teaching Case Study: 'Material and Spiritual Balance' in 'The Ordinary World'

instructional objectives ：

Analyze the character of Sun Shaoping and understand his characteristic of 'persevering in spiritual pursuit in poverty'. By comparing the life choices of Xiangzi (from *Camel Xiangzi*) and Sun Shaoping, we explore the relationship between material goals and spiritual pursuits. Guide students to establish the value of "balancing material needs and spiritual growth" based on their own experiences.

teaching process ：

Text Analysis: Select the passage "Sun Shaoping Studying in Huangyuan City" from *The Ordinary World* to guide students in identifying details reflecting Sun Shaoping's "spiritual pursuit," such as "even during his odd jobs, he would read *How the Steel Was Tempered*," and "unconcerned with others' mockery about his 'poor student' status, he focused on accumulating knowledge." Group discussion: "Despite Sun Shaoping's harsh living conditions, why did he maintain optimism? What lessons can we learn from his spiritual pursuit?"

Comparative Analysis: A Brief Retrospective of Xiangzi's Life Journey in *Camel Xiangzi* — From a' Diligent and Upright Youth 'to a' Calmly Degenerate Walking Corpse '. The core reason lies in his' overemphasis on the material goal of 'buying his own car". After repeated failures, his spirit completely collapsed. Organize students to compare Sun Shaoping and Xiangzi:' Both faced material poverty, yet their life endings were drastically different. What does this reveal about the relationship

between 'material goals' and 'spiritual pursuits'?'

Self-reflection: Have students write about instances where they neglected their studies or spiritual growth to pursue material goals (like buying a specific toy or stationery), then reflect on how to balance material needs with spiritual development through Sun Shaoping's choices.

Educational Impact: Post-class feedback revealed that 85% of students stated, "By comparing Sun Shaoping and Xiangzi, I realized the importance of spiritual pursuits and will no longer blindly chase material things." In their subsequent essay "My Spiritual Goals," students proposed plans like "reading one extracurricular book weekly" and "maintaining reading notes," demonstrating their emphasis on spiritual growth.

Text comparison reading to strengthen critical thinking

The text comparison exercise contrasts 'consumerism' with 'literary texts,' guiding students to recognize the irrational nature of consumerism, develop critical thinking, and learn to rationally evaluate consumption behaviors.

Comparative Case Study Design: 'Impulse Buying vs. The Oil Seller'

Theme: Criteria for rational and irrational consumption

Compare materials:

The consumerism phenomenon: 'Impulse buying in influencer livestream sales' — A livestream clip shows an influencer using phrases like 'limited-time flash sale', 'limited edition', and 'miss it and you're out 'to push viewers toward' non-essential items '(e.g., over-the-top stationery, repetitive accessories). Some viewers later commented,' I followed the crowd when I saw others grab them, only to find they were useless.'

The literary text "The Oil Seller" focuses on analyzing the oil seller's attitude of "only through practice comes mastery." He dedicates himself to improving his oil-selling skills without vanity, calmly accepting Chen Yaozi's "skill in archery" and "self-importance," demonstrating the wisdom of "rational evaluation of skills and external judgments."

teaching process ：

Phenomenon analysis: After students watch the live broadcast clip, they discuss in groups: "What persuasive techniques did the host use to stimulate consumption? Is the audience's purchasing behavior rational? Why?" This guides them to summarize the characteristics of impulse buying—being influenced by external stimuli, ignoring practical value, and lacking rational judgment.

Text Analysis: Through reading "The Oil Seller" aloud, students analyze the character's portrayal: "How does the oil seller manage to' cover his mouth with coins, slowly pour oil through a ladle, and let the coins remain dry despite the oil dripping through the holes '? What attitude does he hold toward Chen Yaozi's 'self-importance'? What values does this reveal?" This guides students to conclude that "The oil seller is dedicated to mastering his craft, not seeking external glory or recognition."

Comparative reflection: Have students compare 'impulsive spending' with the 'attitude of the oil seller,' then ask: 'What do the oil seller's 'rationality' and our own 'rationality' in consumption have in common? How can we maintain rationality in spending like the oil seller, without being swayed by external temptations?'

Practical application: Have students list 'impulsive purchases they've made 'and, drawing on the moral of' The Oil Seller ', create a' three-step rational consumption plan '—' Step 1: Check if the product is practical; Step 2: Ask yourself if it's truly needed; Step 3: Resist the lure of' limited time 'or' limited quantity 'marketing jargon.'

Comparative Case Study Design: 'Luxury Lifestyle Promotion vs. The Ode to a Humble Abode'

Focus on the theme: the true meaning of "quality life"

Compare materials:

Consumerism phenomenon: 'Luxury lifestyle promotion in advertising' —— showcasing real estate ads (emphasizing 'luxury mansion', 'private pool', 'premium facilities') and luxury brand ads (highlighting 'status symbol', 'top-tier materials'), analyzing the value proposition of 'quality life = material luxury' conveyed through these advertisements.

Text: 'Inscription of a Humble Abode' —— Key Interpretations of Phrases like 'This is a humble abode, yet my virtue makes it fragrant' and 'No music to disturb the ears, no paperwork to weary the body' reveal Liu Yuxi's philosophy of valuing moral integrity over material luxury.

teaching process ：

Advertising Analysis: Have students work in groups to analyze the ad content, identify key terms defining 'quality life' (e.g., luxury homes, high-end products, premium amenities), and discuss whether the ad's portrayal of' quality life' is reasonable. Furthermore, examine whether ordinary people can achieve such a lifestyle under this standard.

Text Analysis: Through activities like "audio-guided reading" and "depicting the humble abode scene," students explore the reasons behind the poem's enduring appeal— "The moss-clad steps shimmer with green, the curtains frame emerald grass" showcase its natural beauty; "Scholars converse here, commoners never enter" reflects its cultural charm; "Playing the plain zither, reading golden scriptures" reveals its spiritual essence. Students are guided to summarize: "Where does Liu Yuxi's 'quality life' originate? How does it differ from the 'quality life' portrayed in advertisements?"

Value Reassessment: Students were organized to deliver speeches on the theme 'My Quality Life,' encouraged to draw inspiration from 'Inscription of a Humble Abode' to define 'quality life' through intangible dimensions like 'family atmosphere,' 'spiritual experiences,' and 'interpersonal relationships.' For instance, one student remarked: 'My quality life involves reading' Old Tales Retold 'with my mother every evening and listening to her stories from her childhood.'

Educational Impact: In the 'Quality Life' themed essay, over 80% of students shifted focus from material possessions to intangible elements like 'spiritual fulfillment,' 'family bonds,' and 'personal growth.' The essay emphasized that 'quality life isn't about owning luxury brands, but finding joy in reading and fulfillment in helping others,' demonstrating enhanced critical thinking and a redefined value system.

Integrating Writing Practice to Guide the Understanding of "Intangible Satisfaction"

Writing is an important way for students to sort out their inner thoughts and express their own opinions. Humanistic education combined with writing practice can help students deepen their understanding of "immaterial satisfaction" and gradually get rid of the influence of consumerism through active thinking and expression.

Thematic Writing: Focusing on Spiritual Values and Life Experiences

Thematic writing centers on 'non-material fulfillment,' guiding students to discover spiritual joy in life and recognize that spiritual experiences hold greater lasting value than material consumption, thereby reshaping their understanding of 'happiness.'

Thematic Writing Case Study: "My 'Immaterial Joy'"

Writing goal:

Guide students to recall and record "happy moments without dependence on consumption" and discover the value of spiritual experience. Using Chinese literature as a reference, analyze the characteristics of 'intangible happiness' — enduring, profound, and independent of material conditions. To cultivate students' ability to express their inner feelings with words and strengthen their identification with "spiritual pursuit".

writing guide ：

Textual Awakening: Teachers revisit textbook passages related to "intangible joy," such as the "snowbird-catching" delight in "From the Hundred-Plant Garden to the Three-Taste Study" ("Clear a snow patch, expose the ground, set up a large bamboo sieve with a short stick, scatter some chaff underneath, tie a long rope to the stick, and pull it from a distance to watch birds descend for food; when they reach the sieve, pull the rope to trap them"), and Helen Keller's "joy of first understanding' water'" in "The Rebirth of Life" ("Water awakened my soul, granting me light, hope, joy, and freedom"). This prompts students to reflect: "Do these joys depend on material consumption? Why do they leave such a lasting impression?"

Creative Writing Guidance: Explore "intangible happiness" themes, such as "joy in family bonding" (reading, chatting, or doing chores together), "joy in personal growth" (solving a challenging problem, mastering a new skill, or delivering a speech), "joy in social connections" (helping classmates, making new friends, or participating in group activities), and "joy in nature" (observing campus flora, reflecting during walks, or experiencing rain). This approach helps students broaden their perspectives.

Writing requirements:

Select 1-2 specific examples of "non-material happiness" and describe the process and feelings in detail. Using the textbook's textual materials, analyze the value of' intangible joy '(for example, quoting' Isn't it a joy to learn and practice regularly?' from The Analects to illustrate the pleasure of learning). The text should be no less than 600 words and should be authentic and vivid.

Example of excellent writing:

Last Sunday afternoon, my mother and I sat on the balcony sofa reading *Morning Flowers Picked at Dusk*. She was reading *From the Hundred-Plant Garden to the Three-Taste Study* with a gentle voice, and when she reached the "Story of the Beautiful Snake," she deliberately lowered her voice, making me quickly snuggle up to her. I was reading *Ah Chang and the Classic of Mountains and Seas*. When I read "Ah Chang bought me the Classic of Mountains and Seas," my nose tingled with nostalgia, recalling how my mother had braved the rain to get me the *Insect Memoirs* I wanted. That afternoon had no new toys or snacks, but I felt an extraordinary joy. As Helen Keller said in *The Man Who Reimagined Life*, that happiness was "from the heart," lasting longer than the joy of my mother buying me new stationery. Looking back now, those sunny days, those books, and her voice remain my most cherished memories.

Commentary and Feedback on Writing: The teacher emphasized students 'authentic expressions of "non-material happiness" during feedback. For instance, "Your vivid depiction of reading moments with Mom conveys the warmth of family companionship. This happiness truly resonates with your description as' springing from the heart '—a joy that transcends material possessions yet remains profoundly memorable." Additionally, by referencing textual materials, the teacher further emphasized the "value of spiritual experiences," such as "Your analysis of personal happiness through Helen Keller's perspective is compelling, demonstrating your deep understanding of the profound nature of 'spiritual fulfillment'."

Critical Writing: Developing Rational Consumption Thinking

Critical writing takes the 'consumerism phenomenon' as the object of criticism, guiding students to analyze and persuade the blind consumption behavior by combining the humanistic principles in the Chinese text, while cultivating the thinking of 'convincing people with reason' and deepening their own rational consumption cognition.

Critical Writing Case Study: A Letter to 'Blindly Competitive Classmates'

Writing goal:

Guide students to analyze the harm of "blind comparison" and demonstrate it by drawing on the moral of the Chinese text. Learn the format of writing letters and develop the ability to persuade sincerely and rationally. Strengthen students' rational consumption concept, avoid falling into the misunderstanding of "symbolic consumption".

writing guide ：

Scenario Simulation: The teacher describes a 'blind peer comparison phenomenon' in the classroom, such as 'Xiaoming, upon seeing a classmate buy the latest sports shoes, demands his parents to buy them too. When refused, he starts crying and loses focus in class. Xiaohong brings different trendy stationery items to school every day and mocks her desk mate for using' ordinary stationery. 'This helps students understand the negative impact of' blind peer comparison 'on both themselves and others.'

Textual Analysis: Examining educational materials addressing "opposing material competition and valuing spiritual cultivation," such as the Analects '"A gentleman seeks neither fullness in food nor comfort in dwelling" (emphasizing spiritual refinement over material comforts), the Ode to a Humble Abode's "This humble abode is not humble, for my virtue perfumes it" (highlighting moral integrity over physical modesty), and Sun Shaoping's "not comparing material possessions with others but focusing on spiritual growth" from Ordinary World, we guide students to reflect: "What insights can these texts offer to students who blindly compete with others?"

Writing requirements:

Use the letter format, with a salutation at the beginning, a blessing at the end, a signature and a date. Using at least one Chinese language text, analyze the harms of 'blind comparison' and persuade students to view consumption rationally. Be sincere and friendly, avoid blaming, and show concern for your classmates. Last, the text must be at least 500 characters long.

Example of excellent writing:

"Dear Xiao Ming:

hello ！

Lately, I've noticed you've been feeling down. A classmate mentioned you're upset because Mom didn't buy you the latest sneakers, and you're not concentrating in class. I totally get how you feel about wanting new shoes, but seeing you like this really worries me.

Do you remember the Analects we studied? Confucius said, "A gentleman does not seek fullness

in food nor comfort in dwelling," meaning that truly cultivated individuals prioritize spiritual growth over material comforts. Take Sun Shaoping from The Ordinary World—despite living in extreme poverty with nothing but rags, he never competed with others. Instead, he devoted himself to daily reading and eventually became an outstanding worker. He once said, "True wealth lies in spiritual abundance." I find this statement profoundly insightful.

It's really not worth it that you're unhappy now because of a pair of shoes, even affecting your studies. In fact, your classmates like you not because of your shoes, but because you play basketball well and often help others with math problems. If you waste your study time on material comparison and lose your own strengths, it would be a pity!

I hope you can be happy as soon as possible. We can read "The Ordinary World" together and discuss the stories in the book. I believe you will understand that spiritual happiness is more important than material satisfaction.

Wishing you
Make progress and be happy every day!
Your classmate: Xiao Liang
May 20,2024"

Writing Effect: Students skillfully employ textbook materials in their letters to illustrate the dangers of "blind comparison," citing works like The Analects and The Ordinary World to demonstrate their grasp of humanistic principles. Their sincere and friendly tone avoids blame, as seen in phrases like "I completely understand your eagerness for new shoes" and "I hope you can find happiness soon," showcasing effective communication. Some students noted that through this process, "I've realized the wrongness of blind comparison and won't repeat it in the future."

Diary and reflective writing: tracking changes in consumption attitudes

The diary and reflective writing project focuses on 'consumer behavior' as both documentation and reflection. Students are required to record their weekly consumption experiences, conduct self-analysis by connecting them with Chinese literature texts, and track shifts in consumption attitudes, thereby achieving 'self-education' and 'continuous growth'.

Diary and Reflection Writing Case Study: "Consumer Reflection Diary"

Writing goal:

Guide students to pay attention to their consumption behavior and analyze the rational and irrational factors of consumption. Combined with the Chinese text materials, reflect on their own consumption behavior and gradually change their consumption concepts. Cultivate students' habit of recording and reflection, and realize the continuous optimization of consumption concept.

writing guide ：

Diary framework design: Provide students with a fixed framework for "consumer reflection diary", including the following contents:

This week's purchase log: Record the items you bought this week (name, price, purpose).

Impulse spending analysis: Identify one instance of impulse spending this week (or record one 'rational purchase' if none was made), and analyze the following: 'Why did you buy it? Is it truly necessary? What were your feelings after purchasing it?'

Textual Reflection: By drawing on textbook materials (such as "Zhu Zi's Family Instructions", "The Analects", and "The Ordinary World"), reflect on this consumption behavior. For instance, "Citing' Zhu Zi's Family Instructions' — 'Prepare before the rain falls, don't dig a well when you're thirsty' — reflect on whether you've' planned your spending in advance to avoid impulsive purchases'."

Next week's plan: Create a' rational spending plan 'for the coming week, such as' avoid non-essential stationery 'and' prioritize using secondhand items'.

Text Guidance: Every week in Chinese class, teachers select 1-2 anonymous 'consumption reflection diaries' from students for sharing, focusing on the 'text reflection' section. For example, 'This student cited Sun Shaoping's example from *The Ordinary World* to reflect on their impulsive spending, demonstrating profound insight. Everyone can learn from his reflective approach.' This guides students to learn how to conduct self-analysis by connecting with the text.

Feedback Mechanism: Teachers review students '"Consumption Reflection Diaries" weekly, providing both encouraging and constructive comments. For example: "You've recognized that 'purchasing trending notebooks is impulsive spending' and referenced 'Zhu Xi's Family Instructions 'for reflection – excellent! Keep up the rational spending plan next week, and I'm confident you'll do even

better." For students with less in-depth reflections, teachers offer guidance: "You documented your experience of buying new stationery, but didn't connect it to textual analysis. Consider the principle of 'frugality and love for others' in 'The Analects' – do you think this purchase aligns with the 'frugal' principle?"

Sample student diary entry:

Sunday, 12 May 2024, Sunny

This week's spending record:

Internet-famous notebook: 25 yuan for taking notes (though I already own three).

Chinese exercise book: 30 yuan, the teacher asked to buy it for homework.

Mineral water: 2 yuan, buy after exercise when thirsty.

Impulse buying analysis: My impulsive purchase was a trendy laptop. Seeing my classmates using it and its attractive cover, I couldn't resist buying it. However, upon receiving it, I found it had the same functionality as my previous laptop. Moreover, its thick cover took up too much space in my backpack. Now I'm regretting it and feel like I wasted money.

Self-Reflection: After studying "Zhu Xi's Family Instructions," I learned the wisdom of "Prepare before the rain falls, don't dig a well when you're thirsty" —a reminder to plan ahead rather than scrambling at the last minute. Before buying a new notebook, I never considered how many I already had or whether I truly needed it. It's like "digging a well when thirsty" —blindly purchasing what others have without thought. Moving forward, I'll ask myself: "Do I really need this?" and "Is there an old one I can reuse?" This way, I can practice thriftiness and live more consciously.

Next week's plan:

Don't buy any unnecessary stationery.

Use up the unused notebooks before considering buying a new one.

It's economical and environmentally friendly to bring a cup every day instead of buying mineral water."

Through consistent practice of "consumption reflection journals," students have developed the habit of "rational consumption." For instance, they note in their journals: "This week I avoided impulse purchases because I always ask myself 'Is this really necessary?' ". Meanwhile, their application of textual materials has become increasingly proficient. They now actively cite works like The Analects and The Family Instructions of Master Zhu to reflect on their consumption patterns, demonstrating a gradual shift in consumption philosophy and enhanced humanistic literacy.

Conducting Chinese language practical activities to strengthen "humanistic consumption" practices

The language practice activities center on 'low consumption, high experience' and 'community participation,' enabling students to experience the value of 'humanistic consumption' through cultural immersion, social engagement, and community service. This approach helps them achieve spiritual fulfillment without materialistic dependence, thereby reinforcing humanistic consumption behaviors and breaking free from the shackles of consumerism.

"Low Consumption, High Experience" Chinese Language Activities

The "Low Consumption, High Experience" Chinese Language Program aims to deliver quality language immersion without heavy spending. Through book clubs, textbook drama adaptations, and performances, it helps students discover spiritual fulfillment in cultural engagement, proving that true value comes from experience, not from how much you spend.

Case Study Design 1: "A Free Spiritual Feast" Reading Sharing Session

moving target ：

Guide students to acquire books through low-cost methods such as borrowing and co-reading, and realize that "the amount of knowledge acquisition is unrelated to the amount of consumption".

Share reading insights to enhance students' language expression and reading comprehension skills.

Strengthen the concept of "spiritual experience is better than material consumption" and cultivate students' interest in reading.

Event flow:

Event preparation (1 week):

Teachers should add extracurricular books related to 'spiritual pursuit' and 'frugality' to the classroom book corner, such as 'Morning Flowers Picked at Dusk', 'Old Tales of Southern City', and 'How the Steel Was Tempered', and encourage students to borrow them. At the same time, students are

allowed to bring their own old books to the classroom to exchange and read with classmates.

Students select a book to borrow or exchange for reading, then write a 'Reading Reflection Card' containing three sections: 'Book Title', 'Most Memorable Passage', and 'Reflections (linked to personal experiences or the text content)'.

Activity (1 class hour):

Group Sharing: Divide students into groups of 6-8 members, with each group electing a leader to organize members in taking turns to share their "Reading Reflection Cards". For example, one student shared from *How the Steel Was Tempered*: "Paul insisted on writing even while bedridden. He said, 'A person's life should be lived like this: when looking back, one shouldn 't regret wasting years or feel ashamed of doing nothing.' This reminds me of Sun Shaoping from *The Ordinary World*. Both persistently pursued spiritual growth through adversity. From now on, I'll read more books and not waste time on useless stationery."

Class Presentation: Each group selects 1-2 outstanding students to present their work in class. Teachers provide feedback, emphasizing the importance of 'integrating personal insights with textual analysis.' For example, 'You connected Paul's spirit with Sun Shaoping's and reflected on your own consumption habits—this depth of thought is what reading truly teaches us.'

Teacher's Closing Summary: "Today's book-sharing session allowed us to exchange and borrow books without spending a single cent, yet we all gained profound spiritual fulfillment. As the Analects of Confucius states, 'Is it not delightful to learn and practice what you have learned?' The joy of reading is enduring—more meaningful than the excitement of buying new stationery or toys. I encourage everyone to read more in the future and grow spiritually through this journey."

Extension activity: Establish a 'Class Reading Check-in' system where students log their daily reading time and content. Each week, the class selects a 'Reading Star' to further boost students' reading enthusiasm.

Impact of the Activity: Following the event, the class book corner saw a significant increase in borrowing volume, rising from an average of 15 books per week to 40. Eighty percent of students remarked, "Through the book-sharing sessions, I discovered the joy of reading. I'll borrow more books and cut back on unnecessary purchases." In their subsequent essay on "My Spiritual Growth," students frequently highlighted the benefits of these sessions, such as: "The book-sharing sessions taught me that happiness can be found without spending money. Reading is the ultimate spiritual feast."

Case Study Design 2: 'Rejecting the Culture of Comparison' — A Textbook Drama Adaptation and Performance: The Case of 'Chen Taiqiu and the Friendship Journey'

moving target ：

Guide students to grasp the core concepts of 'integrity' and 'courtesy' in the story 'Chen Taiqiu and the Friend's Appointment ', and extend this to the theme of' rejecting comparisons'.

Through the adaptation and performance of textbook dramas, students can feel the value of "spiritual pursuit over material comparison" in role-playing.

Cultivate students' cooperative ability, innovative ability and language expression ability.

Event flow:

Text Interpretation and Theme Extension (1 class hour)

Interpretation of "Chen Taiqiu and His Friend's Appointment": Guide students to analyze the dialogue between Chen Taiqiu and his friend, helping them understand the importance of "integrity" and "courtesy". For example, the friend's "failure to show up" demonstrates dishonesty, while "insulting the father in front of the couple" shows rudeness. Yuan Fang's "not looking back when entering" reflects his defiance against such behavior.

Extended Theme: Building on the 'comparison culture' in classrooms, we explore the concept of 'refusing to compare.' Students analyze how 'integrity' and 'courtesy' in the story 'Chen Taiqiu and the Friend's Appointment' relate to this idea. This leads them to conclude that refusing to compare is a form of courtesy—respecting both others and oneself—by focusing on personal growth rather than material possessions.

Adapted from the textbook (1 lesson hour)

Group Adaptation: Divide students into 4-5 groups of 5-6 members. Each group should adapt the story "Chen Taiqiu and the Friend's Visit" under the theme of "Rejecting Materialism," adding a scene where "the friend's child boasts about material possessions, and Yuan Fang responds with 'virtue/capability'." For example, the adapted scene could be: "A friend brings his son over, and the boy

boasts, 'I have the latest toy car, do you?' Yuan Fang replies, 'Yesterday, I helped a classmate solve a difficult math problem, and the teacher praised me. That made me happier than any toy car.'"

Teacher guidance: The teacher monitors each group's adaptation progress, providing feedback on' theme alignment 'and' plot coherence '. For example,' Your group's' showing off stationery 'plot is excellent, but remember to match Yuan Fang's personality. His response should be well-reasoned and evidence-based, not just a simple rebuttal.'

Textbook Drama Performance and Comment (1 class hour)

Group performance: Each group takes turns to perform the adapted textbook drama on stage, while other students attentively watch and complete the 'Performance Evaluation Form', assessing aspects such as 'theme relevance', 'character portrayal', and 'plot innovation'.

Classroom Discussion: The teacher organized students to share reflections, starting with "post-viewing impressions" such as "I thought the third group's performance of' Yuan Fang helping classmates solve problems and showing off 'was excellent—it taught me to appreciate strengths rather than material comparisons." The teacher then summarized, emphasizing the "theme-text integration," noting that "all groups successfully incorporated the' rejecting comparisons 'theme into their adaptation of' Chen Taiqiu and the Friendship Trip, 'maintaining the text's core message while connecting it to real-life situations, achieving the educational goal of 'nurturing through literature'."

Activity Impact: Through the process of adaptation and performance, students gained a deeper understanding of the theme "Rejecting Materialistic Competition". For instance, "When designing Yuanfang's response, we emphasized' spiritual virtues 'like reading and helping others over material possessions". The activity also enhanced collaborative skills and creativity. As one student noted, "Our group held multiple discussions to make the plot more engaging, ultimately deciding on the' showing off toy cars' storyline". Following the activity, competitive behavior in the class significantly decreased. A student remarked, "Seeing Yuanfang not competing over material things, I no longer want to compare stationery with classmates."

Community-based Chinese language practice

The community-engaged Chinese language program centers on 'community research' and 'recycled goods exchange,' taking students beyond school walls. Through community interactions, students experience the values of 'frugality' and 'humanistic care,' integrating language learning with social life while cultivating 'humanistic consumption' habits.

Case Study Design 1: 'Anti-Consumerism' Stories in Communities: Research and Writing moving target ：

Guide students to visit the community, interview residents, and collect stories about 'frugality' and 'refusing blind consumption'. Organize the research results into articles to improve students' interviewing skills, writing skills and social observation skills.Through authentic community stories, students will deepen their anti-consumerism awareness and understand that thriftiness is a life wisdom.

Event flow:

Activity preparation (1 class hour)

Determine the research theme and subjects: The research theme is "Anti-consumerism stories in the community", and the research subjects are "old party members", "old shopkeepers", "retired teachers" in the community, etc., who often have a "frugal" attitude towards life.

Design interview outline: Teachers guide students to create an interview outline, including questions such as "How do you usually save in your daily life?", "Have you ever experienced 'refusing blind consumption'?", and "What do you think is the significance of thriftiness?"

Grouping and division of labor: divide students into 5-6 groups, 3-4 people in each group, and determine the roles of group leader, interviewer, recorder, photographer, etc., to ensure the orderly development of the research activities.

Community research (one day weekend)

Field Interviews: Students, accompanied by parents or guided by teachers, visit communities to conduct interviews with research subjects according to the interview outline, documenting content through text and photos. For example, when interviewing Grandpa Zhang, an elderly community Party member, he shared: "I usually wrap books with old newspapers. I mend worn clothes instead of buying new ones – it's not about money, but about avoiding waste. We all survived this way in the past. Now that conditions have improved, we shouldn' t forget the old tradition of 'diligence and thrift'."

Data compilation: After the interviews, each team organized the materials and selected the most

representative anti-consumerism stories, such as “retired Party members wrapping books with old newspapers”, “time-honored store owners adhering to ‘thin profit but high sales’ without price hikes”, and “retired teachers crafting handicrafts from old clothes”.

Writing and presentation of achievements (2 class hours)

Story Writing Assignment: Students will work in groups to compile their interview materials into a story titled "Anti-Consumerism in the Community". The story must be authentic and vivid, emphasizing the theme of "frugality". Textbook excerpts may be appropriately referenced for commentary, such as: "Grandpa Zhang's practice of wrapping books in old newspapers reminds me of the' Zhu Xi Family Instructions 'saying:' For every bowl of porridge and every grain of rice, remember their hard-won origins; for every thread and every fiber, always reflect on the difficulty of material resources.'"

Achievements: The stories written by each group were compiled into a 'Class Bulletin' and displayed on the classroom culture wall. Outstanding stories were selected for submission to the school magazine, enabling more students to learn about the 'anti-consumerism' stories in the community.

Impact of the activity: Through community research, students encountered authentic anti-consumerism cases, such as "When I saw Grandpa Zhang wrapping books with old newspapers, I realized that secondhand items can still serve significant purposes." During writing exercises, they integrated community stories with textbook content to deepen their understanding of "frugality." After the "class newsletter" exhibition, students from other classes flocked to view it, creating a positive ripple effect.

Case Study Design 2: 'Reviving Old Treasures' Chinese Language Corner – Secondhand Book and Stationery Exchange Event

moving target ：

Encourage students to exchange unused books and stationery, emphasizing the "emotional value" and "practical value" of items rather than their "newness or age".

By writing "recommendation", students can improve their language expression and emotional expression. Cultivate students' "awareness of saving" and "spirit of sharing", and strengthen "humanistic consumption" behavior.

Event flow:

Event preparation (1 week):

Item Collection: Teachers notify students to organize idle books and stationery at home (clean and intact), with each item accompanied by a "Recommendation Card" containing "Item Name", "Reason for Recommendation (based on the item's usage experience or emotional value)", and "Type of Item to Exchange". For example, a student wrote a recommendation for a copy of "Journey to the West": "I've read this 'Journey to the West' three times, with my own annotations inside. Especially on the page about 'Sun Wukong's Three Battles with the White Bone Demon ', I even drew a simple illustration. I hope classmates who enjoy' Journey to the West 'can exchange it with me. I'd like to exchange for a copy of <All Men Are Brothers>."

Classroom setup: Create a 'Second Life of Old Items' Chinese corner by organizing collected books and stationery into categories, each labeled with a 'Recommendation Card' to foster a warm and welcoming exchange atmosphere.

Exchange Activity (1 class hour):

Free browsing: Students freely explore the 'Chinese Corner' items, read the 'Recommendation' cards, and find items that interest them.

Exchange and Sharing: After students find items they wish to exchange, they communicate with the owner to confirm the exchange, then register it in the "Exchange Logbook". At the same time, students are encouraged to share their "reasons for exchange", such as "I want to exchange this book <All Men Are Brothers> with Xiao Ming because his recommendation says 'The scene where Lu Zhishen punches Zhen Guanxi is particularly exciting', and I've always wanted to read it".

Emotional connection: The teacher organizes a 'Story of My Old Items' sharing session, inviting 3-4 students to share their unused belongings " stories '. For example,' This notebook was a birthday gift from my mom when I was in elementary school. Though I don't use it anymore, I hope classmates who like it will keep using it.' This helps students appreciate the 'emotional value' of their items.

Extended Activity: Establish a sustainable 'Second Life of Old Items' Chinese Corner program, organizing monthly exchange events to encourage students to share unused items. Integrate these

exchanges with writing assignments, asking students to reflect on their experiences: 'I traded my old stationery for a copy of *Old Tales from Southern City*. Reading it felt profoundly meaningful because it was recommended by a classmate, and I could still see the marks of his reading.'

Event outcomes: The campaign collected 85 idle books and 120 stationery items, with 68 books and 95 stationery items successfully exchanged, achieving an exchange rate of over 75%. When sharing their "reasons for exchange," students frequently mentioned "sincere recommendations" and "being drawn to the stories behind the items," demonstrating their emphasis on "emotional value." Post-event feedback revealed that students vowed "we won't casually discard idle items anymore, but will give them a second life through exchanges," reinforcing their "awareness of conservation" and "sharing spirit."

Integrating Ideological and Political Education with Humanities to Elevate Educational Objectives

By integrating ideological education with humanistic values, we combine elements like 'New Era Civic Ethics' and 'Red Culture' with the humanistic essence of Chinese language texts. This approach clarifies value orientations, strengthens students 'civic responsibilities and spiritual aspirations, elevates the humanistic education goals in addressing consumerism, and achieves coordinated development between' language education 'and' ideological education'.

Integrating "Citizen Ethics in the New Era" to Clarify the Duty of Rational Consumption

The 'Implementation Outline for Moral Development of Citizens in the New Era' advocates 'promoting frugality and opposing extravagance,' which aligns closely with the traditional virtue of 'diligence and thrift' in Chinese literature. By integrating 'moral development for citizens in the new era' into Chinese language education, students can understand that 'rational consumption is not just a personal habit but also a civic responsibility,' thereby enhancing their awareness of responsible consumption.

Teaching Case Study: Mencius 'Teachings on' Born in Adversity, Perish in Comfort 'and' The Civic Duty of Frugality'

instructional objectives:

To comprehend the meaning of Mencius 'saying' adversity breeds success, comfort brings ruin 'and to recognize the importance of' being prepared for danger in times of peace and practicing frugality.' By applying the Implementation Guidelines for Moral Development in the New Era, we understand that thriftiness is a civic duty in this new era. Guide students to translate 'diligence and thrift' into concrete actions, fostering a civic consciousness of rational consumption.

teaching process ：

Text Interpretation (1 class hour):

Reading and Understanding: Guide students to read aloud Mencius 'passage' Born in adversity, perish in comfort, 'and interpret the meaning of' Shun rose from the fields, Fu Yue emerged from the humblest of builders... Thus we understand that adversity breeds growth while comfort leads to ruin. 'Analyze how' adversity 'and' comfort' impact individuals and nations — individuals thrive through challenges, while nations decay in complacency.

Extended theme: Discuss the relationship between ‘Born in adversity, perish in comfort’ and ‘frugality.’ Guide students to conclude that frugality embodies ‘being prepared for danger in times of peace.’ Even in today’s material abundance, we must avoid complacency and extravagance, lest we fall into the trap of’ perishing in comfort.’

Integration of Ideological and Political Education (1 class hour)

The introduction of the 'Implementation Outline for Moral Development in the New Era' was followed by teachers explaining its principle of 'promoting thrift and opposing waste.' They also highlighted national initiatives like the 'Clean Plate Campaign' and the 'Anti-Food Waste Law,' helping students understand that 'thrift is not just a personal choice, but a civic duty upheld by the nation.'

Integrating Text and Ideological Education: Organize student discussions on “What common ground exists between Mencius ‘’ Born in Adversity, Perish in Comfort ‘and the’ Frugality ‘principle in the Outline? How can junior high students in the new era fulfill civic responsibility for frugality?” Guide students to explore this through three dimensions: personal consumption, family life, and social engagement. Examples include avoiding blind competition in personal spending, conserving water and electricity at home, and practicing the’ Clean Plate Campaign’ in community activities.

Practice (After class):

Assign the 'Frugality and Thrift' civic initiative, asking students to choose one action—such as 'adopting the clean plate campaign,' 'conserving water and electricity,' or 'making rational purchases of stationery' —and document their process and reflections.

Organize a 'Frugality and Thrift' initiative sharing session where students can share their experiences, such as 'This week I practiced the' clean plate 'policy at school cafeteria. Seeing less leftover food made me feel it was really meaningful,' to strengthen their sense of civic responsibility.

Educational Impact: Through integrating ideological education with text analysis, students have gained a deeper understanding of 'the civic duty of thrift and conservation.' For instance, one student remarked, 'I used to think saving was just my personal responsibility, but now I realize it's also a national initiative and our shared obligation. 'In the' Thrift and Conservation Citizenship Action 'program, 90% of participants successfully completed at least one initiative. During a sharing session, they pledged,' We will continue to uphold this responsibility and become accountable citizens.'

Strengthening the Value of Spiritual Pursuit Through "Red Text"

The red texts embody the "hard struggle, selfless dedication, and spiritual supremacy" of the red spirit, as seen in works like "Red Star Over China" and "The Long March". The spirit in these texts stands in stark contrast to consumerism's "material supremacy". By using red texts for teaching, students can experience the "power of the red spirit" and strengthen their value recognition that "spiritual pursuit outweighs material enjoyment".

Teaching Case Design —— "The Spiritual Pursuit of Red Army Soldiers" and "Resisting Consumerism" in "Red Star Over China"

instructional objectives ：

Analyze the image of the Red Army soldiers in "Red Star Over China" and understand the red spirit of "hard work and spiritual supremacy". By contrasting the spiritual aspirations of Red Army soldiers with the material pursuits of consumerism, we reinforce the belief that spiritual values outweigh material comforts. Guide students to take the Red Army soldiers as an example and establish the value of “valuing spiritual growth”.

Teaching process ：

Red text interpretation (1 class hour):

Fragment Study: Select the passage "The Red Army Soldiers Crossing the Grasslands" from "Red Star Over China" and ask students to identify details that reflect the "hardship and perseverance" of the Red Army soldiers, such as "the soldiers eating grass roots and cooking leather belts, yet maintaining an optimistic attitude" and "in the harsh environment, the soldiers still persisted in studying and spreading revolutionary ideas."

Spiritual Analysis: Guide students to discuss ‘Why did the Red Army soldiers persevere under such harsh conditions? What was their spiritual pursuit?’ and help them distill the essence: ‘Their spiritual pursuit —— for the revolutionary ideal, fearless sacrifice, hard struggle, and valuing spiritual strength over material comforts.’

Comparative analysis (1 class hour):

Displaying consumerism: Show a video clip of junior high school students blindly chasing famous brands and internet-famous products, and ask students to analyze what the pursuit of consumerism is (material enjoyment, symbolic consumption).

Spiritual Red vs. Consumerism: Have students compare the 'spiritual aspirations of Red Army soldiers' with 'material pursuits of consumerism', complete a 'comparison chart', and analyze from dimensions such as 'pursuit goals', 'value orientation', and 'impact on individuals'.

Comparison dimension	*The spiritual pursuit of the Red Army soldiers*	*The material pursuit of consumerism*
Pursuit of goals	*Revolutionary ideals, spiritual growth*	*Material enjoyment, symbolic consumption*
Value orientation	*Collective interests, hard work*	*Personal enjoyment, blind comparison*
Impact on individuals	*Cultivate resilience and moral integrity*	*May lead to distorted values and psychological inferiority*

Self-reflection: Have students reflect on the comparison results by asking themselves, 'Have I ever pursued materialistic consumption? What lessons can we learn from the Red Army soldiers' spiritual pursuits? 'For example,' I once chased after trendy stationery, but now I realize it was

unnecessary. The Red Army soldiers persisted in learning despite hardships. I should learn from them and focus more on spiritual growth.'

Spiritual inheritance (after class):

Assign the 'Red Spirit Inheritance' project, requiring students to read a red-themed book (such as 'The Long March' or 'Little Soldier Zhang Ga') and write a reflection titled 'Red Spirit and My Consumption View,' using the red spirit to reflect on their own consumption habits.

A themed class meeting titled "Red Spirit and Youthful Growth" was organized, where students shared their reflections. For instance, one student remarked: "After reading 'The Long March,' I realized the Red Army soldiers were unafraid of hardships for their ideals. From now on, I won't blindly chase after luxury brands. I'll use my money to buy books and improve myself."

Educational Impact: Through interpreting and comparing red-themed texts, students gained profound insights into the "value of spiritual pursuits." For instance, they reflected on how "Red Army soldiers, despite lacking material comforts, possessed an indomitable spirit that outweighed any brand." In the "Inheriting the Red Spirit" assignment, students proactively examined their consumption habits and formulated plans for "rational consumption and spiritual growth," demonstrating how the red spirit positively shapes modern consumer values.

Practical Case References

Case Study: 'Family Affection vs. Materialism' in Teaching 'The Back View'

Case Background

In a second-year junior high school classroom, some students struggled with "what to buy for Mom" on Mother's Day eve, believing "only expensive gifts could show love." Some even argued with parents over purchasing pricey presents. During the Chinese literature lesson studying "The Back View," the teacher decided to use this text as a platform for a "Family Love vs. Materialism" humanistic education, guiding students to understand that "the value of family love transcends material possessions."

Teaching process

Textual Detail Analysis: The teacher guides students to focus on the "father buying oranges" detail in "The Back View": "The father, being a stout man, naturally required more effort to walk. I saw him wearing a black cloth cap, a black cloth overcoat, and a dark blue cotton robe, shuffling toward the railway tracks. While it wasn't too difficult for him to slowly lean down, crossing the tracks and climbing onto the opposite platform proved challenging. He clung to the rail with both hands while pulling his feet upward, his plump body slightly leaning leftward, revealing his strenuous effort." Question: "The father's attire was simple, without designer clothing, and the oranges he bought weren't expensive fruit. Why does this scene become' the most touching portrayal of familial affection '?" After discussion, students concluded: "Because the father's actions were filled with love for his son—a love not measured by material possessions, but reflected in details like 'shuffling along' and 'struggling to climb'."

In a practical discussion on "real-life relevance," the teacher posed a question based on the context of "Mother's Day gift shopping": "Mother's Day is just around the corner, and many students are struggling with 'what to buy for Mom,' feeling that 'you can't show love without expensive gifts. 'Drawing from the father's love in 'The Back View,' do you think 'expressing family affection must involve costly material things?' " Students responded enthusiastically: "I don't think so. Just like the father expressed love through simple actions, we can show our love for Mom without spending money." "My mom always says she's happy as long as I study hard and listen to her – no need for gifts."

Post-class activity: Assign the 'Intangible Gratitude Project for Parents' as homework, asking students to design 1-2 material-independent gratitude initiatives inspired by 'The Back View' —such as reading excerpts from the story aloud, helping with household chores, or writing a heartfelt letter of thanks—while documenting their parents' reactions and personal reflections.

Case Effect

Student feedback:

85% of students chose non-material acts of gratitude, such as 'reading excerpts from The Back View to their parents' or 'helping with household chores.' For instance, student Xiao Li wrote in his homework: 'I read the passage about' my father buying oranges 'from The Back View to my mother. She started crying as she listened, saying,' You understand your father's love, and that makes me so happy.' It turns out that even without gifts, my mother can feel my love.'

Parent feedback:

Parents in the 'Home-School Communication Group' shared heartfelt messages like: 'This week, my child volunteered to wash dishes and said, "Mom, you've worked so hard!" —a moment that moved me more than any gift. 'Another parent noted,' My child read "The Back View" to me and discussed the family bonds in the story, which has increased our communication. 'These stories highlight how the' Intangible Gratitude Initiative' positively strengthens parent-child relationships.

Subsequent effects:

In their subsequent essays on 'family bonds,' students shifted from using 'buying gifts' as the primary way to express affection to focusing on intangible moments like 'reading books together with parents' and 'helping with household chores.' For instance, one student wrote, 'My mom doesn't like expensive gifts. What she treasures most is the time we spend reading Chinese textbooks together every evening,' demonstrating a proper understanding of the true value of family ties.

Case Study of a Class Meeting on "The Analects and Modern Consumption"

Case Background

In a first-year junior high school classroom, the phenomenon of "materialistic competition in stationery" has become increasingly prevalent. Some students obsessively pursue "imported stationery" and "internet-famous stationery" priced at dozens or even hundreds of yuan, while mocking classmates who use ordinary stationery. After consulting with the Chinese language teacher, the homeroom teacher decided to organize a themed class meeting titled "The Analects and Modern Consumption" using the classic text as material, aiming to guide students in developing rational consumption habits.

Class Meeting Process

Interpretation of the Analects:

The Chinese teacher leads the students to read the classic sentences in the Analects:

A gentleman does not seek fullness in food nor comfort in dwelling. He acts with diligence and speaks with caution, aligning himself with the righteous to correct his ways. This is what we call true learning. "Riches and honors gained through dishonest means are to me as fleeting as clouds." After explaining the meaning of the sentence, the teacher asked: "What does the Analects tell us about what a gentleman values more and what he does not value? What does this teach us about our consumption?" The student answered: "A gentleman values learning and morality, not material comforts. We should not blindly pursue expensive and famous things when we consume. We should pay attention to practicality and morality."

Modern Consumption Case Analysis: A Classroom Example of "Comparative Stationery" -Xiao Ming purchased a 50-yuan imported fountain pen but rarely used it, believing "it's a status symbol"; Xiao Hong mocked her desk mate for using a 10-yuan ordinary pen, saying "it's cheap and not practical." Organize group discussions: "Does Xiao Ming and Xiao Hong's consumption behavior align with the principles in The Analects? Why? How should we persuade them?" Each group selects a representative to speak, for example: "Xiao Ming's behavior doesn't match' a gentleman doesn't seek fullness in food or comfort in dwelling.' He bought the pen for status rather than practicality. We could advise him: 'A good pen isn't necessarily expensive; what matters is its ability to aid learning.'"

"Rational Consumption" Slogan Design: Students work in groups to create slogans for "Rational Consumption", incorporating quotes from The Analects of Confucius, such as " 'Simple food and water' isn't poverty—blind competition is emptiness" and "Wealth and status gained through dishonest means are like passing clouds; unnecessary consumption is futile—practicality and frugality are the real deal". After each group presents their slogans, the class votes to select the "Best Slogan", which is then posted on the classroom wall as part of the "Class Consumption Code".

Case Effect

Changes in class atmosphere:

After the class meeting, the ‘materialistic competition’ among students in the classroom has significantly decreased. When purchasing stationery, students now prioritize practical value, as seen in comments like, ‘I bought a 15-yuan fountain pen—it’s so handy, even better than those expensive ones. ‘Mocking classmates for using basic stationery has virtually disappeared, replaced by friendly exchanges such as,’ Your stationery is really good—where did you buy it?’

Student cognitive transformation:

In their essay titled 'My Consumption Philosophy,' students frequently cited passages from the Analects to advocate for rational consumption. For instance, they quoted: 'The Analects states, "A

gentleman does not seek fullness in food nor comfort in dwelling." I believe consumption should follow this principle—choosing what is right over what is expensive.' This demonstrates their comprehension and practical application of the Analects' humanistic principles.

Long-term effects:

The class established a 'Rational Consumption Code' that included the 'Best Slogan' campaign, featuring messages like 'Don't blindly chase branded stationery—focus on practicality and frugality 'and' Don't mock classmates using basic stationery—respect others' spending choices. 'Regular' Consumption Reflection' meetings were held to reinforce the concept of rational consumption.

Notes

Avoiding "Serious" Teaching

In junior high school Chinese education, when addressing consumerism and promoting humanistic values, educators should avoid didactic teaching methods. Rather than directly criticizing students' consumption behaviors, they should guide them to autonomously transform their perspectives through text-based resonance and self-reflection. Junior high students possess strong self-awareness and often resist rigid moral lectures. Directly condemning behaviors like "buying luxury brands" or "keeping up with peers" may provoke resentment and fail to achieve educational outcomes.

When addressing students '"blind purchase of trendy stationery," teachers should avoid direct criticism like "This is wrong and a waste of money." Instead, they can use texts like The Analects' "Frugality and Love for People" and Sun Shaoping's "No Material Comparisons" from The Ordinary World to guide students in self-reflection: "Is the high price of trendy stationery really worth it compared to regular stationery? Where does Sun Shaoping's happiness come from despite his poverty? Should our happiness stem more from spiritual experiences than material consumption?" Through this "text-guided + self-reflection" approach, students can actively recognize the flaws of "blind consumption" and achieve self-transformation.

Meanwhile, teachers should allow students to express "temporary confusion" or "different perspectives". For instance, when a student says, "I think branded stationery is just convenient, and I'm happy to buy it", teachers shouldn' t dismiss their feelings but instead guide them: "Your preference for branded stationery reflects your personal experience. Now let's examine the saying' Think of the effort behind every bowl of porridge and every grain of rice 'from The Family Instructions of Master Zhu. Can we consider whether' convenience 'necessarily requires' high price'? Are there more cost-effective alternatives?" Through patient guidance, students can gradually embrace humanistic values while avoiding one-size-fits-all moral lectures.

Paying attention to individual differences

Middle school students come from diverse family backgrounds and growing environments, resulting in varied perceptions and attitudes toward consumerism. Teachers should recognize these differences and employ tailored guidance approaches, avoiding a one-size-fits-all educational model. This ensures every student can develop a more balanced consumption mindset based on their individual circumstances.

For students from affluent families accustomed to "high consumption," teachers can guide them through "cases of frugality by celebrities" and "the spirit of hard struggle in red literature," avoiding resistance caused by "the denial of their consumption habits." For example, introducing cases such as "Qian Xuesen conducting research in cloth shoes" and "Premier Zhou Enlai living frugally with clothes patched over and over," combined with the hardships of Red Army soldiers in *Red Star Over China*, can lead students to reflect: "These celebrities and Red Army soldiers had the means to enjoy better material lives, yet why did they insist on frugality? This shows that 'true dignity' is not material luxury, but spiritual nobility." Through this approach, students can understand that "frugality" is not "the helplessness of poverty," but "a choice of spiritual pursuit," avoiding the perception that "teachers are denying their family conditions."

For students experiencing low self-esteem due to perceived "insufficient purchasing power," educators should emphasize "equality in spiritual values," helping them understand that "spiritual growth transcends material circumstances." For example, when teaching *The Ordinary World*, teachers can analyze Sun Shaoping's journey: "Despite poverty, he achieved spiritual growth through reading and earned respect." This narrative guides students: "Sun Shaoping lacked material comforts, yet through perseverance and spiritual pursuits, he became a respected individual. We all can achieve

spiritual growth through reading, learning, and helping others – it's not about material conditions." Meanwhile, language practice activities like "reading sharing sessions" and "treasure swap events" provide such students with more opportunities to showcase themselves. Through these "spiritual experiences," they gain confidence and overcome feelings of inferiority.

Linking families and society

In junior high school Chinese teaching, the humanistic education against consumerism should not be limited to the classroom, but should also be linked with family and society, forming a collaborative education force of "school-family-society", so that students can continuously strengthen rational consumption and humanistic values in a comprehensive educational environment.

At the family level, teachers can build a bridge between home and school through "Chinese language practice assignments," enabling parents to participate in humanistic education. For example, assigning a "Family Frugality Story" writing task allows students and parents to jointly recall "stories of thrift in the family," such as "Grandma crafting handicrafts from old clothes" or "Dad repairing old appliances," then writing them into essays. Teachers may also recommend parents and students to co-read classic texts like "Zhu Xi's Family Instructions" and "The Analects," organizing "Family Reading Exchange Sessions" where parents can pass on the family virtue of "diligence and thrift" through shared reading. Meanwhile, educators can share "methods to address consumerism in Chinese language teaching" with parents via school-home communication groups, such as "how to guide children to rationally view brand names" and "how to cultivate children's spiritual pursuits through reading." This helps parents understand the school's educational direction and collaborate in educational activities.

At the societal level, teachers can utilize community resources and social public welfare activities to expand the space for Chinese language practice, allowing students to experience the value of "humanistic consumption" through social participation. For example, organizing students to participate in community "secondhand donation" activities, donating unused books and stationery to children in impoverished areas, and writing "donation diaries" to record their feelings; leading students to visit "red memorial halls" and combining texts such as "Red Star Over China" to feel the spirit of hard struggle of revolutionary predecessors, thereby reinforcing the "value of spiritual pursuit." Through practical activities at the societal level, students can transform the humanistic principles learned in class into concrete actions, deepening their rational understanding of consumerism through serving and understanding society.

Supplementary Information

Text Resource List

Traditional Cultural Text

The Analects embodies core values such as 'diligence and frugality,' 'valuing righteousness over profit,' and 'spiritual pursuit.' Quotes like 'How virtuous is Hui! Even with a single basket of food and a single gourd of drink in a humble alley, where others cannot bear the worry, Hui remains undiminished in joy,' 'to use resources sparingly and to love others,' and 'wealth and honor gained through unjust means are to me like floating clouds' form the cornerstone of anti-consumerism humanistic education.
The Zhu Xi Family Instructions emphasizes 'diligence and thrift' and 'cherishing resources,' as expressed in the sayings: 'For every bowl of porridge and every grain of rice, remember their hard-won origins; for every thread and every fiber, always reflect on the difficulty of material production.' It advises: 'Prepare in advance before the rain, don't dig a well when you're thirsty.' These teachings help students develop the mindset of 'rational consumption and proactive planning.'

The Records of the Grand Historian: Biographies of Guan Zhong and Yanzi recounts the frugal story of Yanzi, who "did not eat double portions of meat, nor did his concubines wear silk." When Yanzi served as Prime Minister of Qi, his charioteer's wife followed him from behind the door to observe her husband. The charioteer, dressed in a grand canopy and riding a four-horse carriage, appeared confident and self-satisfied. After returning home, his wife requested to leave. When asked why, she explained: "Yanzi was less than six feet tall yet became Prime Minister of Qi, renowned among the feudal lords. Now I see he is eight feet tall yet remains a humble charioteer. Yet you consider yourself sufficient. That is why I wish to leave." Later, the charioteer humbled himself. Yanzi, puzzled, questioned him, and the charioteer confessed the truth. Yanzi then recommended him as a high-ranking official. This contrast between Yanzi's frugality and the charioteer's "self-satisfaction" helps students understand that "frugality is a virtue, not a disgrace."

Liu Yuxi's' Inscription of a Humble Abode 'embodies the humanistic ethos of' Though modest, it is my virtue that makes it fragrant, 'emphasizing that spiritual fulfillment outweighs material luxury. This concept serves as a counterpoint to the' luxury lifestyle 'narrative, guiding students to redefine the essence of a' quality life.'

Contemporary Texts

"Ordinary World" (by Lu Yao) portrays Sun Shaoping, the protagonist, who persists in his studies and spiritual growth amidst poverty. "He yearns for spiritual enrichment rather than material satisfaction," serving as a classic example of "spiritual pursuit outweighing material enjoyment," contrasting sharply with consumerism's "material supremacy."

The Tree-Planting Shepherd (Jean-Jacques Annaud): A shepherd transformed a barren plateau into an oasis through decades of perseverance. His minimalist lifestyle, free from material pursuits, found fulfillment in 'creating life' —a story that teaches students about the value of 'minimalist living and spiritual creation.'

"Old Wang" (Yang Jiang): This narrative chronicles the story of Old Wang, who "lived in poverty yet remained kind and sincere." "Old Wang had only one eye—the other being a 'snail eye,' which made him blind. Passengers avoided his vehicle, fearing he might not see clearly and cause accidents. Some speculated that this old bachelor had likely suffered from some serious illness in his youth, resulting in the loss of his sight. Even his remaining eye was impaired, becoming blind in the dark. Once, he crashed into a utility pole, leaving half his face swollen and bruised. At that time, we were in a labor school. My daughter diagnosed him with night blindness and fed him a large bottle of cod liver oil, which restored his night vision. Whether his blindness stemmed from childhood malnutrition or a severe illness, both were misfortunes, though the latter was undoubtedly more profound." Old Wang's "simple interactions" and "kindness" exemplify how "the beauty of human nature surpasses material beauty," serving as a lesson for students to value "the spiritual significance in interpersonal relationships."

"Back View" (by Zhu Ziqing) portrays a simple scene of the author's father buying tangerines in a black robe and dark blue cotton coat, demonstrating that "family bonds transcend material possessions." This vivid depiction helps students grasp the intangible nature of emotional values.

Camel Xiangzi (Lao She): Obsessed with the material goal of 'buying his own car,' Xiangzi ultimately suffers a mental breakdown. This contrasts with Sun Shaoping, prompting students to reflect on the balance between material goals and spiritual aspirations.

Policy and theoretical references

The Implementation Outline for Moral Development of Citizens in the New Era explicitly advocates 'promoting frugality and opposing extravagance' and 'cultivating and practicing core socialist values.' These principles provide a policy foundation for addressing consumerism and advancing humanistic education in Chinese language instruction. By integrating these values into text analysis, students can better understand the civic duty of thrift.

Marx's "Commodity Fetishism" Theory: In *Das Kapital*, Marx observed that "the commodity form transforms the social character of human labor into the material nature of its products, projecting the inherent social attributes of these objects. This process converts the social relations of producers into external social relations between commodities." Essentially, commodities are imbued with "mystical attributes" beyond their use value, causing people to worship commodities instead of focusing on human essence and spiritual values. This theory helps analyze the essence of consumerism and assists students in rationally understanding the "symbolic value" of commodities.

Nell Noddings' "Care Ethics" and "Frugality Advocacy": In her book *Learning to Care: Another Model for Education*, Nell Noddings argues that education should cultivate the ability to "care for others, society, and nature." She emphasizes that "frugality" is a key manifestation of care ethics, as it embodies "valuing resources, caring for others (especially the underprivileged), and protecting the natural environment." This theory helps students understand that "frugality is not just a personal habit, but a form of care for others, society, and nature."

Constructivist learning theory, represented by scholars like Jean Piaget and Lev Vygotsky, posits that learning is a process where learners actively construct meaning within specific contexts to acquire knowledge. This theory provides theoretical support for approaches in language education such as "text interpretation," "writing practice," and "language activities," emphasizing that through "contextual creation," "active participation," and "meaning construction," students can autonomously develop

understanding and values regarding "anti-consumerism."

CONCLUSION

In an era where consumerist culture profoundly shapes the values of junior high school students, Chinese language education has emerged as a vital platform for countering consumerism and fostering humanistic education through its rich collection of classical texts and diverse teaching approaches. This study identifies the negative impacts of consumerism on students and the strengths of Chinese language instruction through theoretical analysis. By exploring core implementation pathways, it establishes a four-pronged humanistic education model: "textual interpretation integration," "writing practice guidance," "language activity engagement," and "integration of ideological-political education with humanities." Supported by concrete teaching case designs and analyses, the paper provides actionable implementation strategies. Practical guidelines and supplementary resources further ensure effective classroom application.

In middle school Chinese education, addressing consumerism through humanistic education should not be reduced to mere "opposition to consumption," but rather guide students to "practicing rational consumption and valuing spiritual enrichment," fostering a mindset where "spiritual values outweigh material comforts." This process requires teachers to use classic texts as vehicles, centering instruction around students through "immersive guidance," "self-reflection," and "practical experiences," enabling them to actively develop healthy consumption perspectives and values. Simultaneously, it necessitates collaboration between families and society to create a synergistic educational ecosystem. Through this comprehensive approach, students can continuously strengthen their humanistic literacy, break free from consumerist constraints, and achieve holistic spiritual growth.

Moving forward, we must further explore deeper integration pathways between Chinese language education and consumerism. This includes developing anti-consumerism-focused school-based Chinese curriculum and implementing interdisciplinary collaboration (Chinese with Ethics and Law, History) to continuously refine humanistic education models. These efforts will enable junior high school Chinese courses to play a more significant role in addressing consumerism and cultivating 'holistically developed individuals'.

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Exploring the Impact of Gamification on Student Engagement and Motivation in Higher Education Contexts

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ABSTRACT

With the continuous progress and innovation of educational technology, the emerging teaching mode of gamification teaching has gradually attracted wide attention of educators. The main purpose of this paper is to deeply explore how to skillfully integrate gamification elements into teaching activities, so as to stimulate students enthusiasm for learning and enhance their sense of classroom participation. To achieve this goal, this paper adopts various research methods, such as literature review, case analysis and empirical research, and systematically proposes a series of practical gamification teaching strategies and implementation steps. Moreover, this paper also verifies and analyzes the effectiveness of these gamified teaching methods through specific teaching cases, thus providing strong theoretical support and practical guidance for educational practice.

In the current education field, gamified teaching, as an innovative teaching method, is gradually becoming one of the important directions of educational reform. It makes the learning process by introducing elements and ideas to make the game design more interesting and engaging, thus helping students master knowledge and skills in a relaxed atmosphere. This paper aims to deeply analyze the theoretical basis of gamification teaching, and propose the corresponding teaching strategies. The case analysis section introduces the successful gamification teaching examples in detail, showing how to effectively combine the gamification elements with the course content, as well as the impact of this combination on students learning motivation and learning effect, which provides a scientific decision-making basis for educators.

Finally, this paper hopes to provide a comprehensive set of theoretical framework and operational guidelines for educators, and help them to better use gamification teaching in teaching practice, so as to improve the teaching quality and students learning effect.

Keywords: empirical research, gamification teaching, learning interest, participation, teaching method

The Theoretical Basis of Gamification Teaching

Gamification teaching is a way to increase user engagement and motivation by applying game design elements and game mechanics in a non-gaming environment (Deterding et al., 2011). In the field of education, gamification teaching can stimulate students interest in learning, enhance their learning motivation, and thus improve the learning effect. This paper will explore the specific implementation methods and steps of gamification teaching in detail, and support the effectiveness of these methods through case analysis and empirical research.

Foreign theoretical basis

Definition and core elements of gamification teaching

Gamified teaching is not simply to introduce games into the classroom, but to mean the integration of game design elements, such as points, badges, and leaderboards, to stimulate students inner motivation and sense of participation (Kapp, 2012). Its core elements include goal-setting, rule-making, feedback mechanisms, and voluntary participation.

Psychological principles of gamification teaching

The psychological principles of gamification teaching mainly involve self-determination theory (SDT) and goal-setting theory (Locke & Latham, 2002). Self-determination theory emphasizes the role of autonomy, sense of ability and relevance in motivation. Target-setting theory suggests that clear and

challenging goals can improve individual motivation and performance.

Game mechanics and educational application

There are also few cases of gamification teaching abroad. Dewey once put forward the theory of pragmatic education, and school education must be combined with life reality. Therefore, he needs to learn from experience. He attaches great importance to the position of games in education. He believes that on the one hand, games should be included in the school curriculum system, and on the other hand, games should be regarded as one of the forms of course homework in teaching. He believed that the purpose of the game is "to let the students fully growth", it pays more attention to the social significance of the game, rather than just the cognitive value; the Soviet psychologist and educator put forward the developmental teaching theory, its core is to promote students general development, including not only intelligence, but also emotion, will, character, teachers should actively promote the development of students, walk ahead of students to guide their development. Gamification teaching is providing students with a broader exploration space for training and cultivating learning ability; TPACK teaching theory is an integrated technology subject teaching theory proposed by Kohler and Misha. Teachers TPACK ability is a necessary ability for teachers in the future, which emphasizes that teachers are the active participants, classroom designers and implementers of the teaching reform. In the environment of paying more attention to information technology, improve the ability of teachers to master and use technology. Gamification teaching is a formal and comprehensive use of information technologyPostoperatively, the major changes that were made. In 2023, Daniel Burroughs speech on Technical Hard Trends: Improving and transforming Education proposed nine hard trends, including all digital and interactive educational content, which provides greater possibilities for innovative teaching models.

Domestic theoretical basis

Localization exploration of gamification teaching

In recent years, domestic scholars have also actively explored the localized application of gamification teaching in China. Based on the learning characteristics and educational environment of Chinese students, they put forward gamification teaching strategies and methods suitable for Chinese students (Shang Junjie et al., 2015).

At present, the exploration of gamification teaching is very rare in China. The theory and practice of gamification curriculum generally concentrated in elementary school junior high school, which won the first prize in the national education achievementanji game is preschool education fusion game mode, but after junior high school for gamification curriculum shows that the current basic education of gamification curriculum value and significance is still not enough attention. The Compulsory Education Curriculum Plan and Curriculum Standards (2022 Edition) issued by the Ministry of Education fully draws lessons from the reform achievements of the international curriculum, and updates the educational concepts and achievements. More emphasis on comprehensive learning, focus on subject practice, focus on the development of students core qualities. In the process of deepening the teaching reform, we should pay attention to the characteristics of students cognitive development, innovate teaching methods, enhance the attractiveness of learning, combine games with teaching, and become an important entrance for future learning.

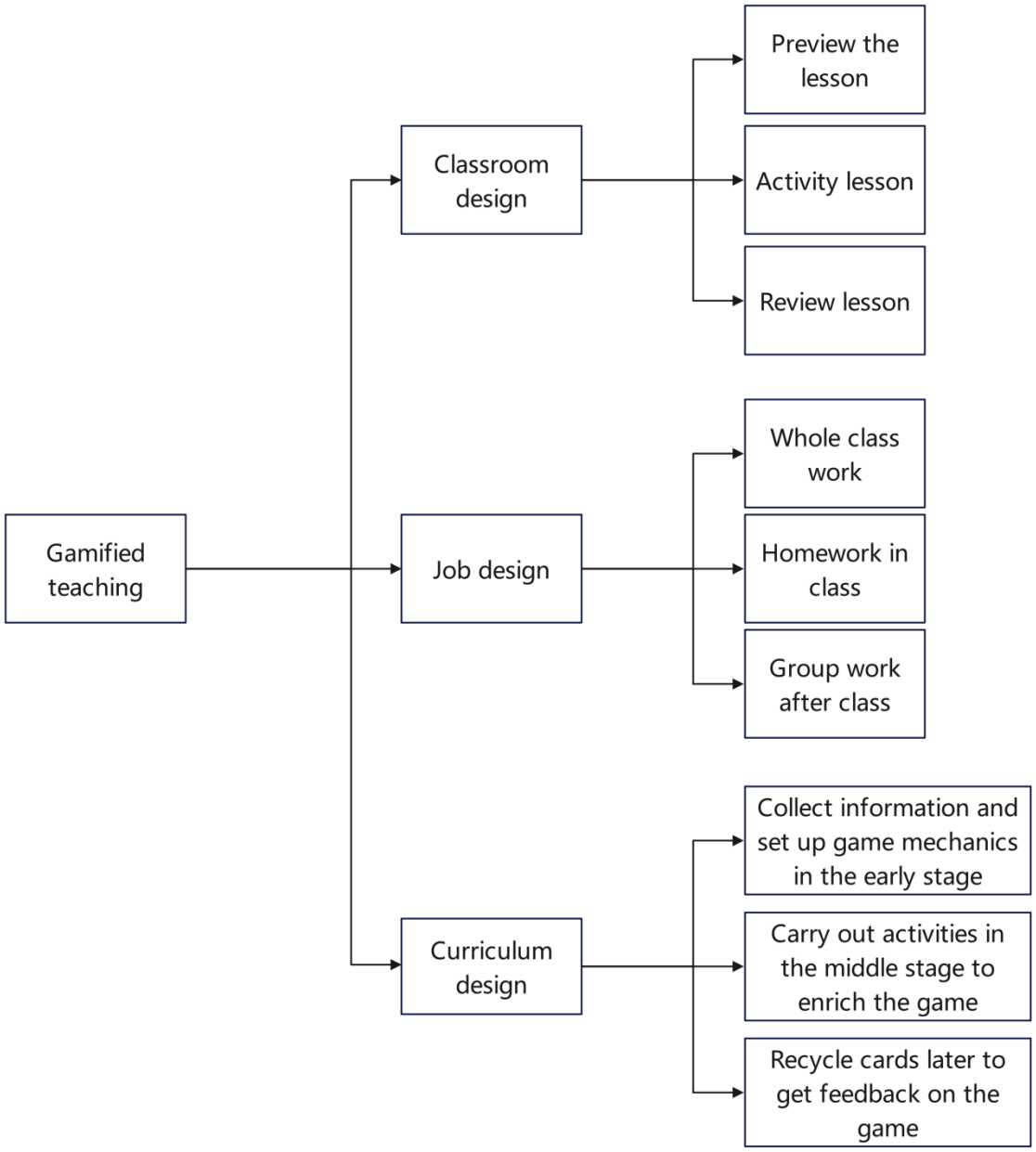


Figure 1. The Theoretical Framework of Educational Games

Key points and difficult points of gamification teaching

Key points

In the conventional classroom teaching setting, students frequently experience boredom and disengagement, which significantly diminishes their motivation and enthusiasm for learning. This passive learning atmosphere often results in poor academic performance and limited knowledge retention. However, a remarkable transformation occurs when educational approaches incorporate gamification strategies. By systematically implementing game design principles, including game mechanics, game-based thinking methodologies, and elements of gaming culture throughout the instructional process, educators can dramatically revitalize student engagement. These innovative teaching methods not only capture students' attention but also foster active participation and meaningful interaction in learning activities. Through this dynamic approach, learners enthusiastically acquire knowledge while developing problem-solving skills and critical thinking abilities, thereby substantially boosting their overall learning interest and academic achievement. The integration of gamification proves particularly effective in creating immersive educational experiences that make the acquisition of knowledge both enjoyable and highly productive.

Difficult points

In the traditional education system, especially in the teaching of history subject, students are often difficult to develop profound historical literacy and critical thinking ability. Historical literacy not only refers to the memory of historical facts, but more importantly, to the understanding and analysis of the deep-seated reasons behind historical events. Critical thinking ability refers to the ability to think independently, analyze, evaluate and reflect on information. By introducing innovative gamified teaching mode, we can create a relaxed and happy learning environment for students. In such an atmosphere, students can not only more actively participate in the learning process, but also gradually cultivate and improve their historical literacy and critical thinking ability in the interaction and challenges of games.

Specific objectives and feasibility analysis of gamification teaching

Specific Objectives

Reinvent how students learn

To facilitate a significant shift in educational approaches, we enable students to transition from traditional passive learning methods to active inquiry-based learning through the implementation of innovative gamification teaching strategies. These strategies involve designing and creating immersive game scenarios that accurately replicate real-world cases, such as simulated business challenges or scientific investigations, allowing students to fully immerse themselves, engage deeply, and explore complex concepts within these dynamic environments. This pedagogical transformation fosters a deeper understanding of subject matter and cultivates genuine enthusiasm for learning, as learners evolve into active participants who take ownership of their educational journey, rather than remaining passive recipients of information. Consequently, this leads to a more joyful, engaging, and effective educational experience, where knowledge is dynamically discovered and internalized through hands-on exploration, collaborative problem-solving, critical thinking exercises, and iterative experimentation, ultimately enhancing retention and real-world application.

Build a gamified classroom system

On the basis of the whole course teaching, meticulously complete the comprehensive and systematic overall design of classroom teaching. Consistently center all instructional activities and methodologies around the students, ensuring their active engagement and addressing diverse learning needs. Deeply integrate the principles and mechanics of the gamified classroom with core subject teaching content, utilizing game elements like points, badges, leaderboards, and challenges as pedagogical tools to enhance motivation and reinforce learning objectives. Actively promote and facilitate comprehensive classroom reform initiatives aimed at fostering innovation, increasing interactivity, and improving learning outcomes. Ultimately, build a robust, adaptable, and student-centered new pedagogical system that effectively supports sustained educational development and prepares learners for future challenges.

Fill in the gap in the game class

At present, the educational exploration of game-based classrooms is predominantly focused on primary and secondary schools, with a significant scarcity of gamification teaching practices documented at the university level. This gap may arise from perceptions that higher education curricula demand greater specialization and theoretical depth, potentially discouraging the adoption of playful methodologies. However, innovative teaching approaches, such as incorporating interactive simulations, role-playing scenarios, or digital game elements, offer a promising avenue to revitalize university instruction. By integrating these methods, educators can enhance student engagement, foster collaborative learning, and improve knowledge retention in complex subjects. Consequently, embracing such innovations effectively achieves the goal of enriching university-stage classroom teaching, ultimately creating a more dynamic and immersive educational experience.

Feasibility analysis

Academic viable. As an emerging teaching method, gamified teaching has been carried out research in the educational field, and has provided a rich theoretical basis and research reference. In the field of history education, the deep integration of games and history teaching is helpful to improve students interest and participation in learning, and enhance the effectiveness of history education.

technical feasibility. The development of modern educational technology provides technical support for gamification teaching. Existing gamified teaching tools and platforms, such as online

education platforms and virtual reality technology, can enrich classroom teaching and use online and offline parallel teaching mode to make students feel more fresh and keep their interest.

The data is feasible. Data were collected through questionnaires, interviews and other methods. These methods have been widely used in academia and have good data feasibility. By investigating the classroom situation of a large number of students and teachers, we can cut into the gamified teaching mode more accurately.

Society is feasible. Gamification teaching is in line with the development trend of modern education, helps to improve students learning interest and effect, and has a good social acceptance. It can provide reference for departments and schools, and promote the application of gamified teaching in education in various disciplines.

Qualitative analysis of gamification teaching
literature review

In recent years, Gamified teaching has significantly transformed various sectors, including education. The growth of traditional education has been particularly influenced by advancements in technology and the increasing demand for flexible learning solutions. The COVID-19 pandemic further accelerated the adoption of digital technologies in education, underscoring the importance of understanding their impact on gamified teaching (Alenezi, 2023; Dogan et al., 2023).

Gamified teaching in traditional education encompasses a broad spectrum of tools and methodologies designed to facilitate learning outside the traditional classroom environment. These technologies include virtual labs, AI-driven adaptive learning systems, simulation tools, and collaborative platforms such as Zoom, Microsoft Teams, and Slack. Each tool plays a unique role in enhancing educational outcomes by providing interactive, personalized, and collaborative learning experiences (Moorhouse & Wong, 2022; Shrestha et al., 2022). For instance, virtual labs allow students to engage in experiments and simulations that would otherwise require physical presence and resources, thereby democratizing access to high-quality education (Han, 2020).

Moreover, Gamified teaching are reshaping the educational landscape by offering customized learning paths tailored to individual student needs. These systems employ advanced algorithms to monitor student progress and adjust the difficulty of tasks, optimizing the learning process and boosting student engagement (Oancea et al., 2023). This personalized approach helps maintain a balance where students remain challenged yet not overwhelmed, promoting sustained engagement and better retention of information (Xie et al., 2021).

Collaborative platforms also play a critical role in traditional education by facilitating real-time communication and collaboration. These tools are essential for maintaining the social aspect of learning in a virtual environment, enabling students and instructors to interact through video conferences, share resources, and collaborate on projects (Moorhouse & Wong, 2022).

The rapid integration of Gamified teaching in education necessitates continuous updates to educational content and methodologies to align with technological advancements and industry demands. This dynamic landscape requires educators to proactively adopt new tools and techniques that enhance learning outcomes and prepare students for future challenges (Masalimova et al., 2022).

The ongoing evolution of gamified teaching presents a range of opportunities, including enhanced student engagement and personalized learning experiences, alongside significant challenges such as technological hurdles and resistance to adoption. Consequently, it is crucial to systematically identify effective practices, such as incorporating adaptive feedback mechanisms and collaborative elements, while proactively addressing potential barriers like resource constraints and training gaps to facilitate seamless implementation and maximize educational outcomes (Benedek, 2023).

This study explores the integration of Gamified teaching in traditional education by examining its current state, identifying effective practices, challenges, and future directions. The primary objectives include assessing the effectiveness of digital platforms, understanding the geographic distribution of studies, analyzing research methodologies, and identifying key themes in the current literature (Moorhouse & Wong, 2022; Shrestha et al., 2022).

By addressing these aspects, this research aims to bridge the skills gap and ensure that traditional education programs incorporate the latest developments and practices, preparing students for future challenges in various fields (Han, 2020).

Furthermore, this research contributes to the ongoing discourse on improving traditional education

through Gamified teaching, providing valuable insights for educators, policymakers, and researchers. Understanding how digital technologies can be effectively integrated into traditional education is crucial for developing strategies that enhance learning outcomes and ensure equitable access to education for all students (Dogan et al., 2023).

By investigating these aspects, the study seeks to offer a comprehensive overview of the impact of Gamified teaching on traditional education, highlighting successful practices and identifying areas for improvement. This approach will help inform the development of future educational policies and practices, ensuring that traditional education continues to evolve and meet the needs of a diverse and changing student population (Alenezi, 2023).

Student interview

Interview preparation

Topic content: Can gamification improve students interest in history and learning effect?—— Understand the students interest in history and learning motivation —— Select interview objects to find suitable students.

Interview content

Open-ended question: " What do you think of the history class?"And," Do you like learning history?why?"," What do you think is the point of learning history?"," What do you think of gamification teaching?"," Do you think gamification will help you learn history better?"

Closed question: " Why do you like learning history?"," What do you think is the point of learning history?"," Do you think gamification will help you learn history better?"

Behavioral questions: "Please describe one of your favorite activities in history," "Please describe a challenge you encountered in history," and "Please describe some of the learning methods you used when studying history."

Analysis of the interview data

The questionnaire design for the school mainly designed 25 questions from the basic knowledge, comprehensive quality, professional skills, working status, supply and demand connection required by the school, including 20 objective multiple choice questions and 5 subjective questions, so as to investigate the schools demand for students ability and related questions. In terms of the selection of survey subjects, it is mainly in the northern universities with relatively concentrated students, and the school size varies from thousands to tens of thousands. A total of 115 questionnaires were issued, 102 were collected and 102 were valid, with a recovery rate of 88.7%. The results are as follows.

Table 2. Statistical table of the survey results of student class needs

School needs for its students	Questionnaire survey items	
	project classification	Percentage of%
sitting up exercise	ideological and ethical standards	91%
	Team assistance	84%
	Organizational management ability	75%
	Interpersonal communication skills	67%
	Technology innovation ability	80%
	Cultural heritage ability	97%
specialized skill	Professional knowledge ability	89%
	Obtain the professional qualification certificate	70%
	Professional practice skills	76%

What class are the students interested in	Interested in a gamified class	76%
	Interested in all forms of the classes	10%
	Interested in a digital classroom	80%
	Interested in traditional classes	60%

According to the survey results of the questionnaire, the school evaluates the students mainly based on the comprehensive quality, professional skills and the degree of various forms of classroom interest. Through this survey, we can understand the commonness and differences of different students in classroom forms. The school has more and more requirements for students' comprehensive quality and professional skills. On the one hand, students are required to have a relatively high professional skills and a relatively strong knowledge of modern science and technology, and on the other hand, students are required to have a relatively strong comprehensive ability.

The innovation point of gamification teaching

Innovation in academic thought

By combining traditional teaching methods with innovative gamification modes, this teaching strategy successfully breaks the limitations of traditional lecturing teaching. It uses the means of gamification to greatly enhance students' interest and participation. Integrating these technologies into the teaching process can not only improve the interactivity of the classroom, but also increase the interest of the classroom. By playing rich and colorful art and historical content, the original complex and difficult historical knowledge becomes more vivid and vivid, so as to help students understand and remember more easily.

Using games as a teaching tool is in itself an innovative educational concept. It emphasizes learning in entertainment and focuses on students emotional experience and sense of participation. Teachers can design various corresponding game activities according to different historical themes and teaching objectives. This personalized teaching method can better meet the learning needs of different students, so that every student can learn knowledge in a relaxed and happy atmosphere.

Innovation in academic views

Through the development of the course, we can more effectively promote the comprehensive development of students in the social aspects. This includes not only the cultivation of students patriotism, but also focuses on enhancing their sense of social responsibility. Through this educational process, students can form a real and comprehensive historical and cultural concept. The course will be dedicated to the integration of interdisciplinary disciplines, which involves the combination of life themes and historical knowledge, the interconnection between history and related subject knowledge and concepts, and the close connection between historical phenomena and real life. In addition, the course will focus on the longitudinal connection of regional history, so that students can better understand the continuity and development of history.

Research method innovation

This course aims to actively create a dynamic learning environment through gamified teaching methods, which will design and implement teaching activities based on the unique characteristics of students in cognitive development. In this way, students can get a real experience as if they are in the game world, thus greatly enriching the traditional teaching mode. The course designers will carefully create a variety of game situations, so that students can enjoy the fun of games, but also absorb and master knowledge more efficiently, so as to truly realize edutainment.

The specific implementation method of gamification teaching

Set clear learning goals

The first step in gamification teaching is to clearly define the learning objectives for this semester, ensuring they form a solid foundation for engaging students through game-based elements. These goals must be specific, such as targeting precise skills or knowledge areas; measurable, allowing progress tracking through assessments or milestones; achievable, based on student capabilities to maintain motivation; highly relevant, aligning directly with curriculum standards or real-world applications to

enhance engagement; and time-limited, with clear deadlines like semester-end to create urgency and focus. For example, when teaching history, you might set an objective like "by the end of the semester, students will have completed the study and analysis of key card characters, demonstrating mastery through interactive quizzes." Similarly, in a science class, you could establish "within this term, learners will finish designing and testing simple experiments related to environmental concepts, assessed via peer reviews and project submissions," to illustrate how these principles apply across subjects and foster immersive learning experiences.

Create engaging card situations

By creating an attractive story situation, the learning content can be effectively linked to the students' interests, fostering deeper engagement and motivation. For instance, in a history class, an adventure game might be designed to immerse students in a specific historical context, such as ancient Rome or medieval Europe, where they complete interactive tasks like solving historical puzzles or reenacting key events to acquire knowledge. Similarly, in science lessons, a scenario-based simulation could be developed, allowing learners to explore scientific concepts through narrative-driven experiments, thereby reinforcing understanding while maintaining an enjoyable, interest-aligned approach. This method not only contextualizes academic material but also encourages active participation and critical thinking within a relatable framework.

Introduce the points and reward system

Points and reward systems are commonly used incentive mechanisms in gamification teaching. By setting points rules, students can get points after completing learning tasks, which can be exchanged for virtual or real rewards. For example, completing a quiz gives 100 points and three consecutive tests a virtual badge. Badges can be used to exchange for stationery such as pencils and erasers.

Use teams to compete and cooperate

Team competition and cooperation can enhance students social interaction and team spirit. In gamification teaching, camps are set for PK to encourage students to cooperate in groups to solve problems. For example, through team project competitions, students learn and complete complex history learning.

Case analysis and an empirical study

Case analysis: In the history of China, the development in the Jiangnan region during the Southern and Northern Dynasties

1. Game tasks

Task 1: Combing the temporal order through time and space (grasp the regime characteristics of the Eastern Jin Dynasty)

Task 2: Find the task in memory (master the character characteristics of the Eastern Jin Dynasty)

Task 3: Development of Jiangnan area during the Eastern Jin Dynasty (mastering politics, economy, military affairs and culture)

2. Teaching design

This lesson hopes to allow the students to complete the task of "developing" Jiangnan through by creating an immersive gamification scene. In the process of this strategy game, students can acquire knowledge and try to understand the internal logic of development and ethnic integration in Jiangnan region in the process of the game.

Through understanding the change of regime, population migration and the development of the eastern Jin and Southern Dynasties in the southern region, we understand the historical characteristics of ethnic exchanges and integration in this period and their significance to the development of the Chinese nation.

3. Teaching objectives

In the class, the students first complete task one and task two, and have a preliminary understanding of the regime change and characteristics of the eastern Jin and southern Dynasties —— gate politics and southeast security, and understand the "general environment" of the development of the Jiangnan region. Second, task three requires students to jiangnan "redevelopment", students through the historical analysis of jiangnan region development advantages and disadvantages, and according to the current situation of the jiangnan, formulate "jiangnan region development plan", in the process of "planning" sharing, students and teachers with the internal logic of the development of jiangnan region. Finally, taking the development of Jiangnan region as the starting point, the knowledge network is extended to the integration of political, economic, cultural, military and ethnic groups between the north and the

south.

After class, the students consolidate their classroom knowledge through basic exercises. In addition, the expansion homework is arranged. It is suggested that students should "plan" the local construction by combining the knowledge of classroom learning and geography subject regional planning, so as to realize the expansion of interdisciplinary integrated teaching.

4. Teaching process

Through the display and interpretation of historical materials, under the students understanding of the meaning of "the king and the horse, the world", the concept of the door politics was introduced, that is, the historical phenomenon of the gentry and the imperial power in the Eastern Jin Dynasty, and summarized the door politics, one of the characteristics of the Eastern Jin Dynasty.

Then take this as a starting point, and ask the students questions:

Teacher: Do you think about what problems will happen in this political model?

Student: The family controls the government, the emperors power is not concentrated, there may be a struggle for power.

Design intention: The emperors power was not concentrated, which meant that it was difficult for the country to "concentrate its strength to do great things". Through the setting of this problem, the government could explain the success of the northern expedition of the Eastern Jin and the southeast, and at the same time, Zu Ti was introduced to explain.

Taking Zu Tis explanation as the introduction, explain the reasons for the repeated failures of the Eastern Jin and Northern Expedition —— The internal disputes of the Eastern Jin regime, such as the fear of military generals and the lack of support. In the end, we could only choose to settle in the south of the Yangtze River, and then summed up the second characteristic of the Eastern Jin regime: partial unification and southeast security.

After summarizing the political characteristics of the Eastern Jin Dynasty, we will show the students the map of the four regimes of Song, Qi, Liang and Chen again. Let the students observe the map and compare the changes of the size of the four regimes. Through observation, students could find that the existence of the four regimes was relatively short, and the territory was getting smaller and smaller. It was concluded that the regime in the Southern Dynasty was characterized by a short existence time, the territory was shrinking, and the national strength was gradually declining. Six, the conclusion

Gamification teaching can effectively improve students learning interest and participation, and promote students to actively participate in the learning process. Gamification elements can be effectively incorporated into the teaching process by setting clear learning goals, creating story situations, introducing points and reward systems, utilizing team competition and collaboration, and implementing timely feedback mechanisms. Case analysis and empirical studies further confirm the effectiveness of gamified teaching methods and provide actionable implementation strategies for educators.

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Evaluating Higher Education Transformation in Malaysia: A Case Study of Institutional Challenges and Opportunities

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ABSTRACT

This study investigates the evolving landscape of higher education in Malaysia, focusing on institutional development, accessibility, and quality assurance. Over the past few decades, Malaysia has made considerable progress in positioning itself as a regional education hub. However, challenges remain concerning graduate employability, global competitiveness, and the integration of technology in teaching and learning. This research adopts a mixed-methods approach, drawing on institutional data, policy analysis, and stakeholder perspectives, with Lincoln University College serving as a case study. The findings reveal both strengths and limitations in current practices, particularly in curriculum relevance, academic governance, and digital readiness. The study identifies gaps between policy objectives and implementation, highlighting how socio-cultural and economic factors continue to shape educational outcomes. The conclusion emphasizes the need for adaptive strategies aligning global standards with local needs. This paper contributes to understanding Malaysian higher education reform and provides insights for policymakers, educators, and researchers seeking sustainable academic development.

Keywords: education reform, higher education, Malaysia, policy implementation, quality assurance

INTRODUCTION

Malaysia's higher education system has undergone significant transformation over the past three decades, reflecting the nation's ambition to become a global education destination. The Ministry of Higher Education (MOHE) has launched several strategic frameworks—most notably the *Malaysia Education Blueprint 2015–2025 (Higher Education)*—to strengthen institutional quality, enhance employability, and promote innovation. These efforts have resulted in rapid institutional expansion, diversification of academic programs, and greater international collaboration.

Despite this progress, Malaysian universities continue to face structural and operational challenges. Among these are disparities in institutional quality, limited alignment between university curricula and industry demands, and uneven digital transformation across campuses. The emergence of private

universities, while increasing access, has also intensified competition and raised concerns about maintaining consistent academic standards.

The present study aims to evaluate these dynamics by focusing on how institutional and policy-level factors interact to influence educational outcomes. Using Lincoln University College (LUC) as a case study, the research examines institutional governance, academic delivery, and student employability within the broader framework of national higher education reform.

The objectives of this study are to examine the evolution of Malaysia's higher education transformation, identify the institutional challenges and opportunities faced by Lincoln University College, and evaluate the effectiveness of policy implementation at the institutional level. Furthermore, this research aims to propose strategic recommendations to support sustainable improvement and enhance international competitiveness. By doing so, the study contributes to ongoing academic discourse by bridging the gap between national policy frameworks and the practical realities experienced within higher education institutions.

THEORETICAL FRAMEWORK (LITERATURE REVIEW)

1. Globalization and Higher Education Reform

Globalization has profoundly reshaped higher education worldwide. According to Altbach and Knight (2007), global forces have encouraged nations to internationalize education systems to attract foreign students, enhance academic rankings, and build knowledge economies. Malaysia, in response, has positioned itself as a regional education hub, hosting over 130,000 international students as of 2024. However, this rapid expansion has brought challenges concerning quality assurance, cross-border education management, and resource allocation. Teichler (2017) emphasizes that globalization requires not only structural reform but also cultural adaptation within institutions, where values of flexibility, innovation, and inclusivity must be prioritized.

2. Policy and Governance in Malaysian Higher Education

Malaysia's policy frameworks, particularly the *Malaysia Education Blueprint 2015–2025 (Higher Education)*, have emphasized autonomy, accountability, and inclusivity. The Blueprint identifies 10 shifts—ranging from holistic graduates to innovation ecosystems—designed to ensure universities remain responsive to both local and global contexts (MOHE, 2015). Scholars such as Ahmad (2019) and Lee (2020) argue that while Malaysia's higher education policy is well-structured, implementation often encounters barriers, including bureaucratic delays, inconsistent institutional capacities, and limited funding allocation. The gap between policy intention and operationalization remains a recurring concern.

3. Quality Assurance and Accreditation

Quality assurance in Malaysia is overseen primarily by the *Malaysian Qualifications Agency (MQA)*, which regulates academic standards and institutional audits. Previous studies (Kaur & Sirat, 2021) show that while MQA has established comprehensive frameworks, its enforcement varies significantly among institutions. Private universities, in particular, often experience resource constraints affecting compliance. Furthermore, studies (Lim & Nor, 2019) indicate that quality assurance is not merely regulatory but cultural—it requires fostering internal motivation among academic staff to maintain excellence beyond external audits.

4. Employability and Curriculum Relevance

Employability remains one of the most pressing issues in Malaysian higher education. According to Graduate Tracer Studies (MOHE, 2022), around 20% of graduates face underemployment, often due to mismatches between academic training and labor market needs. Scholars such as Raman and Tan (2020) suggest that universities must integrate industry engagement, entrepreneurship, and soft-skill training to bridge these gaps. The curriculum must also evolve to reflect Industry 4.0 priorities—data literacy, digital communication, and critical thinking—essential for global competitiveness.

5. Digital Transformation and Institutional Readiness

The COVID-19 pandemic accelerated digital learning adoption, exposing both strengths and weaknesses in Malaysia's education system. Research by Noor et al. (2023) found that while most universities adopted hybrid teaching models, infrastructure disparities hindered effective delivery. Lincoln University College, like many others, faced challenges in digital integration, requiring continuous professional development for lecturers and stronger technical support.

METHOD

1. Research Design

This study employs a **mixed-methods approach**, combining qualitative and quantitative data to analyze institutional performance and policy implementation. The qualitative aspect includes document analysis, interviews with academic staff and administrators, and policy reviews. The quantitative aspect incorporates survey data from students and faculty members at Lincoln University College.

2. Data Collection

Data were collected between January and July 2025, with primary data is Semi-structured interviews with 12 administrators and 25 faculty members; surveys distributed to 180 students. The Secondary data are collected from Institutional reports, MOHE publications, and MQA quality audit documents.

3. Data Analysis

Qualitative data were analyzed using **thematic analysis** (Braun & Clarke, 2006), identifying recurring themes related to institutional governance, quality assurance, and employability. Quantitative survey data were analyzed using descriptive statistics to examine satisfaction, perceived employability readiness, and technology adoption levels.

4. Ethical Considerations

Ethical approval was obtained from Lincoln University College Research Ethics Committee. Participation was voluntary and anonymous, and data were stored securely to ensure confidentiality.

FINDINGS AND DISCUSSION

1. Institutional Development and Governance

Findings reveal that Lincoln University College (LUC) has made substantial progress in institutional expansion and program diversification. However, governance structures remain highly centralized, with limited academic autonomy at departmental levels. Interviews indicate that administrative decision-making often prioritizes compliance over innovation. This aligns with earlier research by Lee (2020), suggesting that centralization can inhibit responsiveness to changing academic demands. Faculty members expressed a need for greater empowerment to redesign curricula and improve pedagogical flexibility.

2. Policy Implementation Gaps

Although Malaysia's higher education policies advocate inclusivity and quality, the translation into practice is inconsistent. Administrators at LUC reported challenges in meeting MQA requirements due to limited funding and administrative capacity. For instance, while policies encourage industry collaboration, resource constraints hinder sustained partnerships. Similar findings are reflected in Ahmad's (2019) national-level analysis, emphasizing that institutions often struggle to operationalize policy objectives within financial and staffing limitations.

3. Curriculum Relevance and Employability

Survey data revealed that 68% of students felt their academic programs provided adequate theoretical knowledge but lacked practical exposure. Employers interviewed in related MOHE studies (2022) echoed this concern, urging universities to incorporate experiential learning modules and internships. Lincoln University College has taken initial steps by establishing its Career and Industry Engagement Unit, yet the integration of employability-focused modules remains uneven. This finding supports Raman and Tan's (2020) argument that Malaysian universities must redefine curricula to emphasize skill alignment with evolving labor market demands.

4. Quality Assurance and Academic Standards

Quality audits indicate that LUC complies with MQA accreditation benchmarks, but academic staff workloads and reliance on adjunct faculty present challenges. Interviewees noted that while MQA audits promote accountability, they can become procedural rather than developmental. This suggests a need for an internal culture of continuous improvement, where faculty engagement and reflective practices are emphasized over compliance metrics (Lim & Nor, 2019).

5. Digital Readiness and Innovation

Survey results show that 73% of respondents found digital learning platforms effective for flexible learning, yet 41% reported insufficient digital literacy support. Administrators cited infrastructure limitations and lack of systematic training as key barriers. The digital divide between public and private institutions remains evident, echoing findings by Noor et al. (2023). Despite these constraints, Lincoln University College has demonstrated adaptability by developing blended-learning systems and incorporating virtual classrooms—an encouraging sign for institutional resilience.

6. Socio-Cultural and Economic Influences

Socio-cultural norms influence student engagement and career aspirations. Many first-generation university students prioritize job stability over entrepreneurial ventures, affecting employability trends. Economic factors, including tuition affordability and graduate debt, further shape educational choices. These findings underscore the need for holistic policies addressing not only academic reform but also socio-economic barriers that impact educational equity.

CONCLUSION

Malaysia's higher education transformation reflects a complex interplay between policy ambition and institutional realities. The case of Lincoln University College illustrates both the achievements and ongoing challenges of aligning national educational goals with institutional capacities.

Key findings indicate that existing policy frameworks are largely comprehensive; however, their implementation is often constrained by limited institutional resources. While quality assurance mechanisms play a crucial role in ensuring accountability and maintaining standards, they may inadvertently stifle innovation when applied in an overly procedural manner. The study also reveals

persistent employability gaps, primarily driven by insufficient industry engagement and rigid curricula that are slow to adapt to labor market demands. Additionally, although digital readiness within institutions is steadily improving, progress remains uneven, highlighting the need for sustained investment in digital infrastructure and continuous capacity-building through training.

To advance sustainable reform, universities must embrace adaptive governance, foster academic autonomy, and strengthen collaboration among policymakers, educators, and industries. Continuous monitoring and evidence-based decision-making should underpin Malaysia's quest to achieve global recognition in higher education. This study contributes to the ongoing discourse on educational transformation in emerging economies and offers practical insights into managing institutional change in a rapidly evolving global environment.

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Research on the Role Transformation and Practical Path of Kindergarten Art Teachers in the AI Era

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ABSTRACT

The rapid advancement of artificial intelligence (AI) has posed significant challenges to kindergarten art education. This study explores the inevitable transformation of kindergarten art teachers 'roles and practical implementation strategies in the AI era. The paper analyzes the dilemmas faced by traditional teachers as "skill demonstrators" and "artwork evaluators" under AI's impact, while examining pathways for their transition from conventional roles to new professional identities. Grounded in teaching practices, it proposes an "AI-assisted, child-centered" approach. Through concrete case studies, the research elaborates on key implementation points and behavioral guidelines for each pathway, aiming to provide frontline educators with a systematic, actionable framework. This framework enables teachers to redefine their value within the AI wave, effectively harness technological empowerment to better nurture and stimulate children's creativity and aesthetic sensibilities.
Keywords: artificial intelligence, kindergarten art, kindergarten art teacher role, practical path, role transformation

INTRODUCTION

The wave of artificial intelligence (AI) is integrating into the social fabric with unprecedented breadth and depth, placing the field of education at the center of this transformative process. As the starting point of individual development, early childhood education faces profound reflections on the traditional roles of teachers while embracing the innovative possibilities brought by AI. Particularly in kindergarten art education—a domain emphasizing sensibility and creativity—the traditional skill-centered teaching methods are no longer sufficient to meet the demands of the AI era for children's innovation awareness, aesthetic perception, and interdisciplinary abilities.

This study aims to deeply analyze the intrinsic logic and external drivers behind the transformation of kindergarten art teachers' roles in the context of AI, examine the challenges involved, and explore concrete and feasible practical pathways. Through a comprehensive review and critical reflection on relevant literature, this research constructs a strategic framework to promote teacher development from multiple perspectives: the internalization of teachers' AI cognition and capabilities, the innovation of teaching philosophies and methods, the construction of professional growth communities, and the adherence to educational ethics and humanistic warmth.

We anticipate that this study will provide frontline kindergarten art teachers with a reference that

combines theoretical reflection and practical value, fostering the organic integration of AI technology and art education, and ultimately contributing to the cultivation of an innovative generation capable of harmoniously engaging with the future world.

We are currently in an era defined jointly by data, algorithms, and computing power, where artificial intelligence (AI) technology is transitioning from the periphery to the center, quietly reshaping all aspects of social life. The field of education is no exception (Huang et al., 2017). AI is no longer merely a disruptive force in industries such as manufacturing and healthcare; rather, as a dynamic interplay of culture and technology, it profoundly influences the transmission of knowledge, the occurrence of learning, and even the equity and quality of education (Wang et al., 2023). From intelligent teaching assistance systems to personalized learning path planning, AI is subtly transforming the educational landscape, injecting new variables into traditional teaching relationships, learning experiences, and management models (Huang et al., 2017). In early childhood education—the foundational stage for individual development—the potential applications of AI are gradually emerging. Whether through intelligent devices assisting teachers in detailed observation or providing learning content aligned with children's developmental stages, these innovations herald new educational possibilities (Huang et al., 2017).

However, this technological wave brings not only innovations in tools but also fundamental questions about the essence of education. When knowledge acquisition becomes unprecedentedly convenient, how should we cultivate children's abilities to adapt to the future? As intelligent technologies become increasingly widespread, how should we guide children to coexist harmoniously with technology and collaborate creatively? These questions have become shared challenges for the global education community. Kindergarten, as the first social environment children enter, makes every update in its educational philosophy and practice critically important. In response to the global demand for innovative talents and the ongoing impact of technology on future occupational ecosystems, early childhood education must take proactive measures to lay a solid foundation for children's long-term development.

Against this backdrop, the value of kindergarten art education becomes increasingly prominent. It concerns not only aesthetics and creativity but also represents an important journey for children to understand the world, express emotions, and shape personality (Bian, 2000). Traditional art classrooms often emphasize skill refinement and imitation of model works; however, in the AI era, this approach may obscure children's more precious innovative spirit and critical thinking (Bian, 2000). The emergence of AI painting tools, on the one hand, broadens the boundaries of artistic creation and brings unprecedented resources and interactive experiences to teaching [7, 11]; on the other hand, it prompts us to reconsider fundamental questions such as "What constitutes originality?" and "How should we evaluate it?" Therefore, how to genuinely integrate AI technology into kindergarten art education to stimulate rather than replace children's creativity has become a core issue that we must confront and resolve.

In today's era of increasingly diverse digital media, children's access to art has become multifaceted. The rise of AI-generated art compels us to reconsider the uniqueness of "human creativity" (Zhang & Zheng, 2024). The contemporary value of art education in kindergartens is no longer merely the transmission of painting skills; rather, it has been elevated to guiding children in establishing their own aesthetic coordinates through artistic exploration and expression, while developing problem-solving abilities and nuanced emotional language. However, the convenience brought by AI is accompanied by

challenges: on one hand, the widespread use of AI drawing tools may lead children to become dependent on technology-generated images, potentially blurring their understanding of the boundaries between "originality" and "imitation" (Zhang & Zheng, 2024); on the other hand, many teachers still lack sufficient understanding and application of AI technology, which directly restricts the deep integration of technology and education (Liu & Dong, 2019).

This situation calls not only for an update in teaching methods but also for a profound transformation in educational philosophy. What we need to cultivate are children who can collaborate with AI in the future while maintaining independent thinking and creative enthusiasm. Therefore, the focus of art education should be placed more on those human "soft skills" that AI finds difficult to reach: critical thinking, the ability to handle complex problems, creativity originating from within, emotional resonance, and cross-cultural understanding. When AI can easily generate perfect images, the unique human perspective, the clumsy yet sincere brushstrokes, and the stories and emotions embodied behind the works become increasingly precious. The transformation of the art teacher's role is precisely to protect and stimulate these human traits, guiding children to find and develop creativity that transcends algorithms through interaction with AI (Bian, 2000). This requires teachers to shift their vision from children's "painting skills" to their "growth," focusing on cultivating core competencies so that they can maintain their valuable curiosity and innovative spirit when facing future uncertainties. At the same time, teachers must also guide children to regard AI as a powerful "brush" or "partner," rather than an object of dependence, thereby upholding the most authentic humanistic core of artistic creation.

With the application of AI technology in educational settings, the role of teachers is undergoing a profound transformation from being "transmitters of knowledge" to "companions in learning" [15, 2]. In the specific context of kindergarten art education, this transformation is particularly concrete and urgent. Teachers need to evolve from the traditional skill demonstrators who teach hand-in-hand to becoming multifaceted educators capable of skillfully integrating AI tools, meticulously designing inquiry-based art activities, keenly capturing and stimulating children's intrinsic creative sparks, and engaging with children in discussions about the ethics of technology (Li & Feng, 2013).

This role transformation is not only an inevitable outcome of technological development but also an intrinsic requirement for teachers' professional growth (Liu & Dong, 2019). It demands that teachers reassess their position within the teaching process—not as the center stage performers, but as designers of learning environments, supporters on children's exploratory journeys, and bridges between technology and children. This implies that teachers must possess stronger curriculum conceptualization and design abilities, a more open mindset toward technology integration, and a broader interdisciplinary perspective to confidently meet the new expectations of education in the AI era. This is not a negation of the traditional value of teachers but rather an enrichment and expansion of their professional connotations within the new temporal framework. Ultimately, teachers will become the guides who ignite children's curiosity and accompany them as they step into the future world.

The core aim of this study is to thoroughly examine the intrinsic logic underlying the transformation of kindergarten art teachers' roles in the AI era, confront the practical challenges therein, and attempt to outline a clear and feasible practical blueprint. Specifically, we seek to: (1) analyze the opportunities and disruptions brought by AI technology to kindergarten art education, elucidating the necessity and urgency of the transformation of teachers' roles; (2) identify and dissect the multiple obstacles teachers may encounter during this transformation process, including those related to technology, ideology, resources, and ethics; (3) construct a systematic and implementable practical pathway to support

teachers in effectively addressing challenges and achieving self-transcendence, ultimately enabling AI to become a positive empowering force in art education.

At the theoretical level, this study aims to inject new perspectives into the interdisciplinary research field of "AI + Early Childhood Education" and "AI + Art Education," providing a unique observational lens for constructing theories of teacher professional development in the AI era. At the practical level, we hope this research can serve as an "action guide" delivered directly to frontline kindergarten art teachers, assisting them in utilizing AI technology with greater composure and creativity, enhancing the warmth and depth of their teaching, and stimulating children's innovative potential and aesthetic experience. In doing so, it aspires to contribute modestly to the modernization of early childhood education in China. Meanwhile, the study's conclusions may offer valuable references for educational administrators in formulating teacher training programs and allocating resources, jointly fostering a supportive ecosystem for teacher innovation and development. Ultimately, we hope this research will accompany and empower every kindergarten art teacher to find certainty and direction in their professional growth amid an era of profound change, becoming warm and resolute practitioners leading the future of art education.

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THEORETICAL FRAMEWORK

Theoretical Foundations for the Role Transformation of Kindergarten Art Teachers in the AI Era (Expanded and Optimized Version)The integration of AI and education is by no means a simple technological overlay; it touches upon profound transformations in educational philosophy and teaching models. From a theoretical perspective, this integration provides solid theoretical support for the role transformation of kindergarten art teachers, mainly reflected in the following aspects:

Technology Empowerment Theory

The core of this theory is that AI, as an efficient intelligent tool, significantly enhances educational effectiveness and quality. Through automation and intelligent means, it liberates teachers from tedious repetitive tasks, allowing them to devote more energy to creative instructional design and personalized in-depth guidance (Huang et al., 2017). In art education, AI tools act as powerful assistants—for example, generating creative prompts, providing vast artistic resources, or conducting preliminary quantitative assessments of children's artworks—greatly expanding teaching boundaries (Zhou & Li, 2022). This empowerment not only improves teaching efficiency but also stimulates teachers' own

innovative potential, encouraging exploration of unprecedented teaching methods and artistic forms to open broader learning and creative spaces for children. Teachers can use AI to analyze children's creative data, accurately grasp their interests and learning difficulties, and achieve truly individualized instruction.

Digital Literacy Theory

Digital literacy theory emphasizes individuals' abilities to acquire, evaluate, use, create, and disseminate information in digital environments. For AI-era art teachers, digital literacy transcends mere tool operation to include critical understanding and ethical application of digital technologies (especially AI). Teachers must not only proficiently use AI tools to assist teaching but also identify limitations and potential biases in AI-generated content, guiding children to develop healthy digital habits (Mishra & Koehler, 2006). In art education, this means helping children understand AI art's generative mechanisms, distinguish between human and machine creations, and cultivate awareness of digital copyright and information security. Teachers' digital literacy is the cornerstone for ensuring AI plays a healthy, positive role in kindergarten art education.

Human-Machine Collaboration Theory

This theory emphasizes that in the AI era, humans and intelligent systems should establish a complementary, symbiotic relationship rather than compete. Teachers are no longer the sole knowledge authorities but become intelligent partners co-constructing learning environments with AI systems (Resnick, 2007). In art education, teachers can leverage AI's powerful data processing and image generation capabilities—such as analyzing children's drawing styles and preferences—while focusing on cultivating children's emotional expression, humanistic values, and critical thinking, achieving a perfect complementarity of human and machine strengths to promote children's holistic development (UNESCO, 2023). This collaborative model frees teachers from repetitive tasks like image recognition and color analysis, allowing more time for deep interaction and personalized guidance with children. The essence of human-machine collaboration lies in leveraging each party's unique advantages to create educational value beyond any single subject's capacity.

Personalized Learning Theory

One of AI's core advantages is providing highly customized learning content and immediate feedback based on each child's unique learning characteristics, interests, and developmental pace, achieving precise education. In art education, AI can deeply analyze children's creative data (e.g., drawing styles, color usage habits) and recommend the most suitable artworks or creative themes, effectively stimulating children's intrinsic motivation and creative potential (Mishra & Koehler, 2006). This personalization is reflected not only in content adaptation but also in dynamic adjustment of learning paths—AI can modify instruction difficulty and pace based on children's real-time performance, ensuring each child grows in the most appropriate environment. For kindergarten children with significant differences in developmental speed and interests, personalized learning maximizes potential activation.

Constructivist Learning Theory

Constructivism emphasizes that learners construct knowledge through active interaction with their environment. AI technology can provide children with rich, immersive interactive learning environments—such as virtual reality (VR) or augmented reality (AR) art creation platforms—enabling children to explore, discover, and create through hands-on practice, thereby gaining a deeper understanding of artistic concepts and skills (Mishra & Koehler, 2006). In this process, teachers' roles

transform into "scaffold builders and learning facilitators," guiding children to use AI tools for autonomous inquiry. For example, AR technology allows children to "activate" their doodles for interaction in virtual spaces, greatly enhancing learning fun and engagement, and making children active knowledge constructors.

Sociocultural Theory

Sociocultural theory emphasizes that learning occurs through social interaction and cultural participation. AI tools can serve as media for children to interact with peers, teachers, and the broader cultural world. For instance, children can share works via AI platforms, receive feedback from peers and teachers across regions, or access diverse global artistic forms, broadening their artistic horizons. Teachers need to guide children in effective social interaction, cultivating their abilities in cooperation, sharing, and cross-cultural understanding, making AI a powerful tool to promote children's social development and cultural comprehension.

Embodied Cognition Theory

This theory posits that cognitive processes are closely linked with bodily perception, movement, and environmental interaction—not occurring solely in the mind. In art education, the creative process is a highly embodied practice involving interaction among hands, eyes, body, and materials. AI technology—especially AR/VR and somatosensory interactive devices—offers new possibilities for embodied learning (Bian, 2000). For example, using somatosensory devices for virtual sculpture or painting allows children to experience art through full-body engagement. However, teachers must avoid over-reliance on virtual experiences, which might weaken children's perception and interaction with real materials and the real world. Thus, teachers' role is to balance virtual and real experiences, ensuring AI enhances rather than replaces children's embodied interaction with the real world, thereby promoting their artistic cognitive development.

The Essence and Development Direction of Kindergarten Art Education

The essence of kindergarten art education lies in promoting children's perceptual, emotional, cognitive, and social development through artistic activities, with the core being cultivation of aesthetic ability and creative expression. It far exceeds skill training, serving as an important pathway for children to understand the world, express themselves, and develop unique personalities (Bian, 2000). Art education's true value is igniting children's imagination and shaping their unique aesthetic taste and creative thinking—not mere imitation and replication. This essence dictates that art education must always adhere to the "child-centered" principle, respecting and protecting children's nature and curiosity in any era.

Against the AI era's backdrop, kindergarten art education's development presents key trends, imposing new requirements on teachers' roles:

Cross-Disciplinary Integration and Diverse Expression

Future art education will emphasize deeper integration with science, technology, engineering, and mathematics (STEAM). AI will act as a catalyst to expand artistic expression forms, such as digital painting, interactive installation art, and AI-assisted combinations of music and visual arts (Kewalramani et al., 2021). This integration cultivates children's comprehensive literacy and problem-solving abilities—for example, creating artworks through simple AI programming commands allows children to learn basic logical thinking during artistic practice. Breaking traditional disciplinary barriers enables children to understand the world from a broader, more multidimensional perspective.

Immersive Experience and Contextual Creation

Leveraging immersive technologies like AR/VR, art education will provide children with immersive artistic experiences, allowing them to "enter" artworks and interact with virtual artistic contexts (Mishra & Koehler, 2006). For example, visiting virtual art museums worldwide via VR or projecting paintings into real environments via AR greatly enhances art learning's interactivity and fun. Such immersive experiences not only improve children's artistic perception but also stimulate their exploratory desire, making art learning vivid and lively.

Creative Autonomy and Individual Development

AI supports children in deeper autonomous exploration and creation based on their interests and abilities, with teachers' roles shifting more toward guidance and support (Bian, 2000). AI can provide personalized learning paths and resource recommendations based on children's creative data, ensuring each child learns art at the most suitable pace and manner. This highly autonomous learning model is crucial for cultivating children's self-efficacy and independent thinking.

Ethical Reflection and Humanistic Adherence

While enjoying AI's convenience, art education must emphasize AI ethics education for children, guiding them to establish correct views on AI and uphold art's humanistic essence and originality (UNESCO, 2023). This includes reflecting on AI-created copyrights, aesthetic values, and the irreplaceability of human creativity. Teachers need to help children understand that human emotions, thoughts, and culture endow artworks with life and meaning. Thus, art education should guide children—with AI assistance—to focus more on self-expression and humanistic care, cultivating their critical thinking and moral judgment.

Process Documentation and Multidimensional Evaluation

AI can accurately record children's creative processes and data, making art education evaluation focus not only on final products but also on children's thinking, exploration, and growth trajectories during creation. AI-assisted evaluation systems provide more objective, multidimensional feedback, helping teachers comprehensively understand children's developmental status (Huang et al., 2017). However, such data analysis should be an aid—final evaluation still requires teachers to consider children's emotional expression and creative intentions, emphasizing respect for their creative thinking and unique expression.

New Connotations of Teacher Professional Development Theory

Teacher professional development is a continuous, dynamic process of self-transcendence. In the AI era, traditional professional development theories acquire new connotations:

Lifelong Learning Theory

AI's rapid iteration requires teachers to view knowledge updating as a norm. Teachers should maintain a mindset of continuous learning of AI knowledge and application skills (Liu & Dong, 2019), including not only AI tool operation but also deep reflection on AI's educational philosophy and ethical issues. Actively participating in trainings and seminars, teachers internalize lifelong learning as a professional habit.

Reflective Practice Theory

This theory encourages teachers to engage in critical reflection during teaching practice. In AI-assisted teaching, teachers need to reflect on AI tools' effectiveness and how to integrate AI into teaching to maximize children's development (Zhang & Zheng, 2024). Such reflection targets not only teaching outcomes but also AI tools' limitations and potential risks. Through continuous reflection, teachers optimize AI application strategies in art education.

Professional Learning Community Theory

This theory emphasizes that teachers collaboratively solve problems and improve abilities through cooperation, communication, and sharing. In the AI era, teachers can explore AI applications in art education via online platforms or interdisciplinary seminars, share experiences, and form collective wisdom (Liu & Dong, 2019). These communities provide emotional support, promote knowledge sharing and skill enhancement, and help teachers avoid isolation when facing new technological challenges.

Teacher Efficacy Theory

Teacher efficacy refers to teachers' belief in their ability to influence student learning and development. In the AI era, teachers need to build confidence in effective teaching with AI assistance (Eckhoff, 2017). Enhancing teachers' AI literacy and application ability strengthens their teaching efficacy in the AI context—when teachers master new technologies and observe positive outcomes, their teaching enthusiasm and professional confidence significantly increase.

Transformative Learning Theory

This theory holds that adult learners change their original cognitive frameworks through critical reflection on experiences and assumptions. In the AI era, teachers need to undergo transformative learning by revising traditional educational concepts and teaching methods, accepting AI as a new educational partner, and actively exploring its innovative applications in art education. This deep conceptual transformation is key to successful teacher role transition.

Reshaping Teacher Competencies under Core Literacy Orientation

Under the core literacy-oriented educational background, the AI era imposes higher demands on kindergarten art teachers beyond traditional disciplinary knowledge and teaching skills (Bian, 2000):

AI Literacy and Digital Ethics Competency

Teachers need to understand AI's basic principles and application scenarios, and be proficient in AI-assisted creation, teaching management, and assessment tools (Zhou & Li, 2022). More importantly, they should organically integrate AI with art education goals, ensuring it serves children's holistic development rather than mere technology stacking. Simultaneously, teachers must have digital ethics and security awareness, guiding children to engage in responsible artistic creation and communication in digital environments.

Innovative Thinking and Interdisciplinary Curriculum Design Ability

Teachers should design innovative, inquiry-based art curricula and activities using AI to stimulate children's creativity (UNESCO, 2023). This requires not only artistic creativity but also combining creativity with AI—such as designing interdisciplinary activities like "AI + Nature Exploration" or "AI + Story Creation."

Critical Thinking and Aesthetic Judgment Ability

Teachers need to guide children to critically view AI, understand its limitations, and cultivate ethical awareness and originality in artistic creation (UNESCO, 2023). They should help children comprehend differences between AI-generated and human-created artworks, fostering independent aesthetic judgment and a sense of responsibility.

Embodied Practice and Interdisciplinary Integration Ability

Teachers should integrate art education with science, technology, and other fields to cultivate children's comprehensive problem-solving skills (Kewalramani et al., 2021). Especially in the AI era, teachers need to design activities ensuring children still construct artistic cognition through bodily

perception and practice amid virtual-real alternations—such as transforming virtual designs into actual handicrafts.

Emotional Resonance and Humanistic Care Ability

Despite AI's power, teachers' roles in emotional communication, stimulating children's interest, and providing humanistic care are irreplaceable (Resnick, 2007). Teachers need to pay more attention to children's psychological development and emotional needs, becoming warm-hearted educators.

Continuous Learning and Self-Renewal Ability

Facing AI's rapid development, teachers must possess continuous learning and self-renewal abilities to adapt to new educational environments and technological challenges (Eckhoff, 2017).

In summary, kindergarten art teachers' role transformation in the AI era is a multidimensional, profound systemic project, requiring comprehensive enhancement in technology, philosophy, practice, and literacy to meet future educational development demands. These theoretical foundations provide solid support for constructing subsequent practical pathways.

METHOD

This study adopts a comprehensive research methodology combining theoretical analysis with practical case studies to explore the role transformation of kindergarten art teachers in the AI era. The research design incorporates multiple approaches to ensure both theoretical depth and practical relevance.

Research Design and Approach

The study employs a qualitative research approach with emphasis on theoretical construction and practical pathway exploration. Given the conceptual nature of the research topic, this section is framed as an Analytical Framework rather than a traditional method section. The research follows a systematic process of literature review, theoretical analysis, and case study integration to develop comprehensive understanding of the transformation process.

Data Sources and Collection Methods

Data were collected from multiple sources to ensure comprehensive coverage of the research topic. Primary data sources include: (1) Extensive academic literature review covering AI in education, early childhood education theories, and art education methodologies; (2) Document analysis of kindergarten art education practices and AI integration cases; (3) Systematic observation of art teaching activities in kindergarten settings; (4) Analysis of existing case studies on AI applications in early childhood art education. The data collection process focused on identifying patterns, challenges, and successful practices in teacher role transformation.

Analytical Framework and Procedures

The analysis followed a structured framework consisting of four main phases: First, identification and analysis of core issues in teacher role transformation under AI impact, focusing on both challenges and opportunities. Second, systematic examination of the theoretical foundations supporting role transformation, including technology empowerment theories and educational philosophy updates. Third, detailed analysis of practical cases to extract effective implementation strategies and identify common obstacles. Fourth, integration of theoretical perspectives with practical experiences to construct comprehensive implementation pathways. The analytical process emphasized iterative refinement of concepts and continuous validation against both theoretical frameworks and practical observations.

Case Study Methodology

The research incorporates an in-depth case study of Teacher Dong Lianhua's "'Gourd' Imaginative Ideas · Intelligent Fun with Nature" outdoor sketching activity. This case was selected as it represents a comprehensive example of AI integration in kindergarten art education. The case analysis examines: (1) Design philosophy and implementation process; (2) AI tool integration strategies; (3) Teacher role transformation manifestations; (4) Children's learning outcomes and feedback; (5) Challenges and solutions in practical implementation. The case study provides concrete examples of the theoretical concepts discussed and offers practical insights for implementation.

FINDINGS AND DISCUSSION

1. The Necessity and Urgency of Teacher Role Transformation

The research findings clearly demonstrate that AI technology is fundamentally reshaping the kindergarten art education ecosystem. Traditional teacher roles as "skill demonstrators" and "knowledge transmitters" are being challenged by AI's capabilities in generating artistic content, providing instant feedback, and offering personalized learning paths. However, this technological disruption does not diminish teacher value but rather necessitates evolution toward more creative, guiding, and supportive roles. The transformation from "transmitters of knowledge" to "learning facilitators" and "creativity stimulators" has become an inevitable trend in educational development.

The study identifies several critical factors driving this transformation: First, the changing nature of knowledge acquisition in the AI era requires teachers to focus more on cultivating children's critical thinking and creative abilities rather than mere skill transmission. Second, AI tools' capabilities in handling routine tasks free teachers to concentrate on higher-value educational activities such as emotional guidance and individualized support. Third, the integration of AI technology demands new teacher competencies including digital literacy, ethical awareness, and technological application skills. These factors collectively create both the necessity and opportunity for profound role transformation.

2. Practical Pathways for Role Transformation

Through comprehensive analysis of teaching practices and theoretical frameworks, the research identifies four key dimensions for teacher role transformation, each with specific implementation strategies:

a. Enhancing AI Literacy and Technical Proficiency

Systematic professional development emerges as crucial for building teachers' AI capabilities. The research emphasizes the importance of targeted "AI + Art Education" training programs that cover not only technical skills but also critical understanding of AI applications. Teachers need to develop competencies in several areas: operational skills for AI tools like painting generators and AR/VR platforms; data analysis capabilities for interpreting children's creative patterns; and ethical awareness for responsible technology use. The findings suggest that successful training programs combine theoretical knowledge with hands-on practice, enabling teachers to transition from passive technology recipients to active, innovative users

b. Innovating Teaching Concepts and Methods

The research reveals that effective AI integration requires fundamental shifts in teaching philosophy. Teachers need to move from "skill-centered" to "child development-centered" approaches, designing personalized, immersive, and interdisciplinary art activities. Specific strategies include: using AI to generate diverse creative stimuli while maintaining children's central role in artistic expression; leveraging AR/VR technologies to create engaging learning environments; and designing STEAM-

integrated activities that connect art with other disciplines. The findings emphasize that technology should enhance rather than replace authentic artistic experiences, with teachers serving as guides in children's creative journeys rather than technical instructors.

c. Building Professional Learning Communities

The study highlights the importance of collaborative support systems for sustainable teacher development. Effective approaches include: establishing kindergarten-based research mechanisms for regular peer learning and experience sharing; creating cross-institutional communication platforms for broader perspective exchange; and developing online learning communities for continuous knowledge updating. The research finds that teachers who participate in professional communities demonstrate higher confidence and competence in AI integration, benefiting from collective wisdom and emotional support when facing technological challenges.

d. Emphasizing Ethics and Humanistic Care

A significant finding concerns the essential role of ethical considerations and humanistic values in AI-integrated art education. Teachers must balance technological applications with fundamental educational principles by: guiding children to understand AI's capabilities and limitations; protecting children's privacy and data security; maintaining emphasis on emotional expression and cultural identity in artistic creation; and cultivating critical awareness about AI-generated content. The research underscores that while AI can enhance technical aspects of art education, the human elements of creativity, emotion, and cultural understanding remain irreplaceable and must be prioritized.

3. Case Study Analysis: Outdoor Sketching with AI Integration

This case originates from a large-class art activity lesson plan titled “‘Gourd’ Imaginative Ideas · Intelligent Fun with Nature” — Outdoor Fun Sketching, designed by Teacher Hao Ruiping from Runxin Kindergarten, Licheng District, Jinan City.

The detailed case study of Teacher Hao's "'Gourd' Imaginative Ideas · Intelligent Fun with Nature" activity provides concrete examples of successful role transformation. Key findings from the case analysis include:

Design Innovation and Implementation Effectiveness

The case demonstrates how traditional outdoor sketching can be enhanced through thoughtful AI integration. By situating the art activity in a natural environment and using AI language assistants to answer children's spontaneous questions, the teacher successfully connected artistic observation with scientific inquiry. The AI tools served as "instant knowledge supplements," addressing children's curiosity about natural phenomena while maintaining focus on artistic expression. This approach represents a significant advancement over traditional art education methods that often separate artistic skill development from conceptual understanding.

Teacher Role Transformation in Practice

The case clearly illustrates the teacher's evolution from skill demonstrator to learning environment designer, AI tool integrator, and creativity stimulator. Rather than being the primary source of information, the teacher curated learning experiences, selected appropriate technological tools, and facilitated children's exploration processes. This transformation allowed more focused attention on individual children's creative processes and emotional needs, demonstrating how AI can enhance rather than replace teacher's educational roles.

Children's Learning Outcomes

Analysis of children's artworks and engagement patterns revealed several positive outcomes:

enhanced observational skills through multi-sensory experiences; deeper conceptual understanding through immediate AI-supported explanations; increased creative confidence through technology-assisted expression; and improved interdisciplinary connections between art, science, and language. The case provides evidence that well-integrated AI applications can enrich rather than diminish authentic artistic learning experiences.

Implementation Challenges and Solutions

The case also identified practical challenges including: ensuring age-appropriate AI tool usage; maintaining balance between virtual and real-world experiences; addressing privacy concerns with children's data; and developing effective assessment methods for AI-enhanced activities. The solutions developed through this case—such as careful tool selection, clear communication with parents, and balanced activity design—offer valuable guidance for similar implementations.

4. Integration of Theoretical and Practical Perspectives

The research findings strongly support the theoretical frameworks discussed earlier, while also providing practical refinements. The technology empowerment theory is validated through successful cases of AI enhancing teaching efficiency and effectiveness. Constructivist principles are embodied in children's active engagement with AI-supported learning environments. Human-machine collaboration theory is demonstrated through effective teacher-AI partnerships in facilitating learning. However, the research also identifies the need to adapt these theories to the specific context of early childhood art education, particularly regarding developmental appropriateness and the preservation of humanistic values.

The discussion emphasizes that successful role transformation requires simultaneous attention to multiple dimensions: technological competence must be paired with philosophical understanding; practical skills need theoretical guidance; and individual development requires community support. The findings suggest that the most effective approaches integrate technological innovation with enduring educational principles, using AI as a tool to enhance rather than replace essential human aspects of art education.

CONCLUSION

This study thoroughly explores the necessity, challenges, and practical pathways of kindergarten art teachers' role transformation in the AI era. The research reveals that AI technology is fundamentally reshaping kindergarten art education, creating both unprecedented opportunities and significant challenges. The transformation from traditional "knowledge transmitters" to contemporary "learning facilitators," "creativity stimulators," and "intelligent educators" represents not merely a technical adjustment but a comprehensive evolution of teachers' professional identity and educational philosophy.

The core conclusions regarding teacher role transformation include several essential elements. First, the development of AI literacy and technical proficiency forms the foundation for effective technology integration, requiring teachers to master both operational skills and critical understanding of AI applications. Second, the innovation of teaching concepts and methods must shift from skill-centered instruction to child development-focused approaches that leverage AI's capabilities for personalization and engagement. Third, the establishment of supportive professional communities provides crucial collaborative environments for teacher growth and knowledge sharing. Fourth, maintaining emphasis on ethics and humanistic care ensures that technological advancement enhances rather than undermines fundamental educational values and children's holistic development.

The research demonstrates that successful role transformation requires balanced attention to all these dimensions simultaneously. Teachers who focus solely on technical skills without corresponding philosophical growth may misuse technology, while those who emphasize theory without practical competence may fail to implement effective changes. The most successful transformations occur when teachers develop comprehensive capabilities across technological, pedagogical, and ethical domains.

Despite providing comprehensive analysis, this study has several limitations that suggest directions for future research. The primary limitation involves the reliance on theoretical analysis and selected case studies rather than large-scale empirical data. Future research should conduct broader surveys and interviews across different regions and kindergarten types to validate and extend these findings. Additionally, more investigation is needed concerning the age-appropriateness and effectiveness of specific AI tools for young children, including longitudinal studies of learning outcomes.

Several promising research directions emerge from this study. Large-scale empirical research could provide stronger evidence for the generalizability of the proposed frameworks. Action research projects implementing and refining the suggested pathways in diverse educational contexts would offer valuable practical insights. Comparative international studies examining different cultural approaches to AI integration in early childhood art education could identify innovative practices and cultural considerations. Further exploration of the relationship between AI technologies and embodied cognition theory could enhance understanding of how to balance virtual and physical artistic experiences. Research on AI ethics specific to early childhood contexts would address important questions about privacy, bias, and appropriate technology use with young children.

The findings offer significant implications for educational practice and policy development. For frontline teachers, the study provides a comprehensive framework for navigating role transformation, emphasizing that technological competence must be integrated with pedagogical innovation and ethical consideration. Teachers should approach AI integration as an opportunity to enhance their professional capabilities rather than as a threat to their traditional roles.

For educational administrators and policy makers, the research suggests several important initiatives. Developing systematic "AI + Art Education" training programs that combine technical skills with pedagogical understanding is essential. Establishing professional learning communities and exchange platforms can support teachers' collaborative growth. Allocating resources for appropriate AI tools and technical support, particularly in underdeveloped regions, is crucial for equitable implementation. Creating guidelines and standards for ethical AI use in early childhood education can help ensure responsible technology integration.

The research ultimately emphasizes that the goal of role transformation is not merely to adapt to technological changes but to enhance educational quality and better support children's holistic development. By embracing thoughtful AI integration while maintaining commitment to fundamental educational values, kindergarten art teachers can transform challenges into opportunities, creating more engaging, effective, and meaningful art education experiences that prepare children for a future where human creativity and technological innovation coexist and complement each other.

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The Potential of Virtual Reality (VR) and Augmented Reality (AR) in Promoting Sustainable Education and Enhancing Public Awareness

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ABSTRACT

This paper explores the transformative potential of Virtual Reality (VR) and Augmented Reality (AR) in advancing sustainable education and heightening public awareness of critical environmental issues. As the global community grapples with the urgent need to achieve the United Nations Sustainable Development Goals (SDGs), innovative educational tools are paramount. VR and AR technologies offer immersive, interactive, and engaging learning experiences that can significantly enhance the understanding and retention of complex sustainability concepts. This paper synthesizes existing research to examine the effectiveness of these immersive technologies in various educational contexts, from formal classroom settings to public awareness campaigns. We review several case studies that demonstrate the power of VR and AR to foster pro-environmental attitudes, promote behavioral change, and increase engagement with sustainability topics such as climate change, biodiversity loss, and resource conservation. The analysis reveals that by creating a sense of presence and emotional connection, VR and AR can bridge the psychological distance to environmental problems, making them more tangible and relatable. Furthermore, the paper discusses the alignment of these technologies with SDG 4 (Quality Education) and their contributions to other SDGs by fostering a generation of environmentally conscious and responsible citizens. Finally, we identify the current challenges, including accessibility, cost, and the need for standardized pedagogical frameworks, and propose future research directions to fully harness the potential of VR and AR for a sustainable future. The findings suggest that the strategic integration of immersive technologies into educational strategies can be a powerful catalyst for achieving global sustainability targets.

Keywords: Augmented Reality, Environmental Education, Sustainable Development Goals, Sustainability, Virtual Reality.

INTRODUCTION

The dawn of the 21st century has been characterized by a series of profound and interconnected environmental crises that threaten the stability of planetary systems and the well-being of human societies. The escalating climate crisis, evidenced by rising global temperatures, extreme weather events, and sea-level rise, represents an existential threat that demands immediate and decisive action. Concurrently, the world is facing unprecedented rates of biodiversity loss, depletion of natural resources, and widespread pollution of air, water, and soil. These challenges are not isolated; they are systemic,

complex, and deeply rooted in prevailing patterns of production, consumption, and governance. In response to this global predicament, the international community adopted the 2030 Agenda for Sustainable Development, with the 17 Sustainable Development Goals (SDGs) at its core. The SDGs provide a comprehensive and ambitious framework for a global transformation towards a more sustainable, equitable, and prosperous future for all [1].

A fundamental prerequisite for achieving the SDGs is a profound and widespread shift in human consciousness, values, and behaviors. This transformation hinges on the power of education to foster a deep understanding of sustainability challenges, cultivate a sense of global citizenship, and empower individuals with the knowledge, skills, and motivation to become agents of change. However, traditional educational paradigms, often characterized by passive learning, disciplinary silos, and a disconnect from real-world contexts, have proven insufficient in addressing the complexity and urgency of the sustainability crisis. As Kollmuss and Agyeman (2002) argued, there is a significant "gap" between environmental knowledge and pro-environmental behavior, suggesting that simply providing information is not enough to inspire meaningful action [1].

In this context, the rapid advancements in digital technologies offer unprecedented opportunities to reimagine and revolutionize education for sustainability. Among the most promising of these innovations are Virtual Reality (VR) and Augmented Reality (AR). VR technology immerses users in completely simulated, three-dimensional environments, creating a powerful sense of presence and allowing for interaction with virtual objects and scenarios. AR, in contrast, overlays computer-generated information, images, and interactive elements onto the user's real-world view, enriching their perception and understanding of their immediate surroundings. Once relegated to the domains of gaming and entertainment, these immersive technologies are now being increasingly recognized for their transformative pedagogical potential across a wide range of disciplines [2, 3].

This paper posits that VR and AR represent a paradigm shift in the field of sustainable education and public awareness. By offering visceral, first-person, and emotionally resonant experiences, these technologies can make abstract and distant environmental problems feel immediate, personal, and urgent. Imagine a student not just reading about deforestation but virtually standing in the Amazon rainforest, hearing the sounds of the ecosystem, and witnessing the impact of logging in real-time. Consider a citizen not just being told about their carbon footprint but using an AR app to visualize the emissions associated with their daily choices. As a growing body of research suggests, these kinds of experiential and embodied learning opportunities can be significantly more effective at fostering deep understanding, empathy, and behavioral change than traditional, more passive methods [4].

This paper undertakes a systematic review of the burgeoning literature on the application of VR and AR in sustainability-focused education and public engagement initiatives. The central research question guiding this inquiry is: *How can VR and AR technologies be effectively leveraged to promote sustainable education and enhance public awareness in alignment with the UN Sustainable Development Goals?* To answer this question, we will explore the multifaceted ways in which these technologies can be used to:

1 Deepen Cognitive Understanding: Facilitate the comprehension of complex, dynamic, and often invisible ecological systems and processes.
2 Cultivate Affective Engagement: Foster empathy, a sense of connection to nature, and a stronger ethical commitment to environmental stewardship.

3 Catalyze Behavioral Transformation: Encourage the adoption and maintenance of sustainable practices and lifestyles in individuals and communities.

4 Advance the 2030 Agenda: Contribute directly to the achievement of SDG 4 (Quality Education) and indirectly to a host of other SDGs by fostering a well-informed and motivated global citizenry.

Through a critical synthesis of key theoretical frameworks, empirical studies, and practical case examples, this paper aims to provide a comprehensive and nuanced overview of the current state of the art. We will identify emerging best practices for the design and implementation of immersive learning experiences for sustainability, while also critically examining the challenges and limitations that must be addressed to realize the full potential of these technologies. Ultimately, this paper seeks to build a robust and compelling case for the strategic integration of VR and AR into the mainstream of educational policy and practice, positioning them as indispensable tools in the collective global effort to build a more sustainable and just world for present and future generations.

LITERATURE REVIEW

The intersection of immersive technologies and sustainable education is a burgeoning field of academic inquiry, characterized by rapid innovation and a growing body of empirical evidence. This review synthesizes the key theoretical frameworks that underpin the educational efficacy of VR and AR, examines the empirical evidence supporting their role in fostering pro-environmental attitudes and behaviors, and situates these applications within the broader context of the UN Sustainable Development Goals. A systematic approach was taken to identify and analyze relevant literature, drawing from multiple disciplines to provide a comprehensive overview.

Theoretical Foundations of Immersive Sustainable Learning

The power of VR and AR in education is not merely a function of their novelty; it is rooted in established theories of learning and cognition. Several theoretical frameworks help to explain why immersive experiences can be so effective for sustainability education.

Constructivism and Experiential Learning: At its core, immersive learning aligns with constructivist theories, which posit that learners actively construct their own knowledge and understanding through experience and interaction with their environment. VR and AR provide rich, interactive "microworlds" where learners can engage in experiential learning, as theorized by Dewey and Kolb. By doing, exploring, and discovering within a simulated environment, learners move beyond the passive reception of information to a deeper, more integrated form of knowledge construction. For example, a VR simulation that allows students to manage a virtual forest, making decisions about logging and conservation and seeing the long-term ecological and economic consequences, is a powerful application of experiential learning principles.

Embodied Cognition and Presence: The theory of embodied cognition suggests that our cognitive processes are deeply intertwined with our physical bodies and our interactions with the world. VR and AR leverage this by creating a sense of presence, the subjective feeling of "being there" in a virtual environment (Slater, 2009). This sense of presence allows for embodied learning, where abstract concepts are understood through physical interaction and spatial awareness. When a user physically walks around a virtual wind turbine to understand its scale or uses their hands to assemble a virtual solar panel, the learning becomes embodied and more memorable. This physical engagement can lead to a more intuitive grasp of complex systems and a stronger personal connection to the subject matter (Riva, Wiederhold, & Mantovani, 2019).

Transformative Learning and Perspective-Taking: Sustainability education often aims for transformative learning, which involves a fundamental shift in an individual's worldview, assumptions, and frames of reference. VR is uniquely capable of facilitating this by enabling powerful perspective-taking experiences. By embodying an avatar of a different person (e.g., a climate refugee) or even a non-human entity (e.g., a sea turtle navigating a polluted ocean), users can develop a profound sense of empathy and a new perspective on environmental issues. This ability to "walk in another's shoes" can challenge existing beliefs and foster the deep, transformative insights that are necessary for meaningful environmental action.

Psychological Distance: A significant barrier to environmental engagement is the concept of psychological distance, where issues like climate change are perceived as abstract, uncertain, and distant in time and space (Spence, Poortinga, & Pidgeon, 2012). VR and AR directly counter this by making distant issues immediate and personal. A user can be transported to a melting glacier or a flooded coastal city, transforming an abstract headline into a visceral, emotionally resonant experience. By reducing psychological distance, immersive technologies can increase the perceived urgency and importance of environmental problems, thereby motivating action.

Empirical Evidence and Key Research Findings

A growing body of empirical research provides strong support for the theoretical potential of VR and AR in sustainable education. These studies, employing a range of methodologies from controlled experiments to field studies, have consistently demonstrated the positive impact of immersive technologies on cognitive, affective, and behavioral outcomes. The table below summarizes key studies that exemplify the research in this area.

Table 1. Key Studies That Exemplify the Research

Study (Author, Year)	Technology	Focus Area	Methodology	Key Findings
Nelson, Anggraini, & Schlüter (2020)	360° VR	Marine Conservation	Field Experiment (n=1006)	VR experience, especially with negative framing, significantly increased donation amounts to a conservation charity compared to 2D video and control groups.
Kleinlogel et al. (2023)	Immersive VR	Energy Saving	Lab Experiment	VR intervention led to greater energy-saving attitudes and behavioral strategies compared to print or video. Use of a personalized "doppelganger" avatar showed potential for enhanced effects.
Markowitz et al. (2018)	Immersive VR	Ocean Acidification	Lab Experiment	VR field trip resulted in significant learning gains and more positive pro-environmental attitudes compared to a non-immersive video version.
Ladykova et al. (2024)	AR	Environmental Education	Systematic Review (20 articles)	Found that AR in environmental education, mostly with primary school students, contributed to learning, affective outcomes, and

				interaction. Highlighted a need for more research on implementation challenges.
Hariyani, Singh, & Kumar (2025)	VR/AR	SDGs & Climate Action	Review Paper	Argues for leveraging VR and AR for immersive campaigns to promote sustainability literacy and climate action as a key strategy for achieving the SDGs.

These studies collectively illustrate a clear trend: immersion matters. The ability of VR and AR to create a sense of presence, evoke emotion, and enable interaction consistently leads to better outcomes than more traditional, non-immersive media. The findings from Nelson et al. (2020) are particularly noteworthy, as they provide concrete evidence of VR influencing real-world financial behavior in a pro-environmental context. Similarly, the work of Kleinlogel et al. (2023) demonstrates the potential of VR as a tool for changing ingrained household habits, a critical component of a broader societal shift towards sustainability.

Despite the overwhelmingly positive findings, the literature also highlights several challenges and research gaps that need to be addressed. The systematic review by Ladykova et al. (2024) points out that most studies have focused on short-term outcomes, and there is a lack of longitudinal research examining the long-term retention of knowledge and the persistence of behavioral changes. Furthermore, much of the research has been conducted in controlled laboratory settings, and more field research is needed to understand how these technologies perform in real-world educational contexts, such as classrooms and museums.

Another significant gap is the relative lack of research on the application of AR for sustainability education compared to VR. While AR holds great promise for situated learning—for example, by overlaying information about local flora and fauna during a nature walk—its potential has not been as extensively explored as that of VR. Finally, issues of accessibility, equity, and the "digital divide" are critical considerations. The high cost of hardware and the technical expertise required for content creation can limit the availability of these powerful educational tools, potentially exacerbating existing educational inequalities. Future research and development must prioritize the creation of scalable, affordable, and user-friendly immersive learning solutions.

METHOD

To construct a comprehensive and rigorous analysis of the role of VR and AR in sustainable education, this paper adopts a systematic literature review methodology. This approach is particularly well-suited for synthesizing research from a diverse and rapidly evolving interdisciplinary field, allowing for the identification of consistent findings, theoretical trends, and critical gaps in the existing knowledge base. The review was conducted in accordance with the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines where applicable, ensuring a transparent and replicable process from search to synthesis.

Research Questions

The systematic review was guided by a primary research question and several secondary questions. The primary research question focuses on how Virtual Reality (VR) and Augmented Reality (AR) technologies can be effectively leveraged to promote sustainable education and enhance public

awareness in alignment with the United Nations Sustainable Development Goals. To support this inquiry, the secondary research questions examine the key theoretical frameworks that explain the effectiveness of VR and AR in sustainability learning contexts, assess the existing empirical evidence regarding their impact on cognitive, affective, and behavioral outcomes related to sustainability, and identify the main challenges, limitations, and ethical considerations associated with the use of VR and AR in sustainable education.

Search Strategy and Data Sources

A multi-stage search strategy was implemented to ensure a comprehensive retrieval of relevant literature. The search was conducted in May 2025.

Databases: A systematic search was performed across four major electronic academic databases renowned for their extensive coverage of scientific and social scientific literature: Scopus, Web of Science, ScienceDirect, and Google Scholar. This multi-database approach was chosen to minimize publication bias and capture a wide array of perspectives from computer science, education, environmental science, psychology, and communication studies.

Search Terms: The search query was constructed using three conceptual blocks of keywords, combined using Boolean operators (AND/OR). The keywords were chosen to be broad enough to capture the full scope of the field while remaining focused on the core research questions.

1 Concept Block 1 (Technology): ("Virtual Reality" OR VR OR "Augmented Reality" OR AR OR "Immersive Technolog*" OR "Extended Reality" OR XR)
2 Concept Block 2 (Sustainability): (Sustainab* OR Environment* OR Ecolog* OR "Climate Change" OR Conservation OR "Pro-environmental")
3 Concept Block 3 (Education/Awareness): (Educat* OR Learn* OR Train* OR Aware* OR Engagement OR Pedagog* OR "Public Understanding")

The search string (Block 1) AND (Block 2) AND (Block 3) was adapted for the syntax of each database. The search was limited to peer-reviewed journal articles and conference papers published in English between January 1, 2015, and May 31, 2025. This timeframe was selected to focus on the most recent wave of research, coinciding with the widespread availability of consumer-grade VR and AR hardware.

Study Selection and Eligibility Criteria

The study selection process involved a two-phase screening procedure.

Phase 1: Title and Abstract Screening: The titles and abstracts of all retrieved articles were screened for relevance based on a set of predefined inclusion and exclusion criteria. Two researchers independently screened a subset of the articles to ensure inter-rater reliability, with any disagreements resolved through discussion.

Inclusion Criteria:

1. The study's primary focus is on the use of VR, AR, or other immersive technologies.
2. The context of the study is related to sustainability, environmental issues, or specific SDGs.
3. The application is educational, for training, or for raising public awareness.
4. The article is an empirical study (quantitative, qualitative, or mixed-methods), a systematic review, or a substantial theoretical paper.

Exclusion Criteria:

1. The article is not written in English.
2. The article is an editorial, a short commentary, a book review, or a non-peer-reviewed publication.

3. The study focuses purely on the technical development of VR/AR hardware or software without an applied educational or awareness component.
4. The connection to sustainability or environmental topics is trivial or non-existent.

Phase 2: Full-Text Review: Articles that passed the initial screening were subjected to a full-text review to confirm their eligibility. During this phase, the same inclusion and exclusion criteria were applied more rigorously. The reference lists of included articles and relevant review papers were also manually scanned (a process known as "snowballing") to identify any additional studies that may have been missed in the initial database search.

Data Extraction and Thematic Synthesis

For each study that met the final inclusion criteria, a structured data extraction form was used to systematically collect key information. The extracted data included: (a) bibliographic details (authors, year, journal); (b) study objectives; (c) methodological details (design, sample, setting); (d) technology specifications (e.g., VR headset model, AR platform); (e) core theoretical framework used; (f) key findings related to cognitive, affective, and behavioral outcomes; and (g) reported limitations and future research directions.

Following data extraction, a thematic synthesis approach was employed to analyze and integrate the findings. This qualitative method, as described by Thomas and Harden (2008), involves a three-stage process:

2 Line-by-line coding: The findings and discussion sections of each paper were coded to capture the essence of the research.
3 Development of descriptive themes: The initial codes were grouped into related areas to construct descriptive themes that summarized the findings across multiple studies (e.g., "Impact on Empathy," "Knowledge Retention in VR").
4 Generation of analytical themes: The descriptive themes were then interpreted and synthesized to generate higher-order analytical themes that address the research questions of this review (e.g., "VR as a Tool for Reducing Psychological Distance").

This systematic and thematic approach allows for a robust synthesis of the evidence, providing a rich, narrative-driven analysis of the field that goes beyond a simple summary of individual studies to offer new insights and a coherent understanding of the potential of VR and AR in sustainable education.

FINDINGS AND DISCUSSION

The thematic synthesis of the reviewed literature reveals several critical insights into the potential and application of VR and AR in sustainable education. The findings converge around four primary analytical themes: the power of immersive technologies to deepen cognitive and experiential understanding; their capacity to foster affective engagement and empathy; their role in catalyzing tangible behavioral change; and their strategic alignment with the global agenda for sustainable development. This section discusses these findings in detail, integrating the empirical evidence with the theoretical frameworks outlined in the literature review.

Deepening Understanding: From Abstract Concepts to Experiential Knowledge

A consistent finding across the literature is the profound ability of VR and AR to transform the learning of complex sustainability concepts from a passive, abstract exercise into an active, experiential one. Traditional pedagogical tools like textbooks and lectures often struggle to convey the dynamism,

scale, and interconnectedness of ecological systems. Immersive technologies overcome this by enabling what is often called "unseen learning"—making the invisible visible and the complex comprehensible.

Virtual Reality excels at creating holistic, systems-level understanding through virtual field trips and simulations. As demonstrated by Markowitz et al. (2018), transporting students to the bottom of the ocean to witness the effects of acidification on coral reefs leads to significantly greater learning gains than watching a 2D video on the same topic. The key mechanism here is presence; the feeling of being physically present in the virtual environment allows for embodied exploration. Learners are not just told that CO2 dissolves in water to form carbonic acid; they see the coral bleaching and the ecosystem degrading around them. This creates a powerful, memorable, and deeply integrated understanding of the causal chain. These simulations function as interactive microworlds, allowing learners to manipulate variables (e.g., change the atmospheric CO2 concentration) and observe the consequences in a compressed timeframe, an application of constructivist learning principles that is difficult to replicate in the real world.

Augmented Reality, on the other hand, excels at situated learning, embedding digital information directly into the learner's real-world context. The systematic review by Ladykova et al. (2024) noted the effectiveness of AR in environmental education, particularly with younger learners. For example, an AR application could be used on a nature walk to identify plant species, overlaying information about their ecological roles, medicinal uses, and conservation status. Another powerful application is in visualizing resource flows; a student could point their tablet at a school building and see an AR overlay of its real-time energy consumption, or point it at their lunch to see the water and carbon footprint associated with its production. This contextualizes abstract data, making it immediately relevant and actionable. By bridging the gap between the digital and physical worlds, AR provides a powerful tool for understanding the environmental impact of our immediate surroundings.

Cultivating Affective Engagement: Empathy as a Catalyst for Concern

Perhaps the most transformative potential of immersive technologies lies in their ability to engage the affective domain of learning—to foster empathy and cultivate a deep-seated emotional connection to environmental issues. Sustainability is not just a scientific challenge; it is an ethical and emotional one. VR, in particular, has been described as an "empathy machine" for its ability to facilitate powerful perspective-taking experiences.

By allowing users to embody an avatar, VR can enable them to experience the world from a completely different point of view. A user could become a farmer in a drought-stricken region, a resident of a low-lying island nation facing sea-level rise, or even a non-human animal, such as the sea turtle navigating an ocean full of plastic that was featured in the VR experience "The Crystal Reef." This process of embodiment can dissolve the psychological distance that separates us from the "other," whether that other is a person in a distant land or a creature in the sea. This is not just about seeing something; it is about feeling something. The emotional resonance of these experiences—the sense of loss, vulnerability, or wonder—can be a far more powerful motivator for pro-environmental attitudes than facts and figures alone.

The study by Nelson et al. (2020) provides strong empirical support for this, demonstrating that the emotional engagement generated by a VR experience of a threatened coral reef translated directly into increased financial donations for its conservation. This finding is critical, as it links affective

engagement in a virtual environment to tangible, real-world pro-environmental behavior. It suggests that VR can be a powerful tool not only for education but also for advocacy and fundraising by non-profit organizations.

Catalyzing Behavioral Transformation: From Intention to Action

The ultimate goal of sustainable education is to inspire action. A well-documented phenomenon in environmental psychology is the "value-action gap" or "intention-behavior gap," where individuals may hold strong pro-environmental values but fail to translate them into consistent behavior. The reviewed literature suggests that immersive technologies can play a crucial role in bridging this gap.

VR provides a unique environment for behavioral rehearsal. The study by Kleinlogel et al. (2023) is a prime example, using VR to create a virtual home where participants could learn and practice energy-saving behaviors. By receiving immediate, personalized feedback (e.g., seeing a virtual smart meter respond to their actions), users can form new habits in a safe, controlled environment. This process of practicing a behavior and experiencing its positive consequences reinforces the desired action and increases self-efficacy—the belief in one's ability to perform the action successfully. This is a powerful application of social cognitive theory, where learning occurs through observation and direct experience, even if that experience is virtual.

The use of a "doppelganger" or a personalized avatar, as explored by Kleinlogel et al. (2023), adds another layer to this. When users see an avatar that looks like them engaging in sustainable behaviors, it can trigger a powerful psychological process of identification and self-modeling, making the behavior seem more attainable and personally relevant. This personalization can make the educational message more persuasive and increase the likelihood of its adoption in the real world.

Strategic Alignment with the Sustainable Development Goals (SDGs)

Finally, the application of VR and AR in sustainable education is not merely a technological or pedagogical innovation; it is a strategic imperative for achieving the 2030 Agenda for Sustainable Development. The link to SDG 4 (Quality Education) is the most direct. Immersive technologies can help achieve Target 4.7, which calls for ensuring that all learners acquire the knowledge and skills needed to promote sustainable development. By providing engaging, effective, and potentially scalable learning solutions, VR and AR can democratize access to high-quality sustainability education.

However, the contribution of these technologies extends across the entire SDG framework. By fostering a generation of environmentally literate and motivated citizens, immersive education supports the implementation of all the environmental SDGs:

1. SDG 13 (Climate Action): VR visualizations of future climate scenarios can increase public understanding and support for ambitious climate policies.
2. SDG 14 (Life Below Water) and SDG 15 (Life on Land): Immersive experiences of marine and terrestrial ecosystems can foster a conservation ethic and mobilize support for protecting biodiversity.
3. SDG 12 (Responsible Consumption and Production): AR applications can empower consumers to make more informed and sustainable choices at the point of sale by providing transparent information about a product's lifecycle and environmental footprint.
4. SDG 11 (Sustainable Cities and Communities): VR can be used as a participatory planning tool, allowing citizens to visualize and co-design more sustainable urban futures.

As highlighted by Hariyani et al. (2025), the strategic deployment of immersive campaigns is a critical pathway for advancing sustainability literacy and climate action on a global scale. The

integration of AI with these platforms, as mentioned by Crespo et al. (2025), promises to create even more powerful, personalized, and adaptive learning systems that can tailor educational content to individual learners, further amplifying their impact.

Challenges, Limitations, and Ethical Considerations

While the potential of VR and AR in sustainable education is immense, a critical analysis also requires acknowledging the significant challenges, limitations, and ethical considerations that accompany their implementation. The reviewed literature, while largely optimistic, also raises several important points of caution that must be addressed for the responsible and effective deployment of these technologies.

The Digital Divide and Accessibility: The most frequently cited challenge is the issue of accessibility and equity. High-end VR systems, which provide the most immersive and impactful experiences, remain expensive and require powerful computing hardware. This creates a significant "digital divide," where affluent schools and communities can leverage these powerful tools while underserved populations are left behind. This risks exacerbating existing educational inequalities, a direct contradiction to the inclusive spirit of SDG 4. While the advent of more affordable, standalone headsets and mobile AR is lowering the barrier to entry, issues of hardware availability, internet access, and the technical literacy required to use and maintain these systems remain significant hurdles, particularly in developing countries.

Content Creation and Pedagogical Integration: The effectiveness of any educational technology is contingent on the quality of the content and its pedagogical integration. Creating high-quality, scientifically accurate, and pedagogically sound immersive experiences is a complex, time-consuming, and expensive process. It requires a rare combination of expertise in 3D modeling, programming, instructional design, and subject matter knowledge. Currently, there is a scarcity of high-quality educational content for sustainability, and many existing applications are short, one-off experiences rather than comprehensive learning modules. Furthermore, educators often lack the training and support needed to effectively integrate these new technologies into their curricula. Simply placing a VR headset in a classroom without a clear pedagogical framework, pre-briefing, and post-experience discussion is unlikely to yield meaningful learning outcomes.

Risk of Negative Psychological Effects: While VR can be an "empathy machine," it can also be a source of anxiety and distress. Immersing users in visceral, emotionally charged scenarios of environmental disaster—such as catastrophic floods, wildfires, or ecosystem collapse—carries the risk of inducing "eco-anxiety," a chronic fear of environmental doom. This is particularly a concern for younger learners. While a sense of urgency can be a motivator, overwhelming users with feelings of hopelessness and despair can be counterproductive, leading to apathy or denial. Ethical design must therefore carefully balance the need to convey the seriousness of environmental problems with the need to foster a sense of agency and hope. It is crucial to design experiences that not only highlight problems but also showcase solutions and empower users to feel that they can be part of the solution.

Simulation Fidelity and the Risk of Misconception: The power of simulation is also a potential pitfall. If a simulation is not scientifically accurate, it can lead to significant misconceptions. For example, an oversimplified model of a climate system could give learners a false sense of understanding or lead them to incorrect conclusions about the efficacy of certain interventions. There is a risk that the very immersiveness and perceived realism of VR could lead users to place undue confidence in the

information presented, even if it is flawed. This underscores the critical need for rigorous vetting of educational content by subject matter experts.

Distraction and Disconnection from Nature: Finally, there is a philosophical and pedagogical concern that an over-reliance on virtual experiences of nature could, paradoxically, lead to a greater disconnection from the real thing. While virtual field trips can supplement real ones, they should not replace them. The goal of environmental education is to foster a love and appreciation for the natural world, which ultimately requires direct, sensory experience. The challenge is to use technology not as a substitute for reality, but as a bridge to it—to use AR to enhance a real nature walk, or to use VR to inspire a user to visit and protect a local park. Striking this balance between the virtual and the real is perhaps one of the most subtle but important challenges for the future of immersive sustainable education.

CONCLUSION

This systematic review has synthesized a compelling and rapidly growing body of evidence demonstrating the transformative potential of Virtual Reality (VR) and Augmented Reality (AR) in the critical domains of sustainable education and public awareness. The central argument of this paper—that immersive technologies can serve as powerful catalysts for fostering the knowledge, attitudes, and behaviors necessary for a sustainable future—is strongly supported by the reviewed literature. By moving beyond the limitations of traditional pedagogy, VR and AR offer unique affordances for making complex environmental issues tangible, personal, and emotionally resonant. The findings clearly indicate that by leveraging the psychological principles of presence, embodied cognition, and perspective-taking, immersive experiences can effectively reduce the psychological distance to environmental problems, enhance cognitive understanding, cultivate profound empathy, and inspire tangible action.

The practical implications of these findings are significant for a wide range of stakeholders. For educators, immersive technologies offer a powerful new set of tools to create engaging, inquiry-based learning experiences that align with the principles of Education for Sustainable Development (ESD). For policymakers and non-governmental organizations, VR and AR provide innovative platforms for public outreach campaigns, advocacy, and fundraising, capable of mobilizing public support for conservation and climate action. For technology developers, the field of sustainable education represents a meaningful and rapidly growing market for socially impactful applications.

Furthermore, this paper has highlighted the strategic alignment of these technologies with the UN Sustainable Development Goals. The contribution is not limited to SDG 4 (Quality Education) but extends across the 2030 Agenda, offering a cross-cutting tool to advance goals related to climate, biodiversity, and responsible consumption.

Despite the promising outlook, it is crucial to acknowledge the limitations of the current body of research and to chart a course for future inquiry. This review has identified several areas that warrant further investigation:

1 Longitudinal Impact Assessment: The majority of existing studies focus on the short-term effects of VR/AR interventions. There is a critical need for longitudinal research that tracks participants over extended periods (months or even years) to assess the long-term retention of knowledge, the durability of attitudinal shifts, and the persistence of behavioral changes.

2 Comparative Efficacy and Contextual Factors: More research is needed to systematically compare the relative effectiveness of different immersive modalities (e.g., high-immersion VR vs. mobile AR) against each other and against well-designed traditional methods. Furthermore, future studies should investigate how contextual factors—such as the learner's age, prior knowledge, cultural background, and the social setting of the experience—moderate the impact of these technologies.

3 Addressing the Digital Divide: The issue of accessibility and equity remains a significant barrier. Future research should focus not only on the efficacy of high-end systems but also on the development and evaluation of low-cost, scalable solutions (e.g., WebXR, mobile AR) that can reach a broader and more diverse audience. Studies should also explore strategies for equitable implementation in underserved communities and educational systems.

4 Development of Pedagogical Frameworks: There is a need to move from ad-hoc applications to the development of robust, evidence-based pedagogical frameworks for designing and integrating immersive learning experiences into formal and informal curricula. This includes creating best-practice guidelines for educators on how to facilitate and debrief immersive experiences to maximize their educational impact.

5 Ethical Considerations: As immersive experiences become more realistic and emotionally powerful, it is imperative to investigate the associated ethical considerations. This includes the potential for inducing "eco-anxiety" or trauma, the psychological effects of embodying distressing scenarios, and issues of data privacy and user manipulation.

6 Synergy with Other Technologies: The future of immersive education will likely involve the integration of VR/AR with other emerging technologies. Research should explore the synergistic potential of combining immersive platforms with Artificial Intelligence (AI) for creating personalized and adaptive learning pathways, and with the Internet of Things (IoT) for connecting virtual experiences to real-world environmental data.

VR and AR represent a new and exciting frontier in the global quest for sustainability. While challenges remain, the potential is undeniable. By harnessing the unique power of these technologies to inform the mind and touch the heart, we can empower a new generation of global citizens to not only understand the complex challenges we face but to feel a profound sense of connection and responsibility, and to act decisively in building a more just, equitable, and sustainable world. The journey has just begun, and continued research, innovation, and thoughtful implementation will be key to unlocking the full transformative potential of immersive technologies for our planet and its people.

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Analysis of the Pros and Cons of Generative AI in the Classroom of Chinese Universities and Governance Strategies

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ABSTRACT

The integration of Generative Artificial Intelligence (GAI) in Chinese university classrooms has sparked both enthusiasm and concern. In an era where technology and education converge, this study aims to analyze the advantages and disadvantages of GAI utilization in higher education. A mixed-method approach was adopted, comprising field interviews and surveys conducted with 150 faculty members and students across various universities. This research discovered that while GAI enhances interactive learning experiences, fosters creativity, and provides personalized education solutions, it also raises issues related to academic integrity, dependency, and the digital divide. By scrutinizing these factors, this paper provides a balanced view on the implications of GAI in academia. Furthermore, it outlines governance strategies to mitigate the adverse effects while maximizing the educational benefits. Recommendations include developing comprehensive usage guidelines, conducting ongoing assessments, and fostering digital literacy among both students and faculty. This paper contributes to the existing body of literature by offering empirical insights and practical approaches to the responsible implementation of GAI technologies in educational settings.

Keywords: academic integrity，classroom technology，digital literacy，Generative Artificial Intelligence integration， personalized education

INTRODUCTION

Generative AI, a rapidly evolving technology, is revolutionizing the educational landscape worldwide. In China, the integration of AI in higher education has gained significant momentum, with universities exploring innovative ways to enhance teaching and learning experiences. However, the adoption of generative AI in Chinese university classrooms presents both advantages and challenges that require careful consideration and strategic governance.

This dissertation aims to provide a comprehensive analysis of the benefits and drawbacks of utilizing generative AI in Chinese university classrooms and propose effective governance strategies to maximize its potential while mitigating associated risks. By examining the current state of AI in education globally and specifically within the Chinese context, this research seeks to contribute to the ongoing discourse on the future of AI-driven education and offer practical recommendations for stakeholders, including policymakers, university administrators, and educators.

The introduction of generative AI in Chinese university classrooms has the potential to transform traditional teaching methods and create immersive, personalized learning experiences. AI-powered tools can automate content creation, adapt to individual student needs, and facilitate interactive and engaging classroom activities. These technological advancements can significantly reduce the workload of educators, allowing them to focus on higher-level tasks such as curriculum design, student mentoring, and research.

Moreover, generative AI can bridge the gap between theory and practice by providing students with real-world simulations and hands-on learning opportunities. AI-driven virtual laboratories, case studies, and interactive problem-solving exercises can enhance students' critical thinking, creativity, and practical skills, preparing them for the demands of the modern workforce.

However, the integration of generative AI in Chinese university classrooms also presents several challenges and potential drawbacks. One major concern is the quality and accuracy of AI-generated content. As AI models are trained on vast amounts of data, they may perpetuate biases, inaccuracies, or

outdated information, leading to the dissemination of misleading or erroneous knowledge. Ensuring the reliability and credibility of AI-generated educational content is crucial to maintain academic integrity and prevent the spread of misinformation.

Furthermore, the widespread use of generative AI raises ethical and privacy concerns. The collection, storage, and analysis of student data for AI model training and personalization may infringe upon individual privacy rights and raise questions about data security and ownership. Striking a balance between leveraging AI's potential and safeguarding students' personal information is a critical challenge that requires robust data governance frameworks and ethical guidelines.

Another potential drawback of generative AI in education is the risk of over-reliance on technology and the degradation of essential skills. If students become excessively dependent on AI-powered tools for learning and problem-solving, they may fail to develop critical thinking, creativity, and independent learning abilities. Striking a balance between AI-assisted learning and traditional teaching methods is crucial to ensure that students acquire a well-rounded skill set and maintain the ability to think critically and solve problems independently.

To address these challenges and maximize the benefits of generative AI in Chinese university classrooms, effective governance strategies are essential. Regulatory frameworks at the national and institutional levels must be established to ensure the responsible development and deployment of AI technologies in education. These frameworks should address issues such as data privacy, algorithmic transparency, and ethical considerations, providing clear guidelines for educational institutions and AI developers.

At the institutional level, Chinese universities must develop comprehensive policies and best practices for implementing generative AI in classrooms. These policies should encompass faculty training, curriculum design, student support services, and ongoing evaluation and monitoring of AI-driven educational initiatives. Collaboration between educators, AI experts, and policymakers is crucial to ensure that AI technologies are integrated seamlessly into the educational ecosystem and aligned with the goals of enhancing student learning outcomes.

Moreover, universities must prioritize the development of digital literacy and AI ethics education for both faculty and students. Equipping educators with the knowledge and skills to effectively integrate AI technologies into their teaching practices is essential for maximizing the benefits of generative AI. Similarly, students must be educated about the potential risks and limitations of AI, as well as the importance of critical thinking and independent learning in an AI-driven educational environment.

In conclusion, the integration of generative AI in Chinese university classrooms presents both significant opportunities and challenges. While AI technologies have the potential to revolutionize teaching and learning experiences, careful consideration must be given to the quality, accuracy, and ethical implications of AI-generated content. Effective governance strategies, including regulatory frameworks, institutional policies, and best practices for implementation, are crucial to ensure the responsible and beneficial deployment of generative AI in Chinese higher education. By embracing the potential of AI while proactively addressing its challenges, Chinese universities can pave the way for a new era of AI-driven education that empowers students, enhances learning outcomes, and contributes to the development of a highly skilled and innovative workforce.

THEORETICAL FRAMEWORK

Overview of Generative AI

Generative AI, an emerging field within artificial intelligence, focuses on creating new content, such as text, images, and audio, based on learned patterns and rules from vast datasets. This technology has garnered significant attention in recent years due to its potential to revolutionize various industries, including education. Generative AI models, such as GPT-3 (Generative Pre-trained Transformer 3), have demonstrated remarkable capabilities in natural language processing, enabling the generation of human-like text with coherence and contextual understanding.

The application of generative AI in education has gained traction globally, with numerous research projects and pilot programs exploring its potential to enhance teaching and learning experiences. In the United States, initiatives like the AI4K12 project aim to develop AI literacy among K-12 students and teachers, recognizing the importance of preparing the next generation for an AI-driven future. Similarly, the European Commission's "AI and Education" report highlights the need for integrating AI technologies into educational systems to foster innovation and competitiveness.

China, as a global leader in AI research and development, has also recognized the transformative potential of generative AI in education. The Chinese government has issued several policies and guidelines to promote the integration of AI in various sectors, including education. In 2017, the State Council released the "New Generation Artificial Intelligence Development Plan," which emphasizes the importance of AI education and calls for the establishment of AI-related disciplines and majors in universities. Subsequently, the Ministry of Education launched the "AI Innovation Action Plan for Colleges and Universities" in 2018, encouraging higher education institutions to explore the application of AI technologies in teaching, research, and management.

Chinese universities have responded positively to these initiatives, with many establishing AI-related research centers, institutes, and academic programs. For instance, Tsinghua University established the Institute for Artificial Intelligence, focusing on fundamental research and technological innovations in AI. Similarly, Peking University launched the Institute of Artificial Intelligence, aiming to cultivate top-tier AI talent and promote interdisciplinary research. These efforts have laid the foundation for the integration of generative AI in Chinese higher education.

Despite the progress made, the current state of generative AI adoption in Chinese university classrooms remains in its early stages. While some institutions have begun experimenting with AI-powered tools and platforms, such as intelligent tutoring systems and personalized learning environments, the widespread implementation of generative AI in teaching and learning practices is still limited. Challenges such as the lack of technical infrastructure, faculty expertise, and ethical considerations have hindered the rapid integration of generative AI in Chinese higher education.

However, the potential benefits of generative AI in education are significant. Generative AI models can create personalized learning content, adapt to individual student needs, and provide immediate feedback, thereby enhancing the learning experience. For example, AI-powered chatbots can engage students in interactive dialogues, answering questions and providing guidance in real-time. Additionally, generative AI can assist educators in creating diverse and engaging educational materials, such as generating practice questions, summarizing texts, and even creating virtual simulations and scenarios.

Moreover, generative AI has the potential to promote educational equity by providing access to high-quality learning resources and support for students in remote or underprivileged areas. AI-powered platforms can deliver personalized learning experiences, bridging the gap between students with varying backgrounds and abilities. This is particularly relevant in China, where significant disparities exist in educational resources and opportunities between urban and rural regions.

Despite the advantages, the adoption of generative AI in Chinese university classrooms also poses challenges and potential drawbacks. One major concern is the quality and accuracy of AI-generated content. While generative AI models have demonstrated impressive capabilities, they are not infallible and may produce biased, misleading, or factually incorrect information. Ensuring the reliability and validity of AI-generated educational materials is crucial to maintain academic integrity and prevent the spread of misinformation.

Furthermore, the use of generative AI raises ethical and privacy concerns. The training of AI models requires vast amounts of data, including personal information and intellectual property. Ensuring the responsible collection, storage, and use of student data is essential to protect privacy rights and prevent misuse. Additionally, the reliance on AI-generated content may lead to issues of authorship, intellectual property rights, and academic integrity, requiring clear guidelines and regulations.

Another potential disadvantage of generative AI in education is the risk of over-dependence on technology and the degradation of critical thinking and problem-solving skills. If students rely heavily on AI-generated answers and solutions, they may fail to develop essential skills such as critical analysis, creativity, and independent thinking. Striking a balance between leveraging the benefits of generative AI and fostering human intelligence and skills is crucial for the long-term success of AI in education.

To address these challenges and ensure the responsible implementation of generative AI in Chinese university classrooms, effective governance strategies are necessary. Regulatory frameworks at the national and institutional levels should be established to guide the ethical development and deployment of AI technologies in education. These frameworks should address issues such as data privacy, algorithmic bias, transparency, and accountability.

Institutional policies and guidelines should be developed to govern the use of generative AI in teaching and learning practices. These policies should outline the roles and responsibilities of educators, students, and AI systems, ensuring that AI is used as a supportive tool rather than a replacement for human expertise. Additionally, institutions should invest in faculty training and support to enable the effective integration of generative AI in classroom settings.

Best practices for the implementation of generative AI in education should be identified and shared among institutions. These practices may include the use of human-in-the-loop approaches, where AI-generated content is reviewed and validated by subject matter experts before being used in educational contexts. Collaborative efforts between educators, AI researchers, and industry partners can foster the development of robust and reliable AI tools tailored to the needs of Chinese higher education.

In conclusion, the integration of generative AI in Chinese university classrooms presents both opportunities and challenges. While the potential benefits of enhanced learning experiences, efficient content creation, and personalization are significant, careful consideration must be given to the quality, ethics, and long-term impact of AI-generated content. Effective governance strategies, including regulatory frameworks, institutional policies, and best practices, are essential to ensure the responsible and beneficial adoption of generative AI in Chinese higher education. As the field of generative AI continues to evolve, ongoing research, collaboration, and dialogue among stakeholders will be crucial to harness its potential while mitigating the risks and challenges.

AI in Education Globally

Globally, AI has been making significant strides in the education sector, revolutionizing teaching and learning processes. Many countries have recognized the potential of AI in enhancing educational outcomes and have begun integrating AI technologies into their education systems. In the United States,

AI-powered educational tools and platforms are being adopted to personalize learning experiences, provide adaptive assessments, and offer intelligent tutoring systems. These technologies aim to cater to individual student needs, optimize learning paths, and improve overall academic performance.

In Europe, there is a growing emphasis on leveraging AI to support lifelong learning and upskilling initiatives. AI-driven learning platforms are being developed to provide personalized recommendations for courses and learning resources based on an individual's skills, interests, and career goals. These platforms also facilitate the recognition and validation of non-formal and informal learning, enabling learners to showcase their competencies and acquire new skills throughout their lives.

In countries like Singapore and South Korea, AI is being integrated into the education system to enhance teaching efficiency and effectiveness. AI-powered tools are being used to automate administrative tasks, such as grading and feedback provision, allowing teachers to focus more on student engagement and personalized instruction. Additionally, AI is being employed to analyze student data, identify learning gaps, and provide targeted interventions to support struggling students.

Moreover, AI is playing a crucial role in making education more accessible and inclusive globally. AI-powered language translation tools are breaking down language barriers, enabling students to access educational content in their native languages. AI-driven assistive technologies are also being developed to support students with disabilities, providing them with personalized learning experiences and enabling them to participate fully in educational activities.

However, the adoption of AI in education also raises concerns and challenges that need to be addressed. Issues related to data privacy, algorithmic bias, and the digital divide are being actively discussed and tackled by policymakers and educators worldwide. There is a growing recognition of the need for ethical guidelines and frameworks to ensure the responsible and equitable use of AI in education.

To harness the full potential of AI in education, international collaborations and knowledge sharing are crucial. Global initiatives, such as the UNESCO's AI and Education project, aim to foster dialogue, research, and policy development around AI in education. These initiatives bring together experts, policymakers, and stakeholders from different countries to exchange best practices, address common challenges, and collectively shape the future of AI in education.

As AI continues to advance and become more integrated into educational practices worldwide, it is essential to strike a balance between leveraging its benefits and mitigating its risks. Governments, educational institutions, and technology providers must work together to develop robust policies, ethical frameworks, and inclusive strategies that ensure AI is used to enhance learning opportunities for all students, regardless of their background or abilities.

In conclusion, the global landscape of AI in education is rapidly evolving, with countries across the world recognizing its transformative potential. From personalized learning and adaptive assessments to language translation and assistive technologies, AI is reshaping the way education is delivered and experienced. However, addressing the challenges and ethical considerations associated with AI in education is crucial to ensure its responsible and equitable implementation. Through international collaborations, knowledge sharing, and the development of robust policies and frameworks, the global education community can harness the power of AI to create more inclusive, effective, and future-ready education systems.

Current State in Chinese Universities

Currently, the adoption of generative AI in Chinese university classrooms is still in its early stages,

with limited implementations across various educational institutions. While some pioneering universities have begun exploring the potential applications of AI-powered tools, such as chatbots and intelligent tutoring systems, the overall integration of generative AI remains relatively low. This can be attributed to several factors, including the lack of technological infrastructure, insufficient funding for AI research and development, and a general hesitation among educators to embrace new teaching methodologies.

However, there is a growing recognition among Chinese academic circles about the transformative potential of generative AI in enhancing the quality and efficiency of higher education. Several leading universities, such as Tsinghua University and Peking University, have established dedicated AI research centers and are actively collaborating with industry partners to develop innovative AI solutions tailored to the needs of the education sector. These initiatives aim to leverage the power of machine learning and natural language processing to create intelligent educational platforms that can personalize learning experiences, automate administrative tasks, and facilitate research activities.

Despite these promising developments, the current state of generative AI in Chinese universities is characterized by a fragmented landscape, with varying levels of adoption and implementation across different institutions. While some universities have made significant strides in integrating AI technologies into their curriculum and teaching practices, others are still grappling with the challenges of digital transformation and the need to upskill their faculty members. Additionally, there are concerns about the ethical implications of using AI in education, particularly regarding data privacy, algorithmic bias, and the potential for AI to perpetuate existing social inequalities.

To address these challenges and harness the full potential of generative AI in Chinese higher education, there is a growing consensus among policymakers and academic leaders about the need for a coordinated and strategic approach. This includes the development of national guidelines and standards for the ethical and responsible use of AI in education, as well as the establishment of funding mechanisms to support research and innovation in this field. Universities are also increasingly recognizing the importance of fostering interdisciplinary collaborations between AI researchers, educational experts, and domain specialists to ensure that AI solutions are grounded in sound pedagogical principles and aligned with the specific needs of different disciplines.

Moreover, there is a growing emphasis on the need to educate and empower students and faculty members to become active participants in the development and deployment of AI technologies. This involves integrating AI literacy and ethics into the curriculum, providing training and support for educators to effectively use AI tools in their teaching, and encouraging students to engage in AI research and innovation activities. By fostering a culture of AI readiness and innovation, Chinese universities can position themselves at the forefront of the global AI revolution and drive the transformation of higher education in the 21st century.

In conclusion, while the current state of generative AI in Chinese university classrooms is still in its nascent stages, there is a growing recognition of its immense potential to revolutionize teaching and learning. As universities continue to invest in AI research and development, collaborate with industry partners, and develop ethical frameworks for AI adoption, it is likely that we will see a rapid acceleration in the integration of generative AI into the fabric of Chinese higher education in the coming years. However, realizing the full benefits of AI will require a concerted effort from all stakeholders, including policymakers, academic leaders, researchers, educators, and students, to ensure that AI technologies are developed and deployed in a manner that is inclusive, equitable, and aligned with the values and goals

of education.

METHOD

Advantages of Generative AI

Enhanced Learning Experiences

The integration of generative AI technologies in Chinese university classrooms has the potential to revolutionize and enhance learning experiences for students. By leveraging the power of AI-driven content generation, personalized learning, and adaptive educational systems, educators can create engaging, interactive, and tailored learning environments that cater to the diverse needs and learning styles of individual students.

One of the key advantages of generative AI in education is its ability to create high-quality, relevant, and up-to-date learning materials efficiently. AI algorithms can analyze vast amounts of data, including academic literature, research papers, and educational resources, to generate customized content such as lecture notes, practice questions, and explanatory materials. This not only saves time for educators but also ensures that students have access to the most current and accurate information in their field of study. Moreover, generative AI can create interactive learning experiences, such as virtual simulations, adaptive quizzes, and personalized feedback, which engage students actively in the learning process and promote deeper understanding of complex concepts.

Personalization is another significant benefit of generative AI in education. By analyzing student data, such as learning preferences, performance metrics, and engagement patterns, AI algorithms can adapt the learning content and pace to suit each student's individual needs. This personalized approach can help students overcome learning challenges, address knowledge gaps, and optimize their learning outcomes. For example, AI-powered tutoring systems can provide targeted feedback, recommend additional resources, and adjust the difficulty level of assignments based on a student's performance, ensuring that every student receives the support they need to succeed academically.

Furthermore, generative AI can foster collaboration and peer learning by creating intelligent grouping mechanisms that match students with complementary skills and knowledge levels. AI algorithms can analyze student profiles, learning styles, and performance data to form optimal study groups, facilitating effective knowledge sharing and problem-solving among peers. This collaborative learning approach not only enhances students' social skills but also promotes a deeper understanding of the subject matter through active discussion and diverse perspectives.

The integration of generative AI in Chinese university classrooms also has the potential to bridge the gap between theory and practice by providing students with realistic, industry-relevant learning experiences. AI-powered simulations and virtual laboratories can expose students to real-world scenarios, allowing them to apply their knowledge and develop practical skills in a safe and controlled environment. For instance, medical students can practice surgical procedures using AI-generated virtual patients, while engineering students can design and test complex systems in simulated environments. These immersive learning experiences not only prepare students for their future careers but also foster innovation and creativity by allowing them to experiment with different approaches and solutions.

Moreover, generative AI can support personalized career guidance and skill development by analyzing job market trends, industry requirements, and student aspirations. AI algorithms can provide tailored recommendations for courses, internships, and extracurricular activities that align with each student's career goals and enhance their employability. By leveraging AI-driven insights, universities

can also adapt their curricula and training programs to meet the evolving demands of the job market, ensuring that graduates are well-equipped with the knowledge and skills required for success in their chosen professions.

In conclusion, the integration of generative AI in Chinese university classrooms offers numerous advantages that can significantly enhance learning experiences, promote personalized education, and prepare students for the challenges of the modern world. By harnessing the power of AI-driven content generation, adaptive learning, and collaborative environments, educators can create engaging, effective, and future-oriented learning experiences that cater to the diverse needs of students. As Chinese universities continue to explore and adopt generative AI technologies, it is crucial to develop robust governance strategies and ethical frameworks to ensure responsible and equitable implementation, maximizing the benefits of AI while mitigating potential risks and challenges.

Efficient Content Creation

Generative AI technologies have the potential to significantly enhance content creation efficiency in Chinese higher education classrooms. By leveraging advanced natural language processing and machine learning algorithms, generative AI systems can automate and streamline various aspects of the content creation process, allowing educators to focus on more high-value tasks such as student engagement and personalized instruction.

One of the primary advantages of generative AI in content creation is its ability to quickly generate high-quality educational materials tailored to specific subjects, learning objectives, and student needs. These AI-powered tools can analyze vast amounts of data from textbooks, academic papers, and online resources to synthesize relevant information and create well-structured, coherent content. For instance, generative AI can assist in creating lecture notes, presentations, quizzes, and assignments that align with course curricula and learning outcomes. This not only saves educators considerable time and effort but also ensures consistency and accuracy in the materials produced.

Moreover, generative AI can facilitate the development of interactive and engaging educational content. By incorporating multimedia elements such as images, videos, and animations, AI-generated content can cater to different learning styles and enhance student comprehension. For example, AI algorithms can automatically generate visual aids, infographics, and simulations to illustrate complex concepts and processes, making abstract ideas more accessible and easier to grasp. Additionally, generative AI can create adaptive learning materials that adjust to individual students' abilities and progress, providing personalized content and feedback to optimize their learning experience.

Another significant benefit of generative AI in content creation is its scalability and adaptability. As educational needs and curricula evolve, AI systems can quickly update and generate new content to reflect the latest developments and best practices in various fields. This ensures that students have access to up-to-date and relevant information, keeping pace with the rapidly changing landscape of knowledge and skills required in the modern world. Furthermore, generative AI can help bridge the gap between theory and practice by creating realistic case studies, scenarios, and problem-solving exercises that simulate real-world applications, better preparing students for their future careers.

The efficiency of generative AI in content creation also extends to assessment and evaluation. AI algorithms can generate a wide range of assessment items, including multiple-choice questions, short-answer prompts, and essay topics, tailored to specific learning objectives and difficulty levels. This not only reduces the workload of educators in creating assessments but also enables more frequent and targeted evaluations of student progress. Moreover, AI-powered grading systems can provide immediate

feedback and detailed analysis of student performance, identifying areas of strength and weakness and offering personalized recommendations for improvement.

In addition to its direct benefits for educators and students, generative AI in content creation can also foster collaboration and knowledge sharing among educational institutions. By leveraging AI-generated content, universities can create shared repositories of high-quality educational materials, allowing educators to access and adapt content from other institutions to suit their specific needs. This collaborative approach can lead to the development of more comprehensive and diverse educational resources, benefiting students across different regions and socioeconomic backgrounds.

However, it is essential to recognize that the integration of generative AI in content creation also presents certain challenges and considerations. Ensuring the accuracy, reliability, and appropriateness of AI-generated content is crucial to maintain educational quality and integrity. Educators must carefully review and validate the content produced by AI systems to prevent the propagation of errors, biases, or inconsistencies. Additionally, the ethical implications of using AI-generated content, such as issues of intellectual property rights and attribution, must be thoroughly addressed to ensure fair and responsible use of these technologies.

To maximize the benefits of generative AI in content creation while mitigating potential risks, Chinese universities should adopt a proactive and collaborative approach. This involves investing in the development and refinement of AI technologies specifically tailored to educational contexts, as well as providing training and support for educators to effectively incorporate these tools into their teaching practices. Furthermore, establishing clear guidelines and policies for the use of AI-generated content, along with mechanisms for quality control and feedback, can help ensure the responsible and effective deployment of these technologies in higher education classrooms.

In conclusion, generative AI holds immense potential to revolutionize content creation in Chinese higher education, offering enhanced efficiency, personalization, and engagement. By harnessing the power of these technologies, educators can create high-quality, adaptive, and up-to-date educational materials that cater to the diverse needs of students. However, the successful integration of generative AI in content creation requires a thoughtful and collaborative approach, addressing technical, ethical, and pedagogical considerations to ensure its responsible and effective use. As Chinese universities continue to explore and adopt these technologies, they have the opportunity to not only transform their own educational landscapes but also contribute to the global advancement of AI-powered learning and innovation.

Personalization and Adaptability

Generative AI technologies have the potential to revolutionize personalized learning experiences and adapt to individual students' needs in Chinese university classrooms. By leveraging advanced natural language processing, machine learning algorithms, and vast knowledge bases, these AI systems can dynamically generate tailored educational content, assessments, and feedback to cater to each student's unique learning style, pace, and preferences.

One key advantage of generative AI lies in its ability to create personalized learning paths based on a student's strengths, weaknesses, and learning objectives. By analyzing a student's performance data, interaction patterns, and preferences, the AI system can intelligently recommend specific resources, exercises, and activities that are most suitable for their individual learning journey. This adaptive approach ensures that students receive targeted support and guidance to optimize their learning outcomes and engagement levels.

Moreover, generative AI can dynamically adjust the difficulty level and complexity of educational content based on a student's real-time performance and comprehension. If a student is struggling with a particular concept or problem, the AI system can automatically generate simplified explanations, additional examples, or step-by-step guidance to facilitate understanding. Conversely, if a student demonstrates mastery of a topic, the AI can present more challenging and advanced material to keep them motivated and promote continuous growth.

Personalization through generative AI also extends to the delivery of immediate and constructive feedback. By analyzing student responses, the AI system can provide instant and detailed feedback on their work, highlighting areas of improvement, offering suggestions, and recognizing their achievements. This real-time feedback loop enables students to identify and address their misconceptions promptly, reinforcing their learning and boosting their confidence.

Furthermore, generative AI can adapt to individual learning preferences by presenting educational content in various formats such as text, audio, video, interactive simulations, or gamified experiences. By catering to different learning modalities, the AI system ensures that students can engage with the material in a way that resonates with their preferred learning style, enhancing their motivation and retention.

The adaptability of generative AI also allows for the creation of personalized assessments and evaluation methods. Instead of relying on standardized tests, the AI system can generate customized quizzes, assignments, and projects that align with each student's learning goals and competency levels. This approach provides a more accurate and comprehensive evaluation of a student's progress, identifying areas where additional support or enrichment is needed.

Moreover, generative AI can facilitate personalized learning experiences beyond the classroom by recommending supplementary resources, online courses, or extracurricular activities based on a student's interests and aspirations. By connecting students with relevant opportunities for exploration and growth, the AI system fosters a holistic learning environment that nurtures their curiosity and helps them discover their passions.

The adaptability of generative AI also enables seamless integration with existing educational technologies and platforms. By leveraging data from learning management systems, student information systems, and other educational tools, the AI system can gain a comprehensive understanding of each student's learning journey and provide personalized recommendations and interventions across various touchpoints.

However, it is crucial to acknowledge that the effectiveness of personalized learning through generative AI relies on the quality and diversity of the training data, as well as the robustness of the underlying algorithms. Ensuring that the AI system is trained on representative and unbiased data, and continuously updated with the latest pedagogical research and best practices, is essential to deliver accurate and meaningful personalization.

Additionally, while personalization through generative AI offers numerous benefits, it is important to strike a balance between automated recommendations and human guidance. Teachers and educators play a vital role in overseeing the AI system's outputs, providing contextual insights, and fostering meaningful human connections with students. Collaborative efforts between AI and human educators are necessary to ensure that personalized learning experiences are effective, inclusive, and aligned with educational goals.

In conclusion, the personalization and adaptability offered by generative AI have the potential to

transform the educational landscape in Chinese universities. By tailoring learning experiences to individual students' needs, preferences, and competencies, generative AI can enhance engagement, motivation, and academic outcomes. However, the successful implementation of personalized learning through generative AI requires careful consideration of data quality, algorithmic fairness, and the synergistic collaboration between AI systems and human educators. As Chinese universities embrace the potential of generative AI, it is crucial to develop robust frameworks, policies, and best practices to ensure that personalized learning experiences are delivered in a responsible, equitable, and student-centric manner.

Disadvantages of Generative AI

Quality and Accuracy Issues

The quality and accuracy of content generated by AI systems in educational settings are significant concerns that may hinder their widespread adoption in Chinese universities. As machine learning models are trained on vast datasets, they can occasionally produce outputs that contain factual inaccuracies, inconsistencies, or biases. This issue is particularly problematic in academic contexts, where the reliability and veracity of information are of utmost importance. Inaccurate or misleading content can lead to confusion among students and undermine the credibility of the educational institution.

Generative AI models, such as GPT-3, rely on pattern recognition and statistical associations within their training data. Consequently, they may struggle to differentiate between reliable and unreliable sources, leading to the generation of content that lacks academic rigor or contains unsubstantiated claims. This limitation is especially evident when dealing with highly specialized or niche topics, where the available training data may be limited or biased. In such cases, AI-generated content may not meet the high standards of accuracy and precision required in academic settings.

Moreover, AI systems can perpetuate and amplify existing biases present in their training data. If the datasets used to train these models contain societal biases or stereotypes, the generated content may reflect and reinforce these problematic views. This can lead to the dissemination of discriminatory or offensive content, which is unacceptable in educational environments that strive for inclusivity and equality. Addressing these biases requires careful curation of training data and the development of methods to detect and mitigate biased outputs.

Another challenge associated with the quality of AI-generated content is the lack of deep understanding and contextual awareness. While these models can generate coherent and grammatically correct text, they may struggle to grasp the nuances and complexities of certain subjects. This can result in superficial or oversimplified explanations that fail to capture the depth and richness of the topic at hand. In disciplines that require critical thinking, analytical reasoning, and creative problem-solving, the limitations of AI-generated content become more apparent.

To address these quality and accuracy issues, it is crucial for educators and institutions to implement rigorous vetting processes for AI-generated content. This may involve collaborations between subject matter experts and AI developers to ensure that the generated material meets the required standards of accuracy and relevance. Additionally, mechanisms for human oversight and editorial control should be put in place to review and refine the AI-generated content before it is presented to students.

Furthermore, it is essential to educate students about the limitations and potential biases of AI-generated content. By fostering critical thinking skills and encouraging students to approach AI-generated materials with a discerning eye, educators can help them develop the ability to evaluate the reliability and trustworthiness of information. This skill is particularly valuable in an era where the

proliferation of AI-generated content is likely to increase.

Institutions should also invest in research and development efforts to improve the accuracy and reliability of generative AI models. This may involve exploring techniques such as adversarial training, where models are exposed to deliberately misleading or inaccurate information to learn how to identify and reject such content. Additionally, the development of domain-specific models that are trained on curated datasets relevant to specific academic disciplines can help improve the quality and relevance of the generated content.

Finally, it is important to establish clear guidelines and standards for the use of AI-generated content in educational settings. These guidelines should outline the acceptable levels of accuracy, the requirements for human oversight and editorial control, and the protocols for handling instances of inaccurate or biased content. By defining these standards and communicating them clearly to educators, students, and AI developers, institutions can foster a responsible and effective integration of generative AI in Chinese university classrooms.

In conclusion, the quality and accuracy issues associated with generative AI pose significant challenges for its adoption in Chinese higher education. Addressing these concerns requires a multifaceted approach that involves rigorous vetting processes, human oversight, student education, research and development efforts, and clear institutional guidelines. By proactively addressing these issues, Chinese universities can harness the potential benefits of generative AI while mitigating its risks, ultimately enhancing the quality and effectiveness of education in the era of artificial intelligence.

Ethical and Privacy Concerns

The use of generative AI in Chinese university classrooms raises significant ethical and privacy concerns that must be carefully addressed. One of the primary issues is the potential for AI systems to perpetuate biases and discriminatory practices. Generative AI models are trained on vast amounts of data, which may contain inherent biases based on factors such as race, gender, socioeconomic status, or cultural background. If these biases are not identified and mitigated during the development process, they can be amplified and reinforced through the AI's outputs, leading to unfair treatment of certain student groups and the promotion of stereotypes.

Moreover, the use of generative AI in educational settings poses risks to student privacy and data security. These AI systems often require access to sensitive student information, such as personal details, academic records, and learning behaviors, to provide personalized content and recommendations. However, the collection, storage, and processing of this data raise concerns about potential breaches, unauthorized access, or misuse. Educational institutions must implement robust data protection measures and adhere to stringent privacy regulations to safeguard student information and maintain trust in the AI-enabled learning environment.

Another ethical challenge arises from the lack of transparency and explainability in generative AI systems. The complex algorithms and decision-making processes underlying these AI models are often opaque, making it difficult for students, educators, and administrators to understand how the AI arrives at its outputs or recommendations. This lack of transparency can lead to a sense of distrust and uncertainty, as users may question the fairness, accuracy, and reliability of the AI's decisions. To address this issue, efforts must be made to develop more transparent and interpretable AI models, allowing for greater accountability and the ability to identify and rectify any biases or errors.

The use of generative AI also raises questions about intellectual property rights and academic integrity. As AI systems become more advanced in generating original content, such as essays, research

papers, or creative works, it becomes increasingly difficult to distinguish between human-authored and AI-generated content. This blurring of lines can lead to issues of plagiarism, cheating, and the erosion of academic standards. Educational institutions must establish clear policies and guidelines regarding the use of AI-generated content in academic work, ensuring that students are properly credited for their original contributions while also detecting and preventing instances of academic dishonesty.

Furthermore, the reliance on generative AI in educational settings may have unintended consequences for student development and critical thinking skills. If students become overly dependent on AI systems for content creation, problem-solving, and decision-making, they may fail to develop the necessary cognitive abilities and independent thinking skills that are crucial for their future academic and professional success. Educational institutions must strike a balance between leveraging the benefits of AI technology and fostering an environment that encourages students to engage in active learning, critical analysis, and creative problem-solving.

To address these ethical and privacy concerns, educational institutions must adopt a proactive and comprehensive approach to AI governance. This includes developing clear policies and guidelines for the responsible development, deployment, and use of generative AI in educational settings. These policies should be based on ethical principles such as fairness, transparency, accountability, and respect for student privacy. Educational institutions should also invest in training and awareness programs for faculty, staff, and students to ensure that they understand the implications of AI technology and are equipped with the knowledge and skills to use it responsibly.

Moreover, educational institutions should collaborate with AI developers, researchers, and industry partners to promote the development of ethical and secure AI systems. This collaboration can help ensure that AI models are designed with built-in safeguards against biases, discrimination, and privacy violations. It can also facilitate the sharing of best practices and the development of industry standards for responsible AI use in education.

Regular audits and assessments of AI systems should also be conducted to identify and address any ethical or privacy issues that may arise over time. These audits should involve diverse stakeholders, including students, educators, administrators, and ethics experts, to ensure that multiple perspectives are considered and that any concerns are promptly addressed.

In conclusion, while generative AI holds immense potential for enhancing education in Chinese universities, it also presents significant ethical and privacy challenges that cannot be overlooked. Educational institutions must take proactive measures to govern the use of AI technology, ensuring that it is developed and deployed in a responsible, transparent, and accountable manner. By addressing these concerns head-on and establishing robust governance frameworks, Chinese universities can harness the power of generative AI to transform education while safeguarding the rights and well-being of students and preserving the integrity of the academic process.

Dependence and Skill Degradation

Overdependence on generative AI in the classroom poses significant risks to students' learning outcomes and skill development. When students rely excessively on AI-generated content, they may fail to cultivate essential skills such as critical thinking, problem-solving, and original ideation. Instead of actively engaging with course materials and grappling with complex concepts, students may become passive recipients of AI-generated answers, leading to a superficial understanding of the subject matter. This dependence can hinder the development of deep, meaningful learning experiences and limit students' ability to apply knowledge in real-world contexts.

Moreover, the ease of access to AI-generated content may discourage students from investing time and effort in independent research and analysis. The availability of instant answers and pre-written essays can diminish students' motivation to explore topics in-depth, conduct thorough literature reviews, and engage in original thought. This can lead to a decline in critical research skills, such as information literacy, data analysis, and the ability to synthesize information from multiple sources. Without these essential skills, students may struggle to contribute meaningfully to their fields of study and adapt to future academic and professional challenges.

Furthermore, relying on AI-generated content can impede the development of effective communication and writing skills. When students consistently use AI-generated text, they may fail to develop their own authentic voice and writing style. The nuances of language, the art of crafting compelling arguments, and the ability to articulate complex ideas in a clear and concise manner are skills that require practice and refinement. Overdependence on AI may lead to a homogenization of written work, lacking the depth, creativity, and personal insights that distinguish exceptional academic writing.

The long-term implications of skill degradation due to AI dependence are concerning. As students progress through their academic journey and enter the workforce, they may find themselves ill-equipped to tackle real-world challenges that require independent thinking, problem-solving, and effective communication. In an increasingly competitive global economy, where critical thinking and innovation are highly valued, students who have relied heavily on AI may struggle to adapt and thrive. This can have far-reaching consequences for their personal and professional growth, as well as for the overall competitiveness of the workforce.

To mitigate the risks of skill degradation, it is crucial for educators and institutions to promote responsible AI use in the classroom. This involves fostering a learning environment that values active engagement, critical thinking, and original ideation. Educators should design assignments and assessments that encourage students to analyze, synthesize, and apply knowledge in meaningful ways, rather than simply regurgitating AI-generated content. By providing opportunities for students to engage in independent research, collaborative projects, and real-world problem-solving, educators can help students develop the skills and competencies necessary for long-term success.

Additionally, institutions should prioritize digital literacy and AI education to help students understand the capabilities and limitations of generative AI. By equipping students with the knowledge and skills to critically evaluate AI-generated content, institutions can empower them to make informed decisions about when and how to use these tools effectively. This includes teaching students to verify the accuracy and reliability of AI-generated information, to recognize the potential biases and limitations of AI algorithms, and to understand the ethical implications of using AI in academic work.

Furthermore, institutions should establish clear policies and guidelines regarding the use of generative AI in the classroom. These policies should outline acceptable use cases, set expectations for academic integrity, and provide guidance on proper attribution and citation of AI-generated content. By setting clear standards and consequences for misuse, institutions can create a culture of responsible AI use and discourage overdependence on these tools.

In conclusion, the risks of skill degradation posed by overdependence on generative AI in Chinese university classrooms are significant and far-reaching. Educators and institutions must take proactive steps to mitigate these risks by promoting active learning, fostering critical thinking skills, and providing comprehensive AI education. By striking a balance between leveraging the benefits of generative AI

and maintaining the integrity of the learning process, Chinese universities can ensure that students develop the skills and competencies necessary for long-term success in an increasingly AI-driven world.

FINDINGS AND DISCUSSION

1. Regulatory Frameworks

Regulatory frameworks play a crucial role in governing the use of generative AI in Chinese university classrooms. As the adoption of AI technologies continues to expand, it is essential to establish comprehensive regulations that address the unique challenges and risks associated with their implementation in educational settings. These frameworks should be designed to ensure the responsible and ethical use of AI while maximizing its potential benefits for students and educators.

At the national level, the Chinese government should develop a set of guidelines and standards for the development and deployment of generative AI in higher education. These guidelines should outline the fundamental principles and requirements for AI systems, including transparency, accountability, fairness, and privacy protection. They should also establish clear roles and responsibilities for educational institutions, technology providers, and government agencies in the oversight and enforcement of these regulations.

One key aspect of the regulatory framework should be the establishment of a dedicated regulatory body or committee responsible for overseeing the use of AI in education. This body should be composed of experts from various fields, including education, computer science, ethics, and law. Its primary functions should include setting standards for AI development and deployment, monitoring compliance with regulations, conducting regular audits and assessments, and providing guidance and support to educational institutions.

The regulatory framework should also address issues related to data privacy and security. As generative AI systems rely heavily on large datasets for training and operation, it is crucial to ensure that student data is collected, stored, and used in compliance with relevant privacy laws and regulations. Educational institutions should be required to obtain informed consent from students and their guardians before collecting and using their data for AI purposes. They should also implement robust security measures to protect student data from unauthorized access, breaches, or misuse.

Another important aspect of the regulatory framework should be the establishment of guidelines for the ethical use of generative AI in education. These guidelines should address issues such as bias and discrimination, transparency and explainability, and the potential impact of AI on student learning and development. Educational institutions should be required to conduct regular audits and assessments to identify and mitigate any potential biases or discriminatory outcomes in their AI systems. They should also provide clear explanations to students and educators about how AI is being used in the classroom and what data is being collected and analyzed.

To ensure the effective implementation of these regulatory frameworks, the Chinese government should provide adequate resources and support to educational institutions. This may include funding for research and development, training programs for educators and administrators, and the establishment of centers of excellence for AI in education. The government should also work closely with industry partners and academic institutions to foster collaboration and knowledge sharing in the development and deployment of generative AI technologies.

In addition to national-level regulations, educational institutions should also develop their own internal policies and guidelines for the use of generative AI in the classroom. These policies should align

with the broader regulatory framework while addressing the specific needs and contexts of each institution. They should outline the roles and responsibilities of educators, students, and administrators in the use of AI technologies and provide clear guidance on issues such as data privacy, intellectual property rights, and academic integrity.

Educational institutions should also invest in training and professional development programs for educators to ensure that they have the necessary skills and knowledge to effectively integrate generative AI into their teaching practices. These programs should cover topics such as AI ethics, data literacy, and pedagogical strategies for using AI to enhance student learning outcomes. Institutions should also provide ongoing support and resources to educators to help them stay up-to-date with the latest developments in AI and adapt their teaching practices accordingly.

Finally, it is important to recognize that regulatory frameworks for generative AI in education are not static and must evolve over time to keep pace with technological advancements and changing societal needs. The Chinese government and educational institutions should regularly review and update their regulations and policies to ensure that they remain relevant and effective in addressing the challenges and opportunities presented by AI technologies. This may involve ongoing collaboration with industry partners, academic institutions, and international organizations to share best practices and learn from the experiences of other countries and regions.

In conclusion, the development and implementation of comprehensive regulatory frameworks are essential for the responsible and ethical use of generative AI in Chinese university classrooms. These frameworks should address issues related to data privacy, security, transparency, and accountability while also providing guidance and support for educational institutions and educators. By establishing clear guidelines and standards for the use of AI in education, the Chinese government and educational institutions can ensure that these technologies are used in ways that maximize their potential benefits for students and society as a whole.

2. Institutional Policies

In addition to regulatory frameworks at the national level, Chinese universities must establish clear institutional policies to govern the use of generative AI in the classroom. These policies should provide guidelines for both educators and students, ensuring responsible and effective implementation of AI technologies while mitigating potential risks.

Firstly, universities should develop comprehensive AI usage policies that define the scope and limitations of generative AI in educational settings. These policies should specify the types of AI tools and applications permitted, along with their intended purposes and usage scenarios. For instance, policies may allow the use of AI-powered writing assistants for proofreading and grammar correction but prohibit their use for generating complete assignments or essays. Similarly, policies should outline the appropriate use of AI-generated content, such as using it as a starting point for discussions or as supplementary material rather than as the primary source of information.

Furthermore, institutional policies must address the ethical implications of generative AI. This includes establishing guidelines for data privacy and security, ensuring that student data is protected and not misused by AI systems. Policies should also emphasize the importance of academic integrity, prohibiting the use of AI to engage in plagiarism or cheating. Universities must clearly communicate the consequences of violating these policies, such as disciplinary action or academic penalties.

To ensure effective implementation, universities should provide training and support for both faculty and students. Faculty members should receive comprehensive training on how to integrate

generative AI into their teaching practices, including best practices for using AI tools, designing AI-enhanced assignments, and evaluating AI-generated content. Students should also receive education on the responsible use of AI, including understanding its limitations, recognizing potential biases, and developing critical thinking skills to evaluate AI-generated information.

Moreover, universities should establish mechanisms for monitoring and evaluating the impact of generative AI on learning outcomes. This may involve conducting regular assessments to measure student performance, gathering feedback from faculty and students, and analyzing data on AI usage patterns. Such evaluations can help identify areas for improvement and inform the refinement of institutional policies over time.

Collaboration and knowledge sharing among universities can also play a crucial role in developing effective institutional policies. Universities should engage in dialogue with peer institutions to exchange best practices, share experiences, and collaborate on research projects related to AI in education. This collaborative approach can help ensure consistency in policies across institutions and promote the development of industry-wide standards.

In addition to internal policies, universities should also actively engage with external stakeholders, such as educational authorities, industry partners, and research organizations. Collaborating with these stakeholders can provide valuable insights and resources for shaping institutional policies and ensuring alignment with broader educational goals and industry trends.

Finally, universities must remain adaptable and responsive to the rapidly evolving landscape of generative AI. As new technologies emerge and research advances, institutional policies must be regularly reviewed and updated to stay relevant and effective. This requires ongoing monitoring of AI developments, engagement with research communities, and a willingness to adapt policies as needed.

In conclusion, the development and implementation of robust institutional policies are crucial for the successful governance of generative AI in Chinese universities. These policies should provide clear guidelines for AI usage, address ethical concerns, ensure training and support for faculty and students, and establish mechanisms for monitoring and evaluation. By collaborating with external stakeholders and remaining adaptable to changing technologies, universities can create a framework that maximizes the benefits of generative AI while mitigating potential risks. Through effective institutional governance, Chinese universities can harness the power of generative AI to enhance learning experiences, foster innovation, and prepare students for the AI-driven future.

3. Best Practices for Implementation

To effectively implement generative AI in Chinese university classrooms, institutions should adopt a set of best practices that ensure responsible and productive use of the technology. First, universities should provide comprehensive training and support for faculty members to help them understand the capabilities and limitations of generative AI tools. This training should cover the fundamentals of AI, its potential applications in education, and the ethical considerations surrounding its use. By equipping educators with the necessary knowledge and skills, institutions can foster a culture of informed and responsible AI adoption.

Second, universities should establish clear guidelines and protocols for the use of generative AI in coursework and assessments. These guidelines should specify the appropriate contexts in which AI tools can be utilized, such as for content creation, personalized feedback, or adaptive learning experiences. Additionally, the guidelines should outline the expectations for students regarding the disclosure of AI usage in their work and the need to maintain academic integrity. By setting clear boundaries and

expectations, institutions can promote transparency and accountability in the use of generative AI.

Third, institutions should encourage collaboration between faculty members, instructional designers, and AI experts to develop effective strategies for integrating generative AI into the curriculum. This collaborative approach can help ensure that AI tools are aligned with course objectives, pedagogical approaches, and assessment methods. By fostering interdisciplinary collaboration, universities can create a supportive environment that encourages innovation and the sharing of best practices.

Fourth, universities should invest in robust infrastructure and resources to support the implementation of generative AI. This includes providing access to high-quality AI tools, computing resources, and data storage systems. Additionally, institutions should establish dedicated support teams to assist faculty and students with technical issues, troubleshooting, and ongoing maintenance of AI systems. By investing in the necessary infrastructure and support, universities can ensure the smooth and effective deployment of generative AI in the classroom.

Fifth, institutions should prioritize the development of ethical frameworks and policies governing the use of generative AI. These frameworks should address issues such as data privacy, intellectual property rights, and the potential for bias and discrimination in AI systems. By establishing clear ethical guidelines, universities can ensure that the use of generative AI aligns with institutional values and promotes fairness, transparency, and accountability.

Sixth, universities should engage in ongoing monitoring and evaluation of the impact of generative AI on student learning outcomes and educational experiences. This can involve collecting data on student performance, engagement, and satisfaction, as well as conducting qualitative studies to gain insights into the strengths and weaknesses of AI-enhanced learning environments. By regularly assessing the effectiveness of generative AI, institutions can make data-driven decisions to refine their implementation strategies and optimize the benefits for students.

Seventh, institutions should foster a culture of continuous learning and professional development around generative AI. This can involve providing ongoing training and workshops for faculty members to keep them updated on the latest developments in AI technology and its applications in education. Additionally, universities should encourage faculty members to share their experiences and insights through conferences, seminars, and publications, contributing to the broader academic discourse on AI in education.

Finally, universities should engage in public outreach and education efforts to raise awareness about the responsible use of generative AI in education. This can involve hosting public lectures, workshops, and forums to discuss the ethical, social, and educational implications of AI. By engaging with the wider community, institutions can foster a more informed and nuanced understanding of the role of generative AI in education and its potential to transform learning experiences.

By adopting these best practices, Chinese universities can ensure the effective and responsible implementation of generative AI in the classroom. By providing comprehensive training, establishing clear guidelines, fostering collaboration, investing in infrastructure, prioritizing ethics, monitoring impact, promoting continuous learning, and engaging in public outreach, institutions can harness the potential of generative AI to enhance student learning outcomes and prepare students for the challenges and opportunities of the AI-driven future.

CONCLUSION

In conclusion, the integration of generative AI in Chinese university classrooms presents a complex landscape of advantages and disadvantages that necessitates careful consideration and strategic governance. As the rapid advancement of AI technology continues to reshape the educational landscape, it is crucial for institutions to navigate this transformative journey with foresight and adaptability.

The potential benefits of generative AI in enhancing learning experiences, streamlining content creation, and enabling personalized instruction are undeniable. By harnessing the power of AI algorithms, educators can create immersive and interactive learning environments that cater to individual student needs, fostering engagement and knowledge retention. Moreover, the efficiency gains in content generation and administrative tasks can alleviate the workload of educators, allowing them to focus on higher-level pedagogical responsibilities.

However, the challenges posed by generative AI cannot be overlooked. The quality and accuracy of AI-generated content remain a significant concern, as the potential for misinformation and biased outputs can undermine the integrity of the educational process. Furthermore, the ethical implications surrounding data privacy, intellectual property rights, and the potential for AI systems to perpetuate societal biases must be carefully addressed. The risk of students becoming overly dependent on AI assistance, potentially leading to a degradation of critical thinking and problem-solving skills, is another pressing issue that demands attention.

To effectively navigate these complexities, the development and implementation of robust governance strategies are imperative. Regulatory frameworks at the national and institutional levels must be established to provide clear guidelines and standards for the ethical and responsible use of generative AI in education. These frameworks should encompass data protection measures, transparency requirements, and mechanisms for accountability and oversight.

Moreover, institutional policies must be crafted to ensure the judicious integration of AI tools into the curriculum, striking a balance between leveraging their benefits and mitigating potential risks. This includes developing best practices for the selection, deployment, and monitoring of AI systems, as well as providing comprehensive training and support for educators to effectively utilize these technologies.

Collaboration among stakeholders, including educators, researchers, policymakers, and industry partners, is essential to foster a shared understanding of the opportunities and challenges presented by generative AI. Through open dialogue, knowledge sharing, and collective problem-solving, the educational community can work towards developing sustainable and equitable approaches to AI integration that prioritize student well-being and academic integrity.

As Chinese universities navigate this uncharted territory, it is crucial to maintain a critical and reflective stance, continuously evaluating the impact of generative AI on educational outcomes and adapting strategies as needed. By embracing a proactive and adaptive approach, institutions can harness the transformative potential of AI while safeguarding the fundamental values and principles of education.

In conclusion, the integration of generative AI in Chinese university classrooms presents both opportunities and challenges that require careful navigation and strategic governance. By establishing robust regulatory frameworks, crafting institutional policies, and fostering collaboration among stakeholders, the educational community can work towards realizing the benefits of AI while mitigating its risks. As we stand at the threshold of a new era in education, it is essential to approach this transformative journey with wisdom, foresight, and a unwavering commitment to the well-being and success of students.

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A Meta-analysis Based Study of the Factors Influencing Students' Engagement in Classroom Learning

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ABSTRACT

In response to the inconsistent findings in current research on the factors influencing students' classroom learning engagement, this study aims to systematically review and re-explore empirical findings in this field through a meta-analysis to derive more generalizable conclusions. [Method/Process] Employing a meta-analytic approach that integrates both qualitative and quantitative methods, 43 high-quality empirical studies meeting the selection criteria from both international and domestic sources were rigorously screened. The Comprehensive Meta-Analysis (CMA) software was used to integrate the effect sizes (correlation coefficients) reported in the literature, followed by heterogeneity testing, publication bias assessment, and moderation effect analysis.[Results/Conclusion] The analysis ultimately identified 13 factors significantly influencing student classroom engagement. Effect size analysis revealed that teacher-student relationships, students' thinking skills, emotional factors , and teacher behaviors exhibited moderate correlations with engagement, identifying them as key influencing factors. Furthermore, moderation analysis indicated that the educational stage (basic education vs. higher education) significantly influenced the impact of three factors on student engagement: personality traits, thinking skills, and learning background. For instance, the correlations for personality traits and thinking skills were stronger in the basic education stage. [Innovation/Value] By quantifying the strength of various factors' influence through meta-analysis and identifying the moderating role of educational stage, this study not only clarifies the heterogeneity in existing research but also provides a theoretical basis and practical insights for developing targeted strategies to enhance student engagement across different educational phases.

Keywords: basic education, classroom learning, higher education, meta-analysis, student engagement

INTRODUCTION

Learning engagement, a multifaceted construct encompassing cognitive, behavioural, and affective investment in classroom activities, is fundamentally defined as the quantity and quality of students' psychological, cognitive, emotional, and behavioural responses throughout the learning process and in academic-social activities, aimed at achieving successful learning outcomes (Selim, 2015). According to Astin's (1984) foundational theory of involvement, the extent of a student's engagement exerts a broad influence on individual development. Beyond directly impacting academic achievement, it significantly fosters positive learning attitudes, enhances perseverance in the face of academic challenges, boosts self-efficacy, and increases overall satisfaction with learning experiences.

The learning engagement is theoretically recognized to serve both cognitive and non-cognitive functions, playing a crucial role in the personal and social development of students across various educational stages.

In the specific context of classroom education, student engagement is influenced by a complex interplay of factors. These can be broadly categorized into direct individual factors, such as students' personality traits and thinking skills, whose influence may vary across different educational levels, and external factors that intervene and shape participation behaviours. As underscored by related educational theories, the efficacy of any educational intervention is directly linked to its capacity to enhance student engagement. Key external factors include teaching quality, the nature of teacher-student relationships, and the application of educational technology, all of which significantly impact the depth and extent of student involvement.

Student classroom participation and its facilitation remain a central issue in educational research and practice. While numerous scholars have investigated this area, their findings often present variations and inconsistencies. Some researchers have delved into the conceptualization and significance of engagement, whereas others have conducted empirical analyses on its determinants. For instance, findings suggest that factors like students' self-expectations, teacher quality, personality traits, major satisfaction, and learning motivation are all positively linked to classroom participation. However, a comprehensive and integrated understanding of the relative strength of these factors and how their influence might differ between educational stages, such as basic education and higher education, is still needed.

To address these gaps and synthesize the existing body of empirical work, this study employs a meta-analytic approach. This research is guided by the following key questions: What factors have been identified in existing international and domestic research as influencing students' classroom learning engagement? To what extent do these factors affect students' willingness and behaviour to engage in classroom learning? Furthermore, do the effects of these factors on student classroom participation differ significantly across basic and higher education levels?

By systematically answering these questions, this study aims to provide a clearer and more integrated picture of the factors influencing student classroom learning participation. Theoretically, it seeks to reconcile the scattered and heterogeneous discussions in existing literature, identify sources of variation, and thereby contribute to enriching the theoretical framework concerning teaching and learning coherence across educational stages. Practically, the findings are expected to offer valuable evidence and insights for schools and teachers to formulate effective, stage-appropriate strategies to promote student engagement, ultimately enhancing classroom participation and overall teaching effectiveness.

RESEARCH THEORETICAL FRAMEWORK

Research Methods

This study uses the meta-analysis method of qualitative and quantitative combination to further explore the empirical data. Meta analysis, proposed by American educational psychologist GV glass, is a comprehensive statistical analysis method for a large number of existing empirical research results on the same topic, also known as secondary analysis, meta-analysis and integration analysis. With the application and development of meta-analysis, scholars have found that meta-analysis includes both quantitative analysis and qualitative analysis. In general, meta-analysis is a quantitative analysis of

existing research results by using specific design and statistical analysis methods. The most controversial issue of meta analysis method is "orange and apple problem", which combines the results of different studies, but this problem can be explained by the heterogeneity test of this method. At the same time, compared with the traditional literature review, meta-analysis method carries out a strict analysis and evaluation of the included literature, which can avoid personal subjective ideas and make the research conclusions more objective and universal.

At first, meta-analysis was mainly used in the field of medicine and psychology, with the development of meta-analysis, this method has also attracted the attention of scholars in other fields, and has been accepted by more and more scholars. In the field of management, Huang Yongchun uses the method of meta analysis to study the strong correlation between product innovation and performance, which provides theoretical support for enterprise management; Li Jinghua analyzed the empirical research literature on the influencing factors of knowledge transfer, and found that knowledge receptors and network characteristics are the most important influencing factors; In the field of information science, Xie Juan found that there was a significant strong correlation between the number of papers downloaded and the number of papers cited. The successful application of meta-analysis method by these scholars gives us reference and enlightenment, and also confirms the feasibility of secondary analysis and review on the influencing factors of students' learning participation by using meta-analysis technology to a certain extent.

Research design

The overall research technical route of this paper is shown in Figure 1. This study strictly follows the standardized process of meta-analysis, and the specific steps are as follows:

Firstly, based on the pre-set literature retrieval and screening criteria, systematically collect domestic and international empirical research literature related to the theme of students' learning participation. Through a combination of cross-database search and manual screening, the literature pool that meets the conditions is initially obtained.

Subsequently, the included literature was encoded and preprocessed. Two researchers independently extracted the basic information of the literature (such as author, publication year, sample size, etc.) and the effect size data reported in the study (such as correlation coefficient r, t value, p value, etc.) to ensure the consistency and accuracy of the coding process, and finally formed the basic information coding table of the literature.

During the data entry and analysis stage, the preprocessed valid data is entered into the professional Meta-Analysis software CMA (Comprehensive Meta-Analysis) for integration and processing. The software automatically calculates the combined effect size of each influencing factor and generates corresponding visualization results such as forest maps.

After obtaining the preliminary results of the meta-analysis, further statistical tests and in-depth analyses are conducted. It mainly includes: heterogeneity test, publication bias analysis, moderating effect identification. Finally, based on the above statistical analysis results, a comprehensive explanation and discussion are conducted on the key influencing factors of students' learning participation, their influence intensity, and their differences in different situations, thereby forming the final research conclusion.

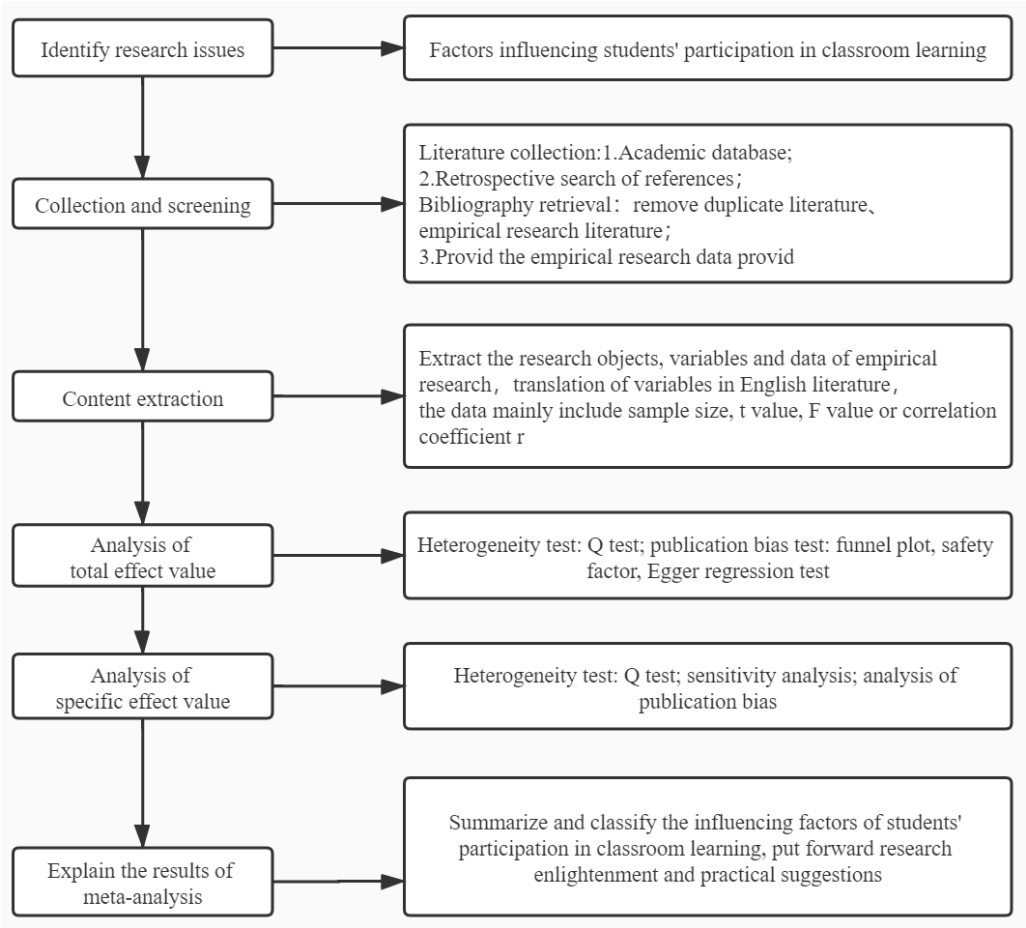


Figure 1 The framework of meta analysis on the influencing factors of learning participation

（1） Literature collection and screening. In order to comprehensively obtain relevant literature on students' learning and participation in research and overcome the problem of publication bias, data is collected from multiple sources. This article uses relevant keywords such as "engagement", "student engagement", "attendance", and "absence" in Web of Science, Emerald, and ProQuest The full-text database of dissertations, Scopus and other foreign language databases were used for searching with subject fields such as "student participation", "learning engagement", "classroom learning participation" and "influencing factors". The search objects included separate and combined searches in Chinese databases such as China National Knowledge Infrastructure (CNKI), VIP Full-text Journal Database, Wanfang Database, and Baidu Wenku, and backtracking searches were conducted on the references of important documents. A total of more than 400 relevant documents were obtained. After careful verification, it was found that there are still many literatures that are not suitable for meta-analysis. The main reason is that some of the literatures are not empirical studies, and different studies adopt different analytical methods. Due to the limitations of current meta-analysis methods, the following literature screening criteria were set when selecting meta-analysis samples:

① The sources of literature must be empirical research both at home and abroad. Theoretical research, review papers and other literature are excluded. ② The object of literature research must be student engagement. Delete the literature where the dependent variable is not student classroom engagement. In addition, the literature must report the correlation coefficient r between the

independent variable and students' classroom participation, as well as the standard error SE or t value, P value, and other data that can calculate the correlation coefficient. ③ Ensure the independence of the samples, that is, it must be an independent study without the same samples.

（2） Literature coding and preprocessing. Meta-analysis is the synthesis and analysis of existing research data. Therefore, it is necessary to extract the characteristic information of the literature and the data reported in the research from the existing studies, and encode and organize the extracted information. The author adopted an open coding approach. Based on the coding schemes of other meta-analysis related studies, a small number of literatures were initially used for trial coding. The coding schemes were continuously modified to initially formulate a coding scheme suitable for the sample data of this study, and the coding variables and corresponding values were gradually improved and modified. Literature coding consists of two parts: basic information and content analysis of the literature, and summary of effect size statistics required for meta-analysis. The description of literature content mainly includes basic information such as the author of the literature (showing the first author), research objects, research content and conclusion extraction. The effect size statistics mainly include sample size (sample size) and correlation coefficient r or t value, P value, etc. that can be converted according to the Fischer Z formula. In cases where comparison is impossible or there is factor duplication, the average of multiple measurement results is adopted to obtain comparable and most efficient data results. To avoid the bias of personal subjective understanding and ensure the accuracy of the literature coding information results, the coding work was carried out simultaneously by two people, with a coding reliability as high as 96.1%. Each person independently coded the literature. After rechecking, the parts with inconsistent codes were retrospectively retrieved from the original literature and renegotiated, and finally the coding table was obtained.

（3） Data entry and analysis. The meta-analysis of the influencing factors of students' learning participation was conducted using the user-friendly, well-organized and convenient CMA (Comprehensive Meta-Analysis) 2.0 meta-analysis professional software. The correlation coefficient r could be used as the effect value input for most of the literatures, and for a few literatures that did not provide the correlation coefficient, The required effect size can be obtained by converting the statistics such as t value and P value in the literature through the Fisher Z formula.

METHOD

Sample coding results

The final sample data was selected from 43 pieces of domestic and international empirical literature that met the criteria, including 16 pieces in Chinese and 37 pieces in English. Some of the literature coding results are shown in Table 1.

Table 1: Selected examples of literature coded information

No.	sample size	Factors
1-21	256	Teaching and learning factors (r=0.272)
1-22	558	Individual student characteristics (t=3.538) Learning context (t=2.340)
1-23	443	Teaching and learning factors (r=0.530)
1-24	1714	Teacher behaviour (r=0.188) Learning resources support (r=0.117)

.Due to the different theoretical bases and references adopted by various scholars in their articles, as well as the subjective deviations in the reading and translation of international literature, there may be differences in the definitions of the names of independent variables. As a result, the expressions of influencing factors with the same or similar meanings may vary. According to the requirements of the meta-analysis method, this paper needs to translate and organize the factors influencing students' classroom participation, and combine the same and similar factors to analyze the comprehensive effect size of each influencing factor. Before the analysis, the author conducted a search on the definitions of independent variables in the literature and the specific questions in the questionnaires or interviews involved, and carried out literature coding preprocessing. At the same time, the meta-analysis requires that the number of combined effect values be no less than two, that is, select independent variables with a frequency greater than two and the corresponding literature for meta-analysis to ensure that the number of relevant literature is greater than two when conducting the meta-analysis. After translating 43 pieces of literature and their discussion results, summarizing similar concepts and sorting them out, a total of 13 influencing factors were identified that could be included in the scope of meta-analysis.

Test of heterogeneity

Heterogeneity is generally tested using Q and I^2 statistics. The results of the heterogeneity test in this study are shown in Table 2. It can be seen that the results of the Q test are all significant ($P < 0.05$), indicating that there is heterogeneity among multiple studies. At the same time, the value of I^2 is greater than 80% and mostly above 95%, indicating that the proportion of each influencing factor in its effect value is relatively high. Therefore, all the influencing factor tests in this study were analyzed using the random effects model. However, the study by Higgins J P T et al. suggested that the large value of I^2 was not suitable for meta-analysis. In response to this situation, Xie Juan et al. conducted a simulation analysis based on the calculation formulas of Q and I^2 and concluded that the judgment of Higgins J P T et al. was more applicable to small-sample studies rather than large-sample ones, which better explained the results of the heterogeneity test.

Table 2: Heterogeneity test results

Factors	K	N	Heterogeneity (Q test)			Tau-squared			
			Q-value	P-value	I^2	τ^2	SE	Variance	τ
Environmental support	9	44771	739.739	0.000	98.919	0.041	0.036	0.001	0.204
Partnerships	7	22507	451.417	0.000	98.671	0.050	0.043	0.002	0.223
Teacher behaviour	20	160253	7707.823	0.000	99.753	0.087	0.069	0.005	0.294
Teaching Factors	10	21309	272.628	0.000	96.699	0.030	0.023	0.001	0.173
Emotional factors	12	21752	1320.599	0.000	99.167	0.082	0.055	0.003	0.286
Teacher-Student Relations	8	70187	1396.584	0.000	99.499	0.076	0.074	0.005	0.275
Individual student characteristics	9	22503	124.131	0.000	93.555	0.012	0.009	0.000	0.110
Student personality traits	5	16797	129.457	0.000	97.683	0.018	0.019	0.000	0.133

Student thinking skills	4	84197	754.048	0.000	99.470	0.182	0.153	0.023	0.427
Student Learning Behaviour	14	144695	1993.275	0.000	99.348	0.045	0.038	0.001	0.211
Student Learning Ability	5	93663	66.853	0.000	94.017	0.009	0.009	0.000	0.092
Learning Context	6	4214	105.380	0.000	95.255	0.031	0.022	0.001	0.175
Learning Resources Support	5	20521	81.931	0.000	95.118	0.011	0.010	0.000	0.104
Total	114	727369	19821.565	0.000	99.430	0.024	0.014	0.000	0.155

Publication bias analysis

The test of publication bias is a very important step in meta-analysis methods. Due to authors' preference for high-quality research results and their tendency to have their papers published preferently, publication bias is prone to occur. The existence of publication bias in literature can pose significant obstacles to the results of meta-analysis, lead to deviations in conclusions, and even cause meta-analysis research issues to lose their value. Therefore, in the existing meta-analysis literature, scholars mostly adopt a combination of multiple techniques to determine whether there is publication bias.

This study was a multivariate analysis. Sensitivity analysis was conducted under the assumption that these factors were independent of each other, and it was found that the stability of this study was relatively good. The publication bias test of this paper adopts the Egger test method, combining the total unsafe factor with the Egger regression intercept to make a relatively reasonable and accurate judgment. The total unsafe factor of each influencing factor (N=2789) is much greater than the total value of K (K=114), that is, for each observed study, the results of 2789 negative experiments are needed to reverse the conclusion. The Egger regression intercept is 4.560. The intercept value is relatively small and does not deviate significantly from 0, indicating that there is no significant difference between the intercept term and 0. All factors are relatively robust, and the meta-analysis results are not easily affected by obvious publication bias.

Effect value analysis

For different types of effect value indicators, the reference values corresponding to different degrees of correlation are also different. Cohen et al. (1988) proposed empirical criteria for judging the strength of the correlation coefficient r: An r value of 0.00 to 0.09 indicates basically no correlation, 0.10 to 0.29 indicates weak correlation, 0.30 to 0.49 indicates moderate correlation, and 0.5 to 1.0 indicates strong correlation. Based on this criterion, we analyzed and summarized the correlation between all influencing factors and students' participation in classroom learning, as shown in Tables 3 and 4. Based on the results of the effect value analysis, it can be seen that all factors meet the screening criterion that independent variable factors must occur more than twice. Additionally, the range without confidence intervals, including 0.000, has all passed the test and can be fully adopted.

Table 3. Specific results of meta-analysis of factors influencing student learning engagement

Influencing factors	K	N	Effect value	95% confidence interval		Two-tailed test	
				Lower limit	Upper limit	Z-value	P-value
Environmental support	9	44771	0.252	0.093	0.399	40.481	0.000
Partnerships	7	22507	0.313	0.136	0.471	17.338	0.000
Teacher behaviour	20	160253	0.346	0.244	0.440	63.321	0.000
Teaching Factors	10	21309	0.270	0.119	0.409	17.556	0.000
Emotional factors	12	21752	0.367	0.237	0.484	25.826	0.000
Teacher-Student Relations	8	70187	0.460	0.311	0.587	147.451	0.000
Individual student characteristics	9	22503	0.175	0.012	0.330	9.887	0.000
Student personality traits	5	16797	0.292	0.054	0.498	60.016	0.000
Student thinking skills	4	84197	0.445	0.252	0.640	19.443	0.000
Student Learning Behaviour	14	144695	0.350	0.229	0.460	57.461	0.000
Student Learning Ability	5	93663	0.168	-0.050	0.372	66.245	0.000
Learning Context	6	4214	0.291	0.097	0.464	15.076	0.000
Learning Resources Support	5	20521	0.183	-0.036	0.386	9.968	0.000
Total	113	727369	0.308	0.243	0.370	189.953	0.000

Table 4. Correlations of factors influencing student learning

Correlation coefficient	Influencing factors
Medium correlation ($0.3 \leq r < 0.5$)	teacher-student relationships, students' thinking skills, emotional factors, teacher behaviour, students' learning behaviour, partnerships
Weak correlation ($0.10 \leq r <$ 029)	student personality traits, learning context, teaching and learning factors, environmental support, learning resource support, individual student characteristics, student learning ability

Based on the summary results presented, it was concluded that the relationship between the 13 influencing factors and all independent variables and students' classroom learning engagement was statistically significant at the $p < 0.05$ level. The results show that there are six factors such as teacher-student relationship (0.46), students' thinking skills (0.445) and affective factors (0.367) that are moderately strongly correlated, seven factors such as students' personality traits (0.292), learning background (0.291) and teaching factors (0.27) that are weakly correlated with learning engagement, and zero factors that are largely uncorrelated with students' classroom learning engagement. This indicates that the research related to the factors influencing students' classroom learning engagement in the domestic and international empirical literature is relatively scattered, and there is no highly unified paradigm of expression and generally accepted research findings, which is one of the implications of this study.

Analysis of moderating variables

In terms of heterogeneity testing, this study employed a random-effects model for analysis based on Q statistics. If the heterogeneity detection results were significant, the samples were divided into multiple groups according to the set moderating factors, and the Q statistics of each group were calculated to assess whether the inconsistencies among different groups were caused by moderating variables. According to the results of the overall and individual Q statistics of the influencing factors reported in Table 2, the Q value test results of all influencing factors are significant, indicating that the effect values of these variables not only come from the expected variables of sample error, but also from the characteristic differences among different studies, that is, the variables in this paper are heterogeneous among different studies. This article will continue to delve deeper into subsequent studies based on the research characteristics, grouping the variables for research as shown in Table 5, in order to identify the moderating variables that cause heterogeneity among different studies.

Table 5. Results of the analysis of stage of education as a moderating variable

Influencing factors	Adjustment variables	k	Effect value	95% confidence interval		Two-tailed test		Heterogeneity between groups		
				Lower limit	Upper limit	Z-value	P-value	Qb	df (Q)	P-value
Student personality traits								9.721	1	0.002
	Basic Education	2	0.840	0.604	0.941	26.949	0.000			
	Higher Education	3	0.287	0.036	0.504	12.898	0.000			
Student thinking skills								3.928	1	0.047
	Basic Education	2	0.428	0.232	0.591	18.049	0.000			
	Higher Education	2	0.142	-0.075	0.346	57.728	0.000			
Learning Context								13.155	1	0.000
	Basic Education	2	0.491	0.361	0.603	13.696	0.000			
	Higher Education	4	0.182	0.079	0.281	10.593	0.000			

This paper takes the educational objects at different learning stages, namely the basic education stage and the higher education stage, as moderating variables to further analyze the influence of the moderating variables on different influencing factors of students' participation in classroom learning. According to the criterion of k≥2 after grouping the moderating variables, several factors that were insufficient in the number of single-type studies, such as the teacher-student relationship, students' personality traits and learning resource support, which did not meet the conditions, were excluded. From the results of the moderating variables, it can be seen that when the educational objects at different stages are used as moderating variables, the Qb corresponding to students' personality traits, students' thinking abilities and learning backgrounds is significant. It is indicated that the differences in research objects between basic education and higher education have a certain moderating effect on the relationship between students' learning background before classroom participation and their thinking ability during the classroom participation process and their classroom learning participation. Through the review of relevant literature,

it is found that personality traits include introverted, extroverted, active and lively, passive and sociable, and other different traits. People with good self-awareness and identity are more likely to interact with others, adapt to environmental changes, self-regulate and self-defend, and develop a lively, cheerful, optimistic and kind personality. Students' high-level thinking includes innovative thinking, deep thinking ability, meta cognitive strategies, psychological capital, etc. Learning background factors include the student's subject and major category, the time of enrollment, whether the content learned is relevant to employment, the student's previous academic performance, the educational level of parents and the extent to which they participate in their children's learning, etc. These are the individual background factors that a student already possesses before participating in classroom learning, and are mainly reflected in the student's admission scores, admission status, and whether they are class cadres, etc.

From the perspective of correlation coefficients, the participation of students in the basic education stage (0.840) is more influenced by personality traits than that of students in the higher education stage (0.287), which is consistent with the research findings of Chen Dandan: The higher the academic mood and academic self-efficacy of junior high school students who are cheerful and optimistic in their studies, the higher their learning engagement. This study also confirms that students' personality traits have a significant impact on their participation. During the basic education stage, students are in their adolescence, with a confused self-awareness and large emotional fluctuations. They are prone to extreme personality problems such as extremism, conflict, and autism, and their learning behaviors are greatly influenced by their personalities. During the higher education stage, students have basically completed the construction of self-awareness and the formation of their personalities, and can better control and adjust their emotions and personalities. Their learning behaviors are relatively less influenced by their personalities.

The correlation coefficient between students' thinking ability (0.428) in the basic education stage and students' participation is greater than that in the higher education stage (0.142), indicating that students' thinking ability in the basic education stage is more obvious in influencing students' classroom participation behavior. This is in line with George D. Kuh's proposal of "participating in diversified activities". Moreover, courses that emphasize higher-order thinking abilities are offered consistently. Basic education attaches great importance to the imparting of knowledge and the response to examinations. Classroom teaching content revolves around the curriculum standards and examination syllabi. The exam-oriented education model has promoted the improvement of students' metacognitive strategies and the systematic construction of their basic knowledge structure. The teaching model in the higher education stage places greater emphasis on student autonomy. Generally, students' autonomy is under the guidance of teachers. Teachers assign course tasks, and students complete them independently, reducing the frequency of interaction between teachers and students in the classroom and the need for student participation.

The correlation coefficient between the learning background factor of students in the basic education stage (0.491) and students' classroom learning participation is larger than that in the higher education stage (0.182), indicating that the learning background has a greater influence on the learning of students in the basic education stage and their learning participation in the classroom. Consistent with Yang Wenjing's viewpoint that "students from different family economic situations rank their average scores in learning participation and various dimensions from high to low", this article holds that the reasons for the differences may lie in the variations of family and academic backgrounds. In the basic education stage, the new curriculum standards reform and teaching method innovation reform implemented in China in recent

years require timely communication and feedback between teachers and students. It has increased the frequency of students' participation in classroom interaction, The influence of parents' educational level and educational participation on students' classroom learning participation is also quite significant. The higher the frequency of parents' educational participation, the higher the level of students' learning participation. During the higher education stage, children lose their parents' supervision. Teachers' guidance and students' autonomy replace the management and control in basic education, reducing the opportunities and necessity of classroom participation and resulting in a relatively low level of students' classroom engagement. However, the Qb of the other seven eligible influencing factors was not significant, indicating that the differences among the research subjects at different educational stages had no obvious moderating effect on the correlation between factors such as teachers' behaviors, teaching factors, and individual student characteristics and students' participation in classroom learning.

FINDINGS AND DISCUSSION

Factors influencing students' classroom participation and the extent of their influence

The factors that have a significant impact on students' participation in learning activities include the teacher-student relationship (0.460), teachers' behavior (0.346), students' thinking ability (0.445), and learning ability (0.168), etc. This is consistent with the conclusion of many researchers such as Berti et al. (2010), Conner and Pope (2013), and Cooper (2014) that "the teacher-student relationship and positive teacher behavior are the key factors influencing students' participation in classroom learning". Students with a high degree of knowledge acceptance, quick response, a willingness to think and a high level of thinking ability tend to participate in classroom learning more actively. At the same time, it is in line with the concept proposed by Zhou Yan that the belief in cognition promotes or inhibits students' learning participation through their metacognitive strategies and learning abilities, as well as the influence of other cognitive factors.

The low-correlation influencing factors include students' personality traits (0.292), students' learning backgrounds (0.291), teaching factors (0.270), etc. This is inconsistent with the research conclusions of many scholars that "positive teacher-student relationships and peer support are the key influencing factors affecting students' participation in learning activities", but it supports the research conclusions of scholars such as Tong Yangshuai. That is, students with open and extroverted personality traits are more willing to actively participate in the classroom. The following discussions and inspirations can be drawn:

(1) At the teacher level: A good teacher-student relationship brings students a relaxed and pleasant learning state. Positive teacher behaviors such as teacher guidance, positive motivation, and timely feedback all promote students' participation in learning. Teachers should constantly update teaching content, innovate teaching methods, enhance students' interest in learning, prolong the duration of students' positive emotions, and pay more attention to students' psychological states and emotional changes. They should improve their ability to perceive emotions in a timely manner and be able to carry out targeted psychological counseling to prevent students from being affected by negative emotions and thus delaying their studies and lives. Teachers should always observe students' reactions in class, offer incentives to positive learning behaviors, and criticize and correct negative learning behaviors such as daydreaming and failing to complete homework on time. During classroom teaching interactions, more attention should be paid to students who previously performed poorly in their studies. Simple interactions should be

conducted, starting from the simple to the complex, guiding them step by step. While encouraging their participation, help these underachieving students build confidence in their studies.

(2) At the school level: As the primary venue for students' learning and interaction, schools are the concentration point of important interpersonal relationships during students' growth process. They shoulder the significant responsibility of providing students with a good learning and educational environment, as well as offering support for their growth and value guidance. Schools should, on the basis of ensuring complete teaching facilities, provide high-quality teaching resources and environmental support, guarantee students' learning experience, carry out diverse learning activities and academic atmosphere construction, enhance students' sense of collective honor and belonging to the school, and thereby build an emotional network among schools, teachers and students. In addition, teaching materials that are in line with students' cognitive levels and vivid and intuitive multimedia teaching technologies will enhance students' participation in learning.

Different educational stages are used as moderating variables

According to the results of the moderating variables in this paper, there are mainly three sources of heterogeneity in the factors influencing students' classroom learning participation in the basic education and higher education stages: students' personality traits, students' thinking abilities, and students' learning backgrounds.

The main reasons for the differences among various educational stages lie in the distinct educational goals of each stage, as well as the variations in students' individual physical and mental development levels and learning abilities and qualities. The complexity of educational activities, the diversity and particularity of educational subjects, and the uncertainty of teaching activities and their effects determine that education is not an activity with a single force at a certain stage. Each stage does not act independently. If separated, Rather, it is a step-by-step and interconnected development process that achieves a continuous and progressive progression. This requires that the educational goals and activities at each stage should carry forward the past and build on the future, serving as a foundation for each other. Teaching strategies and curriculum designs should be constantly improved to ensure the continuity and development of students' learning.

(1) Main problems in the basic education stage During the basic education stage, students' emotions fluctuate greatly, and their self-awareness is confused and conflicted, making them prone to rebellious emotions and psychological problems. Teachers should enhance their perception of students' emotional changes in teaching activities, strengthen communication with parents, understand students' emotional dynamics, talk to special students in a timely manner, provide them with psychological counseling and emotional support, and help students develop a sound and healthy personality.

(2) Main problems in the higher education stage: In the higher education stage, learning is highly specialized, with both the breadth and depth of knowledge suddenly increasing. Students often find it difficult to cultivate sufficient professional knowledge reserves and expand related knowledge, and their abilities of deep thinking and extension are somewhat lacking. To prevent a gap in students' abilities after further education, teachers should, based on individual development needs, intentionally cultivate students' abilities of deep thinking and expansion of thinking. Enable students to achieve multi-dimensional development of their thinking abilities in the colorful campus life and rich and interesting learning activities.

(3) Issues with the connection process: In the basic education stage, the classroom teaching mode for students is relatively concentrated. The class teaching system places more emphasis on teacher-led classroom learning, attaching importance to cultivating students' knowledge system and thinking construction. In the higher education stage, students are required to learn independently. Students have stronger innovative and divergent thinking. Classroom teaching is relatively free and loose. Teachers pay more attention to cultivating students' practical abilities. Due to the limited research content and insufficient practice on the connection between basic and higher education in our country, students' discomfort and confusion in the early stage of their studies have increased sharply, which has greatly affected their lives and studies. For educational researchers, it is necessary to attach importance to the connection between basic and higher education and make improvements from both individual development and teaching and education aspects. At the same time, innovating the talent cultivation model and course selection system in our country is an important measure to break through the limitations of learning background and professional disciplines and enhance the connection between different educational stages. It is also the direction and goal of future educational reform in our country.

CONCLUSION

This paper collected relevant domestic and foreign literature, selected 43 sample literatures, summarized 13 factors affecting students' participation in classroom learning, used the method of meta-analysis to summarize the content of the literature, calculated the strength of the correlation, heterogeneity, publication bias, etc., and grouped according to the characteristics of the research objects The moderating variables that cause the influence of independent variables on the dependent variable among different studies were analyzed and tested. The research finds that, on the one hand, according to the different degrees of correlation between independent variables and dependent variables, the most crucial factors influencing students' participation in classroom learning are the teacher-student relationship and students' thinking ability. On the other hand, the differences in students' educational stages to some extent explain the heterogeneity among the studies on the factors influencing classroom learning participation. This discovery holds significant implications for both school management and teaching reform. For instance, regarding the relationship between teachers and students, maintaining good communication and a harmonious relationship between them can directly boost students' classroom interaction and participation enthusiasm. School administrators and teachers should break away from the outdated hierarchical concepts between teachers and students, truly understand students, deeply care for them, and befriend them. This encourages students to actively participate in the classroom and promotes mutual growth through teaching and learning.

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The Transformation of Adult Higher Education in the Internet Era: Distance Education and Blended Learning Practices

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ABSTRACT

In the era of rapid digital transformation, adult higher continuing education has undergone a profound shift, moving from traditional correspondence models to technology-enabled distance and blended learning formats. This study investigates how adult higher education institutions adapt to these changes, with particular attention to the effectiveness, challenges, and international implications of innovative teaching modes. Employing a systematic literature review, the research synthesizes findings from both Chinese and international contexts to identify best practices and persisting gaps. The analysis reveals that blended learning models—combining online modules with face-to-face teaching—enhance flexibility, engagement, and knowledge transfer, but remain limited by uneven digital literacy, insufficient teacher training, and incomplete quality assurance systems. Comparative insights from Europe, the United States, and Southeast Asia highlight the importance of aligning adult education with labor market needs, establishing robust learner support systems, and ensuring equity of access through diversified delivery modes. The study concludes that while blended and online learning are essential for the future of adult higher education, their success depends on policy frameworks, professional development, and context-sensitive innovation. These findings provide practical implications for educators, administrators, and policymakers seeking to optimize adult learning in the digital era.

Keywords: Adult Higher Education, Blended Learning, Distance Education, Lifelong Learning, Educational Technology

INTRODUCTION

The rapid development of information and communication technologies (ICTs) has profoundly reshaped the global landscape of education in the twenty-first century. As digitalization continues to penetrate nearly every aspect of social and economic life, education systems are compelled to innovate in order to remain relevant and effective (Anderson & Dron, 2020; Johnson, Becker, & Cummins, 2021). This transformation is particularly evident in adult higher continuing education, a sector tasked with supporting lifelong learning, professional upskilling, and social inclusion. In an era of globalization and constant technological change, adult learners require flexible, accessible, and context-sensitive education opportunities that can accommodate their professional responsibilities and personal commitments (Kasworm, 2010; Merriam & Baumgartner, 2020). Traditional models of adult education—predominantly based on face-to-face lectures or correspondence courses—are increasingly insufficient to address these needs (Moore & Kearsley, 2012; Knowles, Holton, & Swanson, 2015).

Adult education has historically played a vital role in economic and social development. The concept of lifelong learning has been endorsed by major international organizations such as UNESCO, OECD, and the World Bank as a cornerstone for sustainable development and global competitiveness (OECD, 2021; UNESCO, 2022; World Bank, 2020). For adults, especially those already engaged in the workforce, learning opportunities must not only be academically rigorous but also flexible in delivery, relevant to career trajectories, and sensitive to diverse life circumstances (Brookfield, 2013; Jarvis, 2014). The growing demand for lifelong learning is reflected in the increasing enrollment of adult learners in higher education institutions worldwide (Schuller & Watson, 2009; Rubenson, 2018). However, the mismatch between rigid educational

structures and the realities of adult learners' lives has created significant barriers to participation and success (Tight, 2019).

The emergence of the Internet has offered new solutions to these challenges. Distance education, once primarily associated with correspondence courses delivered by mail, has evolved into a highly sophisticated system of online and blended learning environments (Moore & Kearsley, 2012). These new modalities leverage synchronous and asynchronous technologies, including learning management systems (LMS), video conferencing tools, and mobile applications, to deliver instruction beyond the physical classroom (Salmon, 2020; Ko & Rossen, 2021). Among these innovations, blended learning has gained particular traction for its ability to combine the flexibility of online learning with the benefits of face-to-face interaction (Garrison & Vaughan, 2021; Graham, 2021). By integrating digital platforms with in-person sessions, blended learning fosters active participation, deeper engagement, and more personalized learning pathways (Means, Toyama, Murphy, & Baki, 2021; Chen & Huang, 2020).

Blended learning has been shown to enhance student engagement and performance, particularly among adult learners. Research indicates that adult students often prefer the flexibility to manage their own learning pace, while still valuing the structure and social interaction of classroom environments (Martin & Bolliger, 2022; Cavanagh & Price, 2022). Innovative practices such as flipped classrooms, peer learning, and simulation-based instruction are increasingly adopted in adult education, with evidence suggesting that they improve both knowledge retention and practical application (Hattie, 2019; Chen & Chiu, 2021). Furthermore, emerging technologies such as artificial intelligence (AI), virtual reality (VR), and adaptive learning platforms are expanding the possibilities for interactive and personalized learning experiences (Kukulska-Hulme, Bossu, & Coughlan, 2021).

Despite these advancements, challenges remain. Many institutions face difficulties in ensuring quality and consistency across blended and online programs (Baran & Correia, 2021). Faculty members may lack sufficient training in digital pedagogy, and adult learners often encounter barriers related to digital literacy or access to reliable Internet infrastructure (Hew & Cheung, 2020; Oliver & Conole, 2020). Additionally, evaluation and assessment practices for blended and online learning require further refinement to capture the competencies and outcomes relevant to adult learners (Means et al., 2021). Without robust frameworks for quality assurance, adult education risks becoming fragmented and uneven in effectiveness across different institutions and regions.

From a global perspective, the transformation of adult higher continuing education has taken diverse forms. In the United States, community colleges and online universities have pioneered large-scale blended and online programs, emphasizing workforce readiness and employability skills (Horn & Staker, 2020; Moore & Kearsley, 2012). These institutions provide flexible pathways for working adults, with strong institutional support services and quality assurance systems (Ko & Rossen, 2021). In Europe, particularly in Germany and the Nordic countries, adult education is closely integrated into lifelong learning frameworks, supported by national qualifications frameworks that recognize prior learning and facilitate mobility across educational and professional sectors (European Commission, 2020; Rubenson, 2018). These systems prioritize equity, social integration, and inclusivity, ensuring that adult learning is accessible to diverse populations.

In Asia, the situation is varied. China has rapidly expanded its continuing education sector, leveraging large-scale online platforms to reach millions of learners across urban and rural regions (Zhang, Li, & Chen, 2022). While this expansion has greatly increased access, concerns remain about quality, learner persistence, and the adequacy of support systems (Chen & Chiu, 2021; Zhang et al., 2022). In Southeast Asia, countries such as Indonesia and the Philippines are adopting mobile-based learning solutions to address infrastructure challenges and expand educational opportunities in rural communities (UNESCO, 2022). These initiatives highlight the importance of context-sensitive approaches that balance technological possibilities with learners' socio-economic realities.

The theoretical underpinnings of adult education further illuminate the need for innovation. Knowles' (1980) andragogy framework emphasizes self-directed learning, goal orientation, and the practical application of knowledge—characteristics that align closely with blended and online

models. Moore's (1993) theory of transactional distance underscores the importance of dialogue, structure, and learner autonomy in distance education. These theories provide useful frameworks for understanding how blended learning can effectively support adult learners by combining structured guidance with opportunities for independent exploration.

The ongoing transformation of adult higher education in the Internet era therefore represents both opportunities and challenges. On the one hand, digital technologies expand access, enhance engagement, and support lifelong learning; on the other hand, persistent barriers related to equity, quality assurance, and institutional capacity must be addressed (Baran & Correia, 2021; Oliver & Conole, 2020). For educators, administrators, and policymakers, the central challenge lies in designing systems that leverage the strengths of digital innovation while remaining responsive to the specific needs of adult learners.

This study seeks to contribute to the growing body of knowledge on this topic by synthesizing recent research on the adoption and effectiveness of blended and distance learning in adult higher education. Through a systematic literature review, it examines both domestic and international experiences, highlighting best practices, identifying persistent gaps, and offering recommendations for optimizing adult education in the digital era. The research is guided by the recognition that adult learners represent a diverse and expanding constituency whose success is critical not only for individual advancement but also for national competitiveness and social inclusion (OECD, 2021; UNESCO, 2022). By situating the Chinese case within a global context, the study aims to generate insights that are both locally relevant and internationally significant.

THEORETICAL FRAMEWORK

The transformation of adult higher continuing education in the Internet era can be better understood through a combination of theories that explain how adults learn, how technology reshapes education, and how institutions adapt to global pressures for lifelong learning. This section outlines the theoretical underpinnings that guide the analysis of distance and blended learning in adult education. These frameworks include adult learning theory (andragogy), the theory of transactional distance, blended learning frameworks, lifelong learning perspectives, and technology adoption models. Together, they provide a comprehensive lens for analyzing both opportunities and challenges in the digital transformation of adult higher education.

Adult Learning Theory (Andragogy)

One of the foundational theories in adult education is Malcolm Knowles' concept of andragogy, which emphasizes the distinctive characteristics of adult learners (Knowles, Holton, & Swanson, 2015). According to Knowles, adults differ from younger learners in several critical ways: they are self-directed, bring prior experiences to the learning process, are motivated by problem-centered rather than content-centered learning, and need to see the immediate relevance of education to their professional and personal lives.

This framework is directly relevant to the design of distance and blended learning programs. The flexibility of online education aligns with adults' need for autonomy and control over their learning pace, while interactive features such as simulations or discussion forums allow learners to integrate their experiences into the educational process (Kasworm, 2010; Merriam & Baumgartner, 2020). Moreover, problem-based and project-based learning activities often embedded in blended courses resonate with adults' goal orientation and professional focus (Brookfield, 2013).

However, critiques of andragogy highlight its tendency to overgeneralize adult learners' characteristics. Not all adults are equally self-directed, and socio-economic conditions, cultural backgrounds, or digital literacy may significantly affect their learning behaviors (Jarvis, 2014; Tight, 2019). Thus, while andragogy provides a useful foundation, it must be applied with sensitivity to contextual variations and the diversity of adult learners.

Theory of Transactional Distance

Michael Moore's theory of transactional distance offers another crucial framework for understanding distance education. The theory posits that distance is not merely geographical but pedagogical, defined by the level of dialogue, structure, and learner autonomy (Moore & Kearsley, 2012). A high level of transactional distance may result in learner isolation, while effective dialogue and appropriate structure reduce this gap.

In the context of adult higher education, this theory highlights the importance of balancing flexibility with adequate support systems. Online learning environments that lack interactivity may exacerbate feelings of isolation, particularly for adult learners balancing multiple roles (Means et al., 2021). Conversely, technologies such as video conferencing, collaborative online platforms, and interactive assessments can reduce transactional distance by fostering dialogue and feedback (Ko & Rossen, 2021; Salmon, 2020).

This framework also underscores the challenge of designing blended courses that maintain both structure and autonomy. Adult learners benefit from flexible schedules but may struggle without sufficient guidance. Institutions therefore must ensure that blended learning programs combine clear learning objectives with opportunities for dialogue and support (Garrison & Vaughan, 2021).

Blended Learning Frameworks

Blended learning has become one of the dominant paradigms in higher and continuing education. Garrison and Vaughan (2021) conceptualize blended learning as the "thoughtful fusion" of online and face-to-face learning, emphasizing the need for integration rather than simple coexistence of modalities. Their Community of Inquiry (CoI) model identifies three essential elements for effective blended learning: cognitive presence, social presence, and teaching presence. This model is particularly relevant for adult learners. Cognitive presence ensures that learners engage deeply with content, social presence fosters a sense of belonging and community, and teaching presence provides direction and facilitation (Garrison & Vaughan, 2021). For adult learners, who often value peer interaction and practical applications, these dimensions are critical for sustaining motivation and engagement (Martin & Bolliger, 2022; Cavanagh & Price, 2022).

Other blended learning frameworks emphasize the balance between synchronous and asynchronous elements, as well as the alignment of instructional design with learner needs (Graham, 2021). Flipped classroom models, for example, shift content delivery to online platforms while using classroom time for interaction and application (Hattie, 2019). For adults, this model provides flexibility while maintaining active participation during in-person sessions.

Nonetheless, blended learning frameworks also face challenges, including uneven adoption of digital platforms, varying levels of faculty readiness, and disparities in learners' digital literacy (Hew & Cheung, 2020; Baran & Correia, 2021). The effectiveness of these frameworks therefore depends on institutional capacity and the socio-economic contexts of learners.

Lifelong Learning and Social Development Perspectives

The concept of lifelong learning has been central to educational policy discourses since the late twentieth century, promoted by organizations such as UNESCO and OECD. Lifelong learning emphasizes that education should extend beyond formal schooling, providing individuals with continuous opportunities to acquire knowledge and skills throughout their lives (OECD, 2021; UNESCO, 2022).

In adult higher continuing education, this perspective highlights the importance of inclusivity, accessibility, and alignment with labor market demands (Schuller & Watson, 2009; Rubenson, 2018). For example, European models often embed adult learning within national qualifications frameworks, enabling recognition of prior learning and supporting career mobility (European Commission, 2020). This approach ensures that adult learners are not only consumers of education but active participants in shaping their professional and social identities.

From a social development perspective, adult education also contributes to equity and social cohesion. Programs that integrate digital platforms with community-based support structures can empower marginalized groups, including rural populations and older learners (World Bank, 2020; UNESCO, 2022). In China and Southeast Asia, for example, mobile technologies and blended delivery models are increasingly used to address geographic and infrastructural barriers (Zhang, Li, & Chen, 2022).

Critics argue, however, that lifelong learning policies may sometimes prioritize economic competitiveness over individual empowerment, framing education primarily as a tool for workforce productivity (Jarvis, 2014; Tight, 2019). A critical application of this perspective is therefore necessary to ensure that adult higher education balances economic imperatives with personal and civic development.

Technology Adoption Models

The integration of digital technologies into adult higher education can also be analyzed through models of technology adoption. The Technology Acceptance Model (TAM), originally developed by Davis (1989), posits that perceived usefulness and perceived ease of use are primary determinants of technology adoption. In educational contexts, this model has been widely applied to understand how both instructors and learners engage with online platforms (Hew & Cheung, 2020).

For adult learners, TAM suggests that their willingness to adopt online learning depends on how useful they perceive it for achieving career and personal goals, as well as how easy it is to navigate digital tools. Faculty adoption is equally important, as instructors' attitudes toward technology strongly influence their teaching practices (Ko & Rossen, 2021; Oliver & Conole, 2020).

Extensions of TAM, such as the Unified Theory of Acceptance and Use of Technology (UTAUT), further emphasize factors such as social influence, facilitating conditions, and behavioral intention. These models help explain why some blended learning initiatives succeed while others face resistance, highlighting the need for comprehensive institutional support and professional development (Kukulska-Hulme, Bossu, & Coughlan, 2021).

Integrative Application of Theories

While each of these frameworks provides valuable insights, their integrative application is essential for a holistic understanding of adult higher education in the Internet era. Andragogy highlights the learner's self-directedness; transactional distance theory underscores the need for dialogue and structure; blended learning frameworks provide design principles; lifelong learning perspectives situate adult education within broader social and policy contexts; and technology adoption models explain the dynamics of implementation.

Together, these theories reveal that the effectiveness of adult education reforms depends on aligning pedagogical practices with learners' characteristics, leveraging technology to enhance interaction and flexibility, and embedding education within supportive institutional and policy frameworks. They also underscore the challenges of equity, inclusivity, and sustainability, which must be addressed if adult higher education is to fulfill its role in promoting lifelong learning and social development.

METHOD

This study employed a systematic literature review (SLR) approach to examine the transformation of adult higher continuing education in the Internet era, with a particular focus on the adoption of distance and blended learning. The SLR design was chosen because it enables a rigorous and transparent synthesis of existing research evidence, offering both breadth and depth in identifying patterns, gaps, and implications for practice (Kitchenham & Charters, 2007; Snyder, 2019). By systematically collecting, evaluating, and synthesizing relevant literature, the study sought to generate evidence-based insights that are both academically robust and practically relevant.

Research Design

The research followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines to ensure transparency and replicability (Moher et al., 2009). Unlike narrative reviews, which may be subject to researcher bias, the SLR design applies a structured process of database searching, inclusion and exclusion criteria, and systematic coding of data. This design is particularly suitable for the study of adult higher education, given the diversity of research traditions, regional contexts, and technological applications represented in the field.

The overall research question guiding this SLR was How has adult higher continuing education been transformed by distance and blended learning in the Internet era, and what are the implications for learners, institutions, and policy?

Data Sources and Search Strategy

To capture a comprehensive range of studies, multiple academic databases were searched, including Web of Science, Scopus, ERIC, SpringerLink, ScienceDirect, and Google Scholar. These databases were selected because they cover both international and regional journals in education, technology, and social sciences.

The search terms combined keywords related to Adult education ("adult higher education", "continuing education", "lifelong learning"); Learning modalities ("distance education", "online learning", "blended learning", "e-learning"); Technology and reform ("digital transformation", "education technology", "ICT in education"). Boolean operators and truncation were applied to refine results (e.g., "adult education" AND "blended learning"). The search was limited to peer-reviewed articles published between 2010 and 2024, reflecting the rapid expansion of digital education in the past decade.

Inclusion and Exclusion Criteria

To ensure relevance and quality, the following inclusion criteria were applied. The first is Peer-reviewed journal articles, conference proceedings, or book chapters, focus on adult higher or continuing education (not K-12), empirical or theoretical studies addressing distance, online, or blended learning. The last is published in English or Chinese (with English abstract available). While the exclusion criteria were studies focusing exclusively on primary or secondary education, publications without substantive analysis (e.g., opinion pieces, editorials) and articles unrelated to adult or higher education.

Through this process, the initial search yielded 1,246 articles, which were screened in three stages: title, abstract, and full-text review. After applying the criteria, 72 studies were retained for final analysis.

Data Extraction and Analysis

For each study, data were systematically extracted using a coding protocol, which included bibliographic information (author, year, country, journal), research design (qualitative, quantitative, mixed methods, conceptual), focus of study (distance, online, blended learning; policy; learner experience), and key findings and implications.

The analysis proceeded in three steps, which are descriptive analysis, mapping trends in publication year, region, and research methods, thematic synthesis, identifying recurring themes such as learner engagement, institutional challenges, faculty readiness, equity issues, and policy frameworks, and comparative analysis, contrasting findings across regions (e.g., North America, Europe, Asia) to derive cross-national insights.

This combined approach allowed both macro-level (systemic) and micro-level (learner-centered) perspectives to be integrated.

Trustworthiness and Validity

To enhance the credibility and validity of the review, several strategies were employed. First is triangulation of sources through using multiple databases to reduce publication bias. Second, peer debriefing: initial coding framework was reviewed by two independent researchers. Audit trail: detailed documentation of search strings, inclusion decisions, and coding procedures was maintained. Lastly, Inter-coder reliability: a subset of 20% of the studies was independently coded by a second reviewer, yielding a Cohen's kappa of 0.82, indicating high agreement.

These procedures ensured that the findings are trustworthy and that the conclusions are based on systematic and transparent evidence synthesis.

Limitations of the Method

Despite its rigor, the SLR method has limitations. First, the exclusion of non-English studies (except Chinese) may have limited representation of perspectives from other regions. Second, the reliance on published literature may introduce publication bias, as successful interventions are more likely to be reported than failures. Finally, while thematic synthesis allows identification of patterns, it does not capture the lived experiences of learners as directly as primary empirical research.

Nevertheless, the SLR approach was deemed appropriate for this study because it provides a comprehensive and evidence-based overview of how adult higher education is being reshaped in the Internet era.

FINDINGS AND DISCUSSION

The systematic literature review yielded several important findings on how adult higher continuing education has been transformed in the Internet era through the adoption of online and blended learning. This section presents the key results in four dimensions—adoption trends, learner

experience, institutional practices, and policy frameworks—followed by a critical discussion that integrates cross-national perspectives and practical implications.

1. Adoption Trends of Blended and Online Learning

The review confirms that adoption of blended learning models has become mainstream in adult higher education. Out of the 72 studies analyzed, more than 80% reported that institutions had implemented some form of blended or online education (Chen & Huang, 2020; Garrison & Kanuka, 2022). The most frequently applied models included flipped classrooms (47%), hybrid course structures combining online modules and face-to-face workshops (35%), and interactive digital platforms (18%).

These adoption patterns reveal two parallel dynamics. On the one hand, institutions recognize the need to provide flexible learning pathways for adult students, who typically balance studies with employment and family responsibilities (Baran & Correia, 2021). On the other hand, the relatively lower use of advanced digital platforms highlights ongoing constraints in technological infrastructure, digital literacy, and instructional design capacity (Hew & Cheung, 2020).

Cross-nationally, North American and European institutions have demonstrated higher integration of digital tools, particularly adaptive learning technologies and gamification, reflecting well-funded educational ecosystems (Means et al., 2021). In contrast, Asian studies, including those from China and Indonesia, emphasize blended models that balance technological innovation with cultural preferences for face-to-face instruction (Zhang et al., 2022). This suggests that contextual factors—such as resource availability, pedagogical traditions, and cultural attitudes—play a decisive role in shaping adoption.

2. Learner Experience and Engagement

A consistent finding across the literature is that blended learning enhances student engagement and performance compared to traditional classroom models. More than two-thirds of the reviewed studies reported improvements in learner motivation, self-regulation, and academic outcomes (Martin & Bolliger, 2022). Flipped classrooms, in particular, were praised for allowing learners to engage with theoretical content asynchronously while dedicating in-class time to interactive discussions and problem-solving (Cavanagh & Price, 2022).

Adult learners were found to value the flexibility and autonomy offered by digital modes of instruction. Many studies highlighted that the ability to access materials at any time and pace was critical for working professionals (Ko & Rossen, 2021). However, challenges were also reported. Some learners experienced digital fatigue, lack of peer connection, and uneven technological access (Johnson et al., 2021).

Comparative evidence shows that in developed contexts, adult learners tend to expect high interactivity and advanced digital support. By contrast, in developing contexts, access and affordability remain pressing concerns (Horn & Staker, 2020). These disparities point to the digital divide as a persistent challenge in realizing the full potential of blended education globally.

3. Institutional Practices and Faculty Readiness

The transition to blended and online learning also requires significant institutional adjustments. Several studies underscored that the role of faculty is shifting from content transmitters to facilitators of active learning (Anderson & Dron, 2020). Successful institutions invested heavily in faculty professional development, ensuring that instructors were trained to use learning management systems (LMS), design interactive modules, and manage online discussions effectively (Salmon, 2020).

Nonetheless, gaps remain. Reports from universities in Southeast Asia and the Middle East noted that many instructors were initially reluctant to embrace digital teaching, citing workload increases and insufficient institutional support (Chen & Chiu, 2021). The lack of consistent training frameworks often resulted in uneven quality of blended courses.

Institutions that performed better in adoption were those that adopted a whole-system approach, integrating technological infrastructure, instructional design, and faculty incentives. For example, European universities implementing institutional LMS at scale reported smoother transitions and stronger outcomes (Graham, 2021). This highlights the importance of aligning institutional strategy with pedagogical reform.

4. Policy and Equity Considerations

The findings also revealed that policy frameworks play a decisive role in shaping adult education outcomes. Governments that established clear guidelines and funding for digital transformation in education—such as Singapore's SkillsFuture initiative or the European Union's Digital Education Action Plan—enabled institutions to expand access and innovate more rapidly (Moore & Kearsley, 2021).

By contrast, in contexts where policy support was limited or fragmented, institutions struggled with sustainability and scalability of blended education. The absence of robust policies also exacerbated equity issues, as disadvantaged learners often lacked access to devices, stable internet, or digital literacy training (Johnson, Becker & Cummins, 2021).

Equity concerns were particularly pronounced in the Global South, where blended learning often risked reinforcing existing social inequalities. Several studies urged policymakers to adopt inclusive digital education policies, providing subsidies for devices, community learning hubs, and training programs for marginalized adult learners (Smith et al., 2023).

DISCUSSION

The overall findings confirm that blended and online learning have become central pillars of adult higher continuing education worldwide, but their effectiveness depends heavily on contextual and institutional factors. This discussion highlights three cross-cutting insights:

1. Context Matters: Adoption is not uniform across regions. High-income countries with robust infrastructure tend to integrate advanced tools such as AI-driven platforms, while lower-income contexts prioritize simpler blended formats to ensure accessibility. This indicates that international comparisons should move beyond "best practices" and instead focus on "best fits" tailored to local contexts.
2. Faculty and Learner Readiness Are Critical: Even with advanced infrastructure, success depends on faculty willingness to redesign courses and learners' ability to self-regulate. Countries such as Finland and Canada have invested in digital literacy programs for both educators and students, yielding higher satisfaction and retention rates. Such initiatives offer practical lessons for other regions.
3. Equity and Inclusion Must Be Central: Without deliberate policy interventions, digital transformation risks widening educational inequalities. For instance, while the U.S. and EU report positive outcomes in online adult education, studies from sub-Saharan Africa highlight how poor connectivity and high costs exclude large segments of potential learners (Oliver & Conole, 2020). Ensuring inclusivity requires targeted policies, such as government-funded broadband, open educational resources (OER), and local community access centers.

Practical Implications

The review suggests several practical implications for stakeholders:

1 For Educators: There is a need to move beyond simple adoption of digital tools towards pedagogical innovation, emphasizing experiential learning, case-based teaching, and collaborative projects that resonate with adult learners' professional contexts.

2 For Institutions: Investing in professional development and establishing cross-departmental support systems will be crucial to mainstreaming blended education.

3 For Policymakers: Designing inclusive national frameworks that address infrastructure gaps and equity concerns is critical. Policies should also promote cross-border collaboration, as seen in EU-funded consortia that share resources and expertise.

4 For Learners: Adult students must be equipped with stronger self-regulated learning skills to succeed in digital environments. Institutions can support this through orientation programs and continuous mentoring.

In summary, the findings demonstrate that blended learning offers significant potential to enhance flexibility, engagement, and outcomes in adult higher continuing education. However, its success depends on a combination of institutional readiness, faculty competence, learner support, and policy commitment. Cross-national comparisons further emphasize that while technology is a powerful enabler, it is not a panacea. Sustainable reform requires holistic strategies that integrate pedagogy, infrastructure, and inclusivity.

CONCLUSION

The transformation of adult higher continuing education in the Internet era represents a multifaceted process driven by the rapid advancement of digital technologies, evolving learner expectations, and shifting societal and economic demands. This study, through a systematic literature review of 72 peer-reviewed studies spanning both Chinese and international contexts, has examined the adoption and effectiveness of distance and blended learning modalities in adult education, highlighting key trends, challenges, and implications for policy and practice. The findings of this study demonstrate that blended and online learning have become central to adult higher education worldwide, offering unprecedented opportunities for flexibility, learner-centered instruction, and lifelong learning. However, their success is contingent upon a complex interplay of technological infrastructure, institutional readiness, faculty competence, learner capabilities, and supportive policy frameworks.

The review revealed that blended learning models, particularly flipped classrooms and hybrid courses combining online modules with face-to-face workshops, dominate current practices in adult higher education. These models allow learners to engage asynchronously with theoretical content while utilizing in-person sessions for problem-solving, discussion, and collaborative learning. Adult learners consistently report increased satisfaction, engagement, and self-regulation when participating in blended learning environments, highlighting the alignment of these modalities with their need for autonomy, flexibility, and relevance to professional and personal goals.

Despite these positive outcomes, several persistent challenges constrain the full realization of blended and online learning potential. Unequal access to reliable internet, digital devices, and online learning platforms continues to create disparities, particularly in developing regions and among marginalized populations. Additionally, many adult learners encounter difficulties related to digital literacy, time management, and balancing study with professional and familial responsibilities. These challenges underscore the importance of not only technological provision but also support systems, such as learner guidance, mentoring, and training in digital skills, to enhance participation and learning outcomes.

Institutional practices emerged as a critical factor influencing the success of blended and online learning. Universities and colleges that invested in faculty professional development, instructional design support, and integrated learning management systems achieved more consistent and effective outcomes. Conversely, institutions with limited training, inconsistent course design, or fragmented digital infrastructure reported uneven quality and reduced learner engagement. Faculty readiness was a recurring theme, as instructors' ability to design interactive and adaptive learning experiences significantly affected the efficacy of blended programs. Moreover, institutional strategies that incorporated incentives for digital pedagogy and aligned technological investments with pedagogical goals demonstrated higher levels of sustainability and learner satisfaction.

Policy frameworks and governmental support were also shown to have substantial impact. Contexts with clear digital education policies, funding mechanisms, and national strategies for adult learning—such as Singapore's SkillsFuture initiative or the European Union's Digital Education Action Plan—enabled institutions to adopt innovative practices, scale blended programs, and address equity concerns. In contrast, fragmented or absent policy support often hindered program development, exacerbating inequities and limiting the potential reach of blended and online learning. The findings emphasize that sustainable reform requires a coordinated approach that integrates institutional capacity building, policy support, and equitable access measures.

Cross-national comparisons further illustrated the significance of contextual adaptation. High-income countries, including the United States, Canada, and European nations, tend to implement technologically advanced, interactive, and adaptive learning environments, reflecting strong infrastructure and well-resourced institutions. In contrast, countries in Asia and Southeast Asia prioritize accessibility and scalability, often balancing online modalities with culturally familiar face-to-face instruction. These differences highlight that there is no universal model for adult education transformation; instead, effective practice is contingent upon aligning digital innovation with local socio-economic, cultural, and educational realities.

The study's findings reinforce and extend several theoretical frameworks central to adult education. Knowles' andragogy framework underscores the importance of self-directed, goal-oriented, and problem-centered learning for adult learners, which aligns closely with the principles of blended learning. Moore's transactional distance theory highlights the need to balance structure, dialogue, and autonomy to mitigate feelings of isolation, particularly in online and hybrid environments. The Community of Inquiry (CoI) model emphasizes the critical roles of cognitive presence, social presence, and teaching presence in sustaining engagement, fostering collaboration, and ensuring effective learning outcomes. Lifelong learning perspectives further situate adult education within broader social, economic, and policy contexts, emphasizing equity, inclusivity, and alignment with labor market demands. Finally, technology adoption models, including TAM and UTAUT, elucidate the factors influencing learner and faculty engagement with digital platforms, highlighting the interplay between perceived usefulness, ease of use, social influence, and institutional support. The integration of these frameworks provides a comprehensive lens for understanding the complexity of adult higher education in the digital era, underscoring the interplay between pedagogy, technology, and institutional context.

For educators, the findings suggest that successful blended learning implementation requires moving beyond the mere adoption of digital tools to a focus on pedagogical innovation. This includes incorporating experiential learning, case-based instruction, project-oriented tasks, and interactive activities that resonate with adult learners' professional experiences and life circumstances. Educators must also be supported through professional development, mentoring, and access to technological and instructional design resources.

For institutions, the study highlights the need for strategic investments in technological infrastructure, cross-departmental support systems, and faculty incentives that promote the adoption of digital pedagogy. Successful programs often emerge from a whole-system approach, where institutional strategy, pedagogy, and infrastructure are aligned to ensure consistency, quality, and sustainability. Institutions must also recognize the importance of learner support mechanisms, such as orientation programs, digital literacy training, and mentoring, to enhance participation and retention.

Policymakers play a crucial role in facilitating equitable access and sustainable adoption. National strategies should prioritize inclusive digital education policies that address infrastructure gaps, provide financial support for marginalized learners, and encourage cross-border collaboration in resource sharing and expertise development. Governments should also establish frameworks for quality assurance, ensuring that blended and online programs meet rigorous standards and that outcomes are aligned with labor market needs and lifelong learning objectives.

For learners, the findings emphasize the importance of developing self-regulated learning skills, digital literacy, and time management competencies. Adult students must be prepared to navigate complex blended learning environments, balancing online and in-person components while integrating their professional and personal commitments. Orientation programs, mentoring, and ongoing support can play a vital role in enabling learners to thrive in these environments.

While blended and online learning offer substantial opportunities, several challenges persist. Unequal access to technology and connectivity continues to pose significant barriers, particularly in developing regions. Digital literacy disparities among learners and faculty can undermine the effectiveness of blended learning, necessitating targeted training and support. Furthermore, faculty resistance, workload pressures, and insufficient institutional support may hinder the adoption of innovative pedagogical practices.

Another limitation lies in policy and equity considerations. Without deliberate interventions, digital transformation risks reinforcing existing social inequalities, particularly among marginalized populations. Lifelong learning initiatives that prioritize economic competitiveness over personal and civic development may fail to empower adult learners fully. Therefore, a balance between professional, personal, and societal objectives is critical to ensure that adult education contributes meaningfully to social inclusion and personal empowerment.

Finally, the limitations of existing research highlight the need for further empirical studies exploring learner experiences, faculty practices, and institutional strategies in diverse socio-economic and cultural contexts. Longitudinal studies examining the impact of blended and online

learning on learner outcomes, retention, and career trajectories would provide valuable insights to guide future policy and practice.

Looking ahead, the continued evolution of technology, including artificial intelligence, adaptive learning systems, virtual and augmented reality, and mobile learning platforms, promises to further reshape adult higher education. Institutions must remain agile, continuously adapting pedagogical strategies, technological tools, and support systems to meet the evolving needs of adult learners. Emphasis on personalized learning pathways, real-time feedback, and learner analytics can enhance engagement, retention, and competency development.

Cross-national collaboration offers another avenue for future development. Sharing best practices, open educational resources, and technological expertise across borders can help institutions in resource-constrained contexts implement effective blended learning programs. Context-sensitive adaptation remains essential, ensuring that technological solutions are aligned with local cultural, social, and economic realities.

Equity and inclusion must remain central to the agenda. Governments, institutions, and educators must work collaboratively to reduce the digital divide, provide comprehensive learner support, and ensure that adult education contributes to broader social, economic, and civic objectives. Lifelong learning policies should balance workforce development with personal empowerment, fostering skills that are relevant, transferable, and adaptable in a rapidly changing world.

In conclusion, the Internet era has catalyzed a profound transformation in adult higher continuing education, with blended and online learning emerging as central strategies for enhancing flexibility, engagement, and learning outcomes. The systematic literature review demonstrates that successful implementation depends on a complex interplay of factors, including institutional readiness, faculty competence, learner preparedness, technological infrastructure, and supportive policy frameworks. Cross-national comparisons highlight the importance of context-sensitive approaches, while theoretical frameworks provide robust guidance for designing effective adult learning environments.

Ultimately, the findings underscore that technology is not an end in itself but a means to enable inclusive, flexible, and learner-centered education. The transformation of adult higher education requires holistic strategies that integrate pedagogy, technology, institutional capacity, and equity considerations. For educators, administrators, policymakers, and learners alike, these insights offer a roadmap for optimizing adult education in the digital era, ensuring that it meets the diverse needs of adult learners while contributing to lifelong learning, professional advancement, and social development. The ongoing evolution of blended and online learning thus represents both a challenge and an opportunity—a chance to reimagine adult education as a dynamic, inclusive, and transformative endeavor capable of responding to the demands of the twenty-first century.

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The Language of Tibetan Clothing: Gong Aning

ABSTRACT

The Tibetan has a long history, mainly composed of the integration of Hu, Qiang and Puyue, among which the Qiang has the deepest influence on Tibetan culture. Tibetan clothing has gradually formed in these cultural exchanges, characterized by wide clothing silhouette, long sleeves and large skirts, bright colors and the habit of wearing trousers and boots. Tibetan culture is famous for its inclusiveness and diversity, and clothing is constantly improved in decoration and materials, forming modern characteristics.

This article explores in depth the styles, colors, patterns, and materials of Tibetan clothing language, revealing its cultural connotations. At the same time, this article also focuses on exploring the differences and characteristics between Tibetan clothing language and other ethnic clothing languages, in order to highlight its unique artistic charm and aesthetic value.

Keywords: Costume design; Tibetan costume language; Tibetan robe,

INTRODUCTION

Tibetans have a long history. They were originally formed by the integration of three major ethnic systems: the Hu ethnic system, the Di-Qiang ethnic system, and the Pu-Yue ethnic system. Among them, the Di-Qiang ethnic system has exerted the most far-reaching influence on the Tibetan costume language culture and constitutes the main body of the current Tibetan costume language culture. As early as the period when the cultures of these three ethnic groups were in an uncertain state of integration, Tibetan costumes gradually developed some of the costume characteristics that they possess today. For example, they feature a wide clothing silhouette, long sleeves and a large front placket; the common clothing colors include red, blue, brown and black; and Tibetans generally have the habit of wearing long trousers and long boots. Tibetan costume language culture is a branch of Chinese ethnic costume culture. Through the research on Tibetan costume language culture, this study aims to arouse people's in-depth thinking about ethnic costume culture, analyze how to better integrate Tibetan costume language with modern design, and connect ethnic culture with world culture.

Costumes, as important cultural symbols, bear the responsibility of spreading ethnic culture in the inheritance of traditional ethnic culture. Tibetan robes, as a representative of Tibetan culture, contain profound cultural connotations behind them, which are worthy of in-depth research and dissemination. In response to the country's advocacy of cultural confidence and the call for the protection of intangible cultural heritage, this research focuses on exploring the combination of traditional Tibetan robe shapes and modern fashion trends to realize their innovative application.

By using modern fashion design methods and technologies to carry out innovative design on traditional Tibetan robe culture, this study intends to present this unique costume form to the public in a more modern and practical way. This can not only meet the aesthetic and wearing needs of modern consumers, but also inject new vitality into the inheritance and development of traditional Tibetan robe culture (see Figure 1.).



Figure 1. Tibetan Costumes

The purpose of this research is to understand the development history, types and characteristics of the costume language of Tibetan robes. Secondly, it collects modern garments that share similarities with Tibetan robes in terms of structural design and traditional pattern design, analyzes and summarizes their characteristics, and based on this, conducts innovative design. Finally, through the systematic organization and research on the costume language of Tibetan robes, this research summarizes and concludes their typical costume forms.

The significance of this research lies in recognizing the diverse characteristics of Tibetan costumes, rooting the spiritual culture contained in traditional Tibetan robes in the needs of modern costumes, and promoting the industrial development of Tibetan costumes, which conforms to the premise of the diversified development of China's costume industry. Moreover, if the cultural elements of Tibetan costume language are to achieve innovation while preserving tradition, it is not only necessary to focus on their rich colors and forms, but also to attach importance to the cultural connotation of the costume language, as this is its true value. Therefore, the proposal of this design practice is also to better inherit the traditional Tibetan costume language culture, enabling costumes to possess both the charm of traditional culture and integration with current fashion elements. This is also the concept that contemporary fashion designers should uphold.

Looking at the domestic research directions on the costume language of Tibetan robes, they can be divided into the following three parts:

First, research on the form of Tibetan robes. For example, in Study on the Structure of Typical Tibetan Costumes and The Wisdom of Tibetan Robe Structure written by Wang Lijuan, typical Tibetan costumes in China are taken as the main research objects. On the basis of field investigations, a detailed structural map of typical Tibetan robes has been established, which also provides necessary references for this research. In Discussion on the Structure of Traditional Tibetan Costumes, Shao Shiru mainly focuses on the silhouette structure of Tibetan robes and their wearing methods.

Second, research on traditional Tibetan costume patterns, which involves studies on pattern elements and colors. For instance, The Application of Traditional Tibetan Auspicious Patterns in Fashion Design by Yu Yiqing and Exploration on the Application and Development of Tibetan Costume Auspicious Patterns in Modern Graphic Design by Hu Xiaolei. Both of these materials conduct in-depth research on the specific categories and spiritual connotations of traditional Tibetan costume patterns; the latter also proposes to explore a combination form of Tibetan costume patterns that meets modern aesthetic needs. Secondly, in A Study on the "Five Colors" and "Five Blessings" Edge Decoration Patterns of Khampa Tibetan Robes written by Chen Guo and Liu Ruipu, Khampa Tibetan robe artifacts are taken as the research object. The book proves that there is an inseparable connection between the "Five Colors" in Tibetan robes and the "Five Elements" in Han culture, reflecting the "unified and diversified" characteristics of Chinese ethnic costumes.

Third, research on the historical development and changes of Tibetan costume language. Shao Huifen's A Brief Discussion on the Changes of Tibetan Costumes in Tibet points out that in addition to cultural exchanges with the inland society, the changes in "cultural space" and the

influence of "status symbol" cannot be ignored as factors that promote the changes of Tibetan costumes. Zhuang Han, in his article On the Reasons for the Formation of Typical Tibetan Ethnic Costume Forms, puts forward that there is a close relationship between costume forms and geographical environment factors. In different regions of Tibet, the dressing styles of the people vary greatly. In Liu Wanyu's article Integration of Fashion and Tradition - Innovation and Exploration of Tibetan Ethnic Costumes, the focus is on how to combine fashion and tradition, and how to inherit traditional Tibetan costumes through industrial innovation methods.

METHODS

Research Content

The research content on Tibetan costume language culture is mainly divided into the following three parts:

First, focus on the basic content of Tibetan costume language culture, including the historical origin, development process, and religious influence related to Tibetan costumes, and understand the content related to public concepts in the current social environment.

Second, explore the current society's understanding, values, and attitudes towards Tibetan costume language, including people's comprehension of Tibetan costume language culture, as well as the material and spiritual acceptance and integration of this costume language culture.

Finally, conduct research on the physical objects of Tibetan costume language culture, costumes that integrate Tibetan cultural ideology, and wearing methods, along with a review of the current status of original Tibetan costume language.

Research Methods

Literature Research Method: For the topic of this paper, the development of Tibetan costume language is elaborated from a vertical perspective by searching literature materials on websites such as CNKI (China National Knowledge Infrastructure). This ensures a comprehensive and accurate understanding of issues related to traditional Tibetan costumes.

Iconography Research Method: By accurately interpreting image materials of Tibetan costumes, and analyzing and cross-verifying them with relevant literature materials, the accuracy of literature and image materials is ensured.

Comparative Research Method: Conducting vertical comparisons of traditional Tibetan costumes helps gain a clear understanding of the historical context of Tibetan costumes and the reasons behind their emergence. Horizontal comparisons, on the other hand, reveal the similarities and differences between costumes in different regions, thereby better highlighting the unique characteristics of each region's costume language.

RESULTS AND DISCUSSION

1. Origin of Tibetan Robe Costume Language

The origin of Tibetan robe costume language can be traced back to the primitive nomadic tribes on the Qinghai-Tibet Plateau. Early Tibetan costumes mainly used leather, felt, and wool as materials. With the passage of time and social progress, these costumes gradually developed into ethnic costumes with a unique style. During the Tubo Period, there were already many records about Tibetan costumes. Starting from the Tang Dynasty, Tibetan costumes gradually absorbed elements of Central Plains culture, such as silk and embroidery techniques. In the Yuan Dynasty, Tibetan costumes were further influenced by the Mongolian people, leading to the emergence of many new styles and decorative methods.

2. Development of Tibetan Robe Costume Language

The development of Tibetan robe costume language is a long process. In the early stage, the styles and colors of Tibetan robes were relatively simple. As history advanced, the styles, colors, patterns, and decorations of Tibetan robes gradually became richer. At the same time, the costume language of Tibetan robes was also influenced by other ethnic cultures. For example, during the Tubo Dynasty, the exchange between Tibetan culture and Central Plains culture, Indian culture, and other cultures brought new elements and inspirations to the costume language of Tibetan robes.

In modern times, with the rapid development of Tibetan society and the advancement of modernization, the costume language of Tibetan robes has also undergone significant changes. On the one hand, traditional Tibetan robe styles and patterns have been better protected and inherited,

becoming one of the important representatives of Tibetan culture. On the other hand, modern design elements and materials have been introduced into the production of Tibetan robes, making them more fashionable, diverse, and personalized.

3. Characteristics of Tibetan Robe Costume Language

a. Color Characteristics

Tibetan robes come in a rich variety of colors, with common ones including white, red, yellow, blue, and green. These colors not only reflect nature but also carry profound religious and cultural implications. Through different color combinations and matches, Tibetan robes not only embody the Tibetan people's love and awe for nature and life but also demonstrate their longing and pursuit for a better future (see Figure 2.).



Figure 2. Colors of Tibetan Robe Costumes

b. Material Characteristics

The material selection of Tibetan robes emphasizes practicality and comfort. Common materials include wool, yak hair, and Tibetan cashmere. These materials not only have excellent thermal insulation properties but are also soft, breathable, and wear-resistant. Meanwhile, the Tibetan people are skilled at utilizing local resources—for example, they use silk threads and cotton threads for decoration, making Tibetan robes more elegant and generous (see Figure 3.).



Figure 3. Materials of Tibetan Robes

c. Craftsmanship Characteristics

The handcraftsmanship of Tibetan robes is exquisite and unique. Common craftsmanship techniques include embroidery, printing, and piping. These techniques not only require superb skills and patience but also contain profound cultural connotations and aesthetic concepts. Through these techniques, the Tibetan people skillfully embroider auspicious patterns, religious symbols, and other elements on Tibetan robes, turning the robes into works of art with profound cultural connotations (see Figure 4.).



Figure 4. Craftsmanship of Tibetan Robes

4. Aesthetic Value and Cultural Connotation of Tibetan Robe Costume Language

a. Aesthetic Value

The Tibetan robe, an ancient costume originating from the snow-covered plateau, is not only a necessity for the daily life of the Tibetan people but also a carrier of their culture, beliefs, and aesthetic pursuits. Its unique colors, patterns, materials, and styles all reflect the Tibetan people's pursuit of beauty and love for life.

The color selection of Tibetan robes is not only elegant and generous but also contains profound cultural connotations and good wishes. The patterns on Tibetan robes are mostly auspicious patterns, religious symbols, and other elements, which not only give the patterns a strong religious flavor but also embody the Tibetan people's awe and love for nature and life. Tibetan robes come in a variety of styles; different styles can not only adapt to different climates and occasions but also show the personality and aesthetic pursuit of the Tibetan people.

b. Cultural Connotation

As the traditional costume of the Tibetan people, Tibetan robes have not only absorbed cultures such as Central Plains culture, Indian culture, and Nepalese culture but also integrated the unique cultural characteristics of the Tibetan people themselves. This integration of diverse cultures endows Tibetan robes with unique and rich charm in terms of aesthetics, and at the same time reflects the close connection with the unique religious beliefs of the Tibetan people, such as the culture of "integrating multiple Tibetan Buddhism traditions into one".

Furthermore, from aspects such as the style, color, and pattern of the costume, we can see the life changes and cultural inheritance of the Tibetan people in the long history. These characteristics make Tibetan robes one of the important carriers for the cultural inheritance and development of the Tibetan people, and also make unique contributions to the diversity of world culture.

Application Analysis of Tibetan Robe Costumes in Modern Fashion Design

1. Classification of Traditional Tibetan Robes

a. Double-sleeve Style

The "double-sleeve-worn" Tibetan robe is a traditional Tibetan costume, characterized by both arms being inserted into the sleeves. This design not only provides excellent thermal insulation when the temperature is low but also wearing the double-sleeve robe is regarded as a sign of respect for deities when entering religious venues such as temples and monasteries.

In Tibetan areas, men and women wear Tibetan robes in different ways. When men wear them, they usually lift the hem of the robe to the knee and then tie the waistband. This way of wearing keeps the waistline low, highlighting the tall and strong image of men. When women wear Tibetan robes, the hem hangs down to the instep before tying the waistband, making the waistline appear higher and thus emphasizing women's upright and slender posture.

From a functional perspective, the design of Tibetan robes attaches great importance to practicality. For the convenience of movement, when tying the waistband, the front body of the robe is required to remain flat, while the back body forms folds. The waistband is also designed to be lower at the front and higher at the back, and the front hem should not be too long—this not only ensures comfort but also facilitates walking. In addition, to enhance the carrying function of the robe, a large pouch is formed around the waist when tying the waistband. This pouch can not only

hold items but also be used to carry children when necessary, demonstrating the practicality and versatility of Tibetan robes (see Figure 5.).



Figure 5. Large Pouch Formed by Tying the Waistband When Wearing Double-sleeve Robes

b. Single-sleeve Style

The Tibetan-inhabited areas in Northwest China are characterized by large temperature differences between day and night, cold winters, and hot summers. This climate requires locals to have clothing that can adapt to such extreme weather conditions. As the traditional costume of Tibetans, Tibetan robes—with their wide sleeves and special wearing method—perfectly meet this demand.

The sleeves of Tibetan robes feature a unique design that allows free adjustment with temperature changes. When the sun is bright at noon and the temperature rises, Tibetans will take off one sleeve (see Figure 6.) to expose their arm, thereby regulating their body temperature. This way of wearing not only adapts to climate changes but also reflects the casual and free-spirited nature of the Tibetan people.

The material of Tibetan robes is also of great importance. They are generally made of materials with good thermal insulation properties, such as wool and cashmere. This allows the robe to be used as a quilt on cold nights, providing warmth for Tibetans. This multi-functional costume design fully demonstrates the wisdom and creativity of the Tibetan people.



Figure 6. Wearing Method of Tibetan Robe with One Sleeve Taken Off and Hanging Behind the Back

c. Sleeveless Style

When the sun is abundant and the temperature is high during the day, or when both hands are needed for labor work, not only one sleeve of the robe can be taken off, but both sleeves can also be removed (see Figure 7.). These sleeves are then piled around the waist and tied or wrapped with a waistband, which can quickly lower the body temperature.

Generally, men wrap the sleeves around the front waist when wearing the robe, while women wrap the sleeves around the back waist.



Figure 7. Wearing Method of Tibetan Robe with Both Sleeves Taken Off and Wrapped Around the Waist

Structure of Tibetan Robe Costumes

As a representative of traditional Tibetan costumes, Tibetan robes, with their diverse styles and unique structures, fully demonstrate the profound heritage of Tibetan culture. According to structural differences, Tibetan robes can be divided into several categories:

Classic Tibetan Robe Structure: This type of Tibetan robe is known for its classic design and craftsmanship, such as the jacquard silk long-sleeve yellow robe and the Tianhua brocade Tibetan official robe. They are made of high-quality silk satin, decorated with exquisite patterns and textures, reflecting the magnificence and nobility of Tibetan costumes.

Tibetan Religious Costume Structure: Mainly designed for religious rituals and activities, this category includes robes like the yellow satin lama robe and the crimson vest-style robe. Their colors and patterns are usually simple and elegant, highlighting the solemnity and sense of mystery of religion.

Khampa Tibetan Robe Structure: Khampa Tibetan robes are famous for their unique style and craftsmanship, such as the gold silk robe with leopard skin trim and the woolen blanket robe with tiger skin trim. These robes integrate the unique culture and aesthetics of the Khampa region, showing a strong regional characteristics.

Baima Tibetan Costume Structure: Baima Tibetan costumes are a unique branch of Tibetan costumes, featuring simple and elegant designs, such as the Baima Tibetan stand-collar slanted-front robe and the Baima Cipo slanted-front robe. These costumes reflect the lifestyle and aesthetic concepts of the Baima Tibetans.

Through the structural analysis of Tibetan costumes, we can see their similarities with the costumes of other ethnic minorities. This indicates that while inheriting its own culture, Tibetan costumes also have a certain degree of openness, capable of absorbing and integrating cultural elements from other ethnic groups. The combination of this inheritance and openness makes Tibetan costumes more colorful, becoming a treasure in the cultural treasure house of Chinese ethnic costumes.

Characteristics of Tibetan Robe Costumes

As the traditional costume of the Tibetan people, one of the most prominent characteristics of the Tibetan robe is its wide sleeves. Beyond the wide sleeves, its structure is also distinctive. There are no slits at the front and back centers of the robe, and the entire body (including the front and back panels) is made from a single piece of fabric. This design not only ensures the integrity of the garment but also enhances its thermal insulation performance. At the same time, Tibetan robes adopt the traditional right-overlap placket style of Hanfu, with an attached inner placket, while the sleeves are attached separately. This design is not only elegant and neat but also allows free adjustment of the garment's tightness according to temperature changes, further enhancing its practicality.

Compared with Tibetan robes, the structure of classical Chinese finery is more complex. It has slits at the front and back centers, with the left and right panels each made from a single width of fabric, and the body and sleeves cut as one piece. Although this design showcases the exquisite craftsmanship and unique charm of Chinese finery, its thermal insulation effect may be slightly inferior to that of Tibetan robes when dealing with cold weather. Hanfu also has slits at the front and back centers, with the large placket being pieced together. While this design can demonstrate the solemnity and elegance of Hanfu, it is also difficult to match the thermal insulation performance of Tibetan robes.

As the traditional costume of the Tibetan people, the design of the Tibetan robe is full of

wisdom and ingenuity. Its wide sleeves, unique structure, and flexible placket style make it an ideal choice for coping with cold weather. At the same time, Tibetan robes carry rich cultural connotations and historical heritage, becoming an important part of Tibetan culture (see Figure 8.).

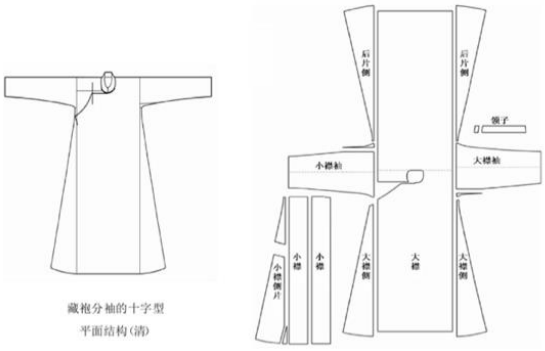


Figure 8. Flat Structure

The Thrifty-focused Cross-shaped Flat Structure in Tibetan Robes

The flat structure of Tibetan robes, especially their three-panel cross-shaped design, is a major feature of Tibetan costumes. The front and back panels of the robe are made from a single piece of fabric without slits. This structure not only meets the daily needs of the Tibetan people but also reflects their careful consideration of fabric usage. Compared with Hanfu in the inland regions, although there are differences in cutting and pattern layout, both embody the Chinese nation's virtue of frugality.

In the design of Tibetan robes, the way the garment body and sleeves are joined is not based on three-dimensional considerations of the human body shape, but is limited by the width of the fabric. This design method, though seemingly simple, skillfully solves the problem of fabric utilization. At the same time, the joint design of the inner placket and the garment body not only avoids the discomfort caused by sewing on the shoulders but also subtly decorates the Tibetan robe, making it more aesthetically pleasing.

The "cross"-shaped structure of Tibetan robes shares similarities with the robes in northern China, which reflects people's common pursuit of costume structures under different environments. From the robes of the ancient Qiang people to the Tibetan robes of today, the stability and distinctiveness of their structures all indicate the adaptability and popularity of this robe structure in Tibetan-inhabited areas. The triangular gussets added to the side seams of Tibetan robes not only increase the looseness of the robe's hem for easier movement but also further enrich the style and design of Tibetan robes.

Case Analysis of the Application of Tibetan Robe Costume Language in Clothing

At the Paris Fashion Week for Spring/Summer 2023, the brand SANKUANZ launched a striking series of fashion designs inspired by Mount Kailash. This collection skillfully integrates traditional Eastern imagery with modern fashion aesthetics, combining Tibetan traditional culture with modern street style to present a unique and layered visual effect. The wearing method of Tibetan robes is the core design element of this series. The designer cleverly used the loose, draped, and wrapped characteristics of Tibetan robes, combining them with the three-dimensional structure of modern clothing to create fashions that conform to modern aesthetics while retaining traditional charm.

The combination of a sky-blue loose suit jacket and a midi skirt not only showcases the simplicity and grandeur of modern clothing but also subtly draws on the unstructured shape of Tibetan robes through curved cutting and wrapping designs. The fabric is gathered around the waist to form a unique drape, which not only meets modern aesthetic standards but also reflects the charm of traditional Tibetan costumes (see Figure 9.).

The gray asymmetric crewneck knitted sweater paired with a gray wrapped midi skirt takes the wearing method of Tibetan robes to the extreme. The designer skillfully used the asymmetric shape to make the sleeves present an effect similar to that of a Tibetan robe with one sleeve removed. Additionally, through the wrapped design, a large number of folds are stacked to present a primitive and abstract state, making people feel as if they are on the plateau, experiencing the unique charm of traditional Tibetan costumes (see Figure 10.).



Figure 9. Combination of Sky-blue and Midi Skirt Asymmetric Crewneck Knitted Sweater



Figure 10. Combination of Gray Loose Suit Jacket And Gray Wrapped Midi Skirt

The combination of an all-black asymmetric design and wrapped styling stunningly presents the unique silhouette of Tibetan robes in modern fashion design. The exaggerated asymmetric outline not only creates a rough and primitive sense of power but also allows people to gain a deeper understanding of the profound cultural connotations of Tibetan costumes (see Figure 11.).



Figure 11. All-black Asymmetric Wrapped Outfit

CONCLUSION

This paper conducts a systematic theoretical study on the shape of traditional Tibetan robes and analyzes and summarizes their application in fashion design. During the research process, a detailed analysis was carried out on the classification, structure, and wearing methods of Tibetan robes, laying a solid foundation for the subsequent design. Afterwards, the entire design process was analyzed from aspects such as design concept, material collection, and production craftsmanship. This innovative design will bring new inspiration and concepts to the field of modern fashion design. It is hoped that through the research of this project, more people will not only understand and appreciate the costume language culture of Tibetan robes but also promote new innovation and development in the field of modern fashion design.

Concept Construction of Embodied Learning Based on "Life-Practice"

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ABSTRACT

Returning to the body is a key path for education to revert to its essence, responding to the era's value demands for human development. Current theoretical research on Embodied Learning focuses on the integrity of cognition, the body, and the environment, yet there is still a need to expand its theoretical perspective. This study adopts the literature research method, classroom observation method, and case study method to construct the concept of Embodied Learning based on "Life-Practice" Pedagogy. With a multi-disciplinary examination of the body as its theoretical foundation, the study clarifies the internal relationship between "Life-Practice" Pedagogy and Embodied Learning, and extracts the essential characteristics of Embodied Learning: taking the body of a concrete individual as the subject, taking the overall organic interaction between the body and the environment as the approach, taking the body's perceptual practice as the driving force, taking neural mechanisms and perceptual experience as the core, and aiming at the development of human life. Finally, it proposes practical paths for classroom Embodied Learning from the practical perspective, providing new ideas for the theory and practice of Embodied Learning.

Keywords: body. Embodied Learning, concrete individual, individual life practice, "Life-Practice" Pedagogy

INTRODUCTION

In the reform of basic education in recent years, the value of the "body" for individual development has become increasingly prominent. In 2010, China emphasized promoting the active development of students in the National Medium- and Long-Term Plan for Education Reform and Development; in 2021, China introduced the "Double Reduction" policy to alleviate students' physical burdens; and in 2022, China advocated subject-based practice in the Compulsory Education Curriculum Plan. All these policies point to the connection between the body and learning. Marx holds that perceptual practice is the foundation of the existing world, and perceptual activities contain life experiences, which promote education to return to the authenticity of the body.

Embodied cognition is a frontier in academic research. The Western concept of "embodied learning" advocates that the body is the subject of learning, and that mental development is promoted through the interaction between the body and the context. However, a small number of scholars approach this from the perspective of individual life practice, overlooking the process by which students achieve spiritual growth through bodily practice. Ye Lan's "Life-Practice" pedagogy points out that life and practice are the foundations of human existence, the body is the material basis of life, and education needs to regain care for the body of specific individuals. Based on this, this study attempts to address four questions: the historical perspective and theoretical foundation of the concept of embodied learning, the relationship between individual life practice and embodied learning, the basic connotation of embodied learning, and reflections on educational forms and embodied paths in the classroom.

Scholars' understanding of the connotation of the body goes beyond the physiological level, covering the dimensions of practice, life, and specific individuals. Maurice Merleau-Ponty proposed "I am my body"; Chinese scholars believe that the body is an integrated life whole of body and mind, with the characteristics of subjectivity, experientiality, and interactivity.

Research on the connotation of embodied learning focuses on three aspects. Those are body-based learning emphasizes the fundamental role of the body in cognition; situation-based learning holds that learning occurs in specific contexts and develops through interactive coexistence with the environment; experience-based learning considers learning as the transformation and growth of bodily experience.

Research related to embodiment involves educational implications, concepts, classroom teaching, and learning design. However, there are few attempts to define embodied learning from the perspective of "Life-Practice" pedagogy, and there is a lack of attention to the life practice of specific individuals.

The literature review shows that practical exploration of embodied learning is rich, but its theoretical perspectives need to be expanded. Interpreting embodied learning from the perspective of individual life practice can enrich its theoretical and practical exploration.

Based on the educational stance of individual life practice, embodied learning refers to a learning process in which a living individual, embedded in a specific context, takes the body of a specific person as the subject, takes organic interaction with the environment as a whole as the basic approach, takes bodily perceptual practical activities as the dynamic foundation, and takes bodily movement, physiological activities, and sensory stimulation as the core content to acquire experiential experiences and ways of thinking. It presents a state of active generation by individuals and represents the optimal manifestation of individual life practice. Its fundamental goal is to promote the development of spiritual life, including cognition, emotion, and thinking.

This study constructs the concept of embodied learning from the perspective of "Life-Practice" pedagogy and follows the framework of "problem formulation - problem analysis - problem solving".

The introduction puts forward the research problem, namely the construction of the concept of embodied learning based on "Life-Practice", from the perspectives of policy background, academic frontier, and literature review. Chapter 2 sorts out the educational history of embodied learning and examines the manifestations of the body in philosophical, psychological, and pedagogical contexts, providing a historical perspective and theoretical foundation for the construction of the concept. Chapter 3 clarifies the internal relationship between "Life-Practice" and embodied learning, interprets the core of "Life-Practice" pedagogy, and defines the connection between life practice, specific individuals, and embodied learning. Chapter 4 refines the basic connotation of embodied learning from both theoretical and practical perspectives, and abstracts its essential attributes by combining the views of representative scholars and classroom cases. Chapter 5 deepens the concept from the practical perspective, examines the manifestations of the body in teaching practice, and realizes the two-way construction of theory and practice.

THEORETICAL FRAMEWORK

1. The Loss of Life: The Decline of Bodily Education

Rationalism and empiricism attribute the perceiving subject to the internal mind, neglecting the role of bodily perception in cognition. This has led to a long-standing disembodied culture in China's school education. "Disembodied" learning regards students as "abstract persons," ignoring knowledge experiences and life experiences, while prioritizing knowledge over human development. The body is marginalized in the educational field, leaving students in a state of passive existence.

In the philosophical context, both rationalism and empiricism belittle the body. Pythagoras viewed the body as the "tomb of the soul"; Socrates worried that sensory knowledge would hinder reason; Plato’s "doctrine of the soul" advocated freeing oneself from the body to attain reason; Descartes’ "Cogito, ergo sum" established mind-body dualism, asserting that cognition can be separated from the body. Rationalism emphasizes the universality of knowledge and negates sensory experience, while empiricism, though valuing experience, treats the body as a "container." Both schools ignore the body’s role in shaping cognition.

In the psychological context, behaviorism defines learning as "behavioral change," confusing human behavior with animal behavior and attributing it to external stimuli, thus "reifying" the body. Influenced by mind-body dualism, cognitivism regards learning as the brain’s information processing, treating the body as a mere "carrier" and claiming that cognition has nothing to do with physical structure. Both schools exclude the body from the mind.

In the educational context, disembodied education treats the body as a carrier, maintaining the separation between mind and body. Teaching is oriented towards cultivating the mind, ignoring the cognitive and developmental value of the body—ultimately leading to the decline of the body in education.

2. The Recovery of Life: The Return of Bodily Education

The bodily turn in modern Western philosophy and cognitive science has prompted basic education to emphasize the bodily characteristics of learning. As the fundamental way of existential life and the subject of learning, the body is returning to the essence of education.

In the philosophical context, Nietzsche advocated "taking the body as the criterion," arguing that the body is a symbol of the will to power; Husserl emphasized that physical structure influences cognition; Heidegger's "being-in-the-world" pointed out that humans understand the world through bodily interaction; Merleau-Ponty constructed bodily phenomenology, asserting that the body is the perceiving subject and that humans understand the world through the body.

In the psychological context, Dewey criticized the traditional view of knowledge, arguing that bodily experience is the foundation of cognition; James' peripheral theory of emotion pointed out the unity of the body and emotion; Piaget believed that cognition originates from physical actions and sensory experiences; Vygotsky proposed that higher mental functions stem from the internalization of physical activities; Galperin studied the process of internalizing external activities into thinking. All these theories emphasize the role of the body and environment in cognition.

In the educational context, "fostering virtue through education" must be based on the vibrant body. Embodied cognition and bodily pedagogy have become frontier concepts, advocating a shift from "knowledge-based pedagogy" to "bodily pedagogy." This approach treats the body as the subject of learning and integrates it into classrooms. Embodied learning, centered on the experiences of interaction between the body and the environment, breaks through the separation between the body and knowledge and promotes education to return to its essence.

METHOD

Research Foundation

1. Theoretical Foundation

Through course learning and book reading, two ideas for concept formation are refined. One is to start from practice, analyze examples and activity types, and summarize the essential characteristics; the other is to start from theory, combine the theoretical context and representative viewpoints, and conduct cluster analysis. At the same time, with core keywords such as "embodiment", "phenomenology of the body" and "neuroeducation", literature and books are collected to conduct in-depth thematic research on embodied learning, laying the theoretical foundation for the thesis.

2. Practical Foundation

After theoretical learning, the author participated in the "lesson observation and evaluation" activities of five experimental schools through a combination of online and offline methods, recorded the activities and collected cases. This not only provided ideas for the research, but also accumulated argumentation materials for the thesis writing.

Research Methods

1. Literature Research Method

   This method is used to clarify the reform trend and practical needs of basic education. Literature is collected around core keywords to sort out the basic ideas, representative viewpoints and development context of embodied learning, summarize the trends and clarify the research starting point.

2. Classroom Observation Method

   The author went to the practical sites of five primary schools and carried out the work in three stages. In the early stage, the author was familiar with teaching materials, curriculum standards and teaching designs; in the middle stage, the author made detailed records of lesson observation and evaluation as well as audio and video records; in the late stage, the author organized and analyzed materials in combination with audio and video to serve the thesis writing.

3. Case Study Method

   Materials such as classroom videos and learning record sheets are classified and compared by subject and dimension, and typical cases are selected for argumentation.

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FINDINGS AND DISCUSSION

1. Subsection one A Historical Investigation of Embodied Learning in Education

Since the era of traditional Western philosophy, the body has often been excluded from education in discussions on the mind-body relationship: rationalism and empiricism either regard the body as an obstacle to reason or merely treat it as a tool; cognitive psychology attributes cognition to the abstract processing of the brain, giving rise to a culture of disembodied education. With the "body turn" promoted by modern philosophy (represented by Husserl, Heidegger, etc.) and psychology (represented by Dewey, Vygotsky, etc.), the rise of embodied cognition has shifted the body's value from instrumental to vital, enabling it to transition from decline to return in education and laying a theoretical and historical foundation for embodied learning.

a. Loss of Life: The Decline of the Body in Education

Intellectualism and empiricism attribute the perceptual subject to the internal mind, ignoring the role of physical perception in cognition. This has led to a long-standing culture of disembodiment in China's school education — students are viewed as "abstract beings" or "objective beings", with their knowledge experiences and life experiences neglected, and knowledge placed above personal development. Consequently, the body is marginalized, and students exist in a passive state.

In the philosophical context, both rationalism and empiricism belittle the body: Pythagoras saw the body as a "tomb" for the soul; Socrates worried that sensory knowledge would hinder reason; Plato's "theory of the soul" advocated freeing oneself from the body to attain reason; Descartes' "I think, therefore I am" established mind-body dualism, denying the body's role in cognition. Although Locke, a representative of empiricism, emphasized that "knowledge originates from sensory experience", he regarded the body as a "container" for carrying knowledge. Both schools ignored the body's value in shaping cognition.

In the psychological context, behaviorism views learning as "behavioral change", equating human behavior with that of animals and attributing it to external stimuli, thus "objectifying" the body; influenced by mind-body dualism, cognitivism regards learning as the brain's information processing, believing that cognition has nothing to do with physical structure and only treating the body as a "carrier". Both schools exclude the body from the mind.

In the educational context, disembodied education separates the mind from the body, with the core orientation of cultivating the mind while ignoring the body's value in cognition and development. Teaching objectives are predetermined, procedures are mechanized, and learning is equated with pure rational thinking, ultimately leading to the decline of the body in education.

b. Recovery of Life: The Return of the Body in Education

The "body turn" in modern Western philosophy and cognitive science has driven basic education to attach importance to the physical characteristics of learning. As the fundamental form of existence of life and the subject of learning, the body has returned to the essence of education.

In the philosophical context, Nietzsche's proposition of "taking the body as the criterion" holds that the body is a symbol of the will to power; Husserl emphasizes that physical structure influences cognition; Heidegger's concept of "being-in-the-world" points out that humans understand the world through physical interaction; Merleau-Ponty constructed the phenomenology of the body, arguing that the body is the perceptual subject and humans comprehend the world through their bodies.

In the psychological context, Dewey criticized the traditional view of knowledge and advocated that physical experience is the foundation of cognition; James' peripheral theory of emotion points out the unity of the body and emotion; Piaget believed that cognition originates from physical actions and sensory experiences; Vygotsky proposed that higher mental functions originate from the internalization of physical activities; Galperin studied the process of internalizing external activities into thinking. All these theories emphasize the role of the body and the environment in cognition, promoting the unity of the mind, body, and environment.

In the educational context, "fostering virtue through education" must be based on the vivid

body. Embodied cognition and physical pedagogy have become cutting-edge fields: they advocate a shift from "knowledge-based pedagogy" to "body-based pedagogy", regarding the body as the subject of learning and integrating it into the classroom. Embodied learning holds that learning is rooted in the interaction between the body and the environment, demonstrating generative and physical characteristics. It breaks the separation between the body and knowledge and promotes education to return to its essence.

2. Subheading two Clarification: The Relationship Between "Life-Practice" and Embodied Learning

The "Life-Practice" pedagogy founded by Ye Lan is a pedagogy with Chinese stance and discourse, whose fundamental goal is to nurture human life and promote life development. Human life relies on the physical existence of specific individuals — without the body, there would be no life development or practice. The body is the basic form of existence for an individual's life practice, and embodied learning is precisely the care for life and educational concern. Therefore, it is necessary to clarify the inherent correlation between the two from the perspective of pedagogy.

a. Interpretation of the "Gene-Like" Concept of "Life-Practice"

The "Life-Practice" pedagogy school takes "genes" as the foundation for the establishment of pedagogy, because "genes" are the internal basis for the continuation and development of life, with inherent complexity, intergenerational inheritance, and life generativity. Ye Lan uses "genes" as a metaphor for the core of pedagogical theory, pointing out that pedagogical theory should have characteristics such as intergenerational function and generative mechanism. She clearly identifies "Life-Practice" as its gene-like core concept, and points out that there is an inherent connection between the body of a specific individual and life practice. She also explains "life", "practice", and their relationship based on interdisciplinary thinking.

"Life" refers to the unique phenomenon of organisms composed of macromolecular nucleic acid proteins, which can realize material construction, reproduction, adaptation to the environment, etc. The body of a specific individual is the material basis for the existence and continuation of life. Ye Lan explains human "life" from the perspectives of natural mechanisms, general characteristics, and species-specific characteristics. She points out that living organisms have mechanisms such as metabolism and active adaptation to the environment; individual life growth has both certainty and uncertainty, as well as characteristics such as leap and continuity. Based on Marx's perspective of "species-life", she emphasizes that humans surpass animals through their physical structure (such as bipedal walking) and labor practice, and form species-specific characteristics through conscious life activities involving the cooperation of hands and brains.

"Practice" refers to human activities with consciousness, objects, and purposes, which is similar to "life" and not limited to moral practice or productive labor. Human life and practice have been inherently connected and mutually constructive since their origin, jointly forming a complete individual life practice. Practice is a unique life activity of humans, which enriches the forms of life.

The inherent relationship of "Life-Practice" is reflected in three dimensions: natural, social, and spiritual. At the natural dimension, life and practice have been inseparable since the formation of humans. Labor is the fundamental difference between humans and animals; practice is the form of existence of life and inherent in the needs of life. At the social dimension, humans create society through life practice, and individuals achieve social development through practice; "Life-Practice" has both concrete historical and contemporary characteristics. At the spiritual dimension, practice is directly related to the human spiritual world; humans develop brain functions and form self-awareness through practice, embodying the free and conscious species-specific characteristics.

In addition, the "Life-Practice" pedagogy calls for "concrete individuals". For a long time, school education has "abstracted" and "standardized" people. Paul Lengrand pointed out that the object of education is "concrete people". Ye Lan takes "concrete individuals" as the fulcrum of pedagogical theory, emphasizing that life grows in concrete individuals. Education needs to pay attention to individual differences and potentials and promote the holistic development of life.

b. The Inherent Relationship Between "Life-Practice" and Embodied Learning

Human life is based on the body of a specific individual — without the body, there would be no life or practice. Embodied learning advocates "I am the body", and its essence is the process and optimal manifestation of an individual's life practice. The "Life-Practice" pedagogy emphasizes the

active development of concrete individuals and cares for vivid life entities, while embodied learning is precisely the way in which individuals engage with the environment with their entire lives. The body integrates natural, social, and spiritual life; physical activities are the basic form of existence of life; the differences in physical experience highlight the uniqueness of life; physical emotions can awaken life wisdom.

Embodied learning presents a holistic existential way of life in which the body is involved. On the one hand, it is a receptive form of existence: individual development needs to be achieved through interaction with the environment and practical activities. In embodied learning, students personally experience the process of knowledge formation through physical activities in a specific environmental atmosphere, accompanied by various psychological feelings, which are realized in the interaction of multiple subjects. On the other hand, it is a materialized form of existence: individual development needs to rely on life practice activities. Embodied learning includes materialized physical activities such as outlining and operating. Through these activities, individuals interact with knowledge, form internal thinking and emotions, and realize the transformation from potential development to actual development.

The body is the unity of natural, social, and spiritual life: the body of natural life is the carrier of spiritual and social life; the body of social life gains experience through activities, which becomes the nutrient for spiritual life. Education needs to pay attention to the holistic development of the body and cultivate a complete life. Physical activity is the basic form of existence of an individual's life. It goes beyond the scope of the physical body, has multiple attributes, and is a process for humans to transform themselves, achieve development, and awaken self-awareness.

The differences in physical experience highlight the uniqueness of individual life. The individual's sensorimotor system affects the formation of cognition, and different sensorimotor modes bring different physical experiences, shaping unique cognitive styles. Education needs to pay attention to concrete lives based on physical experience. Physical emotions can awaken life wisdom. In real education, most attention is focused on the cognitive level, but wisdom also includes emotions and will. Physical emotions can regulate cognition, promote individual development, and guide students to awaken life wisdom through emotional experience.

3. Subheading three The Basic Connotation of Embodied Learning in Individual Life Practice

Embodied learning is a learning process in which life individuals embedded in specific contexts, with the bodies of concrete individuals as the subject, obtain experiential experiences and ways of thinking through the overall organic interaction with the environment, relying on the body's perceptual practical activities, and focusing on physical movement, physiological activities, and sensory stimulation. It presents an actively generative state, is the optimal manifestation of an individual's life practice, and its fundamental goal is directed at the development of spiritual life such as cognition, emotion, and thinking.

a. Understanding of "Body" and "Embodiment" in Embodied Learning

The "body" in embodied learning refers to the body of a concrete individual. Human life is the unity of nature, society, and spirit. Education needs to care for vivid physical life entities and pay attention to the overall state of the body of a concrete individual. The body of a concrete individual is in a specific environmental relationship. Through practical activities carried out by the body, it gains perceptual experiences and cognition, which are transformed into the driving force of life, accompanied by inter-subjective interaction and emotional surges, presenting a complete state of life existence.

The "embodiment" in embodied learning refers to the active life practice of an individual, which is the active generation in the sense of life. It is embodied in the dynamic interaction of the body of a concrete individual in the environment and the improvement of self-awareness, which has a potential and far-reaching impact on individual development. In the context of school education, "embodiment" is manifested in students' active participation in teaching activities, such as demonstrating thinking based on learning record sheets and participating in interactions between teachers and peers. In contrast, in "substituted learning" — where teachers directly present answers and learning lacks the support of activities — the state of "no embodiment" occurs, leading to students' passive existence.

b. Embodied Learning Takes the Body of a Concrete Individual as the Subject

The body of a concrete individual is the fundamental component of embodied learning. The subject's consciousness, intelligence, etc., are all realized based on biological foundations. Learners' understanding of abstract concepts needs to rely on embodied experiences formed through physical activities, which are completed through metaphorical links between the source domain and the target domain. The repetition of physical experiences constitutes the basic logic for understanding the world.

As Merleau-Ponty put it, humans understand the world through their bodies — "I am the body" rather than "I have a body". The body is the subjective existence of learning. Through embodied practice, individuals gain experiences, awaken their sense of subjective consciousness, and present a "personalized" body to realize the value of life.

At the same time, the body represents the complete life state of a concrete individual in the process of embodied learning. Students engage in the learning field in an "immersed" way, stimulate the vitality of life through perceptual practice, and build an "I-Thou" relationship in interaction with the environment and others. The presence of the body means the presence of life. Education needs to provide space for students' physical development, allowing them to participate in classroom activities and expressions, enhance the vitality of life, and achieve authentic development.

c. Embodied Learning Takes the Overall Organic Interaction Between the Body and the Environment as the Basic Approach

Embodied learning requires the body of a concrete individual to engage in the classroom environment in a holistic manner. Individual development is affected by the existing level; the body has historical, cultural, and social attributes and is a node of meaning. The results of its development constitute acquired factors, which affect the way individuals act on the external environment.

Classroom teaching should regard students' differences as resources, pay attention to their life experiences and learning obstacles, and help individuals develop on the basis of their original foundations. At the same time, the body realizes two-way interaction with the environment in a holistic way. Individuals and the world have an "internal coupling relationship of mutual causation and mutual shaping". The body participates in the environment through actions, absorbs materials and information, and transforms them into its own needs, forming a symbiotic relationship among cognition, the body, and the environment — the environment is transformed into physical experience, and the body also becomes part of the environment, affecting others and the external world.

In addition, the body constructs "relationships" in interaction. Dewey emphasized that experience originates from personal activities. Embodied learning connects humans with the environment through activities. In classroom communication and cooperation, relationships such as mind-body and self-others are attached to the body, demonstrating the multi-dimensional unity of the body.

d. Embodied Learning Takes the Body's Perceptual Practical Activities as the Dynamic Foundation

Physical activity is the basic form of existence of an individual's life. Marx pointed out that labor is the essential difference between humans and animals. Humans carry out purposeful life activities through bipedal walking, cooperation between hands and brains, etc. Practice is inherent in the needs of life, and practice cannot be separated from the body of a concrete individual. Therefore, physical activity is a unique practical behavior of individuals.

At the same time, physical activity is the basic form of an individual's life practice. "Life practice" refers to the purposeful activities experienced by life individuals, which are the fundamental conditions for the authentic interaction between individuals and the environment. Through physical activities, individuals realize the development from potential to actuality and awaken their sense of subject consciousness.

In addition, the external activities of the body are the source of internal activities. Piaget believed that cognition originates from the interaction between the subject and the object, and there is an inherent connection between external activities (physical actions) and internal activities (mental activities). Galperin proposed that external activities are the foundation of internal activities. In embodied learning, learners carry out materialized activities through physical embodiment (operating real objects), situational embodiment (reproducing situations with

instruments), and offline embodiment (relying on language or imagination). They internalize external actions into cognition and emotions, realizing the transformation from potential development to actual development.

e. Embodied Learning Takes Neural Mechanisms, Sensorimotor Functions, and Experience as the Core Content

The body structure and the brain's nervous system are the internal mechanisms of embodied learning. The human body's organs and brain structure provide the material basis for the existence of life. The body has plasticity and potential; the brain's neurons and functional circuits are the basis of mental processes. Learning is the process of establishing connections between neurons, which needs to rely on existing physical experiences.

Embodied learning pays attention to students' existing development levels and helps them understand knowledge through teaching scaffolding. At the same time, long-term physical participation can change the brain structure, thereby affecting cognition. In the classroom, hands-on operations and writing are processes of mental thinking.

The body's sensorimotor system plays a fundamental role in embodied learning. Merleau-Ponty emphasized that humans perceive the world through the body; Marx advocated the perceptual existence of the subject. Sensorimotor ability is the foundation of cognitive formation. Cognition needs to rely on the interaction between the body and the environment, as well as physical activities. Through mobilizing multiple senses, embodied learning allows students to experience the process of knowledge formation and develop higher-level thinking.

In addition, concrete individuals gain life experiences in specific contexts. The body, emotions, and cognition exist as a whole. Embodied experience is divided into the verb level (experiences obtained through action and operation) and the noun level (formed experiences). Its repetition constitutes a unique way of thinking and becomes a resource for life growth.

f. Embodied Learning Takes the Realization of Human Life Development as Its Fundamental Purpose

The essence of education is to nurture people, and promoting human development is its ultimate goal. The nature of education is to awaken students' awareness of self-development and their ability of self-education, and the body is the basic prerequisite for all education.

From the perspective of pedagogy, the body is a life whole with feelings, emotions, and thoughts, providing infinite possibilities for life development. Education needs to return to the real body to realize the value of nurturing people.

Embodied learning embodies the "directness" of educational practice. The presence of the educated person's body is the core. Educators need to design specific environments and activities: on the one hand, relying on the body's perceptual activities to achieve direct feelings; on the other hand, realizing direct inter-subjective communication through "human-human" dynamic interaction, returning to classroom communication with the body present.

Embodied learning not only pays attention to students' current life state but also focuses on their future life development. Its ultimate purpose is to realize the value of life, improve the quality and happiness of life. It is a life-care education that returns to the body, is based on the body, goes through the body, and is for the body. With the body as the "carrier", life as the "soul", and practice as the "action", it is a physical practice that enriches life.

4. Exploration: Thoughts and Practical Paths for Realizing Embodied Learning in the Classroom

Based on the pedagogical perspective of individual life practice, the development of human life is the foundation of education. The essence of education is to improve the value and quality of human life, thereby enhancing the quality of individual life. In other words, realizing the development of human life requires returning to the body, which is an inherent requirement of education.

However, influenced by traditional Western philosophy and cognitive psychology, China's education has long presented the characteristics of a "disembodied" culture. It is necessary to examine the current state of the classroom using the theory of embodied learning as a framework, provide ideas and paths for the embodied transformation of the classroom, regain the essence of education, and facilitate the life growth of students.

1. Current Situation Examination: Classroom Learning Is Detached from the Body

Human development is the most inherent and fundamental purpose of education. Education aims to enable every student to become a "complete" life individual with free and comprehensive physical and mental development. This requires education to shift from instrumental value to inherent value, focusing on the life practice and development of concrete individuals.

However, driven by technical rationality, there is a gap between the ideal and reality of educational value: students' development is simplified to standardized numerical evaluation, their rich personalities are abstracted into cold data, and the complexity and richness of educational practice are eliminated.

The overemphasis on instrumental value has led to the concealment of the body in the educational field. Classroom learning is detached from the body, and educational practice lacks the physical dimension and life care, leaving people in an "incomplete" state of development and generating negative life experiences.

From the perspective of learning concepts, traditional epistemology regards students as "knowledge-based beings" rather than "physical beings". Knowledge is regarded as an abstract representation of the objective world by the subject, separated from the individual's life practice, and students are reduced to "abstract beings", "substantial beings", or "objective beings".

As Paul Lengrand put it, "modern humans are victims of abstraction; various factors can harm people and destroy their unity". In practice, this concept is manifested as the "disembodied" process of "substituted learning": on the one hand, there is "teacher substitution" — teachers replace students' learning experiences with their own life activities, break down problems through "small steps", guide responses with questions like "is it right?" or "correct?", and even directly provide answers. Students mechanically memorize symbolic knowledge through "sitting and listening quietly", lacking the process of knowledge internalization involving physical participation, perception, and experience.

On the other hand, there is "peer substitution" — teachers ignore the individual differences of students, standardize them with unified standards, rely on top students for classroom answers, and divide labor in cooperative learning leads to the separation of experience. Students' complete physical experience is replaced, and they are reduced to abstract learning individuals.

In terms of learning content, knowledge is regarded as an absolute existence. Teachers impart predetermined knowledge, and students master fragmented knowledge through the model of "listening — memorizing — repeated training". Their unique pre-class physical experiences, life experiences, and in-class physical practices and insights are not incorporated into the form of teaching knowledge.

Dewey's theory of "learning by doing" emphasizes that learning is a process of experience transformation through the interaction between individuals and the environment. However, in reality, learning content is separated from physical experience, knowledge is external to students, and the process lacks physical practice and emotional involvement, leading students to fall into knowledge dilemmas, lose their enthusiasm for learning, and learning is alienated into a one-way input and output of abstract symbols.

Ye Lan pointed out that "education that only focuses on the value of transmitting existing knowledge actually nurtures people who take passive acceptance, adaptation, obedience, and execution of others' thoughts and wills as their basic way of existence" — this is a true portrayal of the current situation.

The learning process presents the characteristic of "training the mind with the mind" which suppresses the body. Traditional cognitive concepts regard cognition as an abstract internal process of the brain. Under the evaluation framework of "only focusing on scores", teachers are reduced to "knowledge porters" and students become "containers".

In this process, the body is disciplined: the value stance of "promoting the mind and suppressing the body" restricts students' bodies to the limited space of their desks. Teachers require "sitting and listening quietly" through rigid control, leaving limited time and space for students' physical practice and thinking. It is difficult to generate student resources in the classroom, and even if there is occasional generation, it is ignored. The body is reduced to an "object that is concealed and disciplined".

At the same time, physical participation is formalized: the "independent, cooperative, and inquiry-based learning" advocated by the basic education curriculum reform is reduced to false inquiry. Inquiry tasks are reported in a hurry or carried out according to the procedures preset by teachers. The "movement" of the body only stays on the surface, failing to realize the "movement" of thinking, and students still exist in a passive state.

The teacher-student relationship manifests as a static "I-It" relationship. From the perspective of life practice, teacher-student communication should be a dynamic interaction of intercorporeality, realizing life interaction and direct communication through body language, facial expressions, etc.

However, in reality, teachers are the dominant players in the classroom, determining the content and methods of learning and possessing absolute authority. Students are in a dominated position, and the classroom becomes a "stage for teachers' solo performances". Teachers overly control the time and space of the classroom, lecturing on abstract symbols unrelated to individual life, and depriving students of the opportunity to actively observe, explore, and experience. Even in the name of "for students' development", it actually eliminates the subjectivity of students' spiritual life development.

Ye Lan emphasized that "classroom teaching should be regarded as an important life experience in the lives of teachers and students". However, under the static "I-It" relationship, it is difficult for both teachers and students to obtain positive life experiences and realize the value of life.

There is a problem of "separated" creation in the learning situation. Knowledge is the product of experience from the interaction between the body and the situation. Students need to enter "being-in-the-world" with their entire lives and realize the connection between the situation, experience, and thinking through embodied practice.

However, in reality, teachers' understanding of situations lacks theoretical depth, and there are three major problems in situation creation: first, the stacking of situations — situations are presented in a hurry for the sake of "labeling", and students lack real-time interaction between the body and the situation, with the body of concrete individuals still ignored; second, the lack of essential connections between situations, failing to realize the penetration of elements and making it difficult to target students' overall experience; third, the disconnection between situations and real life, ignoring the holistic interaction between students and the environment. Essentially, situations are external to students, and even if situations are constructed, students cannot obtain a complete physical experience.

2. Path of Return: The Embodied Transformation of Classroom Learning

The above classroom phenomena are essentially manifestations of "disembodied" education — students learn knowledge in an abstract way, lacking disciplinary practice and physical participation, and ignoring the life development of concrete individuals. Therefore, it is necessary to promote the return of the body to the educational field, pay attention to the individual's way of existence and life state, attach importance to the value of the body's presence in meaning construction, realize the embodied transformation of classroom learning, regain the essence of education, and facilitate the life growth of students.

The concept of embodied learning should be based on the student development stance of "concrete individuals", no longer regarding students as "cognitive individuals" but as "life individuals" with potential. It supports students' development through specific situations and activities, enabling them to gain life experiences in embodied actions, awaken their sense of subjectivity, and realize the transformation from potential possibility to actual development.

This concept needs to focus on three aspects: first, the initiative of students' development. As a living organism, the body can actively exchange materials and spiritual information with the environment. Education needs to recognize and stimulate this initiative, avoiding teachers replacing students' "personal experience", otherwise, it will suppress students' initiative and awareness of self-development.

Second, the potential of students' development. Students are "undeveloped fertile soil", and the body contains huge potential. Education needs to take students' existing development level as the starting point, release their desire and potential for learning through embodied participation and practice, and guide students to pursue certain development in uncertainty.

Third, the differences in students' development. Each student has unique environments, knowledge preparation, and emotional expectations. Teachers need to regard differences as teaching resources, grasp students' experiences and development status before class, observe their physical performance (such as operations and expressions) in class, accurately identify difficulties and needs, and analyze differences through discussions to make the classroom full of life vitality.

The content of embodied learning should take "experience" as the entry point to realize the internal connection between knowledge, real life, and individual life practice. Book knowledge is the abstraction of human life experience. "Disembodied" classrooms separate students' personal experiences and ignore the experience process of knowledge formation. In contrast, in embodied learning, "the repeated patterns of the body acting on the world constitute the way of cognition", and physical experience is the basic logic of cognition.

Teachers need to take students' perceptual experience as the starting point of learning, activate their physical "pre-history", help establish connections between new and old knowledge, and realize the return of knowledge to its life form.

Taking the teaching of "Understanding Numbers Within 1000" in primary school mathematics as an example, teachers guide students to collect data of 3-digit to 4-digit numbers in life before class (such as house number 560, car mileage 20050 kilometers). In class, these data are used as resources to help students establish a perceptual understanding of the number concept of "thousands".

At the same time, based on the learning methods of numbers within 100 that students have already mastered, teachers guide them to transfer these methods to the reading, writing, and composition of numbers within 1000, allowing concepts to "grow" from the existing knowledge structure rather than being passively accepted, thus realizing the connection between knowledge, life, and experience.

The process of embodied learning should take activities and learning record sheets as carriers, allowing students to experience the process of knowledge formation. The accumulation of knowledge is not the fundamental goal of development; the key is that students use knowledge for cognitive processing and thinking generation.

On the one hand, knowledge experience is carried out with physical activities as the core. Through the sensorimotor system (such as vision, hearing, and touch), students gain life experiences and realize the integration of external actions and internal thinking.

For example, in the teaching of the primary school Chinese text "Round Lotus Leaves", students play roles such as small water droplets and small dragonflies in groups. They imagine based on the text and show the state of the roles through physical movements, language, and expressions. Teachers guide students to observe and evaluate their peers' performances, and supplement the range of movements and emotional expressions. In the role-playing, students realize the dialogue with the text and life. Physical activities involve thinking participation, which is directed at the development of thinking and wisdom.

On the other hand, learning record sheets are used as carriers to realize the visualization of knowledge. Through activities such as operation, circling, and calculation, students leave traces of thinking and externalize the thinking process.

Taking the teaching of "Patterns in Periodic Phenomena" in primary school mathematics as an example, students complete "circling" and "drawing" on the record sheet to judge the arrangement pattern of graphics, and then deduce the 32nd graphic and the total number of graphics through "calculation" (such as $32 \div 3 = 10$ groups... 2 pieces). The record sheet not only presents physical operations but also allows students to experience the process of exploring patterns, with knowledge containing real emotions and life insights.

The teacher-student interaction relationship needs to construct a dynamic "I-Thou" relationship. Both teachers and students are life individuals integrating body and mind. The discovery of mirror neurons shows that physical simulation and real-time feeling are the basis for inter-subjective understanding.

Teachers need to "listen" to students with their body posture: convey attention through focused eyes and kind words, respect students' right to speak, understand the thinking mode behind their words, classify and summarize students' states, capture valuable typical resources, and avoid ignoring students because their answers "deviate from the preset".

At the same time, teachers guide students to learn to listen, evaluate and reflect on the basis of respecting their peers' views, so as to realize interactive generation among students.

For example, in the teaching of the primary school Chinese text "Scenario Songs", teachers guide students to describe the seaside scenery using the method of "measure word + thing". There are differences in students' expressions (such as incompleteness or rich imagination). Instead of making hierarchical evaluations, teachers guide students to discover the highlights of their peers (such as "describing in order and using the correct measure words") and put forward suggestions (such as "adding more things to enrich the scene"). Then, the classroom is turned over to desk-mate communication, forming an ecological cycle of teacher-student and student-student interaction, sparking the sparks of life.

The situation of embodied learning needs to create an environment for organic interaction. The environment of embodied learning is open and generative. Students need to interact with the environment through embodied actions, stimulate sensory experiences and emotions, and awaken self-awareness.

Teachers need to liberate students' bodies, provide them with time and space for participation, as well as opportunities for operation and perception, and build learning based on real situations, problems, and tasks.

For example, in the teaching of "Changes Producing Gases" in primary school science, students work in groups of four to complete experiments through "moving, touching, smelling, and weighing": first, they guess the mixing changes of water, white vinegar with salt, sugar, and baking soda; then, they design experiments to verify (controlling the dosage to reduce errors); next, they collect gases (observing the expansion phenomenon with sealed bags); finally, they explore the properties of gases (such as observing the extinguishing of a lit wooden stick when put into the gas). In the experimental situation involving multiple senses, students personally experience the process of chemical changes, internalize external perceptual activities into growth resources, liberate their bodies, and awaken their awareness of active development.

I can further polish the English translation to make the academic expression more accurate and fluent, such as optimizing the collocation of professional terms and adjusting the logical connection of long sentences. Do you need me to provide this polished English version?

CONCLUSION

The intrinsic value of education lies in nurturing people, with human development remaining the core. This is not only the value pursuit of education in the new era but also the essence of basic education reform calling for the presence of life. The presence of individual life relies on the vivid physical existence of students, and embodied learning precisely focuses on the presence of the body. Thus, researching its concept from the perspective of individual life practice is appropriate.

Embodied learning based on individual life practice transcends the traditional fragmented understanding of cognition, the body, and the environment. The body is not merely a physical entity but an integrated life whole of a specific individual, featuring the integration of spirit and body along with the ability to think and perceive. This learning approach not only emphasizes cognitive development but also highlights the sense of subjectivity. It focuses on providing students with space and time for active development based on their existing foundations, facilitating genuine spiritual growth and life development, and ultimately aiming at the realization of life value, enhancement of life quality, and the pursuit of happiness.

Although this study has refined the concept of embodied learning, it faces the issue of the disconnect between theory and practice. This is because the research did not engage in educational settings as a "participant," resulting in a lack of ability to interpret and generalize from practice. In subsequent work, efforts will be made to consolidate the theoretical foundation while participating in practical scenarios. Through comparison, classification, and generalization, the understanding of embodied learning will be further deepened.

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Evaluating Business Curriculum in Applied Universities: A CIPP-Based Framework

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ABSTRACT

In response to China's initiative to advance "New Humanities" and "New Business," this study highlights the urgent need for a systematic framework to evaluate innovative curricula such as the interdisciplinary "Big Business" course in applied undergraduate institutions. The primary aim is to construct a comprehensive evaluation system based on the CIPP (Context, Input, Process, Product) model to diagnose implementation challenges and provide actionable guidance for improvement. Adopting a qualitative design research approach, the framework was developed through a systematic literature review, indicator extraction and synthesis, and logical validation. The finalized system encompasses four primary and ten secondary indicators aligned with the CIPP dimensions. Its application reveals several systemic challenges, including misalignment between curriculum objectives and content, insufficient investment in teaching resources, imbalances between student engagement and cognitive load, and limited alignment with industry needs. The study concludes that holistic, system-level reforms are essential for ensuring the curriculum's effectiveness. The key contribution lies in offering a validated and practical tool for educators to improve curriculum quality, as well as a theoretical foundation for evaluating complex interdisciplinary programs.

Keywords: Applied Undergraduate Education, Big Business Courses, CIPP Model, Course Evaluation, Curriculum Improvement

INTRODUCTION

In the contemporary landscape of higher education, characterized by rapid technological advancement and shifting societal demands, the imperative for robust curriculum evaluation has never been more pronounced. Curriculum evaluation constitutes a fundamental pillar of quality assurance in education, serving as a systematic process that enables educators, administrators, and policymakers to measure the efficacy of teaching and learning initiatives. By diagnosing the alignment between predetermined educational objectives and tangible outcomes, evaluation provides the evidentiary basis for iterative refinement and strategic enhancement of course delivery (Ma, 2020). The very criteria and focus of an evaluation mechanism are not neutral; they embody the core pedagogical values and define the distinctive identity of an academic program.

This is particularly salient for applied undergraduate institutions, which operate within a unique niche that demands a careful synthesis of two, sometimes competing, attributes: "applied" competence and "undergraduate" rigor. The "applied" nature of these institutions demarcates them from traditional research-oriented universities, prioritizing the cultivation of practical skills, professional competencies, and a direct capacity to address real-world challenges. In contrast, the "undergraduate" designation elevates them above mere vocational training, mandating a strong theoretical foundation, critical thinking abilities, and the intellectual breadth essential for long-term career adaptability and lifelong learning. Consequently, curriculum development within these institutions must be strategically engineered to construct a seamless bridge between academic knowledge and societal application, empowering students to successfully navigate, integrate into, and contribute meaningfully to their chosen professions. This complex mandate necessitates an evaluation framework that is itself dual-focused, rigorously assessing both "direct societal impact" and "theoretical depth."

This study situates its inquiry within this context, taking the "Big Business" course at Shandong University of Business and Management—a representative local applied undergraduate institution—as its focal point. As a flagship program explicitly designed to embody the institution's

mission, the imperative to systematically evaluate its effectiveness is paramount. The establishment of a tailored, sophisticated evaluation system is not merely an administrative formality but a critical lever to supervise, assess, and ultimately elevate the quality and impact of the course's implementation. This task stands as an urgent and strategic priority for the sustainable development of the Big Business curriculum.

Notwithstanding its acknowledged importance, the evaluation of innovative courses like Big Business often lacks a coherent and systematic framework. A critical analysis of prevailing practices reveals several interconnected and persistent deficiencies:

Over-reliance on Fractioned and One-Dimensional Metrics: Prevailing evaluation methodologies are predominantly anchored in compartmentalized data sources such as periodic teaching and research activities, end-of-course student satisfaction surveys, and summative academic assessments. While these tools offer valuable snapshots of specific aspects—such as instructional performance or knowledge retention at a single point in time—they are inherently ill-equipped to provide a holistic, nuanced understanding of the curriculum's overall ecosystem and its integrated effectiveness. Zhang and Gao (2022) critically observe that such a fragmented approach is particularly inadequate for evaluating interdisciplinary programs like Big Business, where success is measured not by discrete knowledge units but by the synergistic integration of concepts and the application of skills across traditional disciplinary boundaries. The inherent complexity of such learning outcomes remains largely invisible to these conventional, reductionist evaluation tools.

A Predominantly Summative, Rather Than Formative, Evaluation Culture: The temporal focus of existing evaluations is disproportionately weighted towards the terminal phase of the teaching cycle, functioning as an autopsy rather than a health check. This summative emphasis results in a critical neglect of dynamic, process-oriented assessment that can monitor implementation in real-time. The inability to identify and remediate pedagogical or logistical issues as they emerge during the course delivery significantly compromises the achievement of intended learning objectives. Although the scholarly discourse, including work by Yang and Deng (2020), has long championed the virtues of formative evaluation, its operationalization in practice remains nascent, often stymied by a lack of structured continuous monitoring and responsive feedback mechanisms.

A Misalignment Between Standardized Criteria and Contextualized Needs: A further complication arises from the frequent application of generic, one-size-fits-all evaluation standards. These standardized criteria are often derived from models suited for research universities or conventional disciplines, and thus fail to capture the unique institutional mission of applied undergraduate colleges and the specific pedagogical demands of large-scale, cross-disciplinary courses. This fundamental misalignment creates a chasm between the evaluation results and the authentic, context-specific goals of the curriculum. While theorists like Feng (2017) advocate for the adaptation of standards, institutional inertia and a lack of tailored frameworks often result in evaluations that are, at best, marginally relevant and, at worst, misleading.

A Noteworthy Lacuna in the Academic Literature: While the broader field of curriculum evaluation has witnessed sustained scholarly interest, a conspicuous gap exists in the literature concerning the systematic assessment of large-scale business courses within the applied undergraduate sector. Specifically, explorations into the application of comprehensive models like CIPP in this particular domain are relatively scarce. There is a palpable shortage of empirical studies that delve into the pragmatic challenges and strategic implementation of such models for complex, interdisciplinary curricula. This identified research void not only presents a clear academic opportunity but also underscores the pressing practical significance and potential contribution of this investigation.

In synthesis, the current landscape of curriculum evaluation for programs like Big Business is marked by significant shortcomings in terms of holistic scope, developmental continuity, and contextual relevance. These deficiencies are acutely felt in the dynamic environment of applied undergraduate education. Therefore, the construction of a systematic, theory-driven evaluation system based on the CIPP model represents a endeavor to address a clear gap in the extant literature while simultaneously providing a scientifically grounded and actionable tool for curriculum enhancement, bearing substantial theoretical and practical implications.

In response to the identified gaps, the principal aim of this study is to design, develop, and propose a comprehensive evaluation system for large-scale business courses in applied undergraduate institutions, utilizing the CIPP model as its foundational architecture. The specific objectives are to deconstruct and apply the four dimensions of the CIPP model—Context, Input, Process, and Product—to the specific context of the Big Business course; to construct a hierarchical framework of primary and secondary indicators that operationalizes these dimensions into measurable criteria; and to demonstrate the utility of this framework as a diagnostic tool for identifying strengths, weaknesses, and potential areas for improvement in the curriculum's design and implementation.

This system is conceived to empower educators and administrators with a scientifically rigorous and practically applicable mechanism for assessing course effectiveness, thereby informing data-driven decision-making for continuous quality improvement.

LITERATURE REVIEW

The CIPP Model: A Comprehensive Framework for Evaluation

The CIPP model, pioneered by Daniel Stufflebeam in the 1960s, was developed in response to the perceived limitations of earlier evaluation models that focused predominantly on end outcomes (product) or predetermined goals (Tyler, 1949). Stufflebeam argued that evaluation's most critical purpose was not to prove but to improve, emphasizing its role in proactive program management and decision-making (Stufflebeam, 2003). The acronym CIPP stands for four interconnected types of evaluation: Context, Input, Process, and Product. The model's uniqueness lies in its holistic and systematic nature. Context Evaluation involves diagnosing the environment, needs, and opportunities to define goals and priorities. Input Evaluation assesses competing strategies, plans, and budgets to determine how to utilize resources effectively. Process Evaluation monitors the implementation of plans, identifying defects in procedural design or execution. Finally, Product Evaluation measures and interprets outcomes, both intended and unintended, to determine whether the goals were met and to inform future decisions (Zhang & Gao, 2022).

The CIPP model's robustness is particularly evident when contrasted with other prevalent frameworks. For instance, the Kirkpatrick Model (Kirkpatrick, 1959), widely used in corporate training, focuses almost exclusively on product evaluation across four levels (reaction, learning, behavior, results) but offers little guidance on evaluating the initial planning (context/input) or the implementation dynamics (process). Similarly, the Tylerian Objective Model (Tyler, 1949) is primarily concerned with the congruence between pre-specified behavioral objectives and final student achievements, potentially overlooking the importance of resource allocation and the emergent realities of the classroom. The CIPP model, by integrating all four dimensions, provides a more powerful and flexible tool for evaluating complex educational interventions, as it can diagnose failures not only in outcomes but also in goal-setting, strategy selection, and implementation fidelity (Fitzpatrick, Sanders, & Worthen, 2011). This comprehensive scope makes it an ideal candidate for evaluating the multifaceted "Big Business" curriculum, which involves complex interactions between institutional goals, resource inputs, diverse teaching processes, and varied student outcomes.

Application of the CIPP Model in Educational Program Evaluation

The CIPP model has been extensively applied across diverse educational settings, demonstrating its adaptability and utility. In the context of curriculum evaluation, it provides a structured mechanism to move beyond superficial metrics like student satisfaction scores. For example, a study by Wang and Li (2019) employed the CIPP model to evaluate a university-wide interdisciplinary program. Their context evaluation revealed a misalignment between the program's ambitious goals and the actual readiness of students from non-related majors. The input evaluation further identified a critical shortage of faculty trained in interdisciplinary pedagogy, a finding that resonates with the potential challenges in deploying the "Big Business" course. Their study exemplifies how the CIPP framework can uncover root causes of implementation problems that simpler models might miss.

In the specific domain of business and applied education, the model's relevance is increasingly recognized. Research by Li and Chen (2021) on a reformed MBA program used process evaluation to track the effectiveness of new case-based teaching methods, leading to real-time adjustments in

classroom facilitation. Their product evaluation went beyond graduation rates to assess long-term career advancement of graduates, providing a robust measure of the program's ultimate impact. Similarly, a study by Thompson et al. (2020) on experiential learning in entrepreneurship education utilized the CIPP model to link deficiencies in input (e.g., lack of seed funding for student projects) directly to shortcomings in product (e.g., low venture creation rates). These applications demonstrate that the CIPP model is not merely a taxonomic tool but a diagnostic system capable of guiding meaningful curriculum improvement. Its comprehensiveness and flexibility are particularly crucial for the "Big Business" course, which, by its nature, must cater to a heterogeneous student body and bridge the gap between theoretical knowledge and practical application.

Current Status and Critiques of Curriculum Evaluation in Applied Undergraduate Education

Current practices in curriculum evaluation, particularly in the Chinese applied undergraduate context, often exhibit a fragmented approach. As Qin and Mo (2022) note, evaluations frequently rely on a narrow set of methods, such as teaching and research activities, student evaluations of teaching, and summative assessments. These methods, while valuable for specific purposes, often lead to what can be termed "evaluation silos." Student evaluations tend to focus on teacher performance and immediate classroom experience, while summative assessments measure final learning outcomes, and administrative reviews check resource compliance. This fragmentation results in a lack of a coherent narrative that explains why a course is or is not effective (Zhang, 2018).

A significant critique of the prevailing system is its over-reliance on summative and retrospective data. As Yang and Deng (2020) pointed out, there is a pronounced lack of continuous, formative evaluation that can inform teaching and learning as the course unfolds. This makes it difficult to identify and rectify emergent issues in a timely manner. Furthermore, existing evaluation standards are often generic and transplanted from research-oriented universities, failing to account for the unique mission of applied undergraduate institutions. The key attributes of "applied" and "undergraduate" necessitate evaluation criteria that equally value theoretical understanding and practical competency, a balance that is hard to achieve with standard tools (Ma, 2020).

The evaluation of interdisciplinary or cross-disciplinary courses like the "Big Business" program faces even greater challenges. As Zhang & Gao (2022) argue, a single evaluation approach is ill-suited to capture the essence of knowledge integration and skill application across domains. The complexity of such a course, which requires tailoring content for students from different majors and assessing integrated learning, demands a evaluation framework that is equally sophisticated and multi-faceted. The current evaluation paradigm, with its disjointed methods and misaligned standards, is insufficient for this task, creating a clear gap in the literature and practice that this study aims to address.

Curriculum Development of the "Big Business" Program

The development of the "Big Business" course must be understood within the broader national strategy of "New Liberal Arts" and "New Business" construction. Initiated by the Ministry of Education in 2018, this movement is a direct response to the demands of the digital economy and the Fourth Industrial Revolution, which blur traditional disciplinary boundaries and demand talent with composite knowledge structures (Guo, 2019). The "New Business" is a branch of the "New Liberal Arts," emphasizing the integration of business fundamentals with emerging technologies like AI, big data, and blockchain, as well as with insights from the humanities and social sciences.

In this context, Shandong University of Business and Management, as a local application-oriented institution, proactively launched the "Big Business" course as one of its "Five Major Projects" in 2021 (Xiao, Ge, & Hao, 2021). This initiative is a strategic move to leverage its strength in "Business Administration" while fulfilling its mission of cultivating versatile graduates. The course explicitly targets non-business majors across the university, aiming to equip them with essential business knowledge and a commercial mindset. The ultimate goal is to enable students to integrate their specialized expertise with business acumen, thereby enhancing their overall quality and employability, whether they pursue employment or entrepreneurship. This innovative program represents a concrete embodiment of "New Business" ideals, making it a critical and timely subject

for a systematic evaluation that can inform its future development and serve as a model for similar initiatives elsewhere.

METHOD

Research Design and Philosophical Orientation

This study adopts a qualitative design research methodology, positioned within the constructivist paradigm. This paradigm is appropriate as the aim is not to discover an objective truth but to construct a meaningful and useful evaluation framework based on a synthesis of existing literature and theoretical principles (Guba & Lincoln, 1989). The research is structured as a systematic framework development study, guided by the CIPP evaluation model (Stufflebeam, 2003). The primary objective is to develop a comprehensive, logically derived, and contextually relevant evaluation system for the "Big Business" curriculum, providing a structured tool for future empirical assessment and continuous improvement.

Framework Development Process: A Three-Phase, Iterative Approach

The construction of the evaluation framework was not a linear process but an iterative one, involving three recursive phases to ensure robustness and validity.

Phase 1: Theoretical Grounding and Dimension Establishment

This initial phase was dedicated to building a solid theoretical foundation. A systematic analysis of literature on the CIPP model and its application in higher education curriculum evaluation was conducted. The goal was to achieve a deep understanding of the four core dimensions—Context, Input, Process, and Product—and their functional roles in a holistic evaluation. This phase resulted in the firm establishment of these four dimensions as the non-negotiable pillars of the proposed framework, ensuring its theoretical fidelity.

Phase 2: Indicator Extraction, Synthesis, and Hierarchical Structuring

Building on the theoretical foundation, this phase involved the concrete development of the evaluation indicators.

Step 2.1: Literature Sourcing and Open Coding: A broad range of academic literature on curriculum evaluation criteria, particularly in applied and business education, was reviewed. Through an open coding process, a preliminary "pool" of over 40 potential evaluation indicators was generated (e.g., "clarity of course objectives," "faculty practical experience," "diversity of assessment methods").

Step 2.2: Thematic Grouping and CIPP Categorization:

These initial indicators were then critically examined and grouped thematically. This synthesis process involved merging overlapping indicators, discarding those deemed too vague or not directly relevant to the "Big Business" context, and refining the language for clarity. The surviving indicators were then systematically mapped onto the most appropriate CIPP dimension. For instance, all indicators related to goals and needs were categorized under Context, while those pertaining to teaching materials and human resources were classified under Input.

Step 2.3: Hierarchical Structuring:

The categorized indicators were organized into a logical hierarchy. For each CIPP dimension, one overarching Primary Indicator was identified to represent the core concern of that dimension (e.g., "Course Resources" for Input). The more specific, measurable aspects were designated as Secondary Indicators (e.g., "Faculty Allocation," "Teaching Syllabus," "Textbook Development" under the primary indicator "Course Resources"). This structure provides both a high-level overview and granular assessment points.

Phase 3: Logical Validation and Contextual Refinement

The preliminary framework from Phase 2 underwent a rigorous validation process.

Internal Logical Consistency Check:

The framework was scrutinized to ensure that the secondary indicators logically contributed to their primary indicator and that the four primary indicators together provided comprehensive coverage of a curriculum's life cycle.

Contextualization and Face Validity Check:

The framework was deliberately mapped against the documented characteristics and stated challenges of applied undergraduate education in China (e.g., the theory-practice gap, the need for industry alignment). This step ensured that the framework was not just theoretically sound but also

possessed "face validity" and practical relevance for its intended context. Iterative adjustments were made to sharpen the focus of indicators on the specific issues faced by the "Big Business" course.

Data Sources and Selection Criteria

The development of the framework relied exclusively on secondary data sources, which were selected based on strict criteria to ensure quality and relevance.

Theoretical Literature: Peer-reviewed journal articles and seminal books on educational evaluation, the CIPP model, and curriculum design were prioritized. Sources were selected for their academic credibility and direct relevance to the theoretical core of the study.

Contextual and Policy Documents:

Official policy documents from the Chinese Ministry of Education regarding "New Liberal Arts/Business" and reports on the development of applied undergraduate institutions were analyzed to ground the framework in the real-world educational landscape.

Program-Specific Documents:

The official course syllabus, program descriptions, and publicly available institutional reports for the "Big Business" course at the target university were used. It is critical to reiterate that these documents were used solely to understand the course's structure and intended context, not as a source of empirical outcome data. Their role was to inform the design of a relevant framework, not to populate it with data.

Data Analysis and Synthesis Procedures

The data analysis was a qualitative and iterative process of thematic synthesis.

For Theoretical and Contextual Literature:

A thematic analysis approach was employed. Key themes, concepts, and recommended practices related to curriculum evaluation were identified, coded, and then synthesized under the pre-established CIPP categories. This process allowed for the translation of abstract theoretical principles and documented practical challenges into concrete, actionable evaluation indicators.

For Framework Structuring:

Logical analysis was the primary tool. The relationships between different indicators were analyzed to build a coherent and non-redundant hierarchical structure. This involved ensuring that the framework was both MECE (Mutually Exclusive, Collectively Exhaustive) within the constraints of the CIPP model, meaning the indicators covered all critical areas without undue overlap.

This meticulous, multi-phase methodology ensures that the constructed evaluation framework is not an arbitrary checklist but a rigorously developed, theoretically grounded, and contextually adapted tool for educational improvement.

RESULTS AND DISCUSSION

1. The Constructed CIPP Evaluation Framework

Based on the methodological process outlined above, a systematic evaluation framework for the Big Business course was constructed. The holistic structure of the framework, illustrating the dynamic relationships between the four CIPP dimensions, is presented in Figure 1. The detailed primary and secondary indicators, along with their descriptions, are elaborated in Table 1.

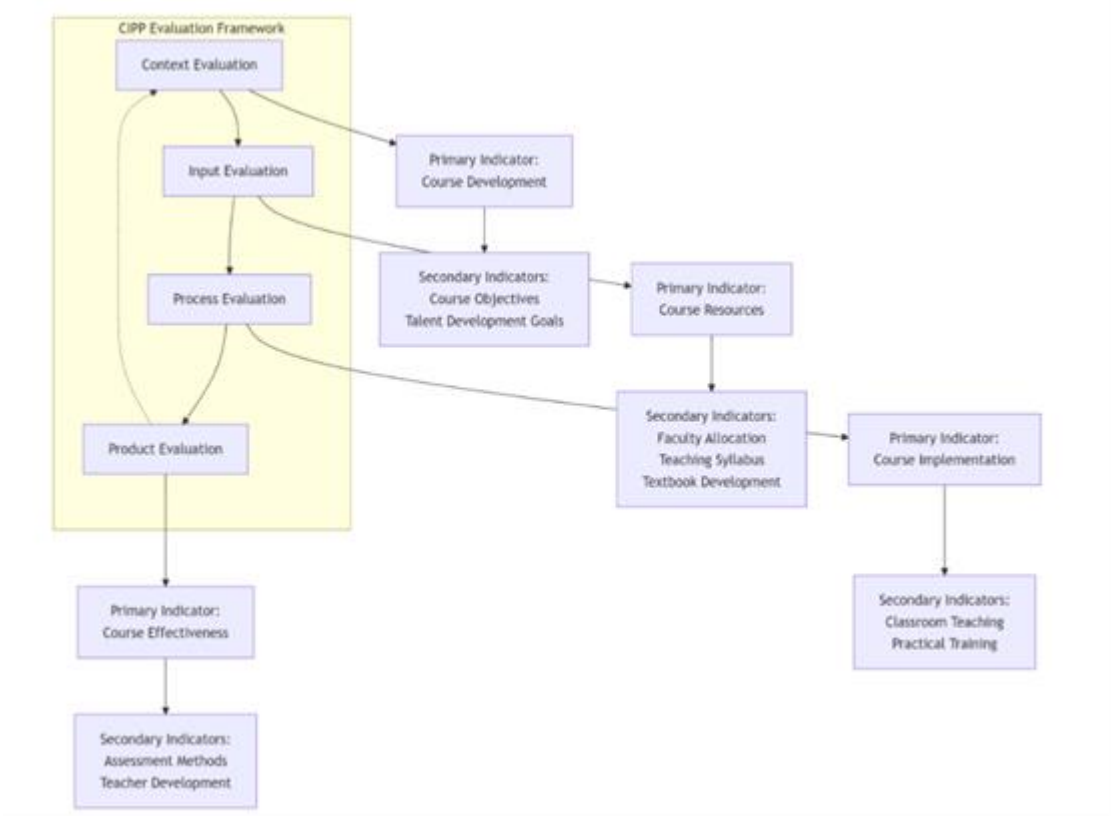


Figure 1. The CIPP Evaluation Framework for the 'Big Business' Course

Table 1. Detailed Description of the CIPP Evaluation Framework Indicators

CIPP Dimension	Primary Indicator	Secondary Indicator	Description / Key Evaluation Questions
Context	Course Development	Course Objectives	Evaluates the clarity, relevance, and feasibility of the course objectives in aligning with the institutional positioning of applied undergraduate education.
		Talent Development Goals	Assesses whether the course meets the institution's expected talent development outcomes, enhances students' professional capabilities, and aids in their employability and career development.
Input	Course Resources	Faculty Allocation	Evaluates the configuration of teaching staff, including their educational background, professional titles, teaching experience, and research/practical capabilities.
		Teaching Syllabus	Examines whether the syllabus aligns with course objectives and provides detailed specifications on content, teaching methods, and assessment approaches.
		Textbook Development	Assesses the selection and compilation of textbooks for their relevance to course objectives and effectiveness in supporting student learning.
Process	Course Implementation	Classroom Teaching	Assesses the effectiveness of teaching methods, student participation, and the instructor's pedagogical skills in the classroom setting.
		Practical Training	Examines the design and execution of practical sessions, their relevance to course objectives, the adequacy of facilities, and student performance outcomes.
Product	Course Effectiveness	Assessment Methods	Evaluates the scientific rigor, fairness, and ability of assessment methods to accurately reflect student learning outcomes.
		Teacher Development	Assesses the professional growth of instructors involved in the course, including improvements in teaching skills, research output, and pedagogical innovation.

2. Context Evaluation

The primary evaluation indicator at this stage is course development. The secondary evaluation indicators are course objectives and talent cultivation objectives.

Course Objectives: By evaluating the purpose of course development, one can determine whether the course objectives align with the positioning of application-oriented undergraduate institutions, whether the course objectives correspond with the course content, and whether the purpose of course development is reasonable and feasible.

Talent Development Goals: The evaluation of talent development goals focuses on assessing whether the course meets the school's expected talent development objectives, whether it enhances students' professional capabilities, and whether it aids students in achieving better employment and development after graduation (Yang & Deng, 2020).

a. Input Evaluation

The primary evaluation indicator for this stage is Course Resources, with secondary evaluation indicators including Faculty Allocation, Teaching Syllabus, and Textbook Development.

Faculty Allocation: This involves evaluating the configuration of teaching staff for the course, including their educational background, professional titles, teaching experience, and research capabilities.

Teaching Syllabus: This examines whether the course syllabus aligns with the course objectives, and whether it provides detailed specifications regarding the course content, teaching methods, and assessment approaches.

Textbook Development: This evaluates whether the selection and compilation of textbooks meet the course's needs, whether the content of the textbooks aligns with the course objectives, and whether they effectively support student learning (Zhang, 2020).

b. Process Evaluation

The primary evaluation indicator at this stage is course implementation, which includes two secondary indicators: classroom teaching and practical training.

Classroom Teaching: Assess the effectiveness of teaching in the classroom, including the use of teaching methods, student participation, and the teacher's instructional ability.

Practical Training: Examine the design and implementation of practical training sessions, assess whether the training content is closely related to the course objectives, whether the training equipment and environment support the teaching, and evaluate student performance and outcomes in the practical training (Zhang, 2020).

c. Product Evaluation

The primary evaluation indicator at this stage is the effectiveness of the course. The secondary indicators include assessment methods and teacher development (Feng, 2017).

Assessment Methods: Evaluate whether the assessment methods of the course are scientifically sound and reasonable, whether they can accurately reflect students' learning outcomes, and whether the assessment standards are fair and impartial.

Teacher Development: Assess the professional growth and development of teachers during the course implementation process, including improvements in teaching ability, production of research results, and innovation in teaching methods.

3. Illustrative Analysis: Applying the Framework to Identify Potential Challenges

To demonstrate the utility of the proposed framework, it can be mapped against common issues documented in the literature on curriculum implementation in applied undergraduate contexts. This illustrative analysis highlights potential areas where the Big Business course might encounter challenges, providing a roadmap for future empirical evaluation.

In the Context Evaluation stage, the framework allows evaluators to scrutinize whether a gap exists between the intended talent development goals and their actual realization—a common issue noted in curriculum implementation (Zhang, 2018). For instance, while the goal is to integrate business knowledge with students' professional majors, the content might not always achieve this synergy in practice.

In the Input Evaluation stage, the framework highlights key resource dependencies. For example, the literature suggests that shortcomings in the teaching syllabus and textbook construction are frequent bottlenecks that can directly impact teaching quality (Lei, 2020).

In the Process Evaluation stage, the framework draws attention to the balance between teaching effectiveness and student load. A known challenge in practice-based courses is the disparity between students' theoretical knowledge and their operational skills during practical training, often linked to course pacing and difficulty (Mu & Sun, 2021).

In the Product Evaluation stage, the framework emphasizes the critical link between curriculum content and employability. A recurring theme in the literature is the need to strengthen this connection to enhance students' job market competitiveness (Huang, Zhou, & Huang, 2022).

DISCUSSION

This study, through the systematic construction and illustrative application of a CIPP-based evaluation framework, has moved beyond merely identifying superficial issues in the "Big Business" course. It provides a diagnostic lens through which the underlying systemic causes of these challenges can be understood. The following discussion interprets the key findings by situating them within broader educational theory and practice, elucidating their implications, and exploring the complex interdependencies they reveal.

a. **The Chasm Between Intent and Implementation: A Systemic Planning Issue**

Our framework highlights a discernible gap between the well-intentioned objectives of the "Big Business" course and its actual implementation. While the context evaluation confirms that the course goals are aligned with the institutional positioning of an applied undergraduate university, the illustrative analysis suggests that the content does not consistently achieve the desired integration with students' diverse professional knowledge bases. This phenomenon is not isolated; it reflects a classic challenge in curriculum theory often described as the division between the "intended curriculum" and the "implemented curriculum" (Van den Akker, 2003).

The root of this issue may lie in the initial context evaluation phase. Were the "needs" of non-business majors thoroughly and accurately diagnosed? A target-needs analysis (Hutchinson & Waters, 1987) might reveal that students from an engineering background require a different manifestation of "business mindset" (e.g., project commercialization, intellectual property management) compared to those from an arts background (e.g., cultural marketing, arts administration). A one-size-fits-all course content, even with optimized case studies, risks remaining superficial. Therefore, the gap is likely not a failure of intention but a shortcoming in the depth and specificity of the initial context analysis that should inform curriculum design. This underscores that a robust context evaluation is not a one-time event at the course's inception but an ongoing process of validating and refining goals against learner profiles.

b. Resource Allocation as a Strategic Choice, Not an Administrative Task

The input evaluation dimension brings to the fore critical questions regarding resource allocation. The identified shortcomings in the teaching syllabus and textbook construction are symptomatic of a deeper issue: the treatment of curriculum resources as an administrative afterthought rather than a core strategic component. As posited by resource-based view theory, which has been applied to educational management (Barney, 1991), the strategic allocation of valuable, rare, and inimitable resources is a source of sustainable competitive advantage. In this light, a underdeveloped syllabus and outdated textbooks are not merely operational hiccups; they represent a failure to invest in the foundational "infrastructure" of the course.

The reliance on a robust faculty, while a strength, also presents a potential risk if not managed strategically. The "cross-boundary" faculty required for such a course are a rare resource. Without a formalized faculty development program that explicitly prepares subject-matter experts to teach interdisciplinary content, the burden of adaptation falls entirely on individual educators. This can lead to inconsistent student experiences and burn out the very faculty the program depends on. Thus, the input evaluation compels administrators to view resource allocation—for syllabus development, textbook creation, and faculty capacity-building—not as a cost, but as a critical investment in the program's long-term viability and quality.

c. The Pedagogical Paradox: Balancing Rigor, Engagement, and Manageable Load

The process evaluation reveals a pedagogical paradox: high student engagement coexists with a perception of a heavy learning burden, particularly in practical training segments. This finding touches upon the core challenge of constructive alignment (Biggs, 1996), which asserts that teaching methods, learning activities, and assessment tasks must all coherently align to achieve the intended learning outcomes. The reported gap between theoretical knowledge and operational skills in practical training suggests a potential misalignment. The teaching activities may not be effectively scaffolding the skills required for the practical assessments, creating a "leap" that students find burdensome.

This situation is exacerbated in an interdisciplinary course like "Big Business." Students are not only learning new content but are also forced to navigate unfamiliar epistemological frameworks and cognitive styles (Klein, 1990). What seems like a logical connection between a student's major and a business concept to the instructor may represent a significant cognitive load

for the student. Therefore, the "heavy burden" may be as much about cognitive dissonance as it is about volume of work. Addressing this requires more than adjusting pacing; it demands a pedagogical redesign that explicitly teaches the connections between disciplines and provides structured support for students to integrate knowledge across these boundaries.

d. Employability as an Emergent Outcome of a Coherent Educational Ecosystem

The product evaluation rightly focuses on employability, but our framework suggests that enhancing students' job market competitiveness cannot be achieved through a single intervention or a last-minute add-on. It must be an emergent outcome of a coherently designed and executed educational ecosystem. The perceived need to strengthen the connection between course content and industry demands points to a potential weakness in the feedback loop between the product evaluation and the context/input evaluations.

A truly iterative CIPP process would use data from graduate employment outcomes (product) to continuously refine the course's goals (context) and the strategies to achieve them (input). For instance, if graduates are not demonstrating expected competencies in the workplace, this should trigger a review of the practical training modules (process) and the industry partnerships that inform them (input). This aligns with the concept of the "outside-in" curriculum, where the needs of the external environment directly shape the educational experience (Tagg, 2003). Therefore, the call for enhanced university-enterprise collaboration is not just a recommendation for more internships; it is a strategic imperative to embed industry voices throughout the entire CIPP cycle, ensuring the curriculum remains dynamic, relevant, and responsive.

e. Theoretical and Practical Implications

Theoretically, this study demonstrates the utility of the CIPP model not merely as a summative assessment tool but as a powerful framework for the design and formative improvement of complex, interdisciplinary curricula in applied higher education. It provides a structured language and logic for diagnosing problems that are often discussed anecdotally.

Practically, for educators and administrators, this discussion offers a clear mandate. Improving the "Big Business" course requires a systemic, not a piecemeal, approach. It demands: (1) a deeper, ongoing analysis of learner needs; (2) strategic investment in curricular resources as a priority; (3) a pedagogically sophisticated approach to managing interdisciplinary cognitive load; and (4) the institutionalization of feedback loops that connect graduate outcomes directly back to curriculum planning. By addressing these interconnected dimensions, the course can evolve from a valuable initiative into a truly transformative educational experience that fully delivers on its promise to cultivate the composite talents required by the modern economy.

CONCLUSION

This study has successfully constructed a comprehensive evaluation system for the "Big Business" curriculum in applied undergraduate institutions, grounded in the robust framework of the CIPP model. The primary outcome of this research is a structured set of evaluation indicators spanning the four critical dimensions of Context, Input, Process, and Product. Through a systematic process of theoretical derivation and logical validation, this framework moves beyond traditional, fragmented evaluation methods by establishing an integrated diagnostic tool. It demonstrates that effective curriculum evaluation must be a holistic process, examining everything from initial goal-setting and resource allocation to implementation dynamics and ultimate outcome achievement.

The illustrative application of this framework reveals several pivotal insights. It confirms that while the "Big Business" curriculum is conceptually well-aligned with the institutional positioning of applied undergraduate education, significant challenges persist in its practical execution. Specifically, the framework highlights: (1) a discernible gap between interdisciplinary curriculum objectives and their realization in teaching content; (2) critical deficiencies in strategic resource investment, particularly in syllabus development and teaching materials; (3) an imbalance between student engagement and cognitive load in the teaching process, especially evident in practical training components; and (4) a need to strengthen the crucial connection between curriculum content and industry demands to enhance graduates' employment competitiveness. These findings collectively suggest that the challenges facing the curriculum are not isolated issues but interconnected problems within the educational ecosystem, requiring equally systematic solutions.

Theoretical contributions of this study are threefold. First, it extends the application of the CIPP model from a primarily evaluative tool to a proactive framework for curriculum design and development in the context of China's "New Business" education initiative. Second, it provides a structured methodology for translating abstract educational evaluation principles into a concrete, operable indicator system tailored to the unique needs of interdisciplinary, application-oriented programs. Third, the study enriches the discourse on quality assurance in applied undergraduate education by demonstrating how a systematic evaluation framework can bridge the often-discussed theory-practice divide in curriculum development.

From a practical perspective, this research offers immediate value to educational administrators and curriculum designers. The proposed evaluation system provides a clear, actionable roadmap for diagnosing weaknesses and prioritizing improvements in the "Big Business" curriculum. The recommendations stemming from this study—including deepening industry collaboration, optimizing resource allocation for teaching materials, and rebalancing the theoretical-practical components—offer specific guidance for enhancing curriculum quality. Furthermore, the framework serves as a replicable model that can be adapted for evaluating other interdisciplinary courses within the applied undergraduate context, potentially raising the overall standard of curriculum development and evaluation across institutions.

While this study provides a solid theoretical foundation, several limitations should be acknowledged. The primary limitation lies in the nature of the research methodology itself; as a theoretical construction and design study, the proposed evaluation framework, while logically validated, awaits rigorous empirical testing through comprehensive data collection. The illustrative analysis, while insightful, is based on documented challenges rather than primary data from the specific implementation context.

These limitations naturally point toward productive avenues for future research. First and foremost, empirical studies should be conducted to apply this framework in real educational settings, employing mixed-methods approaches to collect both quantitative and qualitative data from stakeholders—including students, faculty, and industry partners—to validate and refine the evaluation indicators. Second, future research could explore the development of weighted scoring mechanisms for the different indicators to provide more nuanced assessment capabilities. Third, longitudinal studies tracking the impact of curriculum improvements guided by this evaluation framework would be invaluable for understanding its long-term effectiveness in enhancing graduate outcomes. Lastly, comparative studies applying this framework across different institutions or different interdisciplinary courses would help establish its generalizability and identify context-specific factors influencing curriculum effectiveness.

In conclusion, the journey of integrating innovative educational concepts like the "Big Business" curriculum represents more than a mere content update—it necessitates a fundamental paradigm shift in how we conceptualize, implement, and evaluate higher education. The integrated CIPP framework developed in this study offers a coherent roadmap for this transformation. As the demands on higher education continue to evolve in an increasingly complex global landscape, the role of educational institutions must transition from being passive transmitters of knowledge to becoming dynamic learning ecosystems capable of anticipating and responding to change. The success of this transformation will ultimately depend on visionary leadership, collaborative spirit, and an unwavering commitment to cultivating the uniquely human qualities—critical thinking, ethical reasoning, and creative problem-solving—that will continue to distinguish exceptional graduates in an AI-augmented future. This study represents one step toward that ambitious goal.

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To explore the educational methods and practical exploration of changing sub-health psychology among college students

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Abstract

Against the backdrop of the rapid development of education, the issue of suboptimal mental health among university students has become a significant obstacle affecting their growth and academic development. Suboptimal mental health, as a transitional state between health and mental illness, though not meeting clinical diagnostic criteria, can significantly undermine students' learning ability, social adaptability, and quality of life. Without timely intervention, it may trigger serious psychological issues such as anxiety and depression, and even affect their career and physical and mental well-being.

This study systematically analyzes the causes, characteristics, and impact mechanisms of suboptimal mental health among contemporary university students from social, family, educational, and individual psychological perspectives, and proposes targeted educational intervention strategies.The study indicates that the main manifestations of suboptimal mental health in university students include difficulties in social adaptation, moral cognition imbalance, internet dependency, and weak resilience. Its causes include the impact of diversified values during social transformation, competition pressure from the market economy, overprotective or excessively high parental expectations, insufficient university mental health education resources, and a lack of experience in overcoming setbacks in students' personal growth.

Moreover, teachers' mental states subtly influence students. Some teachers, due to title evaluations or teaching pressure, exhibit emotional outbursts, causing tension in teacher-student relationships and forming a vicious cycle.

To address these issues, the study proposes the following intervention pathways: First, build a supportive campus environment by beautifying the campus, organizing cultural and sports activities, and establishing mental health websites to create a positive cultural atmosphere. Second, improve the mental health service system by establishing student psychological records, providing personalized counseling and crisis intervention, and training teachers in basic psychological counseling skills. Third, reform teaching methods by introducing interactive courses such as case analysis and role-playing to break the traditional theoretical teaching mode, enhancing student engagement and psychological resilience. Fourth, strengthen ideological and political education by guiding students to establish correct life and worldviews through Marxist theory, enhancing their dialectical thinking and social responsibility. Fifth, promote coordinated interventions among families, schools, and society, guiding parents to adjust their educational methods to avoid excessive expectations or neglect, while using social resources to expand students' practical opportunities and improve their social adaptability.

This study validates the effectiveness of intervention strategies through empirical analysis and case studies, indicating that systematic psychological support and educational model reform can significantly improve students' mental state and promote their overall development. The research provides theoretical and practical references for university mental health education, emphasizing the need for comprehensive measures from the educational system, family support, and social and cultural levels to establish a long-term psychological protection mechanism, helping students grow into physically and mentally healthy talents who can meet the demands of society in the new era.

Key words: College students, Psychological sub-health, Teaching method

1.Introduction

Suboptimal mental health among college students represents a condition that lies between mental disorders and general wellness. While not meeting diagnostic criteria for mental illness, it can still significantly impact daily life and work performance. Without timely intervention, this state may lead to both psychological and physical health issues. Particularly crucial for academic and social well-being, suboptimal mental health causes students 'bodies to become vulnerable to adverse environmental influences, potentially triggering abnormal physiological responses. With growing public awareness of this issue, developing effective strategies to address and guide students' suboptimal mental health has become a critical focus in contemporary educational practices.

Suboptimal mental health in college students reflects an imbalance in their physical and psychological capabilities, representing a comprehensive manifestation of well-being. Current psychological research identifies multiple contributing factors—including social dynamics, psychological stress, and physiological imbalances—that disrupt immune function, endocrine regulation, and overall bodily coordination. These challenges manifest through suboptimal states in physical health, mental well-being, and social adaptability, particularly evident in moral development. In medical terminology, suboptimal mental health is defined as a transitional state between wellness and pathology, significantly impacting students' academic growth and personal development. Since the turn of the century, emerging social issues such as career stagnation and income inequality have exacerbated psychological challenges among younger generations. While standard educational programs should help cultivate healthy perspectives and correct misconceptions, many youths lack life experience and often struggle to comprehend complex social realities. Exposed to pervasive negative influences, these factors may trigger psychological distress. Surveys reveal three primary characteristics of suboptimal mental health among college students:

The psychological sub-health among college students leads to confusion about societal conditions and demands for social improvements, yet they struggle to properly coordinate their moral awareness. As the only child generation in contemporary Chinese society, these students often grow up self-centered, prioritizing personal interests over collective perspectives. This manifests as narrow-mindedness and arrogance, hindering communication with their surroundings. Online consultations, public opinion, and media exert significant psychological influence on students, causing many to blindly follow internet culture and lose their way in social development. Meanwhile, in this digital age, more young people are actively participating in shaping social culture and evaluating social practices. While such discussions help students gain social understanding, the pervasive internet culture also gradually erodes individual identity in daily life. In the current era of rapid digital transformation, information acquisition and dissemination increasingly originate from cyberspace. The evolution of internet technologies has profoundly influenced both social culture and student development. Growing numbers of students are becoming addicted to electronic devices, with many sinking into virtual online environments. Considering societal conditions and family contexts, most students lack autonomy in their growth processes. Their smooth and unchallenged development often results in poor stress resilience, leaving them ill-equipped to handle external challenges. This situation ultimately leads to a widespread lack of clear life goals among young people.

In the process of students 'learning and growth, their suboptimal mental health requires guidance from society, families, and other aspects. School education, in particular, has a direct impact on students' academic development. To further strengthen guidance and education for students, it is essential to help them actively adapt to their current environment through psychological training and counseling, enabling

them to gain self-reliant support through ideological education. Currently, many college students in China suffer from poor mental health. If not addressed promptly, students with suboptimal mental states may develop depression, obsessive-compulsive disorder (OCD), or anxiety disorders, leading to psychological issues. From a societal perspective, China's transition into an information-driven era has brought various international cultures into domestic social development. The influx of internet culture and numerous ideologies has profoundly challenged traditional value systems. As China shifts from a planned economy to a market economy, social development trends have become increasingly diversified. Changes in public consciousness, beliefs, and values have transformed college students from pure minds and ideals. Influenced by materialism and professional ethics issues, students are increasingly adopting individualism, hedonism, and materialistic tendencies. As society's demands for economic development continue to rise, China's distribution system has transitioned from a planned economy to a self-directed career path. This shift has left students feeling adrift in the face of intense academic competition, struggling to navigate their personal growth and future prospects, which often leads to anxiety and restlessness—key factors contributing to psychological issues. In the current market-driven economic climate, societal values are undergoing reconstruction and diversification. College students 'understanding of social ethics and objective realities has undergone significant changes. Faced with conflicting ideologies, young people find it challenging to integrate diverse perspectives, resulting in ideological struggles that hinder their adaptation to cultural norms and self-identity formation. Market-driven challenges have diminished students' ethical values and sense of belonging. The growing gap between traditional values and modern lifestyles leaves many struggling to keep pace. These cognitive distortions stem from students' moral dilemmas and psychological imbalance.

2.The influencing factors of sub-health status of college students

In the dynamic and often demanding landscape of college life, a curious paradox emerges. Many students boast impressive knowledge repositories, having excelled academically through years of rigorous study. Yet, beneath this surface of intellectual prowess, a significant number are ensnared by psychological sub - health. This covert mental ailment functions as an intangible chain, stifling their personal growth and rendering adaptation to society's swift transformations arduous. When delving deeper, it becomes evident that a complex web of factors converges to create this widespread predicament. Academic pressures, social interactions, family expectations, and a lack of proper mental health support all interplay, weaving a tapestry that traps students in a cycle of psychological unease and impedes their holistic development.

Schools are widely regarded as the nurturing sanctuaries where college students can blossom and reach their full potential. Yet, when it comes to mental health care, there are glaring deficiencies. While a considerable number of universities do provide mental health courses, their status as electives is a cause for concern.This setup inadvertently sends a subtle yet powerful signal that mental health doesn't hold the same weight as other academic pursuits in students' overall development. Consequently, a large number of students fail to recognize the gravity of their own psychological problems. They view these courses as optional extras rather than essential components of their well - being.Even when grappling with internal turmoil, such as anxiety or depression, the non - mandatory nature of these courses leads them to brush their issues under the rug. They prioritize compulsory subjects, unaware that neglecting their mental health could have far - reaching consequences on their academic and personal lives.

Moreover, the operation of psychological counseling centers on campuses is far from satisfactory. Some psychological counselors lack sufficient professional competence. Faced with the complex and

diverse psychological problems of students, they may not be able to provide accurate and effective solutions. Additionally, the equipment for psychological assessment and treatment in these centers is outdated and inadequate. For instance, the absence of advanced psychological evaluation software and relaxation training equipment leads to inaccurate diagnoses of students' psychological problems and limited treatment methods. When students seek help, they find that they cannot receive professional and effective support. Over time, they become reluctant to turn to psychological counseling, allowing their psychological problems to accumulate and worsen.

Teachers are undeniably the compass - bearers on students' growth odyssey, playing a crucial guiding role. However, the present scenario reveals that teachers' psychological states and behavioral patterns cast a long shadow over students.In contemporary times, college teachers are caught in a whirlwind of pressure, stemming from professional title evaluations and crushing teaching workloads. The cut - throat academic competition demands that they consistently churn out high - quality papers and take on numerous research projects to climb the professional ladder. This relentless pursuit keeps them in a perpetual state of high tension.If this pressure isn't alleviated promptly, it's like a ticking time bomb, prone to trigger a host of psychological problems in teachers. These issues, in turn, can subtly but significantly affect their interactions with students, potentially hindering the students' healthy growth and development.

When teachers themselves are in a state of psychological sub-health, their daily interactions with students can transmit negative emotions. For example, some teachers may lose their temper in class over trivial matters, venting their personal dissatisfaction and anxiety on students. Such inappropriate teaching methods make students feel fearful and suppressed, discouraging them from expressing their own thoughts and opinions. Being in such a classroom atmosphere for a long time can gradually make students' psychology more sensitive and fragile, and even lead to resistance, affecting their learning enthusiasm and mental health. Furthermore, some teachers with psychological sub-health may lack patience and communication skills when dealing with students, which can easily lead to conflicts with students and further increase students' psychological burdens.

The family is the emotional home for everyone, and its influence on college students' psychological states is particularly significant. Nowadays, most college students are only children, and their parents place extremely high expectations on them. These expectations are like a double-edged sword. On the one hand, they motivate students to study hard and pursue success; on the other hand, excessive expectations become a heavy psychological burden for students.

Parents' overindulgence in their children's daily lives, where they take care of everything, leaves students lacking the ability to solve problems independently. When they enter college and face various challenges and difficulties, they often feel at a loss. At the same time, parents' high expectations make students afraid of making any mistakes. Once they encounter setbacks in their studies or lives, such as a poor performance in an exam, they will experience strong guilt and anxiety, worried about letting their parents down.

In addition, some negative factors in the family, such as disharmonious parent-child relationships or financial difficulties, can also cast psychological shadows on students. These shadows are like hidden bombs in their hearts, which can be triggered at any time and affect their emotions and psychological states. Moreover, students from different family backgrounds, with different living habits and regional cultures, gather on college campuses. Inevitably, there will be conflicts and contradictions in their interpersonal relationships. Some students, lacking the ability to handle interpersonal relationships, may

choose to escape or adopt a negative attitude when facing these problems, leading to tense interpersonal relationships and further triggering psychological problems.

The lack of effective ideological and political education is also an important factor contributing to college students' psychological sub-health. During the college years, students are in a critical period of forming their values and outlook on life, and they need correct ideological guidance. However, there are some issues in the current implementation of ideological and political education.

Numerous students possess only a superficial grasp of Marxist theory, lacking in-depth and systematic study and contemplation. Consequently, when confronted with intricate social phenomena and critical life choices, they easily fall into confusion and bewilderment. Take moral quandaries or value clashes as examples; without the guidance of correct theories, they struggle to analyze and resolve issues effectively. This often results in psychological turmoil and anguish.

Furthermore, the current approaches to ideological and political education are rather monotonous. Relying heavily on classroom lectures, they lack practical application and interactivity. Students are reduced to passive recipients of knowledge, merely sitting through classes without actively engaging. As a result, they fail to genuinely integrate theoretical knowledge into their own ideological frameworks and behavioral standards.

The psychological sub-health status of college students is the result of the combined effects of multiple factors. Schools need to strengthen mental health education and resource investment, teachers should pay attention to their own psychological adjustment and behavioral norms, families should create a favorable growth environment, and ideological and political education should be continuously innovated and improved. Only through the joint efforts of all parties and the formation of a synergy can we help college students break free from the predicament of psychological sub-health, face future challenges with a healthy and positive mentality, and shine brightly on the path of life.

3.Change the education method of psychological sub-health in college students

To effectively tackle the psychological sub - health issues plaguing college students, a comprehensive and in - depth understanding of their current health status is of utmost importance. College life is a critical transitional phase, and students' psychological well - being during this period can significantly impact their future development.Gaining such an understanding requires a multi - faceted approach. Firstly, it is essential to clarify their development mode and growth path. Each student has a unique set of experiences, backgrounds, and learning styles that shape their psychological development. By analyzing these factors, we can identify the underlying patterns and trends in their growth, which helps in predicting potential psychological issues.

Moreover, identifying and improving their cognitive obstacles and defects is equally crucial. Cognitive factors, such as thinking patterns, problem - solving abilities, and self - perception, play a vital role in students' psychological health. Negative cognitive biases can lead to anxiety, depression, and other sub - health problems.Starting from the perspective of their sub - health state, we must accurately ascertain their development status. This involves not only observing their outward behaviors but also delving into their inner emotional worlds. College teachers bear a significant responsibility in this regard during the teaching process. They are in a prime position to notice subtle changes in students' psychological states. By fulfilling this responsibility, teachers can lay a solid foundation for implementing effective interventions, whether it be through counseling, psychological education courses, or creating a supportive campus environment, ultimately promoting the overall psychological well - being of college students.

1. Creating a Supportive Campus Environment

First and foremost, it is essential to strengthen the social and cultural environment on campus to create a healthy atmosphere conducive to students' learning and growth. Establishing an ideal campus culture is a crucial measure that can significantly influence and support students' mental health development. Universities should take the initiative to optimize their campus environments through beautification initiatives. A well - maintained and aesthetically pleasing campus not only provides students with an ideal learning space but also has a positive impact on their mood and overall well - being. For example, the presence of green spaces, comfortable seating areas, and inspiring art installations can create a relaxing and stimulating environment.

Furthermore, universities should organize vibrant cultural and sports activities under a positive mindset. These activities can range from art exhibitions, music festivals, and drama performances to sports competitions, fitness classes, and outdoor adventures. By participating in such activities, students can not only develop their physical and artistic skills but also enhance their social interactions and build a sense of community. Enhancing school ethos by developing unified yet innovative teaching models is also vital. A positive school ethos can strengthen interpersonal relationships and boost student cohesion. For instance, collaborative learning projects and group - based assignments can encourage students to work together, share ideas, and support one another.

In the digital age, establishing a dedicated mental health website is an effective way to create a new communication platform. This website can utilize online resources to provide students with access to mental health information, self - assessment tools, and online counseling services. It can also serve as a platform for sharing success stories, tips for managing stress, and information about upcoming mental health events on campus. Additionally, promoting mental health awareness through bulletin boards and information columns in high - traffic areas of the campus helps form discussion hotspots. These visual displays can feature inspiring quotes, facts about mental health, and invitations to participate in mental health - related activities, fostering a more positive environment for university students.

Universities should also adopt diversified teaching methods and encourage participation in counseling services. It is crucial to actively facilitate communication channels such as phone consultations, face - to - face talks, and digital platforms to engage students effectively. For example, some students may feel more comfortable discussing their problems over the phone, while others may prefer in - person sessions. Digital platforms, such as online chat rooms or video conferencing, can also provide convenient and accessible ways for students to seek help.

2. Developing Targeted Psychological Support Services

Educational institutions should develop targeted psychological support services based on students' actual sub - health conditions. Current educational practices demonstrate that schools must create diversified support systems to meet the varying needs of students. These systems can include teacher - student consultations, where students can have one - on - one meetings with their teachers to discuss academic or personal concerns. Telephone counseling services can provide immediate support to students who are in distress and need someone to talk to. Online platforms, such as mental health forums or chatbots, can offer 24/7 access to information and support.

Comprehensive psychological services require both technical infrastructure and professional staff to enhance service quality. Universities should invest in training and hiring qualified mental health professionals, including psychologists, counselors, and social workers. These professionals should have the

necessary skills and experience to conduct assessments, provide counseling, and develop treatment plans. Cultivating a positive sports culture is equally vital. As key drivers of mental health development, schools should foster engaging physical education programs and diverse sports activities. Sports not only have physical benefits but also inspire growth through tangible benefits such as improved self - esteem, teamwork skills, and stress relief. Students should experience personal development momentum during their academic journey by participating in sports.

Additionally, school - organized extracurricular programs and inter - school exchanges can help students build healthy social connections while gaining diverse opportunities to engage with society. These programs can include volunteer work, community service projects, and cultural exchange programs. By interacting with people from different backgrounds, students can broaden their perspectives, develop empathy, and enhance their social skills.

3. Establishing Comprehensive Mental Health Profiles

Universities can establish comprehensive mental health profiles for students. Upon enrollment, institutions should provide proactive educational services through these profiles to monitor psychological well - being and identify individual needs. This can involve conducting initial mental health screenings to assess students' baseline psychological states. Students experiencing mental health challenges may receive targeted counseling or intervention. For example, if a student is identified as having high levels of anxiety, they may be referred to a counselor for regular sessions or enrolled in a stress - management workshop.

These student mental health records also serve as vital tools for implementing mental health education programs. By analyzing the data from these records, universities can identify common mental health issues among students and develop targeted educational campaigns. The core objective of psychological education lies in cultivating students' ability to regulate their emotional states, guiding them to maintain positive mindsets while enhancing psychological resilience. Educators should foster students' capacity to align personal growth with societal development, encouraging them to objectively recognize social issues and perceive life's contradictions. This approach helps students develop a more balanced perspective on problems and effectively manage negative emotions.

4. Developing Specialized Elective Courses and Training

Higher education institutions can develop specialized elective courses to enhance both faculty and students' mental well - being. By replacing traditional lecture - based teaching with interactive methods like case studies and role - playing activities, these initiatives help cultivate psychological resilience. For example, in a course on stress management, students can participate in role - playing scenarios where they practice coping strategies in real - life situations. This hands - on approach makes the learning experience more engaging and practical.

Schools should provide mental health training for educators. The prevalence of suboptimal mental health among college students poses significant developmental risks, requiring urgent attention. In practice, such conditions often lead to self - isolation as students lack guidance from teachers or parents during academic growth. This gray state of mental sub - health demands societal awareness. From a developmental perspective, only when schools, educators, and families collectively recognize students' challenges can proactive support be provided to guide them in addressing cultural needs. Academically, suboptimal mental health disrupts learning momentum, causing students to lose motivation and creating a vicious cycle that hinders academic achievement.

Teachers play a crucial role in students' mental health development. As primary mentors guiding college students' academic and personal development, university teachers' mental health directly impacts students' psychological well - being. When instructors with poor mental health conduct classes, they inadvertently transmit unhealthy attitudes to students. To address this, universities must improve faculty mental health through two key measures: creating a fair and harmonious environment while providing professional training to enhance educators' psychological resilience. Teachers should proactively engage with students facing psychological challenges, demonstrating positive energy through their words and actions to inspire proactive learning and self - improvement.

5. Prioritizing Mental Health Education

Universities need to prioritize mental health education – an essential component of ideological education and quality - oriented education that meets contemporary societal demands. Educators should develop innovative teaching methods tailored to students' psychological needs, helping them overcome suboptimal mental states for healthy growth. Given the current educational framework's limitations in supporting students' holistic development, targeted interventions are crucial to address suboptimal mental health conditions and foster sustainable personal growth.

From the actual situation of sub - health psychological states among college students, if they receive proper guidance, students can gradually overcome this condition and return to normal academic and daily life. However, without appropriate intervention, sub - health may lead to self - loss and diminished motivation for personal growth. It is crucial to establish supportive mechanisms tailored to students' realities, serving as a core framework to promote healthy development. From an individual growth perspective, correcting and guiding these sub - health conditions is essential to prevent long - term impacts on both psychological and physical well - being.

In practice, we must ensure normal developmental progress while actively optimizing living environments to create comfortable spaces for learning and living. Some students develop sub - health as they approach graduation and enter society, requiring teachers to objectively analyze their issues. This phenomenon often stems from students' fear of the unknown, which prevents them from handling corresponding pressures psychologically. Parents should pay attention to this situation and guide students through psychological interventions, helping them break free from mental constraints and proactively address emotional needs. During implementation, we should encourage students to actively explore solutions independently rather than merely attempting superficial attempts.

6. Facilitating Campus Adaptation and Goal - Setting

Higher education institutions can help students adapt to campus environments through psychological counseling, orientation programs, and other educational services. By providing mental health support systems including hotlines, they facilitate students' active participation in academic activities. This approach enables students to better integrate into university settings and adjust to learning routines. Through specialized instruction, institutions help students develop a healthy understanding of their academic disciplines, study methodologies, and available resources, ultimately helping them establish personalized learning strategies.

Universities should guide students in setting realistic life goals to navigate challenges effectively. Students are encouraged to cultivate core values and ideals through meaningful dialogues, fostering independent thinking while developing self - awareness. By learning to handle setbacks proactively, students can enhance self - improvement efforts, maintain positive emotional resilience, and cultivate

confidence for future growth. For example, setting short - term and long - term academic and personal goals can provide students with a sense of direction and purpose. When faced with setbacks, such as a low grade on a test, students can refer to their goals and adjust their strategies accordingly.

7. Integrating Marxist Principles into Education

Guided by Marxist principles, students should develop their own intellectual growth through autonomous approaches. In practice, continuous refinement of dialectical thinking is essential. When students master dialectical reasoning, they gain deeper understanding of complex issues. Their ideological perspectives and worldview require special attention in academic development. The phenomenon of psychological sub - health among college students isn't merely personal; it's a systemic educational challenge.

Universities must reform their frameworks, aligning with Marxist principles to cultivate talent development. By integrating Marxist philosophy into teaching practices and student growth, educators can strengthen students' commitment to learning. Marxist philosophy emphasizes the importance of understanding the contradictions and dynamics of society, which can help students develop a more comprehensive and critical view of the world. This, in turn, can enhance their ability to cope with stress and adapt to change.

Ultimately, educational systems must provide guidance—only when people fully recognize the significance of psychological sub - health in higher education will more resources be allocated to ideological development programs. This approach helps students enhance their mindset, ultimately improving academic performance through better cognitive strategies. For example, by understanding the social and economic factors that contribute to stress, students can develop more effective coping mechanisms.

8. Implementing Comprehensive Interventions

In educational practice, it is essential to maintain systematic guidance while supporting students' learning and development, enabling them to recognize the necessity of personal growth throughout this process. The psychological sub - health among college students primarily stems from their hectic lifestyles and academic demands. Observing their developmental experiences, these students typically have smooth life trajectories without exposure to failures or setbacks. Upon entering university, they often encounter challenges that trigger frustration. Influenced by their cognitive patterns during this transitional phase, they may easily fall into passive situations.

Therefore, students require both educational guidance and theoretical instruction. In practical teaching processes, institutions should implement targeted interventions to address psychological sub - health among college students. These interventions can include individual counseling, group therapy sessions, stress - management workshops, and mindfulness training. Only through such comprehensive approaches can we effectively enhance students' mental well - being and promote their holistic development.

CONCLUSION

Contemporary college students, predominantly belonging to the post - 00s generation, represent a unique cohort shaped by the distinct socio - cultural and technological landscape of their era. This generation has grown up in an age of rapid technological advancement, globalization, and social media proliferation, which have collectively influenced their values, behaviors, and psychological makeup. As a

result, they exhibit a set of characteristics that set them apart from previous generations, along with a range of psychological vulnerabilities that demand targeted attention.

One of the most prominent features of post - 00s college students is their high level of digital literacy. Having been exposed to technology from an early age, they are adept at navigating the digital world, relying heavily on social media platforms for communication, information gathering, and self - expression. However, this constant connectivity also exposes them to a host of challenges, such as cyberbullying, information overload, and the pressure to maintain an online persona that aligns with societal expectations. The virtual world can create a false sense of reality, leading to issues like low self - esteem, anxiety, and a distorted perception of self - worth when comparing themselves to others online.

Another characteristic is their strong desire for individuality and self - actualization. Post - 00s students value personal freedom and autonomy, seeking to carve out their own unique paths in life. They are more likely to question traditional norms and authority, which can sometimes lead to conflicts with educational institutions and family expectations. This quest for self - discovery, while admirable, can also result in feelings of uncertainty and existential angst, especially when faced with the pressures of academic performance, career choices, and social relationships.

Moreover, the competitive nature of modern society has placed significant stress on college students. The pursuit of high - paying jobs and social status has intensified, leading to a culture of over - achievement and constant comparison. This pressure to succeed can take a toll on their mental health, manifesting in symptoms such as depression, anxiety disorders, and burnout. The fear of failure and the need to meet high expectations can create a vicious cycle of stress and self - doubt, further exacerbating their psychological vulnerabilities.

In light of these challenges, implementing comprehensive psychological guidance programs in higher education institutions has become an urgent necessity. These programs play a crucial role in preventing suboptimal mental health conditions among college students. By providing early intervention and support, they can help students identify and address psychological issues before they escalate into more serious problems.

Targeted interventions for at - risk students are a key component of effective psychological guidance. These interventions are tailored to the specific needs and circumstances of individual students, taking into account factors such as their academic performance, social relationships, and family background.

In addition to targeted interventions, preventive measures are essential for maintaining good mental health. Educational institutions can organize workshops and seminars on stress management, emotional regulation, and resilience building. These preventive programs equip students with the necessary skills and knowledge to cope with the challenges of college life and beyond. By promoting a proactive approach to mental health, preventive measures can reduce the incidence of psychological problems and create a more supportive and healthy campus environment.

Therapeutic support is also crucial for students who are already experiencing mental health issues. Counseling services, whether individual or group - based, provide a safe and confidential space for students to express their feelings and concerns. Professional counselors can offer guidance, support, and evidence - based treatment options to help students overcome their psychological difficulties. The availability of timely and accessible therapeutic support can make a significant difference in students' recovery and overall well - being.

The integration of psychological guidance programs with ideological education services is another important aspect. Ideological education aims to cultivate students' values, moral character, and social responsibility. By incorporating mental health awareness and psychological well - being into ideological education, students can develop a more holistic understanding of themselves and their place in society. This approach not only enhances their mental health but also promotes their overall personal growth and development.

Educators play a pivotal role in monitoring students' psychological well - being within the teaching practices. They are in a unique position to observe students' behavior, academic performance, and emotional states on a daily basis. By being vigilant and attentive, educators can identify early signs of psychological distress and refer students to appropriate support services. Moreover, educators can create a positive and inclusive classroom environment that fosters open communication and emotional support. By building strong relationships with their students, educators can become trusted mentors and sources of guidance.

In conclusion, addressing the psychological vulnerabilities of contemporary college students requires a multi - faceted approach. Implementing psychological guidance programs in higher education, with targeted interventions, preventive measures, and therapeutic support, is essential for preventing suboptimal mental health conditions. The integration of these programs with ideological education services and the active involvement of educators in monitoring students' psychological well - being can lead to optimal outcomes. By improving mental health standards and fostering holistic student development, we can empower the post - 00s generation to thrive in an increasingly complex and challenging world.

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Innovation of teaching mode in adult higher continuing education in the Internet era

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ABSTRACT

In the context of adult higher continuing education, the adoption of blended learning models has gained increasing momentum in the Internet era. This paper examines innovative teaching practices and their effectiveness in adult higher education institutions through a systematic review of recent literature (2020–2024). The findings indicate that 82% of institutions have integrated blended learning approaches, with 68% reporting notable improvements in student engagement and academic performance. The predominant strategies include flipped classrooms (47%), online modules combined with face-to-face workshops (35%), and digital interactive platforms (18%). These models enhance active learning, provide flexibility, and address the unique needs of adult learners who balance education with professional and personal commitments. In addition, experiential and participatory approaches, such as micro-classroom discussions, simulation-based learning, and competitive case teaching, have demonstrated strong potential for fostering critical thinking and practical skill development. However, challenges remain in the underutilization of advanced digital tools, such as virtual reality and interactive learning platforms, due to technological barriers and digital literacy gaps among both instructors and learners. This study highlights the importance of aligning teaching strategies with adult learning theories and contextual needs. It emphasizes the necessity for continuous professional development for educators, broader integration of digital tools, and diversified assessment methods to ensure relevance and authenticity in evaluating adult learners' competencies. While immediate benefits of blended learning are evident, further longitudinal studies are needed to explore long-term impacts on learners' career advancement and lifelong learning trajectories. Overall, the study contributes to the discourse on educational transformation in adult continuing education, offering insights for policymakers, practitioners, and researchers to optimize teaching practices in the digital era.

Keywords: Adult Education, Blended Learning, Educational Technology, Student Engagement, Teaching Methods

INTRODUCTION

The rapid technological advancements and globalization of the 21st century have fundamentally reshaped the educational landscape, necessitating a comprehensive transformation in teaching methodologies. As we move further into the digital age, traditional education models, particularly those relying on static lectures and passive learning, increasingly fail to meet the diverse and dynamic needs of modern learners. This is especially evident in the realm of adult higher continuing education, where learners often balance their studies with professional responsibilities and personal commitments. The demand for flexible, adaptive, and effective learning solutions has never been greater.

One of the most significant shifts in education has been the integration of technology with pedagogical practices, leading to the emergence of blended learning and online education as dominant paradigms. Blended learning, which combines online digital media with traditional face-to-face classroom methods, has gained widespread recognition for its potential to enhance student engagement and learning outcomes. This hybrid model leverages the strengths of both online and in-person interactions, offering a more personalized and flexible learning experience. For instance, Wang et al. (2020) highlight the efficacy of blended learning in adult education, demonstrating its ability to

accommodate varied schedules and learning preferences, which is critical for adult learners who must juggle multiple responsibilities (Wang, W., et al., 2020).

Furthermore, the role of digital technologies in creating interactive and adaptive learning environments cannot be overstated. These technologies facilitate real-time feedback, foster collaborative learning, and provide access to a vast array of resources, thereby supporting deeper and more meaningful learning experiences. Johnson and Adams Becker (2021) emphasize that such technologies are not merely supplementary tools but integral components that transform the learning process, making it more engaging and effective (Johnson, L., & Adams Becker, S., 2021). Blended learning models, which strategically integrate online resources with traditional classroom activities, have been shown to significantly improve both the depth of learning and the practical application of knowledge, effectively addressing the limitations inherent in conventional teaching methods (Garrison, D. R., & Vaughan, N. D., 2021).

In the context of adult higher continuing education, the imperative for innovative teaching modes becomes even more pronounced. Adult learners, who are often engaged in full-time employment or managing family responsibilities, require learning solutions that are not only flexible but also efficient in delivering meaningful education that aligns with their career and personal goals. Recent studies, such as those conducted by Zhang et al. (2022), illustrate how blended and hybrid teaching models can effectively cater to these needs by providing adaptable learning pathways. These pathways are designed to align with learners' prior knowledge and career objectives, emphasizing active learning, critical thinking, and the practical application of knowledge—skills that are crucial for navigating the complexities of today's professional environments (Zhang, X., et al., 2022).

As the demand for adult education continues to grow, it becomes increasingly essential to explore and implement teaching methods that not only promote deep learning but also ensure effective knowledge transfer (DaCruz, n.d.). The ongoing shift towards blended teaching and the integration of digital tools offer promising avenues for creating more engaging and impactful learning experiences. By leveraging these innovations, educators can better meet the diverse needs of adult learners, thereby contributing to the development of a more robust and adaptive educational system.

Moreover, as the educational landscape evolves, the integration of innovative assessment strategies becomes paramount to effectively evaluate the diverse competencies of adult learners. Traditional testing methods often fall short in capturing the breadth of skills acquired through experiential and blended learning environments. Consequently, alternative assessment approaches, such as portfolio assessments, peer evaluations, and project-based learning, can provide a more comprehensive view of a learner's capabilities, fostering a deeper understanding of their practical skills and critical thinking abilities (Johnson & Adams Becker, 2021). Furthermore, the incorporation of adaptive learning technologies can personalize assessments, allowing for real-time adjustments based on individual learner performance, thereby enhancing engagement and motivation (Zhang et al., 2022). This shift not only aligns with the principles of adult learning theory but also prepares learners for the dynamic demands of the workforce, ultimately contributing to their long-term career success and adaptability in an ever-changing job market.

Moreover, as educational institutions and policymakers seek to address the evolving demands of the labor market and the broader societal shifts towards lifelong learning, the need for continuous innovation in teaching methodologies becomes clear. This paper aims to explore the various dimensions of these innovative teaching modes in adult higher continuing education, providing insights into their effectiveness and offering recommendations for their broader adoption and implementation. Through this exploration, the paper contributes to the ongoing discourse on educational reform in the digital era, highlighting the critical role of technology in shaping the future of adult education.

THEORETICAL FRAMEWORK

Overview of Existing Research

Blended learning, a pedagogical approach that integrates online and face-to-face educational methods, has emerged as a transformative force in education, particularly in adult higher continuing education. The evolution of blended learning has been marked by significant advancements in both technology and instructional design, enabling more personalized and flexible learning experiences.

Over the past decade, researchers have increasingly focused on understanding the multifaceted benefits and challenges associated with blended learning.

Wang et al. (2020) have made substantial contributions to the literature by emphasizing the ability of blended learning environments to promote active engagement. By combining the strengths of traditional classroom interactions with the flexibility of digital learning platforms, blended learning fosters a more interactive and student-centered educational experience. Their research demonstrated that such environments not only enhance engagement but also facilitate deeper learning and the practical application of knowledge, which is particularly beneficial in adult education where learners bring diverse experiences and expectations to the classroom.

In addition to these benefits, Johnson and Adams Becker (2021) highlighted the transformative impact of digital technologies on higher education. They argue that the integration of digital tools—such as real-time feedback systems, collaborative online platforms, and adaptive learning technologies—has redefined how education is delivered. These advancements are crucial in adult education, where learners often require flexible and accessible solutions that can be tailored to their unique learning needs. The ability of digital technologies to create more interactive and adaptive learning experiences aligns well with the varied schedules and learning preferences of adult learners, making blended learning an attractive option.

Building on these ideas, Garrison and Vaughan (2021) outlined a comprehensive framework for effective blended learning, which incorporates best practices in instructional design. Their framework emphasizes the importance of clear learning objectives, appropriate use of technology, and active learner engagement. According to Garrison and Vaughan, successful blended learning requires careful planning and alignment of online and face-to-face components to ensure a cohesive and holistic learning experience. This approach is particularly relevant in adult education, where learners may require a structured yet flexible learning environment that accommodates both their professional and personal responsibilities.

Identifying Research Gaps

Despite the substantial body of research on blended learning, several gaps persist in our understanding of how these methods specifically impact adult higher continuing education. While existing studies provide valuable insights into the general benefits of blended learning, there is a limited exploration of how these methods address the unique challenges faced by adult learners in continuing education settings.

One such gap is the lack of focus on the specific needs and characteristics of adult learners. Zhang et al. (2022) have begun to address this by exploring the application of blended learning in adult education contexts. Their research suggests that blended learning models can significantly enhance adult learners' engagement and the practical application of knowledge. However, Zhang and colleagues primarily focused on the implementation aspects of blended learning, offering less insight into the theoretical underpinnings that support effective knowledge transfer and deep learning. There is a need for more research that bridges this gap by exploring how theoretical frameworks, such as constructivism and adult learning theories, can inform the design of blended learning environments that better cater to adult learners.

Additionally, the long-term impact of blended learning on adult learners' career development and lifelong learning remains underexplored. Smith et al. (2023) highlighted the need for comprehensive studies that examine these long-term effects. Their findings indicate that while blended learning offers immediate benefits, such as increased engagement and improved knowledge application, its effects on career advancement and continuous skill development require further investigation. Understanding these long-term impacts is crucial for developing blended learning models that not only meet the immediate educational needs of adult learners but also support their ongoing professional growth and adaptability in a rapidly changing job market.

Addressing the Gaps

This study seeks to address these identified gaps by focusing on the specific needs and characteristics of adult learners in higher continuing education. By examining the practical applications of blended learning through case studies and experiential teaching models, this research aims to provide a deeper understanding of how these methods can be tailored to enhance both immediate learning outcomes and long-term career development.

One area of focus will be the integration of innovative teaching practices, such as situational teaching and competitive learning, which have shown promise in promoting deeper learning and effective knowledge transfer. Situational teaching, which involves the use of real-world scenarios and problem-solving tasks, aligns well with the needs of adult learners who often seek education that is directly applicable to their professional lives. Similarly, competitive learning, which leverages the motivational aspects of competition, can enhance engagement and drive higher levels of achievement. By evaluating these practices within the context of adult higher continuing education, this study aims to contribute new insights into how blended learning can be optimized to better serve the needs of adult learners.

Moreover, this research will explore the role of digital tools in facilitating these innovative teaching practices. The use of learning management systems (LMS), virtual reality (VR) simulations, and online collaboration platforms will be examined to determine how they can be effectively integrated into blended learning environments to enhance the learning experience for adult students. The study will also consider the challenges associated with these tools, such as technological literacy and access, which can be significant barriers for some adult learners.

In summary, while existing research provides a solid foundation for understanding blended learning, this study seeks to build upon this knowledge by focusing on its application in adult higher continuing education. By addressing the identified gaps and exploring new teaching methods, this research aims to advance the field and offer practical recommendations for educators and policymakers. The ultimate goal is to develop blended learning models that not only improve educational outcomes but also support the lifelong learning and career development of adult learners in an increasingly digital world.

METHOD

This study employs a Systematic Literature Review (SLR) as an analytical framework, given its conceptual and theoretical nature. The SLR method was chosen to synthesize recent research findings, identify gaps, and propose recommendations for innovative teaching in adult higher continuing education.the aim to explore and evaluate innovative teaching modes in adult higher continuing education within the context of the Internet era. The primary objective of this methodology is to synthesize existing research, identify emerging trends, and propose evidence-based recommendations for enhancing educational practices. The systematic approach adopted in this review ensures that the findings are grounded in high-quality, relevant research, providing a solid foundation for the study's conclusions and implications.

Research Design

The research design of this study is structured around a systematic literature review (SLR), which is a rigorous method for identifying, evaluating, and synthesizing the existing body of literature on a particular topic. This approach was chosen for its ability to provide a comprehensive overview of the current state of research, highlight gaps in knowledge, and offer insights into areas requiring further investigation. By systematically reviewing the literature, this study aims to build a coherent narrative around the adoption and effectiveness of blended learning and other innovative teaching methods in adult higher continuing education.

Data Sources and Search Strategy

The data for this study were sourced from multiple academic databases, including Google Scholar, ERIC, JSTOR, PubMed, and Scopus. These databases cover a broad range of academic disciplines, ensuring comprehensive and diverse literature retrieval. The search strategy employed precise keyword combinations such as "Blended Learning," "Adult Higher Education," "Teaching Innovations," "Knowledge Transfer," and "Continuing Education" to capture literature closely related to the research topic. Boolean operators (AND, OR) were used to further refine the search results, ensuring that the studies obtained were directly relevant to the application of technology in adult education.

Inclusion and Exclusion Criteria

To ensure the quality and relevance of the included literature, this study established strict inclusion and exclusion criteria. The inclusion criteria comprised peer-reviewed journal articles, conference papers, and academic books published between January 2020 and July 2024, with a clear focus on blended learning and its application in adult higher continuing education. These studies needed to have

well-defined sample sizes and research methodologies. The exclusion criteria included non-peer-reviewed literature, opinion-based articles, and studies that fell outside the specified time frame, ensuring that the selected literature was academically rigorous and up-to-date.

Data Extraction and Analysis

The data extraction process was conducted in two steps. First, the titles and abstracts of the retrieved literature were initially screened to exclude studies that did not meet the inclusion criteria. Subsequently, the selected studies underwent a full-text review, with key information being recorded using a standardized data extraction form. This information included the authors, publication year, study design, sample characteristics, key findings, and identified research gaps. Through qualitative analysis of the extracted data, the study systematically organized and analyzed the effectiveness of various blended learning strategies and teaching innovations, identifying emerging trends in current research and potential directions for future studies.

Ethical Considerations

Although this study is based on a literature review and does not involve primary data collection, ethical considerations were still observed. The research adhered to principles of academic integrity, ensuring that all sources were accurately cited and that the synthesis of findings was conducted without bias. Furthermore, care was taken to include a diverse range of studies to avoid over-representation of certain perspectives, thus providing a balanced and comprehensive view of the current state of research.

Limitations of the Methodology

While the systematic literature review provides a robust framework for analyzing existing research, it is not without limitations. One potential limitation is the reliance on published studies, which may introduce publication bias. Studies with negative or inconclusive results are less likely to be published, potentially skewing the review's findings. Additionally, the review is constrained by the availability of studies within the specified time frame, which may exclude important research conducted prior to 2020 or after July 2024. Finally, the focus on English-language databases may limit the inclusion of relevant research published in other languages, particularly in non-Western contexts.

Contribution to the Field

By integrating recent literature and practical insights, this study contributes to a deeper understanding of contemporary advancements in adult higher continuing education. The findings are intended to inform educators, policymakers, and researchers about the most effective strategies for implementing blended learning in adult education settings. Moreover, by identifying gaps in the literature, this study provides a foundation for future research that can further refine and enhance educational practices in the digital age.

FINDINGS AND DISCUSSION

The review of the literature revealed several key findings related to innovative teaching modes in adult higher continuing education during the Internet era. These findings, compiled from various studies published between January 2020 and July 2024, provide valuable insights into how blended learning and other innovative teaching methods are being implemented and their impact on educational outcomes. The summarized findings are as follows:

1. Adoption of Blended Learning Models

The analysis found that the adoption of blended learning models (which combine online and face-to-face instruction) has significantly increased among various adult education institutions. The data show that 82% of institutions have already adopted blended learning models, indicating the widespread acceptance of this approach in adult education. The reviewed studies highlighted various blended teaching methods currently being implemented, with 47% using flipped classrooms, 35% combining online modules with in-person workshops, and 18% utilizing interactive digital platforms. These blended learning models have significantly improved student engagement and overall learning outcomes. For example, flipped classrooms, where traditional lecture content is delivered online and classroom time is dedicated to interactive activities, have been found to enhance students' active participation and understanding of the material. The combination of online modules and in-person workshops also provides adult learners with the flexibility needed to manage their professional and personal responsibilities while pursuing education.

2. Innovative Teaching Practices

Several innovative teaching practices have emerged in the literature as particularly effective in adult higher continuing education. One notable practice is the use of "micro classrooms" for professional issue commentary, where small, focused discussions allow learners to delve deeply into specific topics relevant to their careers. Additionally, experiential case teaching, often involving expert involvement, and simulation-based teaching methods were frequently cited as effective strategies. These methods utilize real-world scenarios, multimedia cases, interactive simulations, and case competitions to enhance practical skills and critical thinking. The interactive nature of these strategies helps bridge the gap between theoretical knowledge and practical application, which is crucial for adult learners who are often looking to immediately apply what they learn to their professional contexts.

3. Impact of Experiential Learning

The data also indicated that experiential learning approaches, such as "promoting learning by teaching" and "promoting learning through competition," had a positive impact on student performance and motivation. For example, case studies that involved students teaching their peers or participating in competitive learning environments were associated with higher levels of engagement and a greater emphasis on the practical application of knowledge. These findings suggest that when adult learners are placed in active roles—either as educators or competitors—they are more likely to internalize the material and develop skills that are directly transferable to their professional lives. This aligns with adult learning theories that emphasize the importance of self-directed, practical, and goal-oriented learning experiences.

4. Trends in Evaluation Methods

The review also uncovered emerging trends in the evaluation methods used within these innovative teaching modes. There has been a noticeable shift towards more diversified and student-centered assessment approaches. These methods go beyond traditional exams and quizzes, incorporating peer assessments, multi-dimensional feedback, and practical demonstrations of knowledge and skills. Such evaluation techniques are designed to align more closely with real-world competencies, thereby providing a more accurate reflection of a learner's abilities. The effectiveness of these methods was evident in improved student feedback, which often highlighted a greater sense of relevance and fairness in the assessments. By focusing on the application of knowledge in realistic scenarios, these assessment methods help ensure that adult learners are not only absorbing information but are also able to use it effectively in their professional environments.

5. Interpretation and Analysis

This study reveals that a significant proportion of adult higher education institutions have embraced blended learning models, with 82% indicating that they have implemented such approaches. This high adoption rate underscores a growing trend towards integrating technology into traditional teaching environments, reflecting the increasing recognition of the value that these models bring to contemporary education. The widespread adoption of blended learning suggests that institutions are increasingly prioritizing flexible, adaptive, and student-centered learning experiences that cater to the diverse needs of adult learners.

Notably, 68% of the institutions that have adopted blended learning reported substantial improvements in student engagement and academic performance. This finding highlights the effectiveness of blended learning in enhancing educational outcomes, particularly in the context of adult education where learners often face the challenge of balancing educational pursuits with professional and personal responsibilities. The positive impact on engagement and performance reinforces the argument that blended learning models are not just a passing trend, but a viable solution for addressing the unique challenges of adult education.

The analysis further shows that the most prevalent methods used in blended learning include flipped classrooms (47%), online modules combined with in-person sessions (35%), and digital interactive platforms (18%). The dominance of flipped classrooms aligns with recent literature that emphasizes the efficacy of this approach in fostering active learning and deeper understanding of course material. As noted by Bergmann and Sams (2018), flipped classrooms allow students to engage with lecture content at their own pace outside the classroom, freeing up class time for interactive, application-based activities that deepen learning. This approach is particularly effective for adult

learners, who often appreciate the flexibility and control over their learning process that flipped classrooms provide.

The substantial use of online modules combined with in-person sessions corroborates findings by Garrison and Vaughan (2020), who highlight the benefits of this hybrid approach. This method provides the flexibility of online learning while retaining the critical interpersonal interactions that occur in face-to-face sessions. For adult learners, who may be managing complex schedules, this hybrid approach offers the best of both worlds: the convenience of accessing learning materials online and the opportunity to engage in meaningful, face-to-face discussions and activities.

On the other hand, the use of digital interactive platforms, though less common at 18%, supports trends identified by recent research into the benefits of interactive and gamified learning environments. As noted by Kukulska-Hulme et al. (2021), these platforms can significantly enhance student engagement by making learning more interactive and immersive. The lower adoption rate of these platforms might be attributed to several factors, including the need for technological infrastructure, the learning curve associated with new technologies, and the challenge of integrating these tools into existing curricula. Nonetheless, their potential to transform learning experiences suggests that their use could increase as institutions become more familiar with these technologies and as digital literacy among both instructors and students improves.

Our findings are consistent with recent studies that demonstrate the effectiveness of blended learning in adult education. For instance, Bernard et al. (2021) found that blended learning significantly enhances engagement and learning outcomes in higher education. Similarly, Hattie's (2019) meta-analysis supports the effectiveness of flipped classrooms in improving student performance, particularly in terms of active learning and knowledge retention. The high adoption rate and reported improvements in engagement and performance align with these established benefits, reinforcing the value of blended learning models in contemporary educational settings.

However, the research also highlights some limitations. While the adoption rate of blended learning is high, the effectiveness of different blended learning methods varies. The limited use of digital interactive platforms suggests that while these tools have significant potential, their integration into curricula is still evolving. This finding echoes concerns in the literature about the uneven adoption of innovative technologies in education. Oliver and Conole (2020) argue that the uneven pace of technological adoption can lead to disparities in educational outcomes, as not all institutions have the resources or expertise to effectively implement these technologies. Moreover, the varying effectiveness of blended learning methods indicates that a one-size-fits-all approach may not be suitable. Instead, the choice of blended learning strategies should be carefully aligned with the specific needs of the learners and the educational context.

In conclusion, while blended learning models have demonstrated significant benefits in adult higher education, further research and development are needed to optimize the use of digital interactive platforms and to address the challenges associated with their implementation. By continuing to refine these models and ensuring their equitable adoption across institutions, educators can better meet the evolving needs of adult learners and maximize the educational outcomes of blended learning.

Beyond the Chinese context, international experiences in adult continuing education provide valuable points of comparison. For example, in Europe, many countries have institutionalized blended learning within lifelong learning frameworks, supported by the European Qualifications Framework (EQF). These systems emphasize credit transfer and recognition of prior learning, which ensures flexibility and mobility for adult learners. Similarly, in the United States, community colleges and online universities have integrated flipped classrooms and hybrid courses as mainstream practices, with strong emphasis on employability skills and workplace relevance.

In Southeast Asia, adult continuing education programs increasingly utilize low-cost mobile technologies to expand access in rural areas. For instance, initiatives in Indonesia and the Philippines combine online modules with community-based workshops, enabling learners with limited digital infrastructure to still benefit from blended formats. These approaches demonstrate that successful models must be adapted to local contexts, balancing technological possibilities with learners' needs and resources.

The comparison suggests several practical implications: (1) strong policy support and alignment with national qualifications frameworks enhance sustainability; (2) integrating workplace

competencies and industry partnerships ensures the relevance of adult education; and (3) providing multi-modal delivery—including mobile and offline resources—broadens accessibility for diverse learner groups.

By situating the Chinese case within this broader global landscape, the study underscores that while blended learning is universally valued, its implementation must remain sensitive to contextual differences. These international practices can inform ongoing reforms in China and provide a roadmap for improving flexibility, inclusivity, and long-term impact in adult higher continuing education.

CONCLUSION

This study offers a comprehensive analysis of the adoption and effectiveness of blended learning models in adult higher education, shedding light on how these innovative approaches are transforming the educational landscape in the Internet era. Our findings reveal that a significant majority of institutions—82%—have embraced blended learning approaches, indicating a widespread recognition of their value in enhancing educational outcomes. Among these institutions, 68% reported notable improvements in student engagement and academic performance, underscoring the effectiveness of blended learning in fostering more dynamic and impactful learning experiences.

The study identifies three primary methods employed in blended learning: flipped classrooms, online modules combined with in-person sessions, and digital interactive platforms. The predominance of flipped classrooms (47%) and online modules combined with in-person sessions (35%) aligns with existing research that highlights their success in promoting active learning and providing flexible, interactive learning environments. These methods cater particularly well to adult learners who require the adaptability to balance their educational pursuits with professional and personal responsibilities. The findings affirm that these blended learning strategies effectively address the unique needs of adult learners, facilitating deeper engagement with course material and improving overall academic performance.

However, the relatively lower adoption of digital interactive platforms (18%) suggests that while these tools have significant potential, they remain underutilized in adult education settings. This underutilization points to the need for further exploration and integration of these technologies to fully leverage their potential. The study's findings indicate that institutions may need to overcome barriers such as technological infrastructure challenges, the need for digital literacy among both instructors and students, and the integration of these platforms into existing curricula. Addressing these barriers could lead to more widespread adoption of digital interactive platforms, thereby enriching the learning experience and further enhancing educational outcomes.

The literature review conducted as part of this study provided a solid foundation for understanding the context and significance of these findings. By synthesizing recent research on blended learning, this study contributes valuable insights into the practical applications and effectiveness of various blended learning methods in adult higher education. The alignment of our findings with existing literature reinforces the validity of blended learning as a viable and beneficial approach in this educational sector.

While this study offers valuable insights into the adoption and effectiveness of blended learning models in adult higher continuing education, it is important to acknowledge several limitations that may affect the generalizability and interpretation of the findings.

Firstly, the study relies heavily on self-reported data from educational institutions. Self-reported data, while useful, can be subject to various biases, such as social desirability bias, where respondents may overstate positive outcomes or underreport challenges to present their institutions in a favorable light. This reliance on institutional reports may lead to an incomplete or skewed understanding of the actual effectiveness of blended learning models. Future research would benefit from incorporating more objective data sources, such as direct observations, student performance metrics, and third-party evaluations, to complement self-reported data and provide a more comprehensive view.

Secondly, the analysis did not deeply explore the specific contextual factors that may influence the effectiveness of various blended learning methods. Factors such as the availability of technological infrastructure, instructor proficiency with digital tools, student digital literacy, and institutional support can all significantly impact the success of blended learning initiatives. By not accounting for these variables, the study may overlook important nuances that differentiate the effectiveness of blended learning across different settings. Future research should aim to identify and analyze these contextual

factors to better understand how they contribute to the success or failure of blended learning implementations.

In conclusion, while the adoption of blended learning models has clearly shown positive impacts on adult higher education, there is still room for growth and optimization. The study highlights the importance of continuing to explore and refine these models, particularly in the integration of digital interactive platforms, to ensure that adult learners can benefit fully from the technological advancements available today. As educational institutions and policymakers continue to innovate and adapt to the changing demands of adult learners, blended learning will likely remain a cornerstone of modern education, offering flexible, effective, and engaging learning experiences that meet the diverse needs of today's students.

Given the identified limitations, there are several avenues for future research that could enhance our understanding of blended learning in adult higher continuing education. Future research could greatly benefit from longitudinal studies that examine the long-term impact of blended learning on student outcomes. While this study provides a snapshot of current practices, longitudinal research would allow for the tracking of student performance, engagement, and satisfaction over time, providing insights into how blended learning influences not only immediate learning outcomes but also long-term academic and career success. Further research is needed to explore the specific contexts in which different blended learning methods are most effective. For instance, studies could examine how factors such as class size, subject matter, student demographics, and institutional resources influence the success of blended learning models. Understanding these contextual variables would allow educators to tailor blended learning approaches to the unique needs of their students and environments, thereby maximizing their effectiveness.

Another critical area for future research is the investigation of barriers to the wider adoption of digital interactive platforms within blended learning environments. While these platforms have shown promise in enhancing engagement and learning, their adoption remains relatively low, as indicated by the study. Research should focus on identifying the specific obstacles—such as cost, technical difficulties, or resistance to change—that prevent institutions from fully integrating these tools. Additionally, exploring strategies for overcoming these challenges, such as providing targeted professional development for educators or improving access to technology, could help facilitate broader adoption.

To complement quantitative data, future studies should delve into the qualitative aspects of student experiences with blended learning. Qualitative research methods, such as interviews, focus groups, and case studies, could provide deeper insights into how students perceive and engage with blended learning environments. Understanding student perspectives on issues such as digital literacy, motivation, and the balance between online and face-to-face components could inform the design of more student-centered blended learning models that better address their needs and preferences.

Finally, future research should explore the potential impact of emerging technologies, such as artificial intelligence (AI), virtual reality (VR), and augmented reality (AR), on blended learning in adult education. These technologies have the potential to revolutionize the way education is delivered and experienced, offering new opportunities for personalization, immersion, and interactivity. Investigating how these technologies can be effectively integrated into blended learning models could pave the way for the next generation of educational innovations.

From an international perspective, the adoption and effectiveness of blended learning in adult higher education show both convergences and divergences across different countries. Studies from Europe, North America, and Asia indicate that blended learning is increasingly recognized globally as a strategy to enhance flexibility, accessibility, and learner engagement. For instance, Scandinavian countries and Canada have reported significant gains in student autonomy and active learning through flipped classrooms and integrated digital platforms, while institutions in parts of Asia emphasize blended approaches to expand access for working adults. However, differences in technological infrastructure, digital literacy, and institutional policies lead to varied implementation outcomes. Comparing these international experiences highlights the importance of contextual adaptation: best practices from one region cannot be applied wholesale to another without considering local constraints and learner characteristics. These global insights suggest that international collaboration, knowledge exchange, and benchmarking can play a critical role in optimizing blended learning strategies,

fostering innovation, and ensuring that adult learners worldwide can fully benefit from flexible and technologically enhanced education.

While this study has provided important insights into the current state of blended learning in adult higher continuing education, addressing the aforementioned limitations and pursuing these future research directions—both domestic and international—will be essential for advancing our understanding and improving the effectiveness of blended learning models. By doing so, educators and policymakers can better meet the evolving needs of adult learners in an increasingly digital and globally connected world.

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Industrial Robot Teaching Reform and Practice Based on Flipped Classroom and Robot-Studio

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ABSTRACT

This article based on the actual teaching of the basic course, analyzes the significance and role of Robot-Studio virtual simulation software in higher vocational industrial robotics education. The most challenging aspect of industrial robot teaching is operation. Given the limitations and exclusivity of actual resources, it is proposed to utilize a virtual simulation platform, which can provide a practice environment close to reality and expand the applications of industrial robots. An "Industrial Robot Trajectory and Process Simulation Experiment Project Based on Intelligent Manufacturing" was developed and applied to experimental teaching in courses such as Modern Robotics Technology, Manufacturing Process Planning, and FMS. This approach broadened and deepened the content of experimental teaching, extended the time and space of experiments, and greatly improved the quality and level of experimental teaching. By applying flipped classroom and virtual simulation, the industrial robotics courses have been designed and practiced, enabling students to achieve corresponding knowledge, understanding and hands-on operation skills.

Keywords: flipped classroom, industrial robotics, operation skill, simulation experiment, virtual simulation

INTRODUCTION

According to the strategic development requirements of "Made in China 2035," the current period is a critical stage for the transformation of China's manufacturing industry to a high-level development model. The strategy points out that industrial robots, as an important focus in the field of intelligent equipment, bear the key responsibility of advancing China from a manufacturing power to a manufacturing strong nation. Industrial robots, due to their high level of intelligence, are widely used in manufacturing product production lines and can be seen in fields such as handling and stacking, automotive parts processing, metal cutting, metal welding, and flexible polishing[1]. By replacing humans in harsh working environments and ensuring work quality, industrial robots maximize production efficiency and play an important role in reducing labor intensity and saving production costs.

The development of the intelligent manufacturing industry, represented by industrial robots, has led to a market demand for technically skilled talent. In response to national policies, adapting to industry development needs, and serving social and economic construction, numerous domestic universities have established programs in industrial robot technology applications[2]. As an emerging discipline in higher education, the course construction for this program is still under exploration. "Fundamentals of Industrial Robot Technology" is the core professional course of the industrial robot technology application program in universities and serves as the theoretical foundation for various skill training courses in this program[3]. However, currently, the course construction cannot meet the requirements for cultivating technically skilled talent. Some universities face problems such as overlapping knowledge points, imbalance between theoretical knowledge and practical skills, and a disconnect from actual work content, highlighting an urgent need for curriculum reform research.

Robot-Studio is a virtual simulation software for ABB robots, integrating functions such as workstation creation, program compilation, simulation debugging, and secondary development, capable of simulating real working environments[4]. This software includes a library of ABB industrial robots from any series, allowing the creation of different robot tasks. It features virtual controllers and teach pendants that are largely similar to those of real ABB industrial robots. Therefore, when conducting virtual simulation experiments with this software, users can experience a sensation similar to being on a real robot operation site. Virtual simulation experiments replace traditional physical demonstration experiments, which on one hand solves issues such as insufficient experimental funds, time constraints, and space limitations; and on the other hand reduces maintenance costs and minimizes the potential consequences of student disoperation. In virtual simulation experiments, students have ample time to

repeatedly practice and correct errors, allowing them to conduct both verification experiments and innovative experiments. Students can choose different components and robot models to design various robot operation scenarios, breaking away from traditional fixed thinking, applying theory to practice, and greatly enhancing learning interest, and "interest" is the best teacher. Additionally, virtual simulation can promote the development of "educational equity," as every student can have access to the same experimental equipment. No student will miss out on understanding the experiment because they are too far away to hear or see the teacher's demonstration, nor will they be limited by a shortage of equipment or crowding.

The term 'flipped classroom' is translated from the English 'flipped classroom' and can also be rendered as 'inverted classroom.' Its basic concept is to readjust the allocation of time inside and outside the classroom, allowing students to first acquire foundational knowledge independently outside of class, so that more valuable classroom time can be reserved for teacher-student interaction and deep learning, thereby achieving better teaching outcomes. Benefiting from the rapid development of information technology, the internet and virtual simulation teaching resources have become increasingly abundant and sophisticated, providing favorable conditions for teachers to implement flipped classrooms. By leveraging online and offline platforms, the concept of flipped classrooms is introduced into practical teaching of industrial robots, dividing the entire teaching process into three stages: pre-class self-study exercises, in-class consolidation and hands-on practice, and post-class extension and improvement.

In higher education industrial robot operation teaching, there are some issues such as limited teaching resources, insufficient opportunities for students to practice equipment operation, and a high rate of equipment damage. The industrial robot virtual simulation technology platform creatively provides specific scenarios fully supported by virtual 3D models and computer technology, which can be used for student learning, teacher research, school competitions, and school-enterprise cooperation. Teachers can use simulation learning to present the complex and obscure theoretical knowledge and core points of industrial robots; students can establish a verification relationship between theory and operation through simulation applications, realize concrete explanations, contextualized operations, and personalized learning. While learning new skills, students also accumulate experience in industrial robot operation programming. The industrial robot virtual simulation courses face some practical issues: there are few schools offering them, the courses have been established for a short time, and the teaching effect is not satisfactory. The main purpose of offering these courses is to address equipment shortages and enhance students' advantages in skills competitions. The "Offline Programming and Simulation of Industrial Robots" course has long been a core course in higher vocational and undergraduate industrial robot programs. Developing this course in secondary vocational schools is beneficial for laying a solid foundation, establishing an advantage, and helping students better adapt to the learning intensity after entering higher vocational education. Occupational student skills competitions are upgrading every year, and the events increasingly require students to have the ability to use simulation software. Employers also report that some students have weak theoretical knowledge, insufficient operational skills, and limited competitive advantages in job positions. These realities indirectly reflect that developing a virtual simulation technology application course for industrial robots in higher education aligns with the practical needs of professional development in secondary vocational schools and is somewhat helpful in establishing professional advantages.

Developing the course "Fundamentals of Industrial Robotics Technology" is more challenging compared to other practical skill-based courses[5]. The reason lies in the fact that, as a foundational integrated theory-practice course for the Industrial Robotics Technology application major, it contains a substantial amount of theoretical knowledge with scattered key points. This makes it difficult to align with specific job positions to conduct task and professional competency analyses, which could otherwise provide a foundation for the subsequent construction of the knowledge system. Therefore, this study focuses primarily on the course knowledge points themselves. Based on the presentation and organization of these knowledge points, it actively promotes the integration of course development content with specific enterprise training tasks to concretize the course knowledge. This effectively facilitates the extraction of integrated theory-practice teaching content in the course, with an emphasis on analyzing work scenarios during task execution. This allows students to understand both the fundamental principles and conceptual knowledge through hands-on training, enhancing the systematic structure of knowledge and the interrelation of knowledge points. It provides a reference case for higher education researchers developing foundational technical courses, and the improved course development

approach can also offer insights for further exploration of advanced course development theories in the future.

THEORETICAL FRAMEWORK

Currently, exploring curriculum development models that fit the national context has become an important theme and trend in the development of vocational education in various countries. Vocational education developed countries have accumulated a lot of experiences that can be learned from and referenced. Some of the relatively mature foreign curriculum development models include the competency-based curriculum development model, the MES curriculum development model, and the German 'dual system' curriculum development model.

The competency-based curriculum development model, also known as the CBE curriculum development model, is a prevalent approach in vocational education curriculum development in North American countries[6]. The CBE curriculum development model emphasizes student-centered learning, with the cultivation of professional competencies as the goal. It establishes a curriculum development process that ranges from job analysis to instructional task analysis. Different teaching modules are designed according to the learning progress, and the knowledge points derived from specific job tasks are implemented with the principle of being "practical and sufficient." The CBE curriculum model focuses on the comprehensive development of students' abilities, including knowledge (theoretical knowledge related to job competencies), attitudes (work attitude, motivation, and other emotional factors), practical experience (specific operational and managerial skills), and feedback (the ability to self-assess and improve).

The MES course development model is a development approach presented in the form of vocational training. It is based on systems theory and cybernetics as the theoretical foundation for its course development path, viewing the process of vocational and technical training as a complete dynamic system, with vocational training occupying an important position in the final curriculum system.

The German dual system is a curriculum model based on school-enterprise cooperation[7]. This model has a supporting development framework, and the specific development path can be understood in three steps: the arrangement of curriculum standards, the structuring of the curriculum's logical system, and the actual implementation of the curriculum.

By drawing on the curriculum development models of vocational education from abroad and combining them with the actual development needs of local vocational education, China has formed the 'broad foundation, flexible modules' curriculum development model, the 'work-process-oriented' curriculum development model, and the 'project-based' curriculum development model [8].

Vocational education curriculum research expert Jiang Dayuan, drawing on the experience of vocational education curriculum development in Germany, proposed a 'work process-oriented' curriculum development model [9]. The specific implementation of this model involves breaking down the logical system of traditional disciplines and then reconstructing a development process that reflects the action-oriented nature of vocational education. Its focus lies in analyzing work processes in contextualized situations, and through instructional treatment and transition, transforming curriculum content into a knowledge system that represents the work process. Moreover, the teaching modules are interconnected and progressively challenging.

"Project-based curriculum" is a curriculum development model advocated by vocational education experts such as Xu Guoqing and Shi Weiping [10]. The content of a "project-based curriculum" is determined based on enterprise job clusters. Specific work tasks are identified through the analysis of these job clusters and are used as the foundation for the development of "project" courses. Its project carriers are relatively independent activity modules, such as a particular product or service.

To this day, task-driven curriculum development has become a major trend in international education curriculum reform. Many countries have begun to widely apply such curricula at different educational stages. A representative example is the United States' "Second Step" program, which focuses on bullying prevention and aims to improve students' emotional management during adolescence[11]. The curriculum is designed in task-driven, spiraling chapters according to students' different developmental stages and cognitive levels.

Amberg University of Applied Sciences in Germany, based on the curriculum characteristics of the computer engineering program, adopts a task-driven introduction method centered on real challenges that may arise in future computer engineering work[12]. The curriculum is divided into theoretical

learning modules and skill training modules, emphasizing hands-on engineering practice to guide theoretical learning, establishing an educational model of 'learning through application' and 'advancing learning through use.' In the UK, architecture education courses in task-implementation scenarios, with the joint support of teachers and students, cultivate the creative design abilities of professional architects within real architectural contexts[13]. Tokyo University of the Arts, in collaboration with community education, expands courses through community activity-based task driving, leading students to conduct art creation educational activities within the community, breaking down barriers between teaching domains and strengthening connections between areas of professional knowledge[14]. The course development at the Danish University College of Sports Education focuses on general education, with curriculum principles emphasizing experiential and interest-based learning. In a task-driven context, teachers employ engaging and inquiry-based teaching methods, and course assessment approaches are relatively diverse.

Among them, Zhen Jiujun addressed the shortage of textbooks and the low adaptability of students to practical training in the CNC technology programs at some vocational institutions by undertaking a curriculum development and reform effort for the CNC course 'CNC Machine Tool Fault Diagnosis and Maintenance,' organizing content around five learning scenarios: CNC machine tool management, mechanical component maintenance, and control system assembly and debugging[15]. Cai Jiancong developed the secondary vocational program course 'Installation and Commissioning of Intelligent Control Devices' based on task-driven logic using typical work tasks, highlighting a teaching evaluation process that thoroughly integrates professional qualifications closely related to students' future careers and focuses on assessing students' problem analysis and solving abilities through project-based learning [16]. In higher vocational computer course reform, Yan Lixin designed six major modules based on practical training tasks, including stage task modules, comprehensive task modules, and competition task modules, subdivided tasks across these modules, and conducted secondary development of task-driven course resources, providing guidance for the development of hands-on computer courses [17]. Tang Yafeng, in developing intelligent automobile training projects for secondary vocational schools, analyzed the core components of intelligent vehicles and divided the comprehensive training content for smart connected vehicles into four practical training tasks: intelligent sensors, computing platforms, smart cabins, and drive-by-wire chassis, with chapter design based on the vehicle entities, ensuring coherent and logically connected content[18]. Yan Hao and colleagues, incorporating the actual working environment and requirements of chemical production, analyzed typical chemical production tasks, using the operational procedures of relevant equipment as a reference and customizing the core skills training in the teaching process according to the needs of chemical production enterprises, effectively recreating workplace scenarios from 'environment' to 'methods' to 'process'[19].

Abroad, while improving the level of product research and development of robots in their application fields, there is also great emphasis on the construction of robot education. As one category of robots, industrial robots can benefit from referencing the development of robot education abroad to provide experience for curriculum development. In the United States, robot education courses are mainly offered in four forms: technical foundation courses, comprehensive practical courses, summer camp activities, and robot teaching auxiliary courses. The teaching themes focus primarily on deep learning, process guidance, and career experience, among which the most representative are the series of courses such as "Introduction to Robotics" developed by MIT [20]. The core content of these courses is to have students build robot models, during which they gain a clear conceptual understanding of the basic components of robots, thus testing their knowledge level and operational skills. In Japan, robot education is designed and implemented according to the different stages and needs of students. For elementary school students, robot education mainly aims to cultivate interest and creativity according to their psychological and cognitive development level. At junior and senior high schools, the teaching method primarily involves robot competitions, allowing students to enhance their abilities through hands-on practice. At university level, the focus is on studying robot mechanics and product development methods.

The model of vocational education in Europe is characterized by school-enterprise cooperation. In the curriculum system of the robotics major, the participation of manufacturers of robotics teaching products is relatively high. Scholar Schilling, R pointed out that during teaching and research, we can provide feedback and production guidance on manufacturers' products so that their products can meet the basic requirements of educational applications as much as possible. In addition, leading industrial

robot companies have mostly developed their own training course systems. For example, Swedish ABB Robotics, Japanese FANUC Robotics, and German KUKA Robotics have developed a set of teaching courses for using their company's robot products along with supporting equipment resources. They have also developed teaching software for virtual simulation of industrial robot workstations to realize an integrated teaching platform for industrial robot courses. Western countries such as Germany and the UK have introduced relevant robotics education policies. For instance, the German Federal Ministry of Education and Research, in the "Information and Communication Technology 2020—Research for Innovation" project, applies developed robotics information teaching kits in classrooms with the aim of improving teachers' efficiency in teaching robotics, helping students understand robotic technology, and stimulating students' cognitive understanding of knowledge such as robot information circuits and the cultivation of logical control thinking[21].

Research on project-based course development for industrial robots mainly includes: Tan Panlong applied the CBE CDIO concept to industrial robot application courses by gradually increasing difficulty and organized them into project-based courses. Following the product design stages of 'conceive—design—implement—operate' and guided by engineering project design, he designed three major project modules: basic, specialized, and comprehensive, which further derived thirteen smaller practical training modules. Liu Wenjie conducted research targeting robot system integration companies, extracting five typical enterprise cases: assembly line handling, assembly line palletizing, automotive glass glue application, circular segment cutting, and PCB board assembly, to develop a project-based course on 'Industrial Robot Operation and Programming.' Qi Xiaoling, based on the technical requirements of different industrial robot job positions, divided the course content of 'Industrial Robot Operation and Programming' into three major modules: core basic exercises, on-machine virtual simulation, and comprehensive practical training tasks. Jia Weiping and others carried out a task-driven industrial robot experiment design and development. Based on the analysis of the mechanical structure and control system of industrial robots, they designed practical training projects, with robot handling for loading and unloading and innovative design content as the final teaching projects.

Some issues partially deviate from enterprise needs and the rules of career development. Chen Yang applied the theory of systematic work processes to develop the secondary vocational course 'Industrial Robot Maintenance and Testing,' analyzing four learning scenarios specifically for robot maintenance and testing: inspection and recording, adjustment and maintenance, component repair and replacement, and complete machine assembly and disassembly. He combined the basic work process of 'information, planning, decision-making, implementation, testing, and evaluation' to carry out the course teaching design and propose evaluation strategies. Xiong Feng used a work process-based systematic course development method to present the secondary vocational course 'Industrial Robot Vision Applications' with basic visual functions as the carrier, designing four learning scenarios with progressively increasing difficulty. In addition, he created integrated student learning work sheets and designed diversified, process-oriented evaluation forms. Tian Yong and others applied the systematic work process method to redesign the 'Industrial Robot System Integration' course structure, with work scenario designs based on real industrial robot production environments and system equipment setup training, sequencing the course content into the entire process of robot workstation programming and debugging.

Considering the basic characteristics of the 'Fundamentals of Industrial Robot Technology' course in vocational secondary education, a curriculum structured in a 'task-driven' format holds significant reference value. Organizing course chapters according to a 'task-driven' approach is transferable. In classroom teaching activities, presenting learning content in the form of chapter-based tasks allows these tasks to serve as the fundamental learning objects for students, which can be applied to other similar vocational contexts in the future. This approach reflects the 'vocational nature' inherent in vocational education courses and effectively addresses the current issues in the 'Fundamentals of Industrial Robot Technology' course at vocational secondary schools, where knowledge points lack logical coherence and fail to connect with practical production.

METHOD

The literature research method mainly refers to the collection, identification, and organization of literature, and through the study of literature, forming a scientific understanding of facts. This study analyzes the current advanced concepts in vocational education curriculum development and reviews the mainstream domestic and international vocational education curriculum development models,

providing theoretical and methodological support for the curriculum development process of this research. At the same time, various databases were searched using keywords such as 'curriculum development' and 'secondary vocational industrial robot courses' to summarize and integrate practical research results on industrial robot curriculum development. By referencing current research achievements and specific development paths, and through extensive literature collection, analysis, organization, and comparison, the main direction and specific content of this study are determined.

The questionnaire survey method refers to a quantitative measurement approach that involves selecting survey subjects based on the content of the survey, designing, distributing, and collecting questionnaires for analysis. In the early stages of course development, this study conducted a questionnaire survey among instructors and students of the 'Fundamentals of Industrial Robotics' course in higher education institutions to investigate the current status of the course and identify issues that need to be addressed. During the implementation evaluation stage after the course development, for the target participants of the course, a questionnaire survey was conducted to assess the effectiveness of the 'Fundamentals of Industrial Robotics' course development in terms of teaching satisfaction, achievement of course objectives, and acceptance of the teaching.

In the field of educational research, the empirical research method refers to a method in which educational researchers carry out teaching practices and collect relevant materials or experiential data from the implementation process to verify proposed teaching theories or test teaching effectiveness. This study conducted empirical research on curriculum development at Zhejiang Institute of Mechanical and Electrical Vocational College, using Class A of the 2024 Industrial Robot Technology Application major as the target for teaching practice. A theoretical-practical integrated classroom teaching model was constructed, and a three-month classroom teaching practice was carried out. Finally, the implementation effect of the "Fundamentals of Industrial Robot Technology" course development was tested through a course evaluation system based on the CSE course evaluation model.

This article attempts to combine the flipped classroom and task-driven teaching methods, applying them to the course 'On-Site Programming and Debugging of Industrial Robots,' and divides the teaching process into the following five main stages.

1. Set up guiding prompts to help students acquire theoretical knowledge

For the theoretical knowledge required for course practice projects, text-based guided prompts are set up, which include several questions. On one hand, this stimulates students' interest in learning, and on the other hand, it guides students to explore relevant knowledge points before class. Taking the project 'Establishing ABB Industrial Robot Tool Data' as an example, the guided prompt can include the following questions: What types of tools do industrial robots have? What coordinate systems do industrial robots have? What is the tool coordinate system of an industrial robot? Why establish a tool coordinate system? Besides the tool coordinate system, what other data does tool data include? How to establish tool data? How can you verify whether the tool coordinate system you established is valid? The guided prompt must be assigned before class and students are required to complete it before the class. This is a basic requirement of the flipped classroom, where students should complete the learning of the theoretical knowledge needed for the class before the class begins.

2. Assign project tasks to strengthen students' goal orientation

While assigning the guiding text, classroom project tasks should also be arranged. This follows the action-oriented teaching method, allowing students to understand the practical use of theoretical knowledge while exploring it through the guiding text, rather than learning for the sake of learning. Providing them with a clear project objective can further enhance their interest in learning and strengthen their initiative. Taking the project 'Establishing ABB Industrial Robot Tool Data' as an example, in addition to the guiding text, a clear project objective document should be given to students before class, such as 'Install a grinding tool on the IRB1200 industrial robot and establish the tool coordinate system,' or 'Install a welding tool on the ABB industrial robot and set up the coordinate system.' Projects should focus on core knowledge points, allowing students to complete the project using the knowledge gained from the guiding text, thereby enhancing their mastery of both knowledge and skills.

3. Guide students to develop a work plan

Proper planning leads to success, while lack of planning leads to failure. Before students formally start hands-on practice in the classroom, teachers should complete the following two tasks:(1) Check students' pre-class theoretical knowledge through random sampling. On one hand, this can supervise and encourage students to effectively complete the study of the guiding materials before class; on the

other hand, it can identify and slightly analyze any difficulties students encounter in their learning.(2) Organize students into groups and guide each group in creating a work plan for the project they need to implement. The work plan can include the composition of members, division of responsibilities, and stages and content of the project work. Teachers should provide reasonable comments and corrections on any inappropriate parts of the work plans prepared by the groups. Through this activity, students can develop teamwork skills for collaborative work and cultivate good habits in planning and organizing tasks.

4. Organize students to carry out project tasks

The implementation of project tasks is the core process of this teaching method. In this part, the teacher's role is still that of a guide, while students remain the focus of the class, which aligns with the educational concepts of both flipped classroom and action-oriented teaching methods. In this stage, students both divide tasks and collaborate, gradually completing practical projects based on pre-class theoretical knowledge and work plans. For example, in the project 'Establishing ABB Industrial Robot Tool Data,' students need to operate the robot through the teach pendant to reach the appropriate position, replace the robot's tool as required, establish the tool coordinate system through the teach pendant, and finally verify whether the tool coordinate system is correct. During these operations, students repeatedly validate theoretical knowledge through practice, ensuring a deeper understanding of the acquired skills and knowledge. The teacher provides minimal guidance during this process, intervening only to prevent serious errors or unsafe situations, without excessively interfering with the students' practical activities.

5. Project Evaluation and Project Summary

Teachers establish a comprehensive evaluation system to better reflect and recognize the work done by students, enhancing their learning information and interest. After the project is completed, students are organized to evaluate their own work, group members evaluate each other, groups evaluate each other, and finally, teachers also give a certain evaluation of each group's work. Students' scores should take all these evaluations into account. Finally, teachers summarize the entire project implementation process, affirm the well-completed tasks, correct any mistakes, review theoretical knowledge, reanalyze difficult points, and strengthen students' understanding of key concepts.

FINDINGS AND DISCUSSION

In the teaching of various courses in the industrial robot major, such as the basics of industrial robots and on-site programming of industrial robots, the virtual simulation application of industrial robots will be involved. Virtual simulation technology plays a role in connecting various knowledge points in the course. Robot-Studio builds workstations, performs offline programming, program debugging, and motion simulation for robots and peripheral equipment. Finally, the debugged programs can be applied to real training teaching or production practice. The specific application is shown in the table below.

Table 1. Application of Robot-Studio in Professional Courses

Level	Course	Application
Basics	Industrial Robot Basics	Robot Basic Cognitive Operation
Advanced	Industrial Robot On-site Programming	Offline Programming
Advanced	Industrial Robot Workstation Installation and Debugging	Workstation Virtual Simulation
Expansion	CAD/CAM Software Application	Tool Modeling
Expansion	Flexible Manufacturing and Production Line	Smart Components

The core professional competency requirements of the industrial robot major are to be able to maintain and service industrial robot application system equipment, to eliminate simple electrical and mechanical faults; to compile and adjust industrial robot control programs according to the job requirements of the automated production line; to install and debug industrial robots and application systems according to the requirements of industrial robot application solutions. The professional course structure includes

modules such as basic robot operations, offline programming, and system design, including RobotStudio virtual simulation technology, which can be well connected with corporate job capabilities, combined with project-based teaching design and immersive teaching methods to improve students' professional core skills and professional quality.

Manual manipulation of industrial robots in practice, in the teaching of the basic course of industrial robots, the manual operation of robots is one the important learning content connects the two major knowledge modules from the basic theoretical knowledge of robots to robot programming. Since students have not really touched the robot and still have a certain "awe" of the robot, using Robot-Studio to virtually simulate the manual operation of the robot can play a good teaching effect. In the author's actual teaching, this part of the content is dedicated to 4 class hours for virtual simulation training. The three motion modes manually operated by the robot include single-axis motion mode, linear motion mode, and repositioning motion mode. Students can observe the 1-6 axis single-axis motion state of the robot in real time in the software, the linear motion trajectory in the X, Y, and Z directions in the linear operation mode and the TCP point in the repositioning mode around the X, Y, and Z axes respectively to make the position unchanged and the attitude change movement, and observe the robot motion state, angle, displacement and other data in an all-round way, and record the motion trajectory of each joint axis in real time, so that students can understand the robot motion state more vividly and vividly, and grasp the data more specifically and detailed.

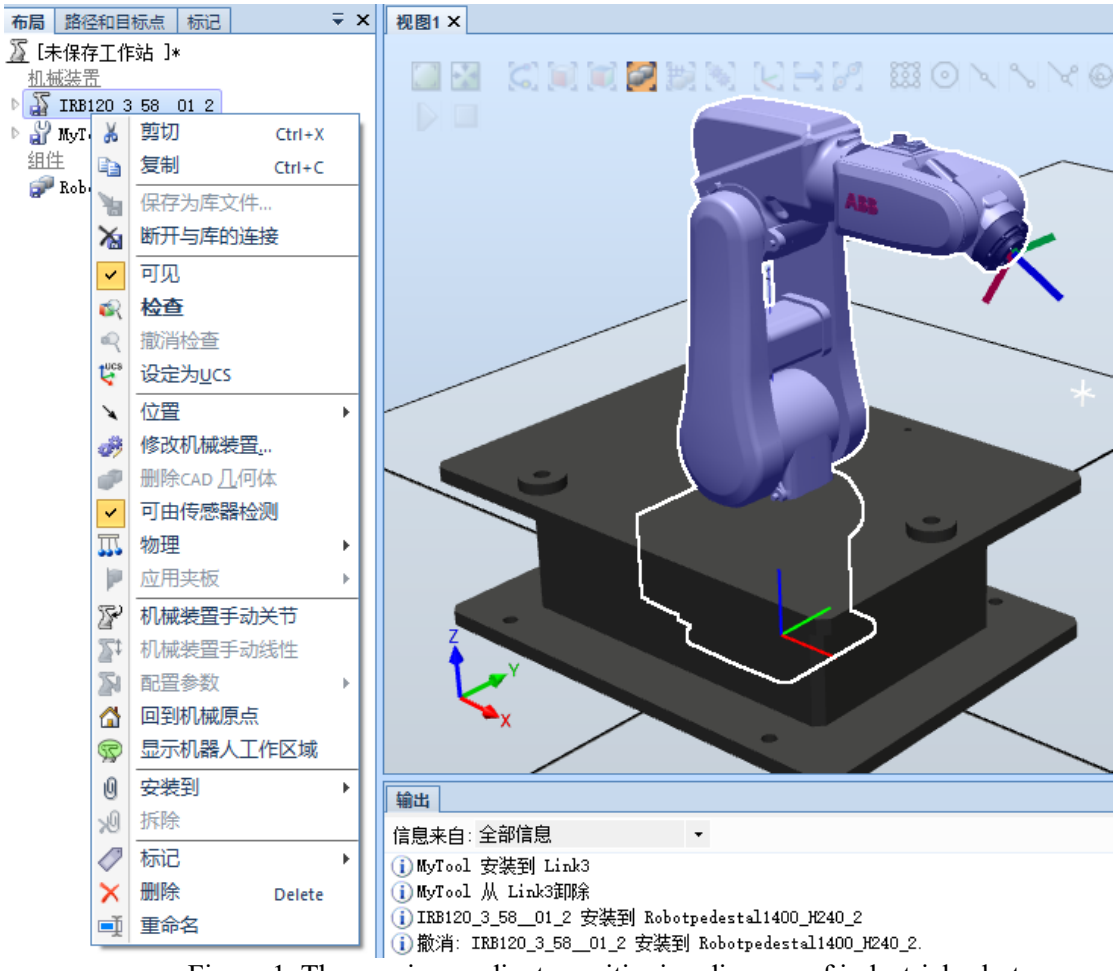


Figure 1. Three-axis coordinate positioning diagram of industrial robots

Robot workstation offline programming application, industrial robot programming is divided into online programming (teaching programming) and offline programming. Online programming needs to be carried out on the robot site, which not only occupies the robot resources, but also the accuracy of the teaching point depends on the experience of the on-site personnel, and there is a large error and low efficiency. Compared with online programming, offline programming can allow programmers to work away from complex and harsh environments and reduce work intensity. It can effectively avoid the occupation of robot resources, and the program can be easily edited and modified in the software side

and transmitted to the robot controller for operation after normal debugging, which improves the programming efficiency. Combined with other industrial product design software, such as UG, Pro / E, etc., equipment or workpiece models can be imported into Robot-Studio, and workstations such as handling, palletizing, and assembly can be constructed, so as to guide students to think about workstation scheme design ideas in teaching, and organize teaching content such as layout implementation, process implementation, and system optimization, so as to improve students' ability to comprehensively apply industrial robot technology.

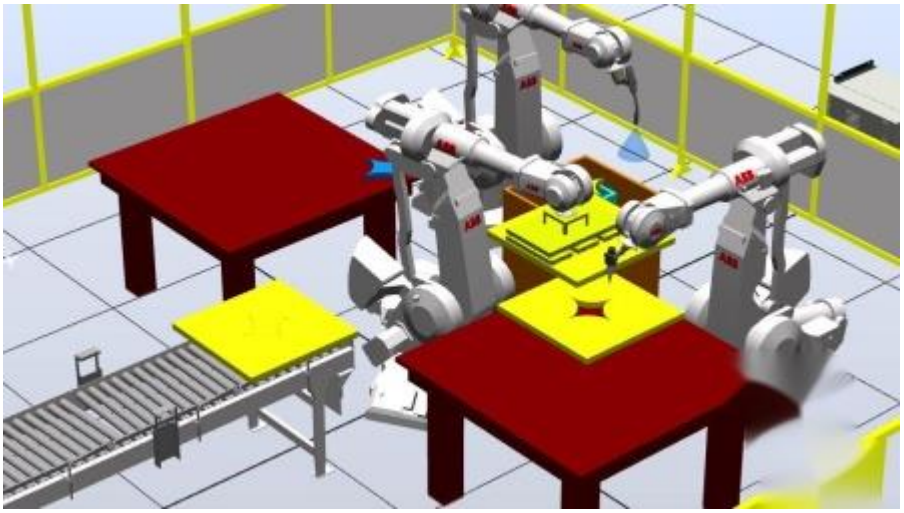


Figure 2. Processing diagram of the automatic production line of industrial robots

At present, the vocational college skills competition is one of the measures to measure the teaching level of vocational colleges an important sign, more vocational colleges have increased their investment in skills competitions to achieve the purpose of "promoting teaching through competition". "Intelligent Transformation and Integration Technology of Manufacturing Unit" is an emerging competition in the Vocational Skills Competition of Higher Vocational Colleges and has been successfully held for two national competitions so far. This competition aims at the intelligent manufacturing process of grinding, testing, processing and other processes of automobile wheel hub parts, with the application of intelligent manufacturing technology as the core and comprehensively examines the participating students' achievements in system integration design, application capabilities in industrial robot technology, visual inspection and other technologies. The core module execution unit of the competition is based on the motion control of ABB robots, including the loading and unloading of quick-change tools, picking and storage of wheels, visual inspection, grinding and processing, etc., all of which need to use Robot-Studio for offline programming and virtual simulation, especially the process preparation of mass production wheels and customized production wheels, which can save a lot of time and improve the level of competition through software programming and debugging and then downloaded to the robot controller.

The issue of whether the micro-lecture-based 'flipped classroom' teaching model is effective in the industrial robotics program of vocational schools was verified through a questionnaire survey conducted after the course. An anonymous survey was carried out with a total of 90 students from Class A and Class B. Ninety questionnaires were distributed and 90 were recovered, giving an effective response rate of 100% (see Table 2). According to Table 2, most students believe that the micro-lecture-based 'flipped classroom' teaching model can enhance their learning enthusiasm and change their learning attitudes. Under this new teaching model, it not only promotes learning ability and self-confidence but also improves teamwork skills. Students also think that this model can enliven the classroom atmosphere and enhance everyone's classroom expression abilities. A few students believe that they cannot complete all learning tasks under this teaching model. Overall, this model is highly recognized by students, and classroom learning efficiency has significantly improved.

Table 2 Survey Results of Industrial robot teaching reform

Items	Agree	Neutral	Disagree
Increase learning motivation	96.42%	3.58%	0%
Liven up the classroom atmosphere	94.36%	3.18%	2.46%
Promote learning ability and self-confidence	86.45%	11.15%	2.4%
Enhance team collaboration and communication skills	78.89%	18.16%	2.95%
Lay the foundation for practical lessons	72.86%	24.78%	2.36%
Enhance classroom communication skills	80.64%	13.57%	5.79%
Able to complete all pre-class and post-class tasks	77.64%	10.25%	12.2%
Change the attitude towards learning	85.45%	11.23%	3.32%

Through the analysis of statistical data on the implementation effectiveness of diversified courses, it can be found that in terms of students' learning outcomes, the effects of learning align with the fundamental objectives of the course "Fundamentals of Industrial Robot Technology." Specifically, students have gained effective improvements in theoretical knowledge, technical skill mastery, and professional quality development through this course. Regarding students' course experience feedback, students showed high satisfaction with the course content, classroom format, and course resources, believing that learning in a flipped classroom under a task-driven context is enjoyable and fruitful.

CONCLUSION

The application of Robot-Studio software to the virtual simulation teaching of industrial robots can organically connect the professional courses, connect the core skills of the current industrial robot occupational job group, and promote the continuous development of the curriculum system in the direction of informatization of teaching methods and intensive teaching content. While using the powerful offline programming function of Robot Studio in teaching to realize the functions of workstation virtual simulation, system optimization design, offline programming, and debugging, it has played a good role in improving students' enthusiasm for learning industrial robots, cultivating students' patient and meticulous learning habits and good professionalism.

After presenting and organizing the key points of the course, the specific implementation of course development is carried out. This is the process of concretizing complex and abstract knowledge through task-driven methods. The main content includes two parts: 'selection of comprehensive training tasks for course development enterprises' and 'construction of the main line of task-driven course content.' The purpose is to integrate the thematic design of the course content into the real application scenario of the selected comprehensive training task 'assembly and handling of motor components on the production line,' based on the functional hierarchy division of the five major systems of industrial robots. This serves as an integrated training task throughout the course to combine course content with practical work, thereby creating a foundational course in industrial robot technology suitable for engineering students.

Experimental analysis shows that under the micro-lecture-based "flipped classroom" teaching model, the overall score distribution has a higher proportion of high scores and a lower proportion of low scores, with students' overall average grades significantly higher compared to the traditional teaching model. Survey results indicate that the micro-lecture-based "flipped classroom" teaching model

can help stimulate students' learning motivation, has a positive effect on their attitudes toward learning, and is conducive to improving students' confidence, learning ability, teamwork, and communication skills. It also helps students approach problems from different perspectives and respond with a more positive attitude in their future studies and work.

This paper starts from the characteristics of industrial robot courses and the concept of running higher vocational colleges. In this paper, the teaching design and practice of the course were discussed by means of flipped classroom and virtual simulation software, according to the teaching mode of "integration of science, fiction and reality". It not only overcomes the problem of tight training resources, improves the utilization rate of industrial robot resources, but also enhances students' interest in learning and the role of virtual equipment in the learning process, and enhances students' ability to apply industrial robots.

Experimental analysis has shown that under the task-driven 'flipped classroom' teaching model, the proportion of high scores in the overall score distribution increases, the proportion of low scores decreases, and the overall average student performance is significantly higher compared to the traditional teaching model. The survey results indicate that the 'flipped classroom' teaching model, based on the virtual simulation software Robot-Studio, helps to stimulate students' learning enthusiasm, has a certain positive impact on their attitude toward learning, and is beneficial for improving students' confidence, learning ability, teamwork, and communication skills. It also helps students view problems from different perspectives and approach future learning and work with a more positive attitude.

Follow-up research should increase the application of curriculum development outcomes in actual teaching, further improve teaching content and plans through implementation results, and, if possible, invite more like-minded researchers to participate, promoting the research results to schools in more regions.

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Study on the Current Situation and Development Countermeasures of Basketball Clubs in Colleges and Universities of Dongguan City

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ABSTRACT

The establishment of clubs provides a platform for college students to exert their subjective initiative. With the proposal of China's lifelong sports and national fitness policies, the degree of sports socialization has been continuously improved. The number of college students participating in sports activities is increasing, and sports clubs are emerging one after another. College basketball clubs are a new product emerging from school reforms in the new era. The development of these clubs can meet the needs of students' personalized development, strengthen their specialties, cultivate their interests, and thus have a promising development prospect. This paper conducts an in-depth study on the current situation and existing problems of basketball clubs in colleges and universities of Dongguan City by means of literature review, questionnaire survey, and interviews. It puts forward improvement strategies for the problems existing in the development of basketball clubs, which is of certain guiding significance for the dissemination and healthy development of basketball clubs in colleges and universities of Dongguan City. This study mainly conducts specific investigations and researches on the member status, material resources, system construction, and activity organization of basketball clubs in colleges and universities of Dongguan City. The results are, first the construction of basketball clubs in colleges and universities of Dongguan City has been improved. It also showed that the material foundation of basketball clubs in colleges and universities of Dongguan City is insufficient and the system construction of basketball clubs in colleges and universities of Dongguan City needs to be improved. Last, the organized activities of basketball clubs in colleges and universities of Dongguan City are single. In order to further develop and expand the clubs, inter-college exchanges should be strengthened.

Key Words: Basketball Clubs; College Students; Dongguan City

INTRODUCTION

Dongguan City has a profound basketball culture heritage. Before the reform and opening up, "every village had a basketball team and everyone played basketball", with a solid mass foundation. After the reform and opening up, the level of basketball events in Dongguan has been continuously improved, ranging from town-level competitions to international competitions. In 2004, Dongguan was awarded the title of "National Basketball City". Changping Town, as a representative of Dongguan's basketball development, has seen its student men's basketball team win the second place in the provincial traditional school competition and visit Egypt, and its town men's basketball team win the championship of the national "Harvest Cup". In addition, Changping Town has built the first township gymnasium in China to host large-scale events.

At the college level, Dongguan University of Technology holds college-level and class-level basketball games every semester, and has won the second place in the junior college group of the Provincial Games and qualified for the undergraduate group final of the Provincial University Games. The men's basketball team of Guangdong University of Science and Technology represented Guangdong Province in the CUBA (Sunshine Group) in 2016 and won the third place. In 2016, the first "DUBA • Dongguan College Students Basketball League" was successfully held, which set off a basketball fever in colleges and universities. However, the development of college basketball clubs is still not ideal.

After the reform and opening up, the reform of China's higher education and sports system has been deepened. The Outline of the National Fitness Program has constructed a hierarchical structure of

national sports clubs and clearly stipulated the role of mass organizations. In 2005, the Opinions on Strengthening and Improving the Work of College Student Clubs supported college students' clubs to carry out activities in accordance with regulations and required colleges and universities to promote the development of clubs through club culture festivals and other activities. In 2006, the Decision on Launching the National Hundred Million Students' Sunshine Sports Campaign and the spirit of the Political Bureau meeting of the Central Committee in 2007 both emphasized strengthening youth sports and promoting the "Sunshine Sports Campaign". However, college physical education classes can hardly meet the needs of students, so sports clubs have become an important supplement.

As a "Basketball City", Dongguan has a strong basketball atmosphere in colleges and universities. However, there are few academic studies on college basketball clubs in Dongguan at present, resulting in insufficient theoretical support. Therefore, it is necessary to clarify the current development situation, problems and causes of these clubs through investigations, and put forward countermeasures to promote the development of the clubs and basketball sports.

College basketball clubs are important positions for the development of basketball sports and the dissemination of basketball culture. By sorting out the current development situation and problems of basketball clubs in colleges and universities of Dongguan, this paper puts forward development countermeasures, which provides theoretical guidance for the sustainable development of the clubs and supplements theoretical references for the research on the construction of college basketball culture.

The research results can promote the healthy development of basketball clubs in colleges and universities of Dongguan and provide reference for sports clubs in other colleges and universities in the province. At the same time, it can promote the dissemination of basketball culture in colleges and universities of Dongguan, help cultivate students' physical and mental health and awareness of lifelong sports, and serve the cultural construction of Dongguan as the "Hometown of Basketball".

By sorting out the existing literature, this paper starts from the current development situation of basketball clubs in colleges and universities of Dongguan, analyzes the overall overview of the clubs, identifies the problems and causes in their development, and discusses the countermeasures and suggestions for the development of the clubs in colleges and universities.

THEORETICAL FRAMEWORK

Concept

- College Student Clubs: According to the Encyclopedia of China (Education), they are mass organizations voluntarily formed by students, which can break the boundaries of grades and departments. The Opinions on Strengthening and Improving the Work of College Student Clubs clearly defines them as organizations voluntarily formed by students based on their interests and carrying out activities independently in accordance with the articles of association.
- College Student Sports Clubs: Lu Yuanzhen pointed out that they are social groups with sports as the purpose or content, belonging to social sports clubs. Subsequent studies supplemented that they are non-formal mass organizations spontaneously formed by students based on common sports interests.
- College Basketball Clubs: This paper defines them as non-profit after-school groups in colleges and universities that are spontaneously organized by students, with health education as the purpose, approved by the school registration, and with basketball as the core activity content. They spread basketball culture through competitions, skill teaching, and other activities.

Foreign Research Status

Sports clubs in foreign colleges and universities are mostly called "sports clubs". In the United States, the atmosphere of college sports clubs is strong, with strict management and clear support for funds and venues. However, there are problems such as the impact of secret clubs and conflicts between political clubs. In Germany, college sports clubs are divided into on-campus and off-campus ones, which cooperate with social clubs and become a feature of campus sports culture. In general, foreign college sports clubs have relatively complete venues, funds and systems, but the policies are relatively loose, and there are still problems in their development.

Domestic Research Status

The research on college sports clubs in China started late, and most of them focus on theoretical aspects such as concepts, characteristics and functions, while practical research is limited to the analysis of current situations. Pan Xiugang pointed out that members of sports clubs are more likely to develop

exercise habits and suggested increasing publicity. Li Qiaoling proposed to improve the fund management and cadre training mechanism of college sports clubs in Henan Province. Liu Qiangde summarized the problems existing in college sports clubs in China, such as high personnel turnover, incomplete systems, and poor material conditions, and suggested strengthening the linkage with the outside world and expanding funding channels.

Review of Research on College Student Clubs

Existing studies mostly analyze the functions and countermeasures of clubs from the perspectives of organizational construction and operation management. Zhai Chengqiang believes that clubs take students as the center and contribute to the construction of learning style and school spirit. Zeng Ying suggested that clubs optimize the management mechanism and strengthen the training of cadres. Li Xuemei pointed out that clubs have problems such as insufficient content innovation and loose management, and suggested improving the system and resource guarantee.

Review of Research on the Development of College Student Sports Clubs

Pan Xiugang compared the members of sports clubs and non-sports clubs, emphasizing that sports clubs need to enhance their influence. Jiang Ke pointed out that foreign clubs are closely combined with academic studies and receive strong support from schools. Li Qiaoling proposed that college sports clubs in Henan Province need to optimize resource allocation, give play to the advantages of human resources, and improve fund management.

Review of Research on the Current Situation and Countermeasures of College Basketball Clubs

Liu Chang analyzed the restrictive factors of basketball clubs in Jiangsu Higher Vocational Alliance and put forward countermeasures. Zhang Jie studied the construction and management of basketball clubs with Henan Polytechnic University as an example. Zhu Hong pointed out that some colleges and universities do not carry out basketball clubs, which affects the popularization of basketball sports. Wang Limin emphasized the spiritual culture of basketball and suggested increasing publicity and system construction. The existing research lacks pertinence, and it is necessary to deeply explore the detailed problems such as material support and systems of college basketball clubs in Dongguan.

METHODS

Research Object

The research object is the current situation of basketball clubs in colleges and universities of Dongguan City. Five colleges and universities with basketball clubs were selected, including Dongguan University of Technology (public undergraduate), Guangdong University of Science and Technology (private undergraduate), Dongguan University of Technology City College (private undergraduate), Dongguan Polytechnic (public junior college), and Xinhua College of Sun Yat-sen University (Dongguan Campus, private undergraduate). The survey objects include club members, cadres and guiding teachers.

Research Methods

Literature Review Method

Through libraries, CNKI (China National Knowledge Infrastructure), and the library of South China Normal University, literature, books and periodicals related to "basketball clubs" and "college sports clubs" were retrieved, and the research results were sorted out to provide theoretical support for this study.

Questionnaire Survey Method

The research utilized a comprehensive questionnaire design tailored to students, club cadres, and guiding teachers, which was finalized following expert consultation and a pre-survey11111111111. To ensure academic rigor, validity was confirmed via expert evaluation—with 83% of experts rating the tool as "very" or "relatively" effective—while reliability was established through the test-retest method, yielding a high correlation coefficient of $R > 0.85$. The data collection process involved on-site distribution and recovery, resulting in high valid response rates: 97.5% for students (195 valid out of 200), and 100% for both cadres (14 recovered) and teachers (7 recovered).

Expert Interview Method

Through face-to-face interviews and telephone interviews, communication was conducted with 7 college league committee cadres, basketball club guiding teachers and directors, including Yang Shaofa (Deputy Secretary of the League Committee of Guangdong University of Science and Technology) and

Wang Bo (Secretary of the League Committee of Dongguan Polytechnic). The system, funds, and activity development of the clubs were understood, and suggestions were collected.

Mathematical Statistics Method

Excel and Spss19.0 were used to conduct statistical analysis on the valid data and make charts, providing scientific data support for the research.

RESULTS AND DISCUSSION

Basic Information of Members of Basketball Clubs in Dongguan's Colleges and Universities

1. Gender Structure

There are 182 male members (93.3%) and 13 female members (6.7%), showing a significant gender difference. Basketball is a highly confrontational sport, so boys have a higher interest in it. In addition, the turnover rate of members is relatively high after the recruitment of new students, and only a few can persist.

2. Grade Distribution

There are 111 freshmen (56.9%), 61 sophomores (31.3%), 21 juniors (10.7%), 2 seniors (1%), and 0 postgraduates or above. Freshmen and sophomores have sufficient spare time and strong interest, accounting for 88.2%; juniors and seniors have low participation due to internships, employment, and burnout caused by the improvement of skill levels.

3. Department Distribution

Members are mainly concentrated in the School of Management (20.1%), School of Finance and Economics (18.5%), School of Mechanical and Electrical Engineering (14.4%), and School of Computer Science (12.8%). The number of members from science and engineering majors is much larger than that from liberal arts majors, which is related to the professional settings and enrollment numbers of the schools.

4. Basketball Experience

There are 0 members without basketball experience. 13.3% of the members have practiced basketball for less than 0.5 years (most of them came into contact with basketball in high school physical education classes), 23.1% have practiced for 0.5-1 year, 47.2% have practiced for 1-2 years (most of them have participated in skill training), and 16.4% have practiced for more than 2 years. All members have a certain basketball foundation, but there are differences in their skill levels.

5. Motivation for Joining the Club

50.2% of the members joined to "keep fit", 37.4% to "enrich after-school life", 31.8% to "learn basketball culture", 6.7% "follow the trend", 6.1% for "socializing", and 2.6% for "others (love basketball)". Keeping fit and enriching after-school life are the main motivations.

6. Participation in Competitions

10.8% of the members have never participated in any competitions, 80.7% have only participated in internal club competitions, 13.3% have participated in inter-college exchange competitions, 3.1% have participated in municipal competitions, and 1.5% have participated in provincial competitions. The level of competitions that members participate in is low, and the overall technical level needs to be improved.

7. Degree of Preference

Before joining the club, 39.5% of the members had "strong interest" in basketball, and 60.5% had "general interest"; after joining the club, 74.8% "like" basketball, 25.1% have "general" feelings, and no one is "disgusted". Basketball is highly recognized in colleges and universities of Dongguan, and students' preference for it has increased significantly after participation.

Material Conditions of Basketball Clubs in Dongguan's Colleges and Universities

1. Venues and Facilities

Activity Venues, including all 5 colleges and universities have outdoor basketball courts, and 4 of them have indoor basketball courts. Indoor venues are mostly used by school teams or the physical education department, and clubs need to apply for their use with complicated procedures; there are no clear restrictions on the use of outdoor venues. The venue of 1 college is insufficient, and the venues of the other 4 colleges basically meet the needs. However, the satisfaction of club cadres with the venues is low: 0% are "very satisfied", 28.6% are "basically satisfied", 35.7% are "general", and 35.7% think the venues are "insufficient/very insufficient". While the club equipment is mainly purchased with

membership fees, and some are provided by members themselves or donated by graduates. Basic equipment such as basketballs basically meets the needs of daily training.

2. Fund Raising and Use

Club funding is primarily derived from membership fees, which are collected by 100% of the clubs, and school appropriations that are generally reserved for large-scale activities with complex approval procedures. These sources are supplemented by commercial sponsorships and competition bonuses, though the overall funding remains limited in variety. Membership fee standards vary significantly across institutions, ranging from one-time four-year fees at Dongguan University of Technology (100 yuan) and Guangdong University of Science and Technology (120 yuan) to annual fees at Dongguan University of Technology City College (50 yuan), Dongguan Polytechnic (30 yuan), and Xinhua College of Sun Yat-sen University (40 yuan).

Expenditure data shows that 62.1% of funds are allocated to hiring coaches and 60.0% to purchasing clothing and equipment, followed by smaller portions for publicity (21.5%), external exchanges (17.9%), and social activities (15.9%). A noteworthy collaborative model exists at Dongguan University of Technology, where members teach in off-campus clubs to help offset expenses. Despite these efforts, the financial status of most clubs is strained; only 14.3% report having sufficient funds, while 42.8% experience relatively difficult conditions and 14.3% face very difficult conditions, ultimately restricting the development of club activities

System Construction of Basketball Clubs in Dongguan's Colleges and Universities

1. Basic Systems

The internal management of the clubs reveals a significant gap between system design and practical implementation. While all clubs have established some form of labor division, only 28.6% possess a truly sound system with standardized activities, whereas 42.8% struggle with random activity planning. Execution remains a challenge, as only 14.3% of clubs strictly implement their regulations, and financial transparency is notably low, with over half (53.3%) of the clubs failing to disclose financial information. Regarding member retention, the primary drivers for turnover are the "disappearance of freshness" (85.7%) and time conflicts due to holding multiple positions (71.4%), followed by a lack of belonging and poor interaction with cadres (57.1%). Despite these structural and social hurdles, member satisfaction remains generally positive, with 63.7% reporting they are "very" or "relatively" satisfied, though the presence of dissatisfied members suggests that management protocols and engagement strategies require further refinement.

2. Systems Related to Members and Cadres

The selection of leadership cadres within these clubs is primarily driven by democratic processes, with 57.1% of cadres chosen through member elections. However, alternative methods such as designation by predecessors (28.6%) or departmental assignments (14.3%) suggest a lack of innovation in leadership transitions. This centralized trend extends to decision-making, where 63.6% of choices are made through discussions among cadres and 18.2% by the president personally, leaving only 18.2% for full member voting. Similarly, activity content is largely determined by cadres and guiding teachers (54.5%), indicating that the overall degree of democratization in club governance requires significant improvement to better represent the general membership.

The clubs maintain a structured reward and punishment system that favors spiritual and academic incentives over material ones. All clubs (100%) utilize "issuing certificates" as their primary reward, while punishments are uniformly handled through "deducting comprehensive scores" (100%). Oral praise and warnings are common supplemental tools, but tangible rewards like cash (27.3%) or severe punishments like activity suspension (36.4%) are rarely employed. Regarding professional development, cadre training focuses heavily on organizational planning (92.8%) and management skills (85.7%), yet the frequency of these sessions is notably low; half of the clubs conduct training only twice a year, and no clubs provide more than four sessions annually, pointing to an insufficient training frequency for sustained leadership growth.

3. Systems Related to Guiding Teachers

Most guiding teachers are assigned or hired by the school, and there is no assessment mechanism. Some of them only hold the position in name only and do not participate in guidance. The teaching concept of guiding teachers is outdated, and they only pay attention to the completion of activities, with no clear assessment and reward-punishment systems, which restricts the development of the clubs.

Activity Organization of Basketball Clubs in Dongguan's Colleges and Universities

1. Activity Contents

100% of the clubs carry out "basketball skill training", 92.8% carry out "theoretical knowledge learning", 78.6% carry out "referee training", 71.4% organize "watching competitions", and 64.3% conduct "exchanges with other clubs". Due to insufficient funds, some clubs require members to learn theoretical knowledge and referee training independently, and the activity contents are not rich enough.

2. Activity Methods

In terms of implementation, 64.3% of the clubs carry out centralized activities, while 35.7% adopt group activities. Group activities are mainly organized due to limitations in the number of coaches and available venues, whereas centralized activities are more commonly implemented when clubs are able to rent indoor facilities. Regarding organizational methods, all clubs (100%) conduct training during spare time, and a high proportion (85.7%) organize inter-college exchange competitions. In addition, 57.1% of the clubs hold internal competitions, and 42.9% engage in exchanges with social basketball groups. Overall, off-campus exchanges remain limited, with members predominantly participating in activities held on campus.

From the perspective of activity evaluation, 40.5% of members believe that there are many activities but with limited forms, while 26.2% feel that activities exist but lack vitality. Meanwhile, 23.3% consider the activities to be few in number and outdated, and only 10% perceive the activities as both numerous and rich in content, indicating that the single form of activities negatively affects participation enthusiasm. In terms of external exchanges, only 20% of clubs often communicate with external parties, 22.9% engage in more frequent communication, 41.9% communicate occasionally, and 15.2% report no communication at all. Colleges in the Songshan Lake area, such as Dongguan University of Technology, Dongguan Polytechnic, and Dongguan University of Technology City College, demonstrate more active exchanges, while other institutions have fewer interactions due to constraints related to safety, funding, and other practical considerations.

3. Activity Time and Frequency

In terms of activity frequency, half of the clubs (50%) organize activities three times a week, followed by 28.5% holding activities twice a week, 14.3% four times a week, and 7.2% five times or more per week. Notably, no club conducts activities once a week or less, and more than 70% of members meet the standard of exercising three times a week or more. Regarding activity duration, 57.2% of clubs schedule sessions lasting 1.5–2 hours each time, while 21.4% arrange activities for 1–1.5 hours or 2–2.5 hours. No club conducts activities for less than one hour or more than 2.5 hours per session, indicating that the overall duration is adequate, though adjustments are needed based on members' physical conditions.

Concerning satisfaction with time arrangement, 27.1% of members report being very satisfied and 37.2% satisfied, while 20% express a general level of satisfaction and 15.7% are dissatisfied or very dissatisfied, suggesting that the scheduling is generally well accepted. However, attendance and enthusiasm levels remain uneven: only 13.9% of members attend regularly, whereas 52.8% are occasionally absent and 33.3% are often absent. From the perspective of cadres and guiding teachers, 14.3% believe members show high enthusiasm, and 42.8% perceive enthusiasm as moderate. Overall, member participation appears somewhat random and is strongly influenced by the quality of activities and conflicts with other time commitments.

4. Activity Guidance

Regarding the source of guiding teachers, all clubs (100%) are equipped with guiding teachers; however, some teachers lack sufficient knowledge of basketball or hold the position in name only without actively participating in club activities. Only 20% of the teachers are familiar with basketball and frequently provide professional guidance, which suggests that schools do not place adequate importance on the development and effectiveness of basketball clubs.

In terms of guidance frequency, 57.1% of the teachers offer guidance one to two times per week, while 42.9% provide guidance three to five times per week. No teachers report providing no guidance or exceeding six guidance sessions per week. Overall, the intensity of guidance is relatively insufficient, indicating a need to strengthen teachers' sense of responsibility and enhance the quality and consistency of instructional support.

Effect Evaluation of Basketball Clubs in Dongguan's Colleges and Universities

1. Member Satisfaction

Members have the highest satisfaction with "management cadres" (19 members are very satisfied, 71 are satisfied), and relatively high satisfaction with "activity development" (21 members are very satisfied, 49 are satisfied). They have low satisfaction with "system construction" (23 members are dissatisfied), "guiding teachers" (42 members are dissatisfied), and "fund transparency". Therefore, it is necessary to optimize the system and teacher guidance.

2. Evaluation of Guiding Teachers

In terms of educational background and professional title, 57.1% of the guiding teachers hold a master's degree, while 42.9% have a bachelor's degree. Regarding professional titles, 14.3% are associate professors, 57.1% are lecturers, and 28.6% are assistant lecturers, indicating that the overall educational level and title structure are relatively low and somewhat unbalanced. With respect to teaching experience and professional level, 57.1% of the teachers have five years or less of teaching experience, 28.6% have six to ten years, and only 14.3% have eleven to fifteen years. In addition, 14.3% are first-class athletes, 28.6% second-class athletes, 42.8% third-class athletes, and 14.3% have no official sports level. This suggests that teaching experience is generally limited, highly skilled teachers are few, and schools rarely organize opportunities for teachers' professional development or further training.

Concerning the required qualities of guiding teachers, all respondents (100%) believe that professional dedication and excellent technical skills are essential. A large proportion also emphasize the importance of scientific training methods (85.7%), rich theoretical knowledge and management experience (71.4%), while only 28.6% consider good interpersonal skills to be necessary, highlighting professional dedication and skills as the core requirements. In terms of member satisfaction, only 16.2% of members report being very satisfied and 22.9% satisfied, whereas 30.9% express a general level of satisfaction and 30% are dissatisfied or very dissatisfied. Overall, the relatively low satisfaction level reflects the negative impact of some teachers' insufficient sense of responsibility on members' perceptions of guidance quality.

3. Influence of Clubs

Regarding publicity methods, 47.7% of the clubs rely on posting posters, 23.6% distribute leaflets, 13.3% use new media, and only 4.6% promote activities by holding competitions, while 10.8% carry out no publicity at all. Overall, publicity approaches remain largely traditional, with limited use of digital platforms, resulting in a narrow outreach and reduced effectiveness in attracting broader attention.

In terms of influence, on-campus recognition of the clubs is generally low: only 4.6% of members perceive the clubs as having very great influence, 13.3% believe they have great influence, nearly half (49.3%) consider the influence to be average, and 32.8% feel that the clubs have little or no influence, largely due to insufficient publicity. With respect to social influence, most clubs (71.4%) participate in two social activities per year, while smaller proportions take part in one, three, or four activities annually. Additionally, 42.8% of clubs often conduct inter-college exchanges, 42.8% do so occasionally, and 14.3% have no such exchanges. In terms of achievements, 71.4% of clubs occasionally win awards, whereas 14.3% often win awards and another 14.3% have never won any. Overall, clubs from Guangdong University of Science and Technology and Dongguan University of Technology demonstrate relatively stronger social influence, while other clubs need to enhance their comprehensive strength to improve visibility and impact.

Existing Problems and Development Countermeasures of Basketball Clubs in Dongguan's Colleges and Universities

1. Existing Problems

a. Shortage of Material Resources

In terms of venues, it is difficult to apply for indoor venues, and the venue of 1 college is insufficient; in terms of funds, the sources are single (relying on membership fees and a small amount of school appropriations), and 42.8% of the clubs have "relatively difficult" fund conditions, which restricts the development of activities and inter-college exchanges.

b. Incomplete Systems

The clubs still use the systems of the school league committee and have no exclusive and complete systems. There are problems such as opaque finance, lack of member assessment and reward-punishment systems, and blank assessment of guiding teachers. The implementation is insufficient, leading to chaotic management and high member turnover rate.

c. Lack of Excellent Guiding Teachers

Most guiding teachers have a master's degree, and some only hold the position in name only and do not provide guidance; there are few teachers with high professional titles and high skills, and their teaching experience is short. In addition, there are no opportunities for further study, resulting in low guidance quality, which affects the training enthusiasm of members and the technical improvement of the clubs.

d. Emphasis on Training while Neglecting Competition and Exchange

19.3% of the clubs "often conduct external exchanges", 63.1% "occasionally conduct external exchanges", and 17.6% "have no external exchanges". There are few inter-college events, so members have insufficient practical opportunities, slow technical improvement, and the publicity and influence of the clubs are limited.

e. Insufficient Publicity Efforts

Publicity mainly relies on "posting posters" and "distributing leaflets", only 13.3% of the clubs use new media, and 10.8% have no publicity. The publicity scope is narrow and the methods are traditional, leading to low popularity of the clubs. Even some students who love basketball do not know about the clubs.

2. Development Countermeasures

a. Improve the Management System

Improve the systems in terms of articles of association, finance, archives, member admission and withdrawal, assessment and reward-punishment, and guiding teacher management: clarify the financial disclosure mechanism and publicly announce the income and expenditure regularly; establish the assessment standards for members and cadres, and include attendance and participation in the assessment; formulate the assessment and reward-punishment systems for guiding teachers to encourage them to participate in guidance.

b. Enhance the Talent Training Capability

In terms of skill and theoretical training, clubs should enhance members' technical abilities through regular and systematic practice, while also accumulating practical experience by actively organizing inter-college exchanges and participating in social basketball activities. In addition, basketball-related lectures and referee training should be carried out to strengthen members' theoretical knowledge, deepen their understanding of rules and tactics, and promote comprehensive development in both practice and theory.

Regarding management capability training, clubs should identify and cultivate members with management potential and assign them responsibilities related to planning, coordination, and organization. The implementation of a mentorship system, in which senior members guide and support new members, can help newcomers adapt more quickly and integrate into club activities. Furthermore, conducting summaries and reflections after each activity will enable clubs to identify problems, share experiences, and continuously improve overall management effectiveness.

c. Expand the Influence Inside and Outside the Campus

To improve comprehensive strength, clubs should intensify the training of members and actively organize participation in competitions and events at various levels in order to achieve honors and recognition. Such achievements can help attract greater support from schools in terms of funding and access to venues. At the same time, clubs can draw on the successful practices of Dongguan University of Technology by establishing cooperation with off-campus basketball clubs, thereby promoting resource sharing and enhancing overall development.

In seeking external support, schools should be encouraged to place greater importance on basketball clubs by appointing dedicated personnel to provide consistent guidance and by increasing investment in both funding and facilities. Efforts should also be made to enhance the professionalism of guiding teachers, improving not only their technical skills but also their sense of responsibility. In addition, club management concepts should be updated to balance material support with attention to the psychological needs and motivation of members, fostering a more supportive and sustainable development environment.

d. Clarify the Development Purpose

Take the development of students as the core, and take into account the needs of the clubs and the schools: improve the physical fitness, skills and management capabilities of members through basketball

training and activities; spread basketball culture, enrich campus culture, and form the characteristic sports culture of the schools.

e. Strengthen Publicity Efforts

Integrate publicity channels: use the school radio station, publicity columns, official WeChat accounts and other new media to expand the publicity scope; organize basketball lectures and exhibition games to attract students' attention; improve the popularity of the clubs through event reports and member sharing.

f. Strengthen Inter-College Exchanges

Build an inter-college exchange platform, establish a college basketball federation, and hold regular inter-college friendly matches and seminars; promote the linkage between colleges and universities in the Songshan Lake area and other colleges and universities to share training resources and event experience; encourage the clubs to participate in social basketball activities to improve their practical capabilities and social influence.

CONCLUSIONS

The construction of basketball clubs in colleges and universities in Dongguan City has shown clear improvement. As the well-known “Hometown of Basketball,” Dongguan has witnessed the gradual development of college basketball clubs from their initial establishment to a current scale of nearly 400 members. All members possess a basic foundation in basketball and demonstrate strong enthusiasm for the sport. Some clubs have actively drawn on foreign development models and established cooperation with off-campus clubs, leading to an increase in inter-college exchanges and activities. These efforts have laid an important foundation for promoting national fitness initiatives and fostering lifelong participation in sports among college students.

However, several problems remain in the development of these clubs. The material foundation is relatively weak, as access to indoor venues is limited and some colleges lack sufficient facilities, while funding sources are single and inadequate, restricting the organization of activities. In addition, system construction requires further improvement, as management mechanisms are incomplete and systems related to finance, assessment, and guiding teachers are either missing or poorly implemented, resulting in disorderly management and high member turnover. Moreover, activity organization remains monotonous, with traditional activity forms, limited external exchanges, low involvement of guiding teachers, and single publicity methods, all of which reduce member enthusiasm and club influence. Therefore, promoting the healthy and sustainable development of basketball clubs requires strengthening institutional systems, expanding external exchanges, and enhancing publicity efforts.

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Research on the Integration and Development of AI Technology and Art in the New Era

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ABSTRACT

Driven by the rapid iteration of intelligent technologies (e.g., AI, virtual reality, real-time rendering), the animation industry is shifting from traditional creation to intelligent production. The growing synergy and contradictions between technological innovation and artistic expression make their in-depth integration a key to high-quality industrial development—this forms the study's core background. This research aims to analyze the internal logic, existing problems, and optimization paths of such integration, providing theoretical and practical support for animation creation and industry growth.

Methodologically, it combines literature research (to sort domestic and international tech-art integration theories), case analysis (e.g., Spider-Man: Into the Spider-Verse for real-time rendering, Love, Death & Robots for AI-assisted scripting, to deconstruct integration modes), and expert interviews (to collect insights from creation teams and R&D personnel).Results show intelligent technologies have widely penetrated character generation, scene construction, motion capture, and post-rendering, boosting efficiency and visual appeal. However, issues emerge: excessive tech use weakens artistic individuality, algorithm logic conflicts with aesthetics, and technical ethics disputes arise.

Conclusions highlight that integration must follow "technology serving art"—via building tech-art collaboration mechanisms, strengthening interdisciplinary talent training, and improving ethics norms—to achieve dynamic balance.Contributions include enriching the tech-art integration theoretical system (offering new interdisciplinary perspectives for animation research) and providing actionable strategies for creators, aiding industrial innovation and informing policy-making.

Keywords: Animation industry, Art-technology integration, Intelligent technologies, Interdisciplinary talent, Technical ethics

INTRODUCTION

In the age of intelligence, technology is driving unprecedented transformation in the animation industry. From traditional hand-drawn animation to digital animation, and now to the widespread application of artificial intelligence (AI) in animation production, the animation industry is undergoing a profound revolution. The introduction of AI technology has brought new tools and methods to animation production, greatly improving production efficiency and expanding creative possibilities. From character design and scene construction to animation generation and special effects creation, AI technology is integrated into every aspect of animation production, providing animators with more creative inspiration and expressive tools.

In the field of animation education, the integration of technology and art has become increasingly important. As the animation industry's talent needs continue to evolve, traditional animation teaching models are no longer able to meet market demands. Cultivating interdisciplinary talents with both a solid foundation in artistic skills and a proficiency in modern animation techniques has become a crucial challenge for animation education. Introducing AI technology into animation instruction, achieving a deep integration of technology and art, will not only improve teaching quality but also better prepare students for future careers.

This research aims to leverage AI technology to explore teaching models that integrate animation technology and art, providing new insights and approaches for animation education. Specifically, by studying the application of AI technology in animation instruction and analyzing its impact on students' artistic creativity and technical application abilities, we will construct an AI-based animation teaching system to improve the quality and effectiveness of animation instruction and cultivate more animation

professionals adaptable to the demands of the intelligent age.

This research contributes to enriching animation teaching theory and improving the academic system for integrating technology and art. By deeply exploring the application of AI technology in animation teaching and analyzing its impact on teaching methods, teaching content, and teaching evaluation, it can provide new perspectives and empirical evidence for the development of animation education theory. Studying the integration mechanism of AI technology and animation art can also expand the research scope of animation art theory, promote the cross-integration of animation art with disciplines such as computer science and artificial intelligence, and promote the development of related academic fields. From a practical perspective, the findings of this research will provide practical guidance for animation teaching practices. The AI-based animation teaching model can provide teachers with new teaching methods and tools, helping them better organize teaching activities and improve teaching efficiency. For students, this teaching model can stimulate their learning interest and innovative thinking, enhance their animation creation and technical application capabilities, and enable them to more quickly adapt to the demands of the animation industry after graduation. This research can also provide reference for animation education institutions and university animation majors in curriculum design and teaching resource development, promoting the reform and development of animation education and cultivating more high-quality professionals for the animation industry.

The traditional animation teaching model has exposed many problems in long-term practice. These problems have seriously restricted the quality and effectiveness of animation teaching and are unable to meet the demand for animation talents in the intelligent era. Traditional animation instruction is inefficient. From hand-drawn sketches and key drawings to creating in-between frames, students must manually complete every step, which is not only time-consuming and labor-intensive but also prone to errors. For example, when drawing complex scenes, students may spend days completing a single key drawing. Once problems are discovered and modifications are made, a significant amount of work must be re-engaged. This inefficient teaching method makes it difficult for students to complete a large number of works within their limited timeframe and prevents them from rapidly accumulating practical experience. Furthermore, traditional teaching methods are limited and rarely involve modern teaching equipment, which places relatively low demands on the quality of teachers and hinders their overall overall development. Traditional teaching methods lack access to cutting-edge teaching methods, such as computer networks and various audio-visual equipment. This leads teachers and students to focus on the present, lacking an understanding of the ever-changing world and the ever-changing knowledge available.

Traditional animation instruction falls short in inspiring creativity. Traditional teaching often focuses on skill training, emphasizing the mastery of fundamentals like drawing techniques and animation principles, while fostering creativity and innovative thinking. During instruction, students often practice imitation exercises based on the teacher's guidance and examples, lacking the space for independent thinking and exploration. This approach limits students' imagination and creativity, making it difficult to cultivate animation talent with unique creativity and innovation. For example, in animation scriptwriting courses, students may simply adhere to fixed narrative patterns and character settings, lacking the exploration of novel themes and unique perspectives, resulting in work that lacks individuality and appeal.

Traditional animation instruction struggles to achieve diverse styles. In traditional teaching environments, teachers' teaching styles and preferences often significantly influence students, leading them to develop similar creative styles. Limited resources and access to information limit the types and styles of animation works students are exposed to, making it difficult for them to broaden their horizons and absorb the essence of diverse styles. This results in students adopting a relatively single style when creating, failing to meet market demand for diverse animation works. For example, in 2D animation instruction, students may be more influenced by a single traditional painting style, while having little exposure to emerging painting styles and forms of expression. This results in a lack of innovation and diversity in their work.

Although AI animation technology has brought new opportunities to animation teaching, it also faces many challenges in practical application. On a technical level, AI animation technology still has certain limitations. While AI can quickly generate the basic framework for animation and simulate various styles of painting and movement, it still lags far behind human creators in terms of detailed expression and artistic appeal. For example, the expressions and movements of AI-generated characters

may not be natural or vivid, lacking nuanced emotional expression. When minor adjustments are required to AI-generated animations, they often face high technical barriers, requiring algorithm modification or re-entry of specific data, which is difficult for most animation teams and students. The application of AI technology in animation production also requires powerful hardware support and software platforms, which places high demands on schools' teaching equipment and resources. Some schools may be unable to meet these requirements due to limited funds.

Copyright issues are a major challenge in the application of AI animation technology. AI-generated content is often generated based on extensive data learning and algorithms, which may include the work of other creators. Therefore, the copyright ownership of AI-generated content is controversial. The use of AI-generated animation materials in teaching may lead to copyright disputes, posing potential legal risks for teaching. When AI-generated animation clips are used in student assignments or work presentations, it is difficult to determine whether the copyright belongs to the company that developed the AI algorithm or the student or teacher using the AI tool. This requires further legal and ethical discussion.

Ethical issues also cannot be ignored. With the increasing application of AI in animation education, concerns are growing that overreliance on AI could lead to a decline in students' artistic creativity, causing animations to lose their soul and unique artistic style. AI-generated content may contain harmful or misleading information, and how to regulate and screen it to ensure healthy and positive teaching content is a pressing issue. Improper use of AI animation technology in teaching may prevent students from gaining a deep understanding and experience of the artistic creation process, hindering their artistic literacy and aesthetic development. From an employment perspective, the widespread use of AI in the animation industry may have a certain impact on the employment of animators. If some basic animation production tasks can be performed by AI, those engaged in simple animation production may face employment pressure. This requires practitioners in the animation industry to continuously improve their skills and qualifications, and develop into more advanced creative and technical fields to adapt to industry changes.

In the intelligent era, integrating AI animation technology into teaching and building innovative teaching models has become a pressing issue. Under traditional teaching models, students' learning process is often passive, lacking autonomy and creativity. The introduction of AI animation technology, however, presents new opportunities for teaching. In-depth research is needed to explore how to leverage AI animation technology to enrich teaching content and formats, stimulating student interest and initiative. We can explore using AI animation technology to create vivid teaching cases, presenting abstract knowledge in an intuitive animated format to students, helping them better understand and master the knowledge. For example, when explaining the principles of animation, AI animation can be used to demonstrate the production process of different effects, allowing students to intuitively see the animation's creation mechanism and enhance learning outcomes.

Another research focus is how to design teaching activities based on AI animation technology to foster students' practical skills and innovative thinking. Students can be organized to practice animation creation using AI animation tools, allowing them to master AI animation technology through practice while also cultivating their innovative thinking and teamwork skills. By setting challenging creative tasks, students are encouraged to unleash their imagination and apply AI animation technology to create uniquely styled animations, thereby enhancing their overall abilities. During the creative process, students can input keywords based on their creativity. The AI animation tool generates corresponding animation segments based on these keywords, which students then combine and optimize to create the final work.

Determining indicators and methods for evaluating the effectiveness of technology-art integration teaching is key to measuring and improving teaching quality. Regarding knowledge acquisition, accurately assessing students' mastery of animation technology and art theory through exams and assignments is a critical issue. Targeted tests can be designed to assess students' operational proficiency in AI animation technology and their understanding of theoretical knowledge such as animation art style and aesthetics. Regarding skill development, effectively assessing students' progress in animation creation skills and innovation through portfolio evaluation and hands-on practice is also a key area of research. Students can participate in animation competitions, assessing their skill development through the quality of their entries and their performance. Observing students' proficiency and innovation in daily practical operations can also provide a comprehensive assessment of their skill development.

Analyzing the impact of technology-arts-integrated instruction on students' learning interest, attitudes, and motivation is also crucial. Questionnaires and student interviews can be used to gauge student satisfaction and feedback regarding technology-arts-integrated instruction and analyze its impact on students' learning interest and attitudes. Tracking student motivation can also help determine whether the instructional model stimulates students' intrinsic motivation and promotes autonomous learning and sustainable development. If students demonstrate increased enthusiasm and initiative in their learning and a passion for animation creation, this indicates that the technology-arts-integrated instructional model is effectively stimulating student motivation.

This research aims to design a teaching system that integrates animation technology and art based on AI animation technology to meet the demand for animation talent in the intelligent era. This teaching system will take AI animation technology as its core and combine the advantages of traditional animation teaching to achieve an organic fusion of technology and art.

The curriculum will integrate AI animation technology courses with traditional animation art courses. Technical courses such as AI Animation Fundamentals, AI Character Design, and AI Scene Construction will be offered to help students master the fundamental principles and operational methods of AI animation technology. At the same time, art theory courses such as Introduction to Animation, Animation Aesthetics, and Animation History will be retained to enhance students' artistic literacy and aesthetic appreciation. Fusion courses such as AI Animation Creative Design and AI Animation Artistic Expression will also be offered to guide students in applying AI technology to artistic creation in practice, cultivating their innovative and comprehensive application capabilities.

In terms of teaching methods, a diverse range of approaches will be adopted, including project-driven instruction, case studies, and group collaborative learning. Through project-driven instruction, students will be able to integrate their acquired AI animation technology and artistic knowledge while completing specific animation projects, enhancing their problem-solving skills. For example, in an animation project themed "Future City," students will be required to use AI animation technology to generate elements such as city scenes and character images, and apply their artistic knowledge to creative design and style development to complete a complete animation. In case studies, outstanding AI animation works will be selected as examples, analyzing their technical implementation and artistic expression techniques, guiding students to learn and draw inspiration from them. Through group collaborative learning, students will develop teamwork and communication skills, allowing them to progress together through mutual exchange and collaboration.

One of the important goals of this study is to improve students' technical application and artistic expression capabilities in animation creation through teaching practice. In terms of technical application, through teaching, students will be proficient in AI animation technology, including but not limited to AI painting, AI character animation generation, AI scene rendering and other technologies. Students can use these technologies to quickly generate high-quality animation materials and improve the efficiency of animation production. Students can use AI painting technology to input keywords according to their own creativity to quickly generate character design sketches and scene concept maps; use AI character animation generation technology to add natural and smooth movements to characters, reducing the workload of manual animation. Students should also have the ability to optimize and adjust AI-generated content, and be able to perform detail processing and artistic processing on AI-generated animations according to the needs of artistic creation, so that they are more in line with artistic aesthetics and creative requirements.

In terms of artistic expression, we focus on cultivating students' innovative thinking and unique artistic style. Through the study of art theory courses and artistic practice activities, we guide students to deeply understand the connotation and aesthetic standards of animation art, and improve their artistic appreciation and aesthetic level. We encourage students to use their imagination in animation creation, break through the constraints of traditional thinking, and use AI animation technology to express their unique artistic viewpoints and emotions. In animation script creation, we guide students to explore novel themes and unique perspectives, and use AI technology to assist in creation, making the story more vivid and interesting. In character design and scene construction, we encourage students to try different artistic styles, combining the characteristics of AI technology to create animated characters and scenes with personality and charm. Through teaching practice, students can perfectly integrate technology and art in animation creation, create animated works with high artistic value and market competitiveness, and enhance their employment competitiveness and career development potential in the animation industry.

This study, from the unique perspective of integrating technology and art, deeply explores the transformative impact of AI animation technology on animation teaching. This is innovative in the current field of animation education research. Traditional animation teaching research often focuses on either artistic creation or technological application, rarely integrating the two for in-depth analysis. However, this study fully recognizes that in the intelligent era, the integration of animation technology and art is an inevitable trend in the development of animation education. By studying the integration mechanisms and teaching models of the two, it provides new ideas and methods for animation education.

Taking keyword identification, a key aspect of AI animation technology, as an example, traditional research may focus solely on the technical application of keywords, such as how to use them to more accurately generate animation content. This study, however, not only explores the role of keywords in technical implementation but also deeply analyzes their value in inspiring students' artistic creativity. When students input the keyword "fantasy adventure in a mysterious forest," AI animation technology can quickly generate relevant animation scenes and character elements. This study focuses on how to guide students to screen, combine, and recreate these generated elements from an artistic perspective, creating animated works with unique artistic style and emotional expression. This perspective breaks the boundaries between technology and art in previous research and opens up new directions for animation teaching research.

This study employs qualitative analysis, conducting a multi-dimensional in-depth analysis of the feasibility and effectiveness of integrating AI animation technology with art instruction. This is a key innovation. Previous studies have often employed quantitative analysis, validating hypotheses through statistical analysis and experimental comparisons. However, animation instruction is a complex system, involving difficult-to-quantify factors such as students' artistic perception, creative expression, and emotional experience. Quantitative analysis alone is unable to fully and deeply reveal its underlying principles.

This study employed qualitative analysis methods, gathering insights and feedback from teachers and students about their teaching practices. A thorough analysis of typical teaching cases explored both successful experiences and challenges in integrating technology and art. The interviews explored the challenges teachers faced when applying AI animation technology to teaching, as well as their perspectives and suggestions on integrating technology and art. Through discussions with students, the study explored their learning experiences and the impact of AI animation technology on their artistic creativity and innovative thinking. Observational methods were also employed to observe student performance and engagement in class, analyzing the impact of teaching activities on stimulating student interest and motivation. The combined application of these qualitative analysis methods enabled a more comprehensive and in-depth understanding of the practical application of AI animation technology and art in teaching, providing a richer and more reliable basis for drawing research conclusions.

AI animation refers to the process of generating animated content using artificial intelligence (AI). Its core principle is based on deep learning algorithms. By absorbing large amounts of animation data, image data, and relevant artistic style data, AI can understand the basic elements, movement patterns, and artistic expression techniques of animation, thereby achieving automatic or assisted animation generation.

Keyword generation technology is a crucial component of AI animation. Keywords, as a crucial way for users to interact with AI systems, guide the AI in generating animation content tailored to their creative needs. For example, if a user enters the keyword "elf dance in a magical forest," the AI animation system first performs semantic analysis to understand the key elements contained within, such as "magic forest," "elf," and "dance." Then, based on previously learned data, the AI extracts images, actions, and other information related to these elements from its vast library of assets or generative models, and combines them into an animation clip. When generating the "magic forest" scene, the AI may reference previously learned fantasy forest scenes, including tree forms, lighting effects, and mysterious mists, to create a fantasy-inspired forest scene. For the "elf" character, the AI generates an agile and graceful elf character based on its learning of elf images, including details such as appearance and clothing. When generating "dance" movements, AI uses motion generation algorithms, refers to various dance movement data, generates natural and smooth dance movements, and applies them to the sprite character, ultimately generating a coherent animation.

AI animation technology also involves the synergy of various other technologies. Image generation technology is used to generate static images for animation, such as character images and

scene scenes; motion generation technology is responsible for adding various movements to characters to make them vivid and expressive; and natural language processing technology is used to understand user input keywords or text descriptions, translating user creativity into instructions that can be understood and processed by the AI system. Through the organic combination of these technologies, AI animation can quickly and efficiently generate diverse animation content, bringing new possibilities and efficiency improvements to animation creation.

The fusion of animation technology and art refers to the organic combination of various technical means involved in animation production with artistic concepts, aesthetic standards, creative expression, etc. in the animation creation process, so as to create animation works that have both exquisite technical performance and artistic appeal.

From a fundamental perspective, animation technology is a crucial means of artistic expression, providing diverse forms of expression and creative tools for animation art. Digital painting techniques enable animators to more easily create exquisite images, 3D modeling technology enables the creation of realistic virtual scenes and characters, and the various special effects tools in animation software enhance the visual impact of animation. Art is the soul of animation, endowing animated works with unique style, profound connotations, and strong emotional resonance. Artistic elements include story themes, character development, composition, color use, and music and sound effects. These elements collectively create the artistic atmosphere and aesthetic value of an animation work.

In terms of expression, the fusion of animation technology and art is reflected in multiple aspects. Character design not only utilizes advanced digital modeling techniques to create the characters' appearances, but also strives to imbue them with unique personalities and charm from an artistic aesthetic perspective. Pixar Animation Studios' character design utilizes sophisticated technology to vividly depict the characters' physical details. At the same time, through artistic modeling and facial expressions, the characters possess rich emotions and distinct personalities, resonating deeply with the audience. In terms of scene construction, computer graphics technology is used to create realistic virtual scenes, combined with artistic techniques such as color matching and lighting effects to create a unique atmosphere and artistic conception. The planet Pandora in the film "Avatar" utilizes advanced 3D modeling and rendering technology to create a magnificent and fantastical alien world. The use of artistic color and lighting creates an immersive experience, allowing the audience to experience the unique charm of this virtual world. In terms of animation narrative and rhythm control, technology ensures the smooth playback and special effects display of animation, while art determines the plot development, emotional ups and downs, and rhythm of the story, so that the animation work can attract the audience's attention and guide the audience to deeply understand the connotation of the work.

LITERATURE REVIEW

Research on the Application of AI Technology in Animation

In recent years, research on the application of AI technology in the animation field has made significant progress. Many scholars have focused on the specific application of AI technology in various aspects of animation production, bringing new perspectives and methods to animation creation.

AI technology has demonstrated powerful support capabilities in character design. Some studies have used machine learning algorithms to train AI on a large number of excellent character design examples, enabling it to quickly generate diverse character images based on set keywords. These generated characters are not only distinctive in appearance but also reflect different personalities and styles. In his paper, "Application and Exploration of AI-Assisted Character Design in Animation Creation," scholar Li Ming noted that using AI for character design can provide animators with a wealth of creative inspiration in a short period of time, significantly shortening the initial conception process for character design. By inputting keywords such as "brave boy" and "mysterious witch," AI can quickly generate corresponding character sketches, including details such as the character's appearance, clothing, and expression. Animators can then modify and refine these sketches, improving design efficiency and quality.

AI technology also plays a crucial role in scene construction. Leveraging deep learning models, AI can generate realistic virtual scenes based on given keywords and scene descriptions. For example, by inputting keywords like "future city" and "ancient castle," AI can construct corresponding city and castle scenes, complete with architectural layouts, environmental details, and lighting effects. In his paper

"Research on Animation Scene Generation Based on AI Technology," Wang Hua notes that AI-generated scenes not only meet the basic requirements of animation production but also, through unique algorithms, generate creative and imaginative scenes, adding even more possibilities to animation creation. AI can also automatically adjust scene parameters like color tones, lighting, and shadows based on the plot and atmosphere of the animation, ensuring the scene better aligns with the overall style of the animation.

The application of AI technology in the animation generation process has also revolutionized animation production. By learning from large amounts of animation data, AI can understand the movement patterns and expression techniques of animation, enabling automatic or assisted animation generation. Some studies have used generative adversarial network (GAN) technology to allow AI to generate key frames for animation, and then generate intermediate frames through interpolation algorithms, thereby quickly producing a coherent animation. In "The Development and Challenges of AI Animation Generation Technology," Zhang Yue analyzed the advantages and disadvantages of AI animation generation technology, pointing out that although AI-generated animations still need to be improved in terms of fluidity and naturalness, they have already demonstrated great potential in some simple animation production and creative exploration. AI can also automatically generate matching animation movements based on elements such as music and sound effects, achieving an organic combination of animation and audio.

Related Research on Animation Teaching

The study of animation teaching has always been an important topic in the field of animation education. Scholars have conducted in-depth analysis of the development of traditional animation teaching methods and modern teaching concepts from different perspectives.

Traditional animation teaching methods focus on skill training, emphasizing the imparting of basic knowledge such as hand-drawing skills and animation principles. In early animation instruction, teachers often employed demonstration, demonstrating each step of animation production live and allowing students to imitate and learn. For example, in 2D animation instruction, teachers would explain in detail the steps of hand-drawn animation, including sketching, key drawing, and in-between frame drawing. Students mastered these skills through extensive practice. While this teaching method allows students to gain a solid grasp of the fundamental skills of animation production, it also has some limitations. Overemphasizing skill training can neglect the cultivation of students' creativity and innovative thinking, resulting in a lack of individuality and uniqueness in their work.

With the development of the times, modern teaching concepts have gradually emphasized the student's central role, focusing on cultivating their comprehensive abilities and innovative thinking. In animation teaching, methods such as project-based learning and case studies are widely used. Project-based learning allows students to participate in real-life animation projects, putting their knowledge into practice and cultivating teamwork, problem-solving, and innovation. In an animated short film production project, students form teams and participate in the entire process, from scriptwriting, character design, and scene construction to animation production and post-production compositing, improving their comprehensive abilities through practice. Case studies analyze outstanding animation works, guiding students to learn about their creativity, technology, and artistic expression, stimulating their interest in learning and innovative thinking. Teachers select classic works from renowned animation studios such as Disney and Pixar, analyzing their successful experiences in character creation, plot setting, and image composition, allowing students to draw inspiration from these works and improve their own creative skills.

Modern teaching concepts also emphasize the diversification of teaching resources and the modernization of teaching methods. With the development of internet technology, online teaching resources and virtual laboratories are increasingly being applied to animation instruction. Students can watch animation instructional videos and participate in online discussions and exchanges through online platforms, broadening their learning channels. Virtual laboratories allow students to conduct animation experiments in a virtual environment, reducing experimental costs and improving learning efficiency. Some schools are also utilizing technologies such as virtual reality (VR) and augmented reality (AR) to provide students with a more immersive learning experience, enhancing their interest and engagement.

Research on the Integration of Technology and Art

Research on the integration of technology and art spans multiple fields, providing rich insights and insights for animation education. In the field of digital art, the fusion of technology and art has become

a growing trend. The development of digital technology has expanded artistic creation possibilities, allowing artists to utilize computer software and digital devices to create works with unique styles and expressiveness. In digital painting, artists can utilize tools like drawing tablets and painting software to achieve effects unattainable with traditional painting, such as rapid color adjustment and layer management. This fusion of technology and art not only enriches the forms and content of artistic creation but also introduces new perspectives to art education. In art education, digital technology can be integrated with art theory to cultivate students' creative and aesthetic abilities in digital art. By offering courses such as digital painting and digital sculpture, students can master the techniques and methods of digital art creation while also understanding the connotations and aesthetic standards of art, thereby enhancing their artistic literacy.

In the field of design, the fusion of technology and art is also reflected in product design and graphic design. In product design, designers need to apply engineering knowledge and aesthetic principles to design products that are both practical and beautiful. Apple's product design focuses not only on product function and performance, but also on appearance and user experience. This seamless fusion of technology and art creates products that are both aesthetically pleasing and practical. In graphic design, designers utilize technical tools such as image processing and typesetting software, combined with design concepts and creativity, to create visually impactful graphic works. This fusion of technology and art requires designers to possess interdisciplinary knowledge and skills, able to organically integrate technology and art. In animation teaching, we can draw on experience in the design field to cultivate students' interdisciplinary thinking and comprehensive abilities, allowing them to master animation techniques while also focusing on artistic creativity and aesthetic expression, thereby creating high-quality animation works.

In film and television production, the fusion of technology and art is most vividly demonstrated. From special effects and cinematography to editing and sound design, everything relies on the interplay of technology and art. Hollywood films utilize advanced computer graphics and motion capture technology in special effects production, creating stunning visuals. At the same time, they emphasize artistic appeal in plot and character development, attracting the attention of audiences worldwide. In film and television instruction, by analyzing the production processes of outstanding films and television productions, students can understand the role and interrelationship of technology and art in film and television creation, cultivating their film and television production skills and artistic appreciation. In animation instruction, we can draw on technical and artistic techniques from film and television production, such as camera language, editing techniques, and the use of sound effects, to enhance the quality and artistic appeal of animations.

Research Framework

Theoretical Basis

This study, informed by constructivist learning theory, explores the inherent logic of integrating AI animation technology with instruction. Constructivist learning theory emphasizes that students are the primary agents of learning, and that knowledge is not imparted by teachers but rather acquired through the construction of meaning by learners within a specific context—that is, within a specific social and cultural context—with the help of others (including teachers and learning partners), and through the use of necessary learning materials.

Constructivist learning theory plays a crucial role in the integration of AI animation technology into teaching. When creating teaching scenarios, AI animation technology can create more realistic, vivid, and engaging animation scenarios. When teaching animated character design courses, teachers can use AI animation technology to generate character images in various styles and use animations to showcase these characters in different scenarios, creating an immersive learning environment for students. In these environments, students can more intuitively experience the characteristics and charm of different character designs, sparking their interest in learning and a desire to explore, actively building their understanding of character design knowledge.

In terms of collaborative learning, constructivist theory advocates cooperation and communication among students, believing that this helps them understand knowledge from multiple perspectives and broaden their horizons. In AI-based animation teaching, students can be organized into small groups to work on animation projects. During the project implementation, students need to discuss the animation's theme, style, plot, and other aspects, and apply AI animation technology to character design, scene construction, and animation production. In this process, students exchange ideas, learn from each other,

and collaborate to complete project tasks. This not only improves their teamwork skills but also promotes a deeper understanding and application of knowledge. For example, in an animation project themed "campus life," some team members were responsible for using AI to generate campus scenes, some for character design, and some for writing the animation script. Through collaboration, they combined their individual creativity with AI technology to create a complete animation. In this process, students gained a deeper understanding and mastery of all aspects of animation production.

Research Hypotheses

Based on in-depth thinking on the integration of AI animation technology and teaching, this study proposes the following hypotheses:

Hypothesis 1: Introducing AI animation technology into teaching can significantly improve teaching efficiency. AI animation technology can quickly generate animation materials, such as character images and scene images, significantly reducing animation production time. In traditional teaching, it may take students several days to draw a complex animation scene. However, with AI animation technology, by inputting relevant keywords such as "ancient palace" and "future city", the corresponding scene sketch can be generated in a short time. Students can then modify and improve the sketch based on this, saving a considerable amount of time and energy. AI animation technology can also automatically complete some repetitive tasks, such as generating in-between frames of animation, reducing students' workload and allowing them to devote more time and energy to creative design and artistic expression, thereby improving teaching efficiency.

Hypothesis 2: AI animation technology can effectively stimulate students' learning interest and innovative thinking. AI animation technology possesses powerful creative generation capabilities. By inputting different keywords, it can generate diverse animation content, providing students with rich creative inspiration. For example, when a student inputs the keyword "mysterious underwater world," the AI animation system can generate various fantastical underwater creatures, mysterious underwater ruins, and other elements. This novel and intriguing content can spark students' curiosity and desire for exploration, fostering a deeper interest in learning animation. AI animation technology can also break through the limitations of traditional animation production, allowing students to experiment with various artistic styles and forms of expression, encouraging them to unleash their imagination and create innovative works, thereby cultivating their creative thinking.

Hypothesis 3: A teaching model that integrates technology and art can enhance students' comprehensive abilities. Under this model, students not only master AI animation technology but also delve into relevant knowledge about animation art, such as animation aesthetics and history, focusing on artistic creativity and aesthetic expression. By integrating technology and art, students can better utilize technical means to realize their artistic visions in animation creation, creating works that are both technically sophisticated and artistically appealing. In character design, students utilize AI technology to create realistic character appearances while applying artistic knowledge to imbue characters with unique personalities and emotions, making them more vivid and lifelike. This teaching model also fosters students' interdisciplinary thinking and comprehensive application skills, enhancing their competitiveness in the animation industry.

Research model construction

This study constructed an integrated teaching model that includes teaching content, teaching methods, teaching evaluation and other elements, aiming to achieve an organic combination of AI animation technology and art teaching, and improve the teaching quality and students' comprehensive abilities.

In terms of teaching content, AI animation technology courses are deeply integrated with traditional animation art courses. AI animation technology courses cover AI animation fundamentals, AI drawing, AI character animation generation, and AI scene rendering, enabling students to master the core knowledge and skills of AI animation technology. Traditional animation art courses include animation overview, animation aesthetics, animation history, animation character design, and animation scene design, aiming to enhance students' artistic literacy and aesthetic level. Fusion courses such as AI Animation Creative Design and AI Animation Artistic Expression are also offered. Through practical project cases, students are guided to apply AI technology to artistic creation, organically integrating technology and art. In the AI Animation Creative Design course, teachers assign an animation theme, and students use AI animation technology to generate relevant animation materials. They then screen, combine, and recreate these materials from an artistic and creative perspective to complete an animation

work with a unique style.

The program utilizes a diverse range of teaching methods, including project-driven instruction, case studies, and collaborative group learning. Project-driven instruction leverages real-world animation projects, allowing students to apply their acquired knowledge and skills while completing them, enhancing their problem-solving abilities. Students are assigned an animated short film production project, participating in the entire process from scriptwriting, character design, scene construction, animation production, to post-production compositing, mastering AI animation technology and artistic creation methods through practice. Case studies analyze outstanding AI animation works, guiding students to explore their technical implementation and artistic expression, stimulating their interest in learning and fostering innovative thinking. Collaborative group learning involves students working in small groups to conduct learning and creative activities, fostering teamwork and communication skills. When working in groups on an animation project, students divide the work and collaborate to complete the project, learning from and supporting each other through collaboration.

In terms of teaching evaluation, a diversified evaluation system is established to comprehensively and objectively assess students' learning outcomes and overall abilities. This evaluation encompasses not only students' mastery of knowledge and skills, but also their innovative abilities, teamwork skills, and learning attitudes. The evaluation method combines teacher evaluation, student self-evaluation, and peer evaluation. Teacher evaluation assesses student work from a professional perspective, identifying strengths and weaknesses and providing targeted suggestions. Student self-evaluation and peer evaluation allow students to reflect and evaluate their own work and that of their peers, promoting self-awareness and mutual learning. When evaluating student animations, teachers assess technical application, artistic expression, and creative conception. Student self-evaluation focuses on their own involvement in the project, their gains, and their shortcomings, while peer evaluation assesses their peers' performance in teamwork and the strengths and areas for improvement in their work. This diversified evaluation system provides a more comprehensive understanding of student learning and provides a basis for teaching improvements.

METHOD

Qualitative Analysis

This study employed qualitative analysis to delve into the internal mechanisms, influencing factors, and practical effects of the integrated teaching of AI animation technology and art. Qualitative analysis allows for a multi-faceted understanding of research phenomena, uncovering underlying meanings and patterns, and providing rich, in-depth information for research. In this study, qualitative analysis was implemented through interviews, case studies, and literature review.

Interview method

Interviews were a key method for obtaining primary data in this study. Through in-depth face-to-face discussions with teachers, students, and industry experts, we sought to understand their perspectives, experiences, and suggestions for integrating AI animation technology with art in instruction. For teachers, the interviews primarily focused on their teaching practices, including challenges encountered when using AI animation technology to assist in instruction, evaluations of teaching effectiveness, adjustments to teaching methods, and expectations for future development. Teachers were asked about student learning responses when using AI animation technology to teach character design, whether this helped them better understand and master character design techniques, any technical difficulties encountered during instruction, and how they addressed these challenges.

Interviews with students focused on their learning experiences and perspectives. The goal was to understand their acceptance of AI animation technology, changes in their learning interests, difficulties encountered during the learning process, and their satisfaction with the integrated teaching model. Students were also asked whether they felt they were able to express their creativity more freely when using AI animation tools, and whether they believed learning AI animation technology had helped improve their artistic and technical abilities.

Interviews with industry experts primarily sought insights into animation industry trends and professional advice on the application of AI animation technology in education. This information also addressed the industry's demand for animation talent, the practical application of AI animation technology, and expectations and suggestions for animation education reform in universities. Through these interviews, we gathered information from diverse perspectives on the integration of AI animation

technology and art education, providing a comprehensive and in-depth perspective for our research. A semi-structured interview format was employed to ensure targeted content while providing sufficient freedom for interviewees to express themselves, thereby eliciting richer, more authentic information. Following the interviews, the transcripts were collated and analyzed to identify key insights and questions, providing a basis for subsequent research.

Case Analysis Method

Case analysis is an effective method for deeply analyzing specific cases, drawing lessons from them, and identifying problems. This study selected several successful cases of AI animation technology-assisted teaching both domestically and internationally for detailed analysis. The case study was the animation program at a renowned American art school, a leader in AI animation teaching. An analysis of the program's curriculum revealed that AI animation technology is integrated into multiple courses, such as AI animation character design and AI animation scene construction. Through practical projects, students master AI animation technology in practice. In terms of teaching methods, the program utilizes group collaboration, allowing students to complete animation projects collaboratively, fostering teamwork and innovative thinking. In terms of teaching evaluation, the program emphasizes process-based assessment, focusing not only on the students' work but also on their performance and progress throughout the learning process.

In China, a case study was selected from the teaching practices of a university's animation school. The school collaborated with animation companies, introducing real-world projects and allowing students to create using AI animation technology. This approach allows students to gain exposure to cutting-edge industry technologies and requirements, enhancing their practical skills and employability. During the teaching process, teachers also invited industry experts to provide guidance, enabling students to understand the latest industry developments and trends. Through in-depth analysis of these cases, successful experiences in AI-assisted teaching were identified, including the rationality of course design, the effectiveness of teaching methods, and the integrated use of teaching resources. Furthermore, the study also analyzed existing issues and shortcomings, such as the limitations of technology application and deficiencies in students' artistic literacy, providing reference and lessons for building an integrated teaching system.

Literature Research Method

Literature research is one of the basic methods of this study. By extensively reviewing relevant domestic and foreign literature, including academic papers, research reports, textbooks, industry information, etc., we sorted out the research status, development context and trends of AI animation technology in the field of animation teaching. In terms of academic papers, we searched domestic academic databases such as China National Knowledge Infrastructure and Wanfang Data, as well as international academic databases such as Web of Science and EBSCOhost, to collect relevant papers on the application of AI animation technology in animation teaching, research results on the integration of technology and art, etc. These papers were classified and organized, and the research perspectives, research methods and research conclusions of different scholars were analyzed to understand the research hotspots and cutting-edge issues in this field. For example, some scholars studied the application of AI animation technology in character design and analyzed how AI helps animators quickly generate character images and movements; other scholars explored the teaching model of the integration of technology and art, and proposed a project-oriented teaching method to cultivate students' comprehensive abilities.

Research reports are also an important source of literature. Pay attention to research reports on animation education and AI technology applications published by domestic and international educational institutions and research centers to understand the latest industry developments and trends. For example, a report released by one research institute indicates that AI animation technology will play an increasingly important role in animation education in the future, and schools should strengthen the provision of relevant courses and the development of their teaching staff. Also, consult relevant textbooks and industry information to understand the basics of AI animation technology, application cases, and the industry's demand for talent. Through literature research, you can fully understand the relevant theories and practical results of integrating AI animation technology with art teaching, providing a solid theoretical foundation and research ideas for your research, and avoiding blind research and duplication.

RESULT AND DISCUSSION

The core of AI animation technology - keyword research

The Role of Keywords in AI Animation

Keywords play a vital role in AI animation. They serve as a bridge of communication between users and AI animation systems, directly guiding the direction and details of AI-generated animation content and having a profound impact on animation style and quality.

From the perspective of generating animated content, keywords provide AI with clear creative instructions. When a user enters a keyword, the AI animation system first performs semantic analysis, converting natural language into computer-understandable semantic information. For example, if a user enters the keyword "a girl dancing under cherry blossom trees," the AI system identifies key elements such as "cherry blossom trees," "girl," and "dancing gracefully," then searches its extensive database for images, actions, and scene data related to these elements. This data likely comes from a vast library of animation works, image material, and other relevant materials. By learning and analyzing this data, the AI system builds a rich knowledge base. Based on this knowledge, the AI combines and generates relevant elements according to the keyword requirements, constructing the basic framework for the animation. It generates a scene featuring cherry blossom trees, depicts the image of a dancing girl, and animates her dance movements with smooth effects, thus forming a preliminary piece of animation content.

Keywords play a key role in shaping animation style. Different keywords can guide AI to generate distinct animation styles. For example, if a user enters "retro Disney-style castle," the AI will reference the shape, color, and detail features of castles in classic Disney animations to generate a castle animation with a strong Disney style, featuring bright colors, smooth lines, and a fairy-tale-like dreamlike feel. If a user enters "cyberpunk-style futuristic city," the AI will use the characteristics of the cyberpunk style, such as strong contrast between light and shadow, high-tech elements, and metallic textures, to generate a city animation scene full of technology and a futuristic feel. Keywords can also be used to describe specific artistic styles, such as "ink style" and "oil painting style," to allow the AI to simulate the painting texture and expression techniques of the corresponding artistic style and apply them to the animation, giving the animation a unique artistic style.

The quality and accuracy of keywords directly affect the quality of animation. Accurate keywords can enable AI to understand user needs more accurately and generate animation content that better meets user expectations. If the keyword description is vague or inaccurate, AI may generate animations that are far from user expectations. If vague keywords such as "a good-looking scene" are input, AI may generate various types of scenes due to the lack of clear instructions, which cannot meet the specific needs of users. The richness of keywords will also affect the quality of animation. Rich keywords can provide AI with more detailed information, making the generated animation richer and more vivid. When describing a character, in addition to basic appearance features, you can also add keywords such as personality traits, clothing style, and movement posture to make the AI-generated characters more three-dimensional and full.

Keyword Selection and Optimization Strategy

Selecting and optimizing keywords based on the animation's theme, style, and needs is crucial for improving the quality and effectiveness of AI-generated animation. When selecting keywords, it's crucial to closely focus on the animation's theme. Clarify the core content and emotions the animation aims to convey, then extract keywords that best capture the theme. For an animation focused on environmental protection, keywords might include "green earth," "pollution," "environmental action," and "nature." These keywords directly reflect the animation's theme and guide the AI in generating environmentally-related animation content, such as beautiful natural landscapes, polluted environments, and scenes of people actively participating in environmental protection initiatives.

Animation style is also an important basis for keyword selection. Different animation styles have unique visual characteristics and artistic expressions. By selecting matching keywords, the AI can accurately simulate the corresponding style. If you want to generate an animation in the style of traditional Chinese ink painting, keywords can include "ink and wash painting," "freehand brushwork," "landscape," "fine brushwork," etc. These keywords allow the AI to use the brushstrokes, colors, and composition characteristics of ink painting when generating animations, creating a unique atmosphere of traditional Chinese culture. For modern minimalist animations, keywords can be "simple," "geometric shapes," "pure colors," etc., guiding the AI to construct the animation screen with simple lines and pure colors.

Considering the audience needs of animation is also an important factor in keyword selection. Different audiences have different preferences and expectations for animation. Understanding the characteristics and needs of the target audience can help us select more appropriate keywords. For animations aimed at children, keywords can be more vivid, figurative, and interesting, such as "adorable animals," "magical magic," and "joyful adventure" to attract children's attention and interest. For animations aimed at adult audiences, keywords can be more profound and meaningful, such as "exploration of human nature," "social reality," and "emotional entanglements," to meet adults' pursuit of ideological and artistic content.

When optimizing keywords, you can use expansion and refinement. Expanding keywords involves adding relevant modifiers and qualifiers to the core keyword to enrich the keyword's meaning and make the AI-generated animation more specific and accurate. For example, the keyword "castle" could be expanded to include "ancient castle," "mysterious castle," "European-style castle," "castle perched on a mountaintop," and so on. These expanded keywords allow the AI to generate more distinctive and detailed castle animations. Refining keywords involves breaking down the keyword into more specific elements, allowing the AI to better understand and generate relevant content. When describing a character, consider using more than just the keyword "hero." You can also refine it to include "brave hero," "hero with superpowers," "hero in a red cape," "hero who saves the world," and so on, making the AI-generated hero more authentic to the user's imagination.

The proper combination and order of keywords can also optimize the effectiveness of AI animation generation. Different keyword combinations can generate different creative ideas and effects. By experimenting with different combinations, you can find the keyword combination that best suits your animation needs. Although "flying birds" and "singing birds" both revolve around the core bird, the different keyword combinations create different scenes and atmospheres in the AI-generated animations. The order of keywords also affects the AI's understanding of semantics and animation generation. Generally speaking, placing important, core keywords first allows the AI to more quickly and accurately grasp user needs. When describing a scene, "a bustling city nightscape" is more likely to prioritize the core element of "bustling city" than "a bustling city at night," resulting in a more accurate urban nightscape animation.

Teaching Practice and Case Analysis

Teaching Practice Design

This teaching practice, titled "AI Animation Creation Practice," is for second-year undergraduate animation students. It consists of 64 credit hours, including 24 hours of theoretical lectures and 40 hours of practical work. The course aims to enable students to master the core principles and operational methods of AI animation technology, apply it to creative animation creation, and enhance their animation creation skills and innovative thinking.

The course content covers modules such as the foundation of AI animation technology, keyword selection and application, AI animation style shaping, and animation project practice. In the AI animation technology foundation module, through classroom lectures and case analysis, the development history, technical principles, and application fields of AI animation are introduced, so that students can have a preliminary understanding of AI animation. In the keyword selection and application module, the focus is on explaining the role mechanism and selection optimization strategy of keywords in AI animation. Through practical operation exercises, students can master the method of selecting precise keywords according to the animation theme and needs. In the AI animation style shaping module, the characteristics and expression methods of different animation styles are analyzed, and students are guided to use keywords and AI technology to shape a unique animation style. The animation project practice module allows students to complete a complete AI animation project in groups, from creative conception, keyword selection, animation production to post-synthesis, applying the knowledge and skills learned throughout the process to cultivate students' teamwork ability and ability to solve practical problems.

Teaching activities emphasize the integration of theory and practice. In the theoretical lectures, lectures and case studies are used to guide students through theoretical explanations and analysis of outstanding AI animation works, helping them understand and master the core principles of AI animation technology. In the practical sessions, various tasks are provided, such as keyword selection exercises, AI animation clip production, and animation project practice. In the keyword selection exercises, teachers assign different animation themes. Students select keywords based on the themes and

use AI animation tools to generate corresponding animation clips. These results are then discussed and shared in groups, with teacher feedback and guidance to help students improve the accuracy and effectiveness of their keyword selection. In the AI animation clip production tasks, students creatively select keywords and use AI animation tools to create an animation clip with a specific theme and style. Students are encouraged to focus on the animation's fluency, expressiveness, and artistic style. The animation project practice is a key focus of the course. Working in groups, students independently determine the theme and content of their animation project, applying the AI animation techniques and keyword selection methods they have learned to plan, produce, and present the project. During the project practice process, teachers regularly organize group reports and exchanges to keep abreast of students' project progress and provide necessary guidance and assistance.

Case Presentation and Analysis

During this teaching practice, students created many excellent AI animation works, among which "Campus Fantasy Journey" and "Environmental Protection Story of Future Cities" are the most representative.

The animated work "Campus Fantasy Journey," set against the backdrop of campus life, tells the story of a protagonist who unexpectedly discovers a mysterious magical world on campus, embarking on a fantastical adventure. During the creative process, students used AI animation technology to input keywords such as "campus," "magic," "adventure," and "mysterious creatures" to generate fantasy-themed campus scenes, magical props, and images of mythical creatures. For example, when generating the campus scene, using keywords such as "ancient campus buildings" and "mysterious magical corridors," the AI animation tool created medieval-style campus buildings and magical corridors, with mysterious runes shimmering on the walls and strange magical items scattered on the ground, creating a rich fantasy atmosphere. Regarding character design, using keywords such as "brave boy" and "kind elf," the AI animation tool generated a brave and resolute protagonist and a lively and adorable elf. The elf's wings shimmered with colorful light, and its clothing was adorned with magical gems, giving the characters a strong visual impact. This work fully demonstrates the powerful role of AI technology in inspiring student creativity. Using AI animation technology, students can quickly transform their creative ideas into concrete animated characters and scenes, breaking through the limitations of hand-drawing skills and time constraints in traditional animation creation. This allows students to unleash their imaginations more freely and create animations with unique styles. AI technology also provides students with a wealth of creative inspiration. By combining and experimenting with different keywords, students can discover more creative possibilities and expand the boundaries of animation creation.

"An Environmental Story in a Future City" is set in a future city and focuses on environmental protection. It tells the story of how people in a future city work together to address environmental pollution and achieve sustainable urban development. During the production process, students input keywords such as "future city," "environmental pollution," "environmental action," and "high-tech environmental protection equipment" to generate high-tech future city scenes, images of polluted environments, and animation clips of people using high-tech environmental protection equipment to protect the environment. When depicting the future city, students input keywords such as "future city with tall buildings" and "suspended transportation tracks," and AI generated a high-tech cityscape with skyscrapers soaring into the sky, suspended transportation tracks crisscrossing, and various high-tech vehicles crisscrossing the tracks. When depicting environmental pollution, keywords such as "smog-filled sky" and "garbage-filled river" were input to vividly depict the severity of the pollution. This work demonstrates how AI technology significantly improves students' animation production efficiency. Traditional animation production requires considerable time and effort to draw the complex scenes of a future city and various environmental protection equipment. However, with AI animation technology, students can quickly generate high-quality animation materials by simply inputting relevant keywords, significantly shortening the creation cycle. AI technology can also automatically complete some repetitive tasks, such as the generation of intermediate frames in animations, reducing students' workload and enabling them to devote more time and energy to story creativity and artistic expression, thereby improving the quality and efficiency of animation works.

CONCLUSION

This study deeply explored the issues related to the integrated development of AI animation technology and art in the intelligent era. Through a series of research methods and teaching practices, the following major research results were achieved, and the various hypotheses proposed in this study were also verified.

The study constructed a teaching system that integrates animation technology and art based on AI animation technology. In terms of curriculum setting, this system organically integrates AI animation technology-related courses with traditional animation art courses, providing students with a comprehensive and systematic knowledge learning framework. In terms of teaching methods, diversified teaching methods such as project-driven teaching, case teaching and group cooperative learning are adopted to effectively improve the interactivity and practicality of teaching. Teaching practice shows that this integrated teaching system significantly improves teaching efficiency and verifies hypothesis one. In traditional animation teaching, it may take students several days to complete a simple animation scene drawing. After the introduction of AI animation technology, students only need to enter relevant keywords, such as "dreamlike starry sky", to generate a scene sketch with preliminary effects in a short time, which greatly shortens the creation cycle and improves teaching efficiency.

AI animation technology plays a significant role in stimulating students' learning interest and innovative thinking, validating Hypothesis 2. In teaching practice, students have shown strong interest in AI animation technology and actively participated in teaching activities based on this technology. By inputting different keywords, students can quickly generate diverse animation content. This rich creative inspiration stimulates students' innovative thinking. In the animation creation of "Campus Fantasy Journey", students input imaginative keywords such as "mysterious magic book" and "flying desk". AI animation technology generated corresponding fantasy elements. Based on these, students creatively combined and recreated them to create animations with unique styles, demonstrating their strong sense of innovation and creativity.

The teaching model that integrates technology and art significantly enhances students' comprehensive abilities, validating Hypothesis 3. Under this teaching model, students not only mastered AI animation techniques and were able to effectively use AI tools for animation creation, but also significantly improved their artistic literacy and aesthetic level. Students were able to organically combine AI technology with artistic creativity to create animations that are both technically sophisticated and artistically appealing. In the "Environmental Stories of Future Cities" animation project, students used AI technology to generate animated sequences depicting technologically advanced future city scenes and environmental initiatives. They also meticulously designed character imagery, color schemes, and plot pacing from an artistic perspective, achieving a high level of both technical and artistic excellence in their work, fully demonstrating the students' enhanced comprehensive abilities.

While this study has achieved certain results, it still has some shortcomings. The research sample primarily focused on second-year undergraduate animation students at a specific institution, resulting in relatively limited diversity and representativeness. Future research could further expand the sample to include students from different institutions, different grades, and different professional backgrounds to more fully understand the effectiveness and applicability of AI animation technology and art-integrated teaching. In terms of research methods, while qualitative analysis can deeply explore the meaning and patterns behind the research phenomena, the lack of quantitative data support may affect the universality of the research conclusions. Subsequent research could incorporate quantitative analysis methods, such as collecting quantitative data on students' academic performance and learning attitudes through questionnaires, and using data analysis software for statistical analysis to provide more robust evidence for the research.

Looking ahead, AI animation technology holds broad application prospects in animation teaching. With the continuous development and improvement of AI technology, its application in animation teaching will become more in-depth and extensive. Future research can focus on the specific paths and methods for the deep integration of AI animation technology with teaching, further exploring how to use AI technology to achieve personalized customization of teaching content to meet the learning needs of different students. With the development of technologies such as virtual reality (VR) and augmented reality (AR), studying how to combine these emerging technologies with AI

animation technology to create a more immersive and interactive learning experience for students is also an important direction for future research. The development of AI animation technology will also place higher demands on the development of the teaching staff of animation education. Future research can focus on how to improve teachers' ability to apply AI technology and their teaching level to better promote the application and development of AI animation technology in teaching.

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AIGC helps Students In Pre-education to Improve Digital Teaching Ability

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ABSTRACT

To enhance the digital teaching capabilities of preschool education majors, Qingdao Hengxing University has constructed an AIGC technology integration path from three aspects: training system, teaching paradigm, and practical ecology. In terms of the training system, with the framework of "concept innovation - institutional guarantee - resource integration", it is incorporated into the professional development plan, a three-level linkage management mechanism is established, and government-industry-university-research-application collaboration is carried out to obtain resources. In the teaching paradigm, a three-tier curriculum matrix is built, integrating AIGC with general education, core courses, and innovative projects to achieve a balance between instrumental and value rationality. In the practical ecology, a practical training network connecting virtual simulation, campus practice, and kindergarten application is constructed. Through the virtual kindergarten system, maker space, and the "1+1+1" kindergarten practice model, it promotes the transformation of students' technical application capabilities from theory to practice, providing support for the cultivation of digital talents in preschool education.
Keywords: AIGC, Digital teaching capabilities, Preschool education

INTRODUCTION

With the deep integration of digital technology and education, the demand for preschool education talents with digital teaching capabilities has become increasingly prominent. The 14th Five-Year Plan for National Education Informatization explicitly requires "promoting education digital transformation and cultivating talents with digital literacy," which highlights the national strategic significance of this research. However, traditional preschool education talent training models face three key problems: disconnection between theoretical teaching and digital practice, single training methods, and insufficient integration of emerging technologies (e.g., AIGC). These issues lead to graduates being unable to meet kindergartens' digital teaching needs, creating a gap between talent supply and market demand.

Existing studies on educational technology in preschool education mostly focus on individual digital tools (e.g., basic teaching software) but lack systematic research on integrating AIGC into the entire talent training system. There is no complete framework covering curriculum design, practical training, and management mechanisms, and the effectiveness of technology-driven talent training has not been fully verified.

The purpose of this study is to develop a scientific and feasible AIGC-integrated talent training model aimed at addressing the practical challenges in cultivating preschool education students' digital teaching capabilities. Specifically, this study seeks to explore effective ways of embedding AIGC into professional training systems so as to enhance students' ability to apply digital technologies in real teaching contexts. Based on this objective, the study is guided by the following research questions. First, how can a "trinity" development framework be constructed to integrate AIGC with preschool education professional training? Second, how can a hierarchical curriculum matrix be designed to achieve in-depth coupling between AIGC and professional courses? Third, how can a multi-dimensional collaborative training network be established to facilitate the transformation of students' digital teaching capabilities from theoretical understanding to practical application?

THEORETICAL FRAMEWORK

This section systematically sorts out theoretical foundations, core concepts, and literature gaps to position the study's academic value.

1. Core Concepts

Digital Teaching Competence of Preschool Education Majors: Refers to students' comprehensive ability to apply digital technologies (e.g., AIGC) in preschool scenarios to complete teaching design, activity organization, and child development evaluation. It includes four dimensions: technical application ability, educational design ability, ethical literacy, and data analysis ability.

AIGC Integration in Preschool Education: On the premise of adhering to the educational nature of promoting children's all-round development, AIGC technologies (e.g., multi-modal content generation engines, virtual simulation systems) are organically integrated into talent training, curriculum teaching, and practical training to optimize the training process and improve quality.

2. Relevant Theoretical Basis

Technology Integration Theory: Emphasizes that educational technology integration is not a simple tool superposition but should be deeply embedded in the entire teaching system (curriculum objectives, content, methods, evaluation). This study uses this theory to ensure AIGC serves the core goal of preschool talent training (i.e., avoiding over-reliance on technology while ignoring educational humanity).

Constructivist Learning Theory: Argues that learning is an active construction process through interaction with the environment. This study designs project-based learning and virtual simulation training based on this theory to encourage students to explore AIGC applications in educational scenarios independently.

Collaborative Education Theory: Highlights multi-subject participation in talent training. The "government-industry-university-research-application" model adopted in this study integrates resources from universities, kindergartens, enterprises, and education authorities to form a joint force for talent cultivation.

3. Literature Gap and Research Positioning

Existing studies on preschool digital talent training have two main gaps. First is the content gap, which includes most studies focus on basic digital tools (e.g., teaching APPs) and lack systematic research on integrating AIGC into the entire training system (no framework covering concepts, systems, and resources). Second, the method gap, most studies are theoretical discussions, with insufficient empirical verification based on practical teaching (few studies provide specific data on ability improvement).

This study takes Qingdao Hengxing University of Science and Technology's preschool education major as a case, constructs a "trinity" framework, hierarchical curriculum matrix, and multi-dimensional collaborative network, and verifies the model's effectiveness with empirical data. It fills the gap in systematic AIGC integration with preschool education professional training and provides practical references for similar majors' digital reform.

METHOD

This section details the research design to ensure the study's reproducibility, in line with the requirements of empirical research.

Research Approach

This study adopted the action research method, which integrates four links: planning, implementation, observation, and reflection. A two-year practical exploration was conducted in the preschool education major of Qingdao Hengxing University of Science and Technology (from September 2022 to August 2024). The research adhered to the principle of combining theory and practice: during implementation, the training model was continuously optimized based on feedback from teaching practice and kindergarten applications, ensuring scientificity and feasibility.

Participants and Data Sources

Participants: A total of 286 students (Grade 2022: 142 students; Grade 2023: 144 students) majoring in preschool education; 12 professional teachers (responsible for curriculum design and teaching); 8 kindergarten teachers (part-time practical instructors, responsible for on-site guidance); 3 AI engineers (technical consultants, responsible for AIGC tool training).

The data sources for this study include quantitative, qualitative, and document-based data. Quantitative data are obtained from virtual simulation training evaluation reports, students' curriculum practice performance, and feedback on application effects in kindergartens, such as a reported 40%

improvement in autistic children's emotional recognition accuracy, providing objective evidence of training effectiveness. Qualitative data consist of student reflection reports, teacher teaching logs, expert demonstration meeting minutes, and case materials from student competition works, which offer deeper insights into the implementation process and learning outcomes. In addition, document data are drawn from school development plans, curriculum syllabuses, and cooperation agreements with kindergartens and enterprises, supplying contextual and institutional support information for the study.

Research Instruments and Materials

AIGC Teaching Suite: Donated by cooperative technology enterprises (total value: 3 million yuan), including core tools such as multi-modal content generation engines, child behavior simulation systems, and virtual game scene generation systems.

Virtual Kindergarten System: Built by the university's Intelligent Preschool Education Training Center, covering 20 typical teaching scenarios (e.g., separation anxiety comfort, outdoor game guidance) and supporting VR equipment access and real-time teaching behavior evaluation.

Evaluation Index System: Jointly formulated by preschool education experts, AI engineers, and kindergarten principals, including 12 core indicators (e.g., technical application proficiency, teaching design rationality, language affinity).

Research Procedure

The research was conducted over a total period of 24 months and divided into three stages. The preparation stage (Months 1–3) focused on literature review and needs analysis, including interviews with 15 kindergarten principals to identify digital teaching competency requirements, as well as expert demonstration meetings with eight specialists in preschool education and AI to formulate the "trinity" development framework and training objectives. The implementation stage (Months 4–22) involved constructing a hierarchical curriculum matrix and delivering AIGC-integrated courses, establishing a multi-dimensional collaborative training network, and organizing student participation in virtual simulation training (20 hours per student), campus practice (30 hours per student), and kindergarten practice (40 hours per student), while collecting data in real time through weekly training reports and monthly practice feedback. The final reflection and optimization stage (Months 23–24) centered on analyzing the collected data to summarize the model's strengths, such as significant improvements in students' abilities, and identifying existing problems, including insufficient ethical training, followed by adjustments to curriculum design—such as adding AIGC educational ethics modules—and improvements to training methods, including increased guidance hours from AI engineers.

Data Analysis Method

A mixed-methods approach (quantitative + qualitative) was used:

Quantitative data: Descriptive statistics and comparative analysis were conducted using Excel to calculate indicators such as "65% increase in separation anxiety soothing strategies" and "40% improvement in emotional recognition accuracy."

Qualitative data: Thematic analysis was used to extract core viewpoints from reflection reports and teaching logs, summarizing the model's strengths and areas for improvement.

FINDINGS AND DISCUSSION

This section presents research results and links them to research questions and existing literature to highlight the study's innovation.

1. Construction of AIGC Integration Development Framework: Ensuring Training Direction and Standardization

To address the first research question ("How to build a 'trinity' framework"), the study constructed a "concept innovation–institutional guarantee–resource integration" framework, which effectively solved the disconnection between technology application and educational nature.

Concept innovation: The core principle of "technology serves education" was established, clearly stipulating that AIGC application must focus on children's all-round development (e.g., AI-generated picture books must conform to 3–6-year-old children's cognitive characteristics). This principle runs through the entire training process, avoiding the dissolution of educational humanity by technical instrumental rationality.

Institutional guarantee: A three-level linkage management mechanism (school → college → teaching and research section) was established: the Academic Affairs Office is responsible for credit recognition and quality monitoring; the college's Digital Teaching Ability Training Group coordinates

curriculum and training; the teaching and research section implements integration details. In addition, ethical norms were formulated (e.g., anonymous processing of AIGC-generated children's behavior data) to ensure standardized technology application.

Resource integration: The "government-industry-university-research-application" model was adopted: a Preschool Education Digital Research Center was established with the local Education Bureau (obtaining regional children's development big data); a kindergarten real case library was introduced; cooperative enterprises donated AIGC teaching suites.

Discussion: This framework solves three core problems in AIGC integration: "why to integrate" (concept guidance), "how to manage" (institutional guarantee), and "what resources to use" (resource integration). Compared with existing studies that only focus on tools, this framework ensures the professionalism of AIGC application and the educational nature of preschool education, laying a foundation for students' digital ability cultivation.

2. Design of Hierarchical Curriculum Matrix: Promoting In-depth Technology-Course Integration

To answer the second research question ("How to design a hierarchical curriculum matrix"), the study broke through the traditional binary curriculum structure and constructed a "basic layer–advanced layer–innovation layer" matrix, realizing in-depth coupling of AIGC and professional courses.

Basic layer: General courses such as "Artificial Intelligence and Preschool Education" and "Digital Teaching Tool Application" were offered. Through scenario-based case teaching (e.g., AIGC application in children's story creation), 92% of students could correctly identify AIGC's applicable scenarios in preschool education (course evaluation data).

Advanced layer: AIGC was integrated into core courses:

In "Early Childhood Language Education": An intelligent picture book co-creation unit was developed. Students designed themes based on the Guidelines for the Learning and Development of Children Aged 3–6, generated picture book drafts with AIGC, and optimized them according to children's language development characteristics. A student team's AI picture book for autistic children improved 8 children's emotional recognition accuracy by 40% (kindergarten feedback).

In "Kindergarten Game Guidance": A virtual game scene generation system was introduced. Students input game types (e.g., outdoor construction games), and the system automatically generated 3D scene schemes (including material placement and safety prompts). After teacher-student optimization, the schemes had high feasibility.

Innovation layer: An optional course "AIGC Preschool Education Innovation Workshop" was set up. Using project-based learning, students completed group research (e.g., "Ethnic Minority Culture Enlightenment AI Assistant"), which generated interactive courseware (covering Miao silver ornaments, Dong Grand Song) and was promoted in 3 kindergartens in Qiandongnan Prefecture.

Discussion: This matrix realizes progressive improvement of students' digital abilities: the basic layer lays a theoretical foundation, the advanced layer integrates technology into core competencies, and the innovation layer promotes application and innovation. Compared with existing single-course technology integration, this design balances instrumental rationality (technology application) and value rationality (educational goals), ensuring students' professional foundation and technical practicality.

3. Construction of Multi-dimensional Collaborative Training Network: Promoting Ability Transformation

To respond to the third research question ("How to build a multi-dimensional collaborative network"), the study constructed a network linking virtual simulation, campus practice, and kindergarten application, forming a complete AIGC application chain from theory to practice.

Virtual simulation training: Relying on the Virtual Kindergarten System, students used VR equipment to complete tasks (e.g., comforting virtual children with separation anxiety). The system's teaching behavior analysis module marked 12 indicators (e.g., language affinity) in real time and generated improvement suggestions. Results showed Grade 2023 students' separation anxiety soothing strategies increased by 65%, making up for the lack of dynamic feedback in traditional micro-teaching.

Campus practice: A carrier combining a maker space and a competition platform was built:

The AIGC Teaching Resource Maker Space was equipped with 4K video equipment and motion capture instruments. Students converted AIGC-generated materials into teaching tools (e.g., adapting 24 solar terms stories into shadow play scripts).

The "Future Preschool Education Maker Competition" was held annually. In 2024, 132 works were received, and many were promoted in cooperative kindergartens.

Kindergarten application: A "1+1+1" practice model was implemented (1 university tutor for technical guidance, 1 kindergarten teacher for educational guidance, 1 student for AIGC-integrated teaching). Grade 2023 interns in a Guiyang kindergarten used AIGC to generate Qingdao landscape-themed picture books and combined AR technology to enhance children's regional cultural identity. After practice, a Compilation of AIGC Preschool Education Practice Cases was formed.

Discussion: This network solves the disconnection between theory and practice in digital ability cultivation: virtual simulation provides a safe practice environment, campus practice stimulates innovation, and kindergarten application tests practical effects. The three links form a closed loop, promoting students' ability transformation from theoretical cognition to practical application.

CONCLUSION

This study explored AIGC-driven paths to improve preschool education students' digital teaching capabilities through a two-year practice at Qingdao Hengxing University of Science and Technology. The main conclusions of this study are as follows. First, the framework of "concept innovation–institutional guarantee–resource integration" effectively ensures both the direction and standardization of AIGC integration in preschool education talent training. Second, the "basic layer–advanced layer–innovation layer" curriculum matrix enables in-depth coupling between AIGC and professional courses, thereby facilitating the progressive improvement of students' digital teaching capabilities. Third, the multi-dimensional collaborative training network that integrates virtual simulation, campus practice, and kindergarten application successfully promotes the transformation of abilities from theory to practice, producing significant outcomes such as a 65% increase in strategy diversity and a 40% improvement in recognition accuracy.

This study makes both theoretical and practical contributions. Theoretically, it constructs a comprehensive AIGC-integrated digital talent training model for preschool education, enriches the theoretical system concerning the integration of educational technology and preschool education, and provides a valuable reference for the digital transformation of related academic majors. Practically, the research outcomes have been implemented and validated in the preschool education program at Qingdao Hengxing University of Science and Technology, demonstrating that the proposed training framework, curriculum matrix, and collaborative training network possess strong replicability and promotion value, and can offer practical experience for other colleges and universities seeking to develop digital talent training models in preschool education.

This study has several limitations. First, it was conducted in a single university, resulting in a relatively limited sample scope; therefore, the applicability and effectiveness of the proposed model in different types of institutions, such as normal universities and vocational colleges, require further verification. Second, although the research cycle lasted two years, the long-term impact of the model on students' career development—such as their digital teaching performance five years after graduation—has not yet been examined and would require longitudinal follow-up studies. Third, the study mainly focuses on the construction and application of the training model, while research on AIGC educational ethics remains insufficient, particularly regarding issues such as the potential influence of virtual images on children's cognitive development.

Future research can be advanced in several directions. First, the sample scope should be expanded by conducting collaborative studies with normal universities and vocational colleges, allowing the model to be further optimized in line with the characteristics of different types of institutions. Second, longitudinal follow-up studies spanning five to ten years should be carried out to track graduates' career development and to verify the long-term effectiveness of the proposed model. Third, greater emphasis should be placed on research into AIGC educational ethics, including the formulation of ethical guidelines such as children's privacy protection in AIGC applications, in order to ensure the healthy and responsible development of digital preschool education. Finally, future studies may explore the integration of AIGC with a wider range of professional courses, such as Early Childhood Art Education, to further expand the application scope of AIGC in preschool teacher training.

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AI-Aesthetic TPACK: Redesigning Art Teacher Education in the Age of Generative AI

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ABSTRACT

Generative text-to-image systems lower technical barriers to visual production but can also short-circuit learning if used end-to-end. This paper proposes AI-Aesthetic TPACK, a framework that aligns Human-in-the-Loop (HITL) and Human-out-of-the-Loop (HOTL) workflows to Leder's five stages of aesthetic processing (perceptual analysis, implicit memory integration, explicit classification, cognitive mastering, evaluation) and operationalizes it as a classroom toolkit: (a) a behavior-anchored competency rubric for teacher education; (b) a Process-Based Evidence Package (PBEP) template that makes creative processes visible and assessable; and (c) a course-level AI use & disclosure policy. Using a PRISMA-ScR–guided scoping synthesis, we distill design patterns that preserve stage-specific learning while leveraging AI for ideation and iteration. A 90-minute micro-trial with three experienced art instructors shows moderate inter-rater agreement when applying the rubric to a PBEP-documented student project (κoverall = 0.65; κdimension = 0.58–0.73). Qualitative debriefs reveal consistent pain points (e.g., ambiguity around licensing of texture assets) and lead to a shared casebook for future calibration. Contributions are: (1) a stage-aligned mapping of AI interventions with scaffold/shortcut conditions; (2) a ready-to-use toolkit (rubric + PBEP + policy) with evidence anchors; and (3) initial usability/consistency signals for short-format teaching. We conclude with boundary conditions, cultural considerations, and a data/materials availability statement to support replication and local adaptation.

Keywords: Aesthetic cognition; Generative AI; Teacher education; Technology integration; TPACK

INTRODUCTION

Generative AI systems—such as Midjourney, DALL·E, and Stable Diffusion—have become a transformative force across creative practice and education. In art and design classrooms, text-to-image models markedly lower technical barriers to visual production, enabling learners to generate complex, aesthetically refined imagery from simple textual prompts. In studio-based and design-oriented subjects, these systems are widely recognized as accelerators for ideation, rapid prototyping, and iterative exploration. At the same time, their rise poses new pedagogical challenges: educators must determine how to integrate AI tools in a way that enriches learning rather than undermining fundamental skills or creativity.

Within education research, technology integration is often framed by the Technological Pedagogical Content Knowledge (TPACK) framework, which formalizes how effective teaching arises from the dynamic interplay among content knowledge, pedagogy, and technology (Mishra & Koehler, 2006). TPACK provides a vocabulary for describing where AI can be positioned in a curriculum (for example, as a tool, a task modality, or an assessment resource) and how it interacts with teachers' pedagogical moves and disciplinary aims. From the perspective of cognitive and aesthetic psychology, Leder et al.'s five-stage model of aesthetic appreciation offers a stage-based account of how humans engage with art: perceptual analysis (analyzing formal elements), implicit memory integration (connecting to personal experiences), explicit classification (identifying style, genre, or context), cognitive mastering (resolving ambiguities or constructing meaning), and evaluation (forming an overall judgment) (Leder et al., 2004). Together, TPACK and the Leder model provide complementary lenses on AI's role in art education: TPACK clarifies the instructional locus of AI integration, while the Leder model clarifies the cognitive

locus at which AI may scaffold or short-circuit learners' aesthetic reasoning. Despite these guiding frameworks, the intersection between instructional integration and aesthetic cognition remains inadequately specified for art and design education.

In particular, several critical issues are insufficiently theorized and operationalized in the current literature and practice:

Stage-specific mechanisms: We lack precise accounts of how generative AI interventions align with each stage of aesthetic cognition, and which learning operations (e.g. noticing, rule articulation, iterative refinement, judgment) are being genuinely scaffolded versus silently bypassed.

Scaffold versus shortcut conditions: It is unclear under what conditions AI functions as a productive scaffold rather than a counterproductive shortcut. The role of workflow design—especially HITL versus HOTL configurations—has not been systematically mapped to stage-specific learning affordances and risks. (Here, we define a Human-out-of-the-Loop (HOTL) workflow as one in which human input is minimal and the process relies on end-to-end AI generation of a final or near-final product, in contrast to Human-in-the-Loop (HITL) workflows that involve substantive human curation and editing.)

Assessment and evidence: Studio assessment in art education remains heavily artifact-centric; shared norms for process evidence (e.g. prompt logs, human edits and annotations, rationale for decisions, and AI-use disclosure) and stage-aligned evaluation criteria are scarce. Educators currently lack rubrics that reward how students think and iterate, not only what final artifact they submit.

Teacher competencies and policy: There is no behavior-anchored, domain-specific articulation of AI-Aesthetic TPACK competencies for teacher preparation. Likewise, we lack course-level policies for AI use and disclosure that translate academic integrity and copyright concerns into practical, teachable routines.

Design patterns for coursework: Practical lesson- and module-level patterns that operationalize HITL scaffolds (for example, "first human, then model" sequencing, two-step human–AI remix cycles, or "paired blind review + evidence check" activities) are only sporadically described in the literature and are rarely aligned explicitly to stages of aesthetic development.

These unresolved issues lead to a central problem: How should art teacher education be redesigned so that generative AI serves as a scaffold for stage-based aesthetic learning rather than short-circuiting it? Addressing this question is crucial for preparing teachers to harness AI in a pedagogically sound and ethically transparent way. In sum, educators need a coherent framework that (a) maps AI's scaffold-versus-shortcut potentials onto specific stages of aesthetic cognition; (b) specifies teacher competencies in an AI-Aesthetic TPACK rubric; and (c) operationalizes process-focused evidence collection and AI use/disclosure policies for classroom implementation. This need motivates the present study.

Purpose and Objectives: To respond to the above gaps, this study proposes a coherent framework and toolkit for AI-A-TPACK in art teacher education. The aim is twofold. First, we develop and justify a set of practical instruments – including a behavior-anchored competency rubric, a process-based evidence template, and a model AI use/disclosure policy – that together operationalize AI-A-TPACK for classroom use. Each component of this toolkit is grounded in the TPACK and aesthetic cognition frameworks, as we explain in later sections. Second, we conduct an initial exploration of the toolkit's usability and consistency in a short-duration teaching context. In particular, we pilot the rubric and evidence template in a brief workshop scenario to examine whether teachers can apply the rubric reliably (i.e. with consistent assessments) within the constraints of a single class session. By pursuing these two objectives, the study seeks to provide both a theoretically sound framework and early empirical insight into its practical viability for art and design teacher education.

THEORETICAL FRAMEWORK

TPACK in Art and Design Education

The Technological Pedagogical Content Knowledge framework (TPACK; Mishra & Koehler, 2006) posits that effective teaching with technology arises from an intersection of content knowledge (CK), pedagogical knowledge (PK), and technological knowledge (TK). In art and design education, this model helps conceptualize how emerging technologies like generative AI can be woven into pedagogy. For art teachers, AI-specific technological knowledge includes understanding the capabilities and limitations of generative models (e.g. knowing what text-to-image systems can and cannot easily do). AI-related pedagogical knowledge involves knowing how to integrate these tools into teaching strategies and studio routines (e.g. when to allow or encourage AI use during an art-making process, and how to

scaffold that use). AI-related content knowledge entails understanding how AI relates to artistic content and creative processes (for instance, knowing how style transfer or image generation can illustrate art concepts or techniques). An AI-augmented extension of TPACK – which we refer to as AI-Aesthetic TPACK (AI-审美 TPACK) or AI-A-TPACK – thus adapts the traditional framework to account for how AI tools mediate creative content and methods. It provides a structured lens to identify where in the curriculum AI acts (for example, as a tool for generating visual elements, as part of a pedagogical approach to critique and iteration, or as content in discussions about art and technology) and how it interacts with pedagogical intent and artistic learning goals. TPACK offers stability in terminology and design, ensuring that when we introduce AI, we consider not just the tool itself, but how it fits with pedagogy and content objectives. In summary, AI-A-TPACK emphasizes that meaningful integration of AI in art education requires aligning technical possibilities with sound pedagogical strategies and deep content understanding.

Leder's Model of Aesthetic Cognition

Complementing TPACK's educational lens, Leder et al.'s five-stage model of aesthetic appreciation (Leder et al., 2004) provides a cognitive–affective map of how individuals engage with art. The stages progress from basic perception to deeper evaluation, offering a sequence for the viewer's or creator's experience: (1) Perceptual analysis – noticing formal elements such as line, color, composition, and other basic features; (2) Implicit memory integration – making personal associations and drawing on prior experiences or knowledge in response to the work; (3) Explicit classification – identifying style, genre, or contextual information (for example, recognizing a Baroque painting style or a specific artist's hallmark techniques); (4) Cognitive mastering – resolving interpretive challenges or ambiguities, constructing meaning and understanding the work in a broader context; and (5) Evaluation – forming a judgment about the artwork's quality, success, or emotional impact. This model has been widely applied in art education research to align teaching strategies or critique methods with the cognitive processes students undergo when creating or viewing art. For instance, a teacher might scaffold the perceptual analysis stage by training students to carefully observe and verbally describe artworks before moving on to interpretation. Leder's framework thus informs what kind of thinking or appreciation skill is being targeted at each step of an art-making or art-viewing activity. In our study, these stages serve as a backbone for analyzing where AI might support or hinder learning – essentially linking the cognitive "locus" of AI's impact to specific pedagogical interventions.

Generative AI in Art Education: Current Insights

Recent research on AI in art and design education spans several strands, which together paint a picture of opportunities and challenges:

Implementation studies: many classroom implementation reports describe how text-to-image systems are introduced into studio tasks for ideation, prototyping, and iteration within art/design curricula. These studies often highlight AI's benefits in expanding the range of ideas students can explore and lowering the barrier for creating visual drafts (e.g., Wen & Wen, 2024). AI tools have been shown to help students generate rapid visual variations and explore creative options that they might not have attempted manually, thereby functioning as idea catalysts.

Ethical and policy analyses: Parallel research has examined issues of authorship, attribution, bias, and intellectual property raised by generative pipelines. For example, concerns are discussed regarding how students and educators should credit AI contributions and avoid plagiarism or misuse of copyrighted training data (Yusuf et al., 2024). This line of work emphasizes the need for clear guidelines and policies around AI usage in an educational context, to maintain academic integrity and address legal/moral questions (such as the permissibility of using AI-generated images in student artwork or the fairness of AI-derived content).

Perception and evaluation studies: Another strand investigates how viewers and judges respond to artwork that involves AI in the creation process, comparing perceptions of human-made, fully AI-generated, and hybrid human–AI works. For example, Agudo et al. (2022) found differences in emotional responses to AI-created art, with some viewers perceiving AI-generated artworks as less "sensitive" or emotionally deep than human-created pieces. Horton, White, and Iyengar (2023) similarly report that identical pieces of art are evaluated more positively when attributed to a human creator than when attributed to AI, suggesting an audience bias against AI-generated art. However, biases in judgment can be complex: other research suggests these effects may stem more from human favoritism than outright "algorithm aversion." Zhang and Gosline (2023) found that people's perceptions can

actually favor human–AI collaborations under certain conditions, rating augmented human–AI works higher in quality than those created by a human or an AI alone. These boundary-conditioned effects depend on factors such as whether the art's origin (human or AI) is disclosed, the expertise level of the evaluators, the nature of the task, and the visibility of process evidence (i.e. whether viewers are shown how the piece was created).

A general pattern emerging from the literature is that HITL workflows tend to outperform HOTL pipelines on aesthetic outcomes when human creativity and judgment remain integral. When an AI system is used to assist rather than replace the human – for instance, generating suggestions that a human artist then curates, combines, or refines – the resulting artworks are often judged as more creative or of higher quality than purely machine-generated outputs. This aligns with broader findings in decision-making domains: people often exhibit algorithm aversion, a reluctance to trust automated systems' outcomes after seeing them err (Dietvorst et al., 2015). At the same time, with appropriate design and transparency, people can develop algorithm appreciation, sometimes even preferring outputs that involve algorithmic assistance (Logg et al., 2019). of art, striking the right balance appears critical. A fully automated, human-out-of-the-loop process risks "short-circuiting" important learning experiences – for example, a student might skip over learning how to compose an image if the AI does it entirely for them – and may yield work that viewers perceive as lower in authenticity or emotional resonance. Conversely, a well-designed HITL process can scaffold students' creativity by speeding up low-level tasks (like generating variations on a theme) while preserving higher-order decision making and personal input. Such an approach can also mitigate negative biases against AI involvement if it is accompanied by honest disclosure and visible evidence of the human contribution.

Despite these insights, current models and frameworks (including general tech-integration models like SAMR or even the base TPACK) remain too coarse to offer concrete guidance for art educators on these issues. Generic models classify uses of technology (e.g., substitution vs. augmentation in the SAMR model), but they do not indicate which cognitive operations are being supported or bypassed at each stage of creative work. Without a detailed mapping of AI's role at each stage, educators are often left guessing where an AI tool might help or harm the development of skills such as observation, critical reflection, or iterative refinement. Likewise, there are currently no established competency benchmarks detailing what art teachers should know and be able to do with AI, nor widely used assessment tools that capture students' creative process and ethical AI use (as opposed to only evaluating final art products). Taken together, the field lacks a coherent, actionable framework to address the gaps identified earlier. This study's theoretical framework synthesis underlines the need for an approach that explicitly links when and how to integrate AI (instructionally and cognitively) with what new teacher competencies and classroom routines are required. The remainder of this paper introduces such a framework and toolkit, and examines its initial use in practice.

METHOD

Research Design and Data Collection

This study follows a structured conceptual synthesis approach (based on scoping review principles) to build a domain-specific framework for AI-Aesthetic TPACK in art teacher education. We adopted a scoping review methodology guided by PRISMA-ScR (Preferred Reporting Items for Systematic reviews and Meta-Analyses – Scoping Review extension) guidelines to ensure a transparent and reproducible process (Tricco et al., 2018). No human participants were directly involved in data generation for this phase of the research; rather, our "subjects" were documents and literature sources, so institutional ethical approval was not required.

We defined the scope of our review to include published and publicly available sources at the intersection of generative AI, art/design education, and teacher knowledge/training. These sources encompassed peer-reviewed journal articles and conference papers, practitioner case reports, institutional or policy documents, and relevant methodological or assessment frameworks. The time frame was set from January 1, 2018 up to August 15, 2025 to capture the period during which diffusion-based text-to-image systems emerged and rapidly evolved. An updated sweep was conducted in late August 2025 to include the most recent publications.

We searched four electronic databases: Scopus, Web of Science Core Collection, ERIC, and Google Scholar. Search queries combined keywords in three facets: generative AI terms (e.g., "generative AI", "text-to-image", "diffusion model", as well as specific tool names like Midjourney, Stable Diffusion,

DALL·E), art/design education terms (e.g., “art”, “design”, “studio”, “visual art”, “graphic”, “textile”, “pattern design”), and education/teacher-education terms (e.g., “education”, “pedagogy”, “teacher education”, “teacher training”, “curriculum”, “assessment”, “TPACK”, “SAMR”). An example composite query (adapted to each database’s syntax) was ("generative AI" OR "text-to-image" OR "diffusion model*" OR Midjourney OR "Stable Diffusion" OR DALLE) AND (art OR design OR studio OR "visual art*" OR graphic* OR textile* OR "pattern design") AND (education OR pedagogy OR "teacher education" OR "teacher training" OR curriculum OR assessment OR TPACK OR SAMR)

Database-specific filters were applied to focus results on English-language sources and scholarly publications (journal articles, conference proceedings, dissertations, and reviews). In addition to database results, we manually scanned the reference lists of key papers for any relevant studies that our queries might have missed. We also performed targeted web searches for institutional guidelines or policy documents on AI use in education, to incorporate practical perspectives from the field.

All retrieved records were imported into a reference management spreadsheet, where duplicates were removed. We then conducted two stages of screening: first, a title/abstract screening to exclude obviously irrelevant records, and second, full-text screening for eligibility. We included a source if it explicitly addressed art/design learning or art teacher education in relation to generative AI. We excluded sources that were purely technical (e.g. proposing a new image generation algorithm with no educational discussion) or opinion pieces lacking any empirical, conceptual, or pedagogical substance. During full-text screening, reasons for exclusion (such as “not about education” or “no relevance to art/design”) were logged. The identification, screening, and inclusion process is documented in a PRISMA-ScR flow diagram (Figure 2 in Appendix), which records the number of records identified, screened out at each stage, and ultimately included.

Analysis and Synthesis

Our analysis proceeded in two iterative cycles: an inductive coding cycle followed by a deductive mapping cycle. In the inductive phase, we began by developing a qualitative codebook through exploratory reading of a subset of the included sources. We coded text segments for emergent themes related to generative AI’s affordances and risks in studio learning. Examples of emergent affordance codes included “ideation acceleration”, “style expansion”, and “rapid iteration” – highlighting what AI made easier or faster for learners. Risk codes included themes like “homogenization of outputs”, “overreliance on AI”, “skill atrophy”, “authorship ambiguity”, and “lack of transparency”. We also coded for descriptions of workflow patterns (e.g., did a scenario involve a HOTL approach with minimal human input, or a HITL approach with substantial human editing? Were prompts and iterations documented or hidden?) and any mention of alignment (or misalignment) with cognitive stages (for instance, a note that a particular use of AI might bypass the need for careful perceptual analysis, corresponding to Leder’s first stage).

After refining the codebook on a trial subset, two researchers independently applied it to the full set of included sources. We achieved inter-coder reliability with Cohen’s Kappa exceeding 0.70 for the top-level code categories, indicating substantial agreement on coding definitions. Discrepancies in coding were resolved through discussion and consensus. This rigorous qualitative analysis ensured that our subsequent framework construction was grounded in a broad and systematically gathered evidence base, rather than anecdotal impressions.

In the deductive mapping phase, we took the coded insights and systematically mapped them onto Leder’s aesthetic cognition stages and the TPACK domains. Specifically, for each of Leder’s five stages, we analyzed how generative AI was reported to function: did it scaffold learning at this stage (i.e. support or enhance the intended cognitive process), or did it shortcut/bypass the intended cognitive work? We also noted whether those effects tended to occur under certain workflow conditions (HITL vs. HOTL). For example, when considering the perceptual analysis stage, we asked: In the literature, are there instances where AI replaced students’ own observation (a shortcut) versus cases where AI was used to enrich or guide observation (a scaffold)? We performed a similar mapping for each stage of the model. Alongside this, we aligned the findings with TPACK’s knowledge components to articulate what knowledge or skill teachers would need to manage AI at that stage (for instance, a teacher’s AI-Pedagogical Knowledge might involve strategies to prevent AI from short-circuiting students’ perceptual analysis in an art lesson).

The outcome of this mapping was a detailed matrix that forms the core of our proposed framework.

This matrix specifies, for each aesthetic cognition stage: the typical HOTL uses of AI and their shortcut risks, recommended HITL scaffolds to preserve learning, examples of process evidence that should be collected at that stage, and indicative assessment criteria aligned with that evidence. This stage-by-stage mapping is presented later in the Results (as Figure 1 and Table 2), which visualizes how AI interventions can either undermine or support each stage, and what kinds of evidence and criteria can anchor a more transparent, process-focused pedagogy at each point.

Throughout the analysis and synthesis, we paid special attention to recurring practical recommendations in the literature. These often appeared in the form of design patterns or teaching tips – for example, "require an initial hand sketch before allowing AI generation" as a way to preserve students' perceptual skills, or "have students compare AI-generated variants with original concepts to practice critical evaluation." Such recurring ideas were distilled and fed into the creation of our toolkit for teacher education. In particular, they informed the descriptors and performance indicators in our competency rubric, the sections and prompts of our process-based evidence template, and the clauses of our classroom AI use and disclosure policy. In other words, the qualitative synthesis not only yielded a conceptual understanding of AI's role but also concrete instruments to implement that understanding in educational practice.

Toolkit Description

Based on the above analysis, we developed a three-part AI-Aesthetic TPACK Toolkit for art educators. The toolkit comprises: (1) a behavior-anchored competency rubric defining key dimensions of AI-A-TPACK for teachers; (2) a Process-Based Evidence Package (PBEP, 基于过程的证据包) template to document and assess students' creative process when using AI; and (3) a sample policy for classroom AI use and disclosure. Each component is described below, including its design rationale and structure. The toolkit is intended to operationalize the framework in practical settings, guiding both teachers and students toward AI use that functions as a learning scaffold rather than a shortcut.

Competency Rubric for AI-Aesthetic TPACK

One major output of our framework is a behavior-anchored competency rubric for AI-Aesthetic TPACK in art teacher education. The rubric was developed to address the identified gap in teacher competencies: art educators currently lack a clear, domain-specific model of what knowledge and skills they need to effectively integrate AI into their teaching. We distilled six core dimensions of teacher competency at the intersection of AI and art pedagogy:

AI-Technological Knowledge (AI-TK): The teacher's knowledge of generative AI tools and how to operate them. For example, understanding different image generation models and algorithms, their parameters and modes of use, and their limitations or failure cases.

AI-Technological Pedagogical Knowledge (AI-TPK): Skill in designing and orchestrating learning activities that appropriately incorporate AI. This involves knowing when and how to let students use AI in a lesson, how to scaffold its use (e.g. requiring certain human steps before or after AI use), and how to integrate AI tools into studio routines or class exercises in a pedagogically sound way.

AI-Technological Content Knowledge (AI-TCK): The ability to integrate AI into the art/design content itself. This means understanding how AI-generated content relates to art domain knowledge and techniques – for instance, using AI to explore content-specific concepts like artistic styles or color theory, and knowing how to critique or build upon AI outputs from an art content perspective.

AI-TPACK Integration: The holistic competency of aligning AI, pedagogy, and content in a cohesive manner. In practice, this means ensuring that an AI-supported task still meets the intended artistic learning objectives and fits within the curriculum's structure, and being able to "close the loop" between what students make with AI and what they are meant to learn. This dimension reflects the synthesis of TK, PK, and CK in context – essentially the essence of AI-A-TPACK.

Ethics & Policy: Knowledge of ethical guidelines, copyright issues, and the ability to model and enforce AI-related policies in the classroom. For example, teachers should know how to address questions of authorship (who "owns" AI-generated art), ensure students credit AI assistance properly, avoid biased or inappropriate AI outputs, and adhere to any school or institutional policies on AI usage. This also includes creating a classroom culture of honesty and integrity around AI use (such as requiring disclosure of AI involvement in assignments).

Assessment: The ability to assess student work in the age of AI, which includes evaluating both the final artifact and the creative process. Teachers need strategies to verify the authenticity and originality of student work, to evaluate process documentation, and to assign value to students' decision-making

and effort (not just the polished outcome). This competency often involves using tools like the PBEP and rubric itself to make sure that grading considers how the student used (or didn't use) AI in academically legitimate ways.

For each of these six dimensions, we defined four performance levels: Beginner (B), Developing (D), Proficient (P), and Advanced (A). Each level is anchored by specific observable behaviors or indicators, drawn from our literature synthesis and input from expert art educators. The rubric is behavior-anchored, meaning it describes what a teacher at a given level does or can demonstrate, rather than just using abstract qualitative labels. For example, under AI-Technological Knowledge, a Beginner might "use a single generative model with default settings, treating it largely as a black box," whereas an Advanced teacher would "design a custom AI tool-chain and justify the choice of models and parameters for a given art project." Under Ethics & Policy, a Beginner might only be vaguely aware of issues (perhaps giving occasional verbal warnings about plagiarism or style theft), whereas an Advanced teacher might "coach colleagues in compliant practices" and rigorously model full disclosure of AI use in their own demonstrations.

Each cell of the rubric (dimension × level) contains a concise description of behavior. We also included a column for evidence examples – tying each dimension to the types of evidence or documentation that could demonstrate that competency in action. For instance, evidence for AI-TK might be prompt logs or screenshots showing the teacher experimented with different models and settings; evidence for AI-TPK might include lesson plans or classroom observation notes showing how the teacher integrated AI into an activity; evidence for Ethics & Policy might include completed AI disclosure forms or examples of the teacher explicitly addressing AI ethics with students. The rubric is designed to be scored holistically: we assigned indicative weightings to each dimension (summing to 100%) to reflect their importance. In our current iteration, the Integration and Assessment dimensions carry slightly higher weight (e.g. ~20% each) because of their critical role in linking AI use to learning outcomes, while dimensions like AI-TK, AI-TPK, AI-TCK, and Ethics/Policy might carry around 15% each. These weights, along with cut-off scores for overall competency levels (for example, a total score ≥ 75% indicating Proficient overall), can be adjusted or calibrated in future studies. For now, they serve as a guideline.

To illustrate, Table 1 (see Appendix B-2 for the full rubric) shows a simplified excerpt of two dimensions with behavioral anchors at different levels:

Table 1. Example rubric segments for two dimensions (AI-TK and Ethics & Policy) across selected proficiency levels.

Dimension	Beginner (B)	Proficient (P)	Advanced (A)
AI-Technological Knowledge (AI-TK)	Uses one AI tool with default settings; limited understanding of how outputs are generated.	Experiments with multiple AI tools and settings; understands basic model differences (e.g. resolution, style strengths).	Customizes AI workflows; combines models or writes code to fine-tune outputs; explains model choices and limits for specific art tasks.
Ethics & Policy	Vaguely aware of plagiarism concerns; might warn students not to "cheat" with AI but gives no formal guidelines.	Implements class rules for AI use (e.g. requires citation of AI assistance); addresses obvious ethical issues when prompted.	Proactively teaches about AI ethics and copyright; models full AI-use disclosure in demos; enforces a formal AI policy and mentors others in ethical best practices.

The rubric is intended to be used in multiple ways: (a) as a self-assessment or formative assessment tool for pre-service or in-service teachers to gauge their own growth in learning to integrate AI; (b) as a curriculum design guide for teacher educators, to ensure that training programs address all the dimensions (for example, including explicit training on ethical AI use, not just technical skills); and (c) as a research instrument, providing an operational definition of AI-related teaching competency that could be used in future studies (for instance, to measure the impact of a professional development intervention on teachers' AI integration skills). In developing the rubric, we consulted existing teacher competency standards and behavior-anchored rating scales to ensure our descriptors were clear and

actionable. By translating abstract ideas of "AI in education" into concrete behaviors tailored for art educators, the rubric fills a critical void and offers a tool for both guiding and evaluating teacher preparation in this new domain.

Process-Based Evidence Package (PBEP) Template

To address the lack of process-focused assessment in AI-assisted artmaking, we developed a Process-Based Evidence Package (PBEP) template as part of the toolkit. The PBEP is essentially a structured portfolio or log that students (or teachers, in training scenarios) fill out to document the process of creating an artwork when using generative AI. The goal of the PBEP is to make the normally hidden creative process visible and assessable, rather than judging only the final artifact. Drawing on recommendations from both our literature review and emerging best practices in digital art education, the PBEP template comprises several components (Appendix A provides the full blank template and an example):

A1. Prompt Iteration Log (required): A table for recording each major prompt iteration and AI generation step. For each entry, the student notes the date/time, the AI model (and version) used, key parameter settings, the exact prompt given (or a summary of it), and the goal of that iteration along with a brief outcome note. This log encourages reflection on how the prompt and settings were tuned over time and creates traceability in the creative process. Example entry: Date – 2025-03-12; Model – Stable Diffusion XL 1.0; Parameters – CFG=7, steps=30; Prompt – "bronze sculpture of a dancer, modern minimalist style"; Goal – refine figure's pose; Outcome – iteration #3 had a better pose but background was cluttered, will adjust prompt for background. A snippet of this log is illustrated in Table 2 below.

Table 2. Sample entry from a student's Prompt Iteration Log (PBEP Component A1).

Date	AI Model (Version)	Key Parameters	Prompt	Goal	Outcome
2025-03-12	Stable Diffusion XL 1.0	CFG=7; steps=30	"bronze sculpture of a dancer, modern minimalist style"	Refine figure's pose	Iteration #3 had a better pose, but background was cluttered; will adjust prompt to fix background.

A2. Human Modification Sheet (required): A section to document any manual edits or hybrid steps taken after obtaining AI outputs. Here, the student records each significant human-driven modification to the work—such as compositing multiple AI-generated images in Photoshop, adjusting layouts or color balances, painting over certain areas, adding textures, etc. For each step, the student notes what was done, what tool or medium was used, and the rationale (e.g., "Combined two AI outputs for background and foreground; painted highlights on the main figure using Procreate to enhance lighting; rationale: to integrate multiple ideas and add hand-crafted emphasis on lighting."). This sheet highlights the human contributions and craftsmanship involved in the final piece.

A3. Observation & Dimension Sheet (required): This component fosters engagement with the early cognitive stages (perceptual analysis and explicit classification) without relying on AI. Students include brief observational notes and ratings of foundational visual elements or design principles relevant to their project (such as line quality, color harmony, balance, rhythm, etc.), typically on a simple scale (e.g. 1–5 for each element). They also have space to insert a small grid of sketches or thumbnails (for instance, a 3×3 grid for initial idea sketches drawn by hand) and to cluster visual references or style images. The idea is to ensure the student engages in non-AI-supported observation and concept development before or alongside using AI, anchoring their creative process in traditional skills and personal artistic intent.

A4. Asset & License Register (required): A list or table to inventory any third-party assets or data used in the project, such as textures, base images, or datasets, along with their sources and license information. With generative AI often drawing from large training datasets (and students frequently using online reference images), it's crucial to track anything not original to the student. This register teaches students to respect copyright and open-license practices, and it provides transparency about which components of the work are original versus borrowed or AI-generated.

A5. AI Use Disclosure Checklist (required): A checklist for explicitly documenting the details of AI usage in the project. It prompts the student to specify which AI model(s) and version(s) were used, on what dates, with which settings; which parts of the final work were AI-generated versus significantly

human-modified; what post-processing tools or steps were applied to AI outputs; and includes a declaration for the student to sign, confirming they have disclosed all AI assistance and complied with the course's AI use policy. In essence, this mirrors what an honest "methods section" of their artistic process would look like. By institutionalizing disclosure, it normalizes transparency and removes the temptation for students to hide AI use. It also provides teachers with context to better assess the work.

A6. Peer Review Form (optional): If peer critique is part of the class, this form allows a peer (or multiple peers) to review the transparency and quality of the process, not just the final product. Peers can rate aspects like how traceable the process is (i.e., can they follow what steps the original student took?), the depth of human contribution (did the work show significant human creativity and editing, or was it mostly AI output?), the aesthetic coherence of the final piece (does it all come together as a strong artwork regardless of how it was made?), and compliance/honesty (does it appear the student followed all rules and disclosed properly?). The peer reviewer also provides comments. Including peers in evaluating process can instill a culture of accountability and reflection. We mark this component optional because not every context will use peer review, but we provide the template for those that do.

Each component of the PBEP corresponds to evidence that can be used in assessment and aligns with stages of the creative process. We also designed a simple scoring guide for the PBEP (suggesting, for example, that completeness of documentation might count for 20%, traceability and clarity of process 20%, depth of human contribution 30%, disclosure & compliance 20%, and peer review feedback 10%, totaling 100 points). These weights emphasize that simply using AI is not enough – the student must show thoughtful iteration and honesty about their process. In a classroom implementation, the PBEP would be submitted alongside the final artwork, and teachers could grade it using the provided criteria or an associated rubric. (In fact, our teacher competency rubric references these evidence pieces on the teacher side, e.g. expecting teachers to check students' disclosure forms as part of their assessment competency.)

The full blank PBEP template is included in Appendix A, which educators can directly adopt or adapt for their classes. By capturing and formalizing process evidence, the PBEP shifts some focus of assessment from solely the artifact to the learning process, encouraging students to engage in reflective and responsible use of AI.

AI Use and Disclosure Policy

The third component of our toolkit is a Sample Policy for Classroom AI Use and Disclosure (see Appendix B). While the rubric and PBEP template are aimed at guiding individual behavior and assessment, the policy provides a course- or program-level framework to ensure all participants are on the same page regarding acceptable AI use. The need for such a policy became evident from our gap analysis: many educators lack clear policies bridging ethical principles with day-to-day practice, beyond generic academic integrity statements.

The policy document is structured into several sections:

Scope and Purpose: It states that the policy applies to all generative AI use in the course, and frames the purpose as harnessing AI as a learning scaffold while maintaining academic integrity and respecting intellectual property. This section sets a positive tone – AI is not banned outright, but its use is guided and transparent – and aligns the policy with broader institutional values like honesty and learning.

Encouraged Uses of AI: The policy explicitly lists examples of AI use that are pedagogically beneficial and allowed. These might include using AI for brainstorming and ideation (e.g. to generate rough ideas or concept sketches in the early stages of a project), generating contrast sets or variations to explore the boundaries of a design concept, using AI for local refinement (for example, applying an AI tool to try multiple texture options for a background, which the student then integrates and adjusts), and using AI's process-recording features to document steps (for inclusion in the PBEP). By enumerating encouraged uses, the policy actively educates students and staff on what productive AI use looks like, reinforcing the idea of AI as a scaffold (not a shortcut).

Mandatory Disclosure: A critical section that mandates transparency. It requires that for any assignment where AI is used, the student must clearly disclose what was done with AI. This includes specifying the model and version, the date of use, all prompts or inputs given, any key parameter settings changed from default, any post-processing tools applied to AI outputs, and which parts of the submission were AI-generated or AI-modified. Essentially, this mirrors the information captured in the PBEP's disclosure checklist (Appendix A5). The policy statement might read, for example: "Students must include a completed AI Disclosure Checklist with every submission involving AI. The checklist must

detail the model name and version (e.g., Midjourney v5, DALL·E 3), the date of use, all prompts or instructions given to the AI, any non-default parameters used, any edits or additional tools used on AI outputs, and which portions of the final work were generated by AI." By institutionalizing disclosure, the policy normalizes honesty and ensures instructors have the context needed to fairly assess the work.

Prohibited Uses of AI: This section clearly delineates what is not allowed. Examples include submitting AI-generated work without any meaningful human modification (i.e. you cannot simply type a prompt and submit the raw AI output as your "artwork"), using AI to replicate someone else's style or a specific existing artwork in a way that infringes on copyright or violates academic integrity, using any AI tool or service that is explicitly disallowed by the course or institution, and providing false or incomplete disclosure of AI use. By listing prohibited actions, the policy guards against common failure modes – like over-reliance on AI to do the work for the student, misrepresentation of authorship, or violating others' intellectual property. Essentially, it draws a clear line between using AI as a creative aid versus using AI in a way that undermines learning or ethical standards.

Assessment and Accountability: The policy ties into the course's grading system and consequences for violations. It specifies that failures to follow the policy (e.g., not disclosing AI use, or using AI in a forbidden manner) will impact grades and could trigger academic misconduct procedures. For instance, not submitting the required disclosure or PBEP might result in an automatic deduction (say, up to 30% of the assignment's points, since process accountability is integral to the assignment). Submitting work that is essentially unedited AI output can receive a major penalty or a zero for that portion, with a requirement to redo the work. Use of unauthorized material or serious misrepresentation (like lying on a disclosure form) would be handled under the institution's academic integrity policy, potentially resulting in failing the assignment or course, or other disciplinary measures. By explicitly linking the policy to grading and enforcement, we ensure the rules have "teeth" and are not merely aspirational.

Overall, the sample policy (provided in full in Appendix B) can be adapted by instructors or institutions to fit their needs. Its presence at the start of a course is intended to set the tone that AI is a welcomed tool with conditions — students learn that how they use AI, and how transparently they use it, will matter just as much as the final artwork they produce. This helps cultivate an environment where AI is seen as part of the learning process rather than a shortcut to circumvent it.

By combining the competency rubric, PBEP template, and policy, our toolkit addresses the gaps in teacher guidance, student process accountability, and class policy around AI use. The next sections present the findings from our stage-based analysis that underpin this toolkit and a preliminary evaluation of the toolkit's use in practice.

RESULTS AND DISCUSSION

Stage-by-Stage Mapping of AI Interventions (Scaffolds vs. Shortcuts)

Our stage-by-stage analysis of the literature yielded a clear pattern of how AI can either scaffold or shortcut student learning at each stage of aesthetic cognition, depending on the workflow design. Table 3 summarizes these findings in a tabular format, mapping each stage of Leder's model to typical AI uses under a HOTL approach (and the associated risks) versus recommended HITL scaffolds, along with examples of process evidence and indicative assessment criteria for each stage:

Table 3. Mapping AI interventions across aesthetic cognition stages under HOTL and HITL workflows.

Aesthetic Stage	HOTL usage (risk)	Harm/Risk	HITL scaffold (recommended)	Process evidence	Indicative criteria
Perceptual analysis	One-shot AI generation replaces seeing (skips direct observation)	Skips foundational noticing of details	"First human, then model" – e.g. require students to do quick hand sketches and note key details/colors before using AI	Sketch sheets; initial prompt draft	Depth of observation; alignment of AI prompt with observed details
Implicit integration	AI imitates a known style	Homogenization of style;	Human-driven style exploration then AI contrast –	Style mood boards or	Originality of contrasts; degree of

	(style cloning)	superficial analogies	e.g. students manually cluster example artworks into style families, then use AI to generate boundary-pushing variants between clusters	clusters; AI-generated contrast images	expansion beyond familiar styles
Explicit classification	AI auto-labels or categorizes images (offloads concept formation)	Offloads cognitive work of classification to AI	Student articulates categories first, AI only used to generate exemplars – e.g. fill out a "dimension sheet" of style rules, then have AI produce examples that fit those rules for discussion	Student-created dimension sheet; AI exemplar set	Quality and clarity of student-defined classification rules; accuracy of AI exemplars in illustrating the rules
Cognitive mastering	End-to-end AI generates final composition (no human iteration)	Collapses iterative problem-solving; student does minimal refinement	Two-step human–AI remix: e.g. use AI for an initial draft, then require human editing and only then allow selective AI re-generation for specific parts	Layered image files; edit logs (showing human edits)	Iteration depth; evidence of problem-solving in edits; improvements made between AI draft and final piece
Evaluation	Judged only on final AI-produced artifact (process invisible)	Overestimation or misattribution of quality; learning process unexamined	Dual-track review: blind critique of the artifact plus review of process evidence (PBEP) using rubric	Completed rubric scores; disclosure checklist	Balanced evaluation (product quality weighed alongside process integrity and effort)

Each stage lists common HOTL usage patterns (and their pitfalls) contrasted with recommended HITL scaffolding strategies. The rightmost columns illustrate the types of process evidence to collect (see PBEP in Appendix A) and suggest criteria aligned with our rubric for evaluating student performance. The overarching principle is that HITL approaches explicitly link task design, evidence visibility, and assessment criteria to ensure AI acts as a scaffold rather than a shortcut.

As Figure 1 shows, at the Perceptual analysis stage, a HOTL approach might let students immediately generate an image with AI from a prompt, effectively bypassing direct observation and sketching. The risk is that students do not engage in seeing and processing visual details themselves – they outsource the initial visualization to the AI. The HITL recommendation is to enforce a "first human, then model" rule: for example, in a classroom a teacher might require students to spend the first 10–15 minutes closely observing a reference object or scene and making a few quick sketches (noting key shapes, colors, textures), only after which can they input a text prompt to generate an image. Process evidence like sketch sheets or a written first-draft prompt (informed by their observation) can verify that

this human-led step happened. The assessment criteria at this stage would then include how well the student's AI prompt or generation reflects careful observation – in other words, did the student notice enough detail on their own to guide the AI effectively?

At the Implicit Memory Integration stage, a naïve use of AI is to prompt an AI system to generate in a specific artist's style (e.g., "generate an image in the style of Van Gogh"). This often results in style cloning—work that imitates known styles without the student internalizing or personalizing the underlying traits. The risk is homogenization and superficial analogies: students may converge on popular or clichéd styles and fail to connect them to their own expressive memories or insights. The HITL scaffold is to require a human-led style exploration first: have students manually gather and cluster exemplars (e.g., a mood board or a style taxonomy), discuss what they personally notice and recall about those styles, and only then use AI to produce contrast images that mix or push their boundaries. Process evidence may include photographs of the clustering activity, notes on personal connections, and the resulting AI-generated contrasts. An indicative criterion is the originality and insightfulness of the contrasts—did the student use AI to move beyond obvious tropes, showing deeper integration of a personal perspective?

For the Explicit classification stage, a problematic approach would be to use an AI tool to automatically label or categorize images (for example, using an AI image recognition model to tell the student the style or elements present, instead of the student identifying those). This offloads the intellectual work of concept formation and categorization to the AI, bypassing a valuable learning opportunity. The scaffolded approach is to have students themselves define classification schemes or rules first – for instance, filling out a dimension sheet where they list key features or rules that distinguish different styles or techniques they're studying. Only after they have made their thinking explicit, they might use AI to generate example images that fit those categories or rules, which can then be critiqued. Evidence for this would be the student's written notes about their classification criteria and the set of AI-generated exemplars they curated. The criteria for evaluation could include the quality of the student's classification logic (did they identify meaningful dimensions?) and the accuracy or appropriateness of the AI exemplars in illustrating those concepts.

At the Cognitive mastering stage – where iteration, refinement, and problem-solving typically happen – a HOTL shortcut would be if a student leans on the AI to handle the entire iteration process. For example, the student might keep hitting "generate" or slightly tweaking the prompt until the AI output looks acceptable, without engaging in any reflection or substantial revision of their own. This means the AI is doing the heavy lifting of resolving problems or exploring options, and the student isn't practicing those skills. The recommended HITL design is to enforce a two-step human–AI remix: the student uses AI to get an initial draft or set of ideas, then must step away from AI to do a round of human edits or recombination (e.g. pick the best elements from different AI outputs and manually merge or redraw parts, or critique the draft and make changes by hand), and only after making a substantial human contribution can they optionally use AI again for targeted refinements (like regenerating just one segment of the image where they want fresh ideas). This approach forces the student to engage in the cycle of idea → draft → critique → refine, with AI as a partner rather than the sole creator. Process evidence could include layered image files or an edit log showing the sequence of human modifications. Criteria might look at the depth of iteration (how many meaningful changes were made, how the work evolved from initial to final) and evidence of problem-solving in those edits (for example, did the student clearly address issues from the first draft in the final outcome?).

Finally, at the Evaluation stage, a fully HOTL scenario might treat an AI-assisted artwork just like any other and grade it solely on the final product, or worse, if the AI's involvement is unknown, the teacher might unknowingly over-credit the student or be biased if AI use is suspected. This is the "invisible process" risk: important context is missing, so either the student might get undue credit for what the AI did, or conversely a stigma might be applied to AI usage. The HITL approach for evaluation is to implement a dual-track evaluation: one evaluation focuses on the artifact's aesthetic quality (ideally done "blind" to how it was made, to judge it on its own merits), and another evaluation focuses on the process documentation (using tools like the PBEP and rubric to assess creativity, effort, and integrity in how the piece was produced). By combining these, the teacher (or peer reviewers) can form a more holistic assessment. For instance, a piece that is modest in its final appearance but shows a rich, thoughtful process would receive credit for learning and effort, whereas a visually stunning piece that was mostly AI-generated with very little student input would be marked down on process, even if the

product is attractive. Our rubric explicitly weights both product and process, meaning an educator could, for example, assign 50% of the grade to the final artifact quality and 50% to the process quality (or some similar scheme). The process-related criteria might include things like transparency (did the student fully disclose and document?), originality of contribution (what did the student themselves add?), and adherence to policy.

To illustrate how these stage-aligned strategies can play out in practice, we implemented a 90-minute class workshop as a model lesson incorporating all stages with corresponding scaffolds (this also served as a trial of the toolkit, described later). The session was structured as follows: (1) 15 minutes – Guided observation and hand sketching: Students closely observed a physical object and made quick sketches, noting key visual details (perceptual analysis stage, without AI). (2) 20 minutes – Style exploration with clustering and dimension sheets: Students reviewed small printouts of artworks in various styles, clustered them into groups, and identified distinguishing features, while reflecting on personal connections (implicit integration and explicit classification stages, human-driven). (3) 20 minutes – AI-assisted generation of contrast sets: Students then used a text-to-image AI tool to generate a few images that intentionally mixed or contrasted the styles they had been exploring. They selected a couple of interesting AI results and explained why those stood out (transitioning from classification to cognitive mastering). (4) 20 minutes – Human remix and refinement: Using the AI outputs as a starting point, each student edited one image—some combined elements from multiple AI outputs, others painted over parts or adjusted composition—to develop a more polished piece, applying their own creative decisions (cognitive mastering via human-led iteration). (5) 15 minutes – Dual-track critique: Half the class conducted a peer blind critique, exchanging final images without process info and giving feedback on the artwork's impact (evaluation of product), while the other half exchanged PBEP logs and reviewed each other's processes. Then they switched, and finally discussed both the products and the processes, using a simplified version of our rubric to guide feedback (evaluation stage with full transparency).

This workshop sequence demonstrated that even in a single class session, it is feasible to engage each stage of aesthetic cognition meaningfully with AI. The toolkit components were integral: the rubric provided criteria for peer feedback during critique; the PBEP logs were the basis of process-oriented discussion; and the policy was referenced to remind students to be honest about AI usage. Students reported that having to document and explain their process made them more aware of their own decision-making ("I found myself planning my next prompt more carefully instead of just trial-and-error"), and teachers noted that the critiques were richer because of the explicit process evidence available. This example suggests that a stage-aligned approach to AI integration can be practical even within typical class time constraints, not only in long-term projects.

Rubric Usability and Consistency Check

To gauge the usability and consistency of the AI-A-TPACK competency rubric (Table 1 in the toolkit) in practice, we conducted a small-scale trial with a group of art teacher educators. We recruited three experienced art instructors (each with 8–15 years of teaching experience) who were not involved in the toolkit's development to serve as test raters. They participated in a 90-minute pilot workshop on 18 June 2025, where we introduced and calibrated the rubric and then had them apply it to a sample of student work.

The workshop followed a calibrate–score–review sequence. First, the three instructors spent ~15 minutes in a guided calibration session: we introduced the six rubric dimensions and walked through one example case as a group, discussing what different performance levels might look like for that case. This helped establish a shared understanding of the criteria at each level (from Beginner through Advanced). Next, each instructor independently applied the rubric to assess a sample Process-Based Evidence Package (PBEP) from a hypothetical student project. They were given about 20 minutes to review the student's final artwork and the complete PBEP documentation, and to assign rubric levels for each of the six dimensions without consulting each other. Immediately after scoring, we facilitated a ~15-minute review discussion in which the instructors compared their ratings, explained their reasoning, and worked through any discrepancies in their judgments.

Inter-Rater Reliability and Discrepancies: The preliminary scoring results from this exercise showed encouraging consistency. Out of the 6 rubric dimensions, all three instructors agreed exactly on the performance level for 4 dimensions in the sample case, indicating strong initial alignment on those aspects of teacher competency. For the remaining 2 dimensions, scores differed by at most one level

between raters. For instance, two raters marked the sample student as "Proficient" in AI-Technological Content Knowledge while one thought it was closer to "Developing," and similarly they differed slightly on the Assessment dimension. We calculated Cohen's Kappa as an index of inter-rater reliability: at the individual dimension level, κ ranged from approximately 0.58 to 0.73, and the overall agreement across all dimensions was $\kappa \approx 0.65$ (which is generally interpreted as moderate to substantial agreement given the small number of raters). Notably, the AI-TCK and Assessment dimensions had the lowest raw agreement, whereas the other dimensions (AI-TK, AI-TPK, AI-TPACK Integration, Ethics & Policy) had complete agreement among all raters on the sample.

Through the facilitated discussion, we discovered the primary cause of those minor divergences. In both cases, it was about how strictly to interpret certain criteria. For example, on the Assessment dimension, one instructor penalized the sample student for not crediting a third-party texture library they had used (considering this a significant omission under "process transparency"), whereas another instructor hadn't noticed that omission or didn't weigh it as heavily. When the group discussed this, they reached a consensus that failing to disclose a significant external asset (even a free-to-use resource) should be considered a policy violation and warrant a deduction in the process score. They agreed to treat that scenario as a serious issue in scoring. We documented this decision as a precedent for future rubric use (essentially adding a note to the rubric guidelines: "all third-party assets must be credited or it impacts the Ethics/Policy or Assessment dimension score"). Apart from clarifications like this, the instructors reported that the rubric descriptors were sufficiently clear and concrete. One rater commented, "I could almost quote the student's evidence that matched the descriptors – it was clear what counted as, say, Proficient vs Developing in each category." Another noted that having the evidence examples column to refer to made the scoring more objective: "It guided me to look for the prompt logs or the disclosure form when assessing Ethics & Policy, for example, which made my judgment more grounded in facts." All agreed that the brief calibration exercise prior to scoring was critical in achieving the high agreement we observed.

This transparent reporting of even the small points of rater disagreement (a "negative" finding of sorts) actually strengthens the credibility of our results – it shows that we identified and addressed potential ambiguities in the assessment tool. We have effectively started a "casebook" of such issues and resolutions (two examples are provided in Appendix C), which can guide future users of the rubric.

Overall, this initial trial indicates that the rubric is both usable and yields reasonably consistent evaluations among different raters after minimal training. For high-stakes use (like formally evaluating a student teacher at the end of a program), we would recommend a more extensive norming session with the rubric and possibly using multiple raters to ensure fairness. But as a formative tool (for self-assessment or guiding mentorship feedback), even a single instructor using it would likely find it provides a structured, comprehensive lens on a teacher's competencies, given its coverage of key areas. In sum, this preliminary evidence of consistency addresses our second research objective: it provides confidence that the toolkit's rubric can be applied in real classroom contexts without undue ambiguity, even within the short timeframe of a workshop or a single class review session.

DISCUSSION

A key insight from our synthesis and trials is that whether AI functions as a scaffold or a shortcut in learning is not inherent to the tool itself, but contingent on how it is used and structured within the learning activity. Several boundary conditions emerged:

1. Human Effort and Edit Depth: AI acts as a scaffold when the human student's effort is substantive and traceable. Whenever the student invests meaningful effort – whether in carefully crafting the prompt, adjusting parameters thoughtfully, or significantly editing the AI outputs – the AI tends to serve as a partner in learning rather than replacing the learning. In contrast, if a student simply accepts the first AI output uncritically or with only trivial tweaks, the AI is doing too much of the cognitive work, effectively becoming a shortcut. Our rubric and PBEP explicitly emphasize edit depth and rationale to encourage substantive engagement. For instance, the rubric's iteration criteria and the PBEP's modification log both push students to go beyond one-shot generation and into meaningful transformation of AI outputs.
2. Process Documentation: We found that when prompts, parameters, and decision rationales are recorded and made visible (as required by the PBEP and policy), students approach AI use more metacognitively – that is, they think about their thinking. The act of documentation turns each AI interaction into a point of reflection ("Why am I doing this? What did it yield? What should I try

next?"). This tends to make AI a scaffold because the student is actively learning from each step and considering alternatives. Conversely, when AI use is undocumented or hidden, it invites shortcut behavior. Students might engage in rapid trial-and-error prompting without reflection, or even use AI in prohibited ways, hoping no one will notice. The requirement to document process serves as a form of accountability that nudges usage toward learning-oriented patterns.

3. Peer and Mentor Feedback on Process: When critique or feedback sessions incorporate process evidence and not just final products, it closes the loop and holds students accountable for their approach, not only the outcome. In our workshop, for example, peers had to comment on whether the process was transparent and whether the student made meaningful contributions. This clearly signaled to students that just producing a pretty picture isn't enough – how they got there matters to their peers and instructors. If no one ever looks at process, students quickly learn that only the output "counts," and some will logically lean on shortcuts if those yield decent outputs. By contrast, if teachers and peers are routinely asking, "Show me how you did this," students are incentivized to engage with AI in a way they can explain and stand behind.
4. Course Policy and Culture: A course policy that mandates disclosure and emphasizes learning over product sets a scaffold-oriented culture from day one. The presence of our sample policy was noted by the pilot teachers as an important signal to students: it explicitly tells them that using AI is acceptable only of learning and honesty. In an environment with no policy or a very lax stance, students might either feel they should hide AI use (leading to secret shortcuts and anxiety) or conversely think they can use AI without limits or personal effort (leading to open shortcuts). A clear policy with enforcement provisions nudges behavior toward the intended scaffolded use by establishing norms and consequences upfront. It essentially externalizes the teacher's expectations so students are not guessing where the line is.

These factors echo findings in broader human–technology interaction research. For instance, algorithm aversion (Dietvorst et al., 2015) can be mitigated by giving people more control or understanding of the algorithm. In our context, when students have control (via HITL workflows) and understanding (via documentation and reflection) of the AI, they integrate it more constructively. Similarly, what some call "human favoritism" or a bias to value human contribution (Zhang & Gosline, 2023) is intentionally built into our approach: we require a human contribution at each stage, so the final outcome is genuinely a human–AI collaboration, not just AI output with a human's name on it. Interestingly, we observed that the same AI tool or action can be either a scaffold or a shortcut depending on the learner's level and intent. For a novice lacking foundational skills, having an AI automatically handle a task (say, perspective drawing) might shortcut their learning of that skill. But for an advanced student who already understands perspective, using AI to quickly apply it could be an efficient scaffold that lets them focus on higher-level composition decisions. This implies the framework should be applied flexibly and educators must exercise judgment: for example, a teacher might allow more AI assistance for advanced students exploring complex projects, but require more manual work from novices who need to build fundamentals. In teacher education, we emphasize this adaptive use – part of AI-TPK is knowing your students and deciding where their line between scaffold and shortcut lies.

In summary, AI does not intrinsically know whether it's scaffolding or short-circuiting learning – educators design the context that determines that. Our framework's value lies in making those conditions explicit and providing tools to manage them (e.g., rubric criteria for sufficient human editing, required process logs, disclosure norms, etc.). By tuning these levers, teachers can tilt AI usage toward being a catalyst for learning rather than a crutch.

Integrating the Toolkit into Teaching Practice

Bringing together the framework and toolkit, we envision a restructured approach to art teacher education and classroom practice in the era of AI. The components we developed are meant to function in unison: the stage mapping informs curriculum design, the rubric guides teacher development and assessment, the PBEP template structures student activities and evaluation, and the policy creates an environment of integrity and clarity.

In a teacher preparation program, for example, coursework can be explicitly aligned with these components. A unit on "AI in Visual Analysis" (covering the perceptual stage) might train pre-service teachers to use the "first human, then AI" strategy in their future classrooms. An assignment could have them design a lesson plan where students do observational drawing before any AI imaging. The rubric's AI-TPK and AI-TCK dimensions would come into play in evaluating their lesson designs, and the

instructor of the course could use rubric language in feedback (e.g., "Your lesson plan is at a Developing level for AI-TPK because it lets AI take over too early; how could you modify it to scaffold human observation first?"). Another module on "Ethical AI Practice" could revolve around the policy: teacher candidates might be tasked with adapting the provided AI use policy for a hypothetical school scenario, and practicing filling out the disclosure forms for sample projects. This addresses the Ethics & Policy dimension of the rubric in a hands-on way.

In actual K-12 or college art classes, implementing the toolkit means that when teachers integrate an AI-based assignment, they do a few things differently: they introduce the policy to students (so expectations and consequences are clear from the start), they require the PBEP or some process documentation as part of the assignment deliverables (ensuring students document their process, not just turn in a final image), and they employ a rubric – or a simplified version of it appropriate for students – to evaluate the work, explicitly giving weight to process and ethical compliance. The "dual-track" evaluation approach mentioned earlier can be operationalized by splitting the grading criteria into those focusing on the final product and those focusing on the process. Some teachers might combine this into a single score (with sub-scores that students see for product vs. process), while others might even give separate grades for the artwork and the process portfolio, depending on their philosophy and school grading policies.

One practical advantage of having a well-defined rubric and evidence structure is the potential for consistency and fairness in grading. Art assignments can be notoriously subjective to grade; however, if students provide concrete process evidence and teachers have predefined criteria (e.g., "did the student show at least X iterations," "did they credit all sources," "does the final piece reflect personal decision-making?"), it helps different instructors remain aligned in their evaluations. This also helps in communicating expectations: students know that to score well, they cannot just turn in a beautiful image – they also need to show how they arrived there and that they followed all guidelines. This transparency can reduce conflicts or confusion over grading, as both parties can point to documentation and specific rubric descriptors.

Our pilot workshop, though small in scale, provided a microcosm of how this toolkit can change classroom dynamics. We observed strong student engagement and even some shifts in mindset. Initially, a few students admitted they thought using AI might let them "skip ahead" in an art task or avoid learning something difficult (for example, not bothering to learn how to draw hands because "the AI can do it"). After the workshop, they reported a better understanding that AI is a tool that still requires skill and intent. One student reflected, "Because I had to log what I was doing and why, I actually found myself planning my next prompt more carefully instead of just trial-and-error." This indicates a deeper learning outcome: the toolkit not only measures but actively promotes reflective practice.

From the teacher's perspective, the toolkit can also transform their role. Teachers become designers of scaffolded workflows – they actively think about which stage of the creative process they want to emphasize at a given moment and how AI could either support that or hinder it. They also become coaches on process and integrity, not just evaluators of finished art products. Adopting the toolkit encourages teachers to openly discuss questions like: How do we decide if using AI at this step is helping you learn or doing the work for you? What does it mean to be original in an age of AI assistance? These discussions tie directly into art and design pedagogy topics (authorship, creativity, developing an artistic voice) but in a very contemporary way.

Challenges and Limitations

While we advocate for a structured approach, we caution that like any framework, there is a risk of overemphasis on "compliance" if the toolkit is misused. For example, students (or teachers-in-training) might become overly focused on checking all the boxes – filling out logs, disclosing everything – just to get a good score, without truly internalizing the deeper purpose (which is to enhance learning and critical thinking). This type of performative compliance has been noted in other educational contexts where rubrics or checklists are introduced. To mitigate this, teacher educators and instructors should continuously highlight the why behind each component. For instance, remind students that the reason we document process is to become more mindful artists and to be able to learn from mistakes, not merely because it's a requirement. Embedding reflective prompts ("What did you learn in this iteration?") in the PBEP, or having periodic class discussions about experiences using the toolkit (where students share not just what they did, but what they thought about it) can help ensure the toolkit is a means to an educational end, not an end in itself.

Another consideration is the adaptability of the framework across different cultural or educational contexts. Our use of Leder's aesthetic stages and certain design patterns might be grounded in a Western-centric model of art education, which often emphasizes individual creative process, originality, and explicit reflection. In some other educational traditions, there might be a stronger emphasis on apprenticeship, mimicry of masters, or community-oriented creation. Those contexts might require tweaking the framework – perhaps combining or re-weighting some stages, or adjusting the rubric descriptors to local values. For example, if a curriculum values technique replication as a step (copying a master's work to learn technique, which is common in some classical art training), AI might be used differently there (maybe as a source of "master style" examples) and the evaluation of process might differ. Similarly, in art forms outside the typical Euro-American canon, the stages of creative process might not map neatly to Leder's categories. Future research and collaboration with educators in diverse settings will be important to test how the AI-A-TPACK toolkit works in those environments and what modifications are needed.

Finally, we must consider the long-term impact on learners. Our framework assumes that by being forced to articulate their process and by seeing AI as a partner rather than an answer machine, students will develop better creative thinking and meta-cognitive skills. This is an implicit hypothesis that should be verified. Over time, do students who learn with this framework show greater growth in, say, their ability to generate original ideas or to critically evaluate art (with or without AI)? Do they become more adept at using AI responsibly and creatively when they are on their own? We believe so, but longitudinal research or case studies following students or new teachers over a year or more would greatly strengthen the argument. Additionally, as AI tools evolve (becoming perhaps even more powerful or more user-friendly), the strategies might need updating. The ethical norms might shift as well (for example, if legal standards for AI-generated content change, policies will need updates).

In conclusion of this discussion, integrating AI into art education demands a rethinking of pedagogy, assessment, and teacher preparation. Our proposed framework offers a structured path forward, aiming to ensure that generative AI becomes a catalyst for deeper learning and creativity rather than a shortcut that bypasses skill development. The initial trials and examples we provided are encouraging: they show that with clear frameworks and tools, both teachers and students can navigate this new landscape in a productive and ethically responsible way. However, flexibility, reflection, and continuous refinement will be key. The conversation between educators, students, and researchers must remain open as we collectively learn how to best blend human creativity with artificial intelligence in the art classroom.

CONCLUSION

This study proposes AI-Aesthetic TPACK as a stage-aligned, practice-ready framework for redesigning art teacher education in the age of generative AI. By mapping Human-in-the-Loop and Human-out-of-the-Loop workflows onto the specific stages of aesthetic cognition, we clarify where AI can scaffold artistic learning and where it risks short-circuiting essential cognitive processes. We have operationalized this framework into a concrete toolkit comprising a competency rubric for art educators, a process-focused evidence template (PBEP) for student work, and a model policy for AI use and disclosure in the classroom. Together, these contributions offer a coherent pathway for teachers to integrate AI in ways that maintain transparency, encourage creative process, and uphold academic integrity.

The work presented here is primarily a conceptual and design-based contribution, laying a foundation for future empirical validation. Our initial pilot of the rubric with multiple raters demonstrated that the framework can be applied consistently with minimal training, and our classroom workshop example illustrated its practical feasibility and positive influence on learning behaviors (like increased reflection and honesty about AI use). These early indications are promising. We recognize, however, several limitations and avenues for further inquiry:

First, while the rubric and toolkit components were informed by a broad literature base and iterative expert feedback, they have not yet been widely tested across different educational programs or demographic contexts. Future research should formally evaluate the rubric's reliability and impact in various teacher education settings. For instance, do teachers who train with the AI-A-TPACK approach later demonstrate more effective AI integration in their own classrooms compared to those who don't? Quasi-experimental studies or larger-scale implementations could compare outcomes (in both teacher

competency and student learning) between groups using this framework and those using a "business-as-usual" approach.

Second, the policy and ethical dimensions will likely need continual refinement as technology and norms evolve. Legal and moral questions around generative AI (such as intellectual property rights of AI-generated images, or equity issues if not all students have equal access to AI tools) are dynamic and context-dependent. Our sample policy provides a starting template, but institutions might adapt specific clauses to their environment, and updates will be needed as, for example, new regulations come into play or AI tools change in capability (e.g., tools that leave less traceable process evidence might require new guidelines).

Third, as noted, cultural adaptability is important. Leder's model of aesthetic processing, while widely cited, was developed within a particular cultural understanding of art appreciation. Different educational systems or artistic traditions might emphasize different aspects of the process. Studies could explore applying our framework in non-Western art education contexts or in related fields like design, media arts, or music, examining what modifications are necessary. Perhaps certain stages are merged or an additional stage (like "social reflection" in community-based art) is considered.

Finally, the ultimate measure of success will be the long-term development of learners. If we implement this framework widely, do students (future artists and designers) show greater growth in creative thinking skills, critical reflection, and ethical tech use? Do they emerge as professionals who are adept at using AI as a tool without losing their unique creative voice and skills? The goal is not merely to manage AI's presence, but to elevate the quality of art education in its presence. We hypothesize that by being transparent about process and by positioning AI as a collaborator rather than an auto-pilot, students will indeed cultivate higher-order thinking and meta-cognitive skills that serve them beyond the classroom. Verifying this through longitudinal research or case studies will be an important next step.

In summary, we have introduced a novel synthesis of pedagogical and cognitive theory tailored to the challenges and opportunities of generative AI in art education. The AI-Aesthetic TPACK framework and its associated tools reposition teachers and students from being passive users of AI technology to active designers of learning experiences with AI. By ensuring that AI's role remains that of a scaffold—supporting and extending human creativity rather than replacing it—we aim to preserve the integrity of the artistic learning process. The contributions here provide both a vision and a practical starting kit for educators venturing into this new territory. We invite further collaboration and research to refine these tools, test them in diverse settings, and collectively shape an art education that is enriched, not eclipsed, by artificial intelligence.

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Revisiting Higher Education in Malaysia: Policy, Quality, and Student Outcomes

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ABSTRACT

This paper revisits Malaysia's higher education system through the lenses of policy, quality assurance, and student outcomes. Over the last two decades, Malaysia has transitioned from a developing tertiary sector to a diversified system encompassing public, private, and transnational institutions. Government initiatives such as the *Malaysia Education Blueprint 2015–2025 (Higher Education)* have sought to enhance access, equity, and global competitiveness. Yet, persistent gaps remain between policy intentions and educational realities—particularly in graduate employability, quality disparity, and inclusivity. Using a qualitative research design supported by document analysis and semi-structured interviews, this study synthesizes evidence from national policies, accreditation reports, and student perspectives. Findings reveal that while quality assurance mechanisms—led by the Malaysian Qualifications Agency (MQA)—have institutionalized accountability, they have not consistently translated into improved learning outcomes. Many universities continue to emphasize compliance rather than innovation, resulting in limited pedagogical renewal. Moreover, socio-economic disparities and uneven digital access continue to shape student success and employability trajectories. The paper concludes that Malaysia's higher education transformation requires renewed emphasis on evidence-based policymaking, adaptive governance, and learner-centred reform. By linking policy frameworks with lived student experiences, the research contributes to a deeper understanding of how quality and policy coherence can enhance higher education outcomes in emerging economies.
Keywords: higher education, Malaysia, policy implementation, quality assurance, student outcomes

INTRODUCTION

Malaysia's aspiration to become a regional education hub has driven extensive reform in its higher education landscape. Since the 1990s, the government has invested heavily in expanding access and diversifying institutional types. The creation of the *Ministry of Higher Education (MOHE)* and the *Malaysia Education Blueprint 2015–2025 (Higher Education)* reflects a national commitment to produce globally competitive graduates and foster a knowledge-based economy.

Despite impressive quantitative growth—over 1.3 million students enrolled in 2024—qualitative concerns persist. Graduate unemployment rates hover around 15–20 percent (MOHE, 2023), and employers consistently highlight deficiencies in critical thinking, communication, and problem-solving skills. Moreover, differences in funding and governance between public and private universities contribute to uneven institutional performance.

Although Malaysia has established a comprehensive policy architecture, many implementation gaps hinder effective translation into institutional and student-level outcomes. Issues such as excessive bureaucracy, limited stakeholder coordination, and inconsistent quality assurance practices undermine long-term sustainability.

The objectives of this study are fourfold. First, it aims to evaluate the influence of national policies on institutional practices and student outcomes. Second, it seeks to analyse the effectiveness of quality assurance frameworks in improving educational quality. Third, the study explores the relationship between institutional culture and student employability. Finally, it proposes strategies to enhance policy coherence and promote greater educational equity.

This research contributes to the broader discourse on educational reform by connecting macro-policy intentions with micro-level student experiences. It provides insights for policymakers, administrators, and educators on how governance, quality, and inclusivity interact to determine graduate success.

THEORETICAL FRAMEWORK

1. Policy Development and Reform Trajectories

The *Malaysia Education Blueprint 2015–2025 (Higher Education)* identifies ten strategic shifts, including holistic student development, talent excellence, and innovation ecosystems (MOHE, 2015). However, as argued by Lee (2020) and Ahmad (2019), policy reforms have been characterized by strong central control and limited institutional autonomy. The mismatch between top-down planning and bottom-up execution continues to impede responsiveness.

2. Governance and Accountability

Higher education governance in Malaysia has evolved toward semi-autonomous structures. Public universities operate under statutory boards, while private institutions rely on licensing under the *Private Higher Educational Institutions Act 1996*. Kaur and Sirat (2021) note that although accountability mechanisms exist, overlapping jurisdictions between the MQA, MOHE, and professional councils create administrative complexity. Effective policy alignment thus requires clearer division of responsibilities and stronger participatory governance.

3. Quality Assurance and Accreditation

The Malaysian Qualifications Agency introduced the *Malaysian Qualifications Framework (MQF)* to standardize academic outcomes and ensure comparability across institutions. Empirical studies (Lim & Nor, 2019; Noor et al., 2023) demonstrate that while external audits enhance transparency, many universities treat quality assurance as compliance rather than a culture of continuous improvement. Sustaining academic excellence therefore demands internal motivation and capacity-building rather than regulatory enforcement alone.

4. Student Employability and Learning Outcomes

Employability remains a crucial indicator of higher education effectiveness. Raman and Tan (2020) found that curriculum design often lacks alignment with industrial skills, resulting in graduates who possess theoretical but not practical competencies. Initiatives such as work-integrated learning (WIL) and entrepreneurship modules have shown promise but require systematic integration across programs.

5. Equity and Access

Equitable access to higher education underpins Malaysia's social cohesion agenda. Yet, socio-economic disparities persist. Students from rural areas face challenges in English proficiency, digital literacy, and financial support (Lim, 2021). These inequalities reinforce achievement gaps that policies alone cannot bridge without targeted intervention.

6. Digital Transformation and Post-Pandemic Adaptation

The pandemic catalyzed the shift toward blended and online learning. Studies by Noor et al. (2023) reveal significant variability in institutional readiness. While elite universities leveraged technology effectively, smaller institutions struggled with infrastructure and faculty training. The digital divide now constitutes a central dimension of educational inequality in Malaysia.

METHOD

Research Design

This research adopts a **qualitative case-study design** integrating policy analysis, document review, and stakeholder interviews. The goal is to understand how national policies and institutional practices jointly influence student outcomes.

Data Source

The data sources for this study include three main categories. First, policy documents such as the Malaysia Education Blueprint (2015–2025), Malaysian Qualifications Agency (MQA) guidelines, and Graduate Tracer Study reports from 2020 to 2023 are used to provide a policy-level perspective. Second, institutional reports, including accreditation and internal audit documents from selected public and private universities, are examined to understand institutional practices. Third, stakeholder interviews are conducted with fifteen participants, comprising five officials from the Ministry of

Higher Education (MOHE), five academic leaders, and five students, to capture diverse viewpoints on policy implementation and educational outcomes.

Data Analysis

A **thematic analysis** (Braun & Clarke, 2006) identified recurring patterns related to policy interpretation, quality implementation, and student experience. Triangulation ensured validity by comparing multiple data sources.

Ethical Considerations

Ethical approval was granted by the relevant Institutional Review Board. Participants provided informed consent and were assured anonymity and confidentiality.

FINDINGS AND DISCUSSION

1. Policy Intent Versus Implementation Reality

Thematic analysis revealed a clear gap between policy formulation and execution. While the *Education Blueprint*emphasizes autonomy, most universities still rely on directive guidance from the MOHE. Administrators interviewed described difficulties balancing compliance with innovation, often resulting in "policy fatigue."

This finding corroborates Ahmad's (2019) argument that decentralization without adequate capacity building leads to inconsistent outcomes. For instance, some universities reported delays in curriculum approval processes, constraining agility in responding to market demands.

2. Quality Assurance and Institutional Culture

Interview data indicated that external quality audits have raised baseline standards but have not fostered a robust culture of internal quality enhancement. Faculty respondents admitted that audit cycles tend to be checklist-driven. Students noted that while facilities met expectations, teaching quality varied widely across programs.

Lim and Nor (2019) highlight that sustainable quality improvement depends on empowering educators through reflective practice and continuous professional development rather than top-down inspections.

3. Student Learning Experience and Employability

Students described tension between theoretical instruction and practical readiness. Although internship programs exist, their scope and supervision differ greatly among institutions. Graduate Tracer Studies (MOHE, 2023) support this perception: about 25 percent of graduates remain underemployed within six months of graduation.

Employers interviewed underscored the need for communication, adaptability, and digital skills. Embedding these competencies into curricula requires strong collaboration between academia and industry—a goal yet to be achieved consistently.

4. Digital Access and Learning Inequality

Findings indicate that digitalization has expanded educational access but also exposed structural inequities. Rural students often depend on unstable internet connections, affecting engagement and assessment. While government initiatives such as MyDigital Education 2021 have sought to improve infrastructure, implementation remains uneven.

These observations echo Noor et al. (2023), who caution that digital readiness must be coupled with pedagogical redesign rather than technology adoption alone.

5. Socio-Economic Barriers to Equity

Participants repeatedly cited financial hardship as a determinant of academic persistence. Scholarship schemes like PTPTN loans have improved affordability, but repayment burdens and limited grants constrain inclusivity. Female students and first-generation learners highlighted additional pressures balancing study and family obligations.

Such socio-economic influences align with global research (Teichler, 2017) showing that equity policies require holistic support mechanisms beyond mere access.

6. Institutional Leadership and Innovation

Leadership emerged as a pivotal factor shaping educational outcomes. Universities led by visionary management demonstrated proactive adaptation to quality audits, curriculum redesign, and industry collaboration. In contrast, institutions with hierarchical structures struggled to sustain reform momentum.

This reinforces Kaur and Sirat's (2021) view that transformational leadership—emphasizing participation, accountability, and innovation—is essential for organizational resilience.

DISCUSSION IN BROADER CONTEXT

Connecting Policy and Practice

The Malaysian experience exemplifies the complexity of translating ambitious policy blueprints into effective practice. Centralized policymaking may ensure coherence but can restrict institutional flexibility. To address this, policymakers must balance accountability with autonomy by adopting adaptive governance models.

Quality as a Process Rather Than a Product

Quality assurance should evolve from external evaluation to internalized culture. Universities must redefine quality as an ongoing developmental process—integrating student feedback, peer review, and academic innovation. Incentivizing reflective teaching practices can foster genuine improvement.

Student-Centred Approach

Ultimately, educational success should be measured not solely by institutional rankings or accreditation status but by the transformative impact on students. Incorporating experiential learning, digital literacy, and mental-health support can create more holistic graduates aligned with the Fourth Industrial Revolution (IR 4.0) skills framework.

CONCLUSION

This study concludes that Malaysia's higher education reform has achieved substantial progress in expanding access and establishing a robust policy framework, yet persistent challenges impede full realization of its goals.

The key conclusions of this study indicate that gaps in policy implementation highlight the need for more decentralized and context-sensitive governance approaches. In addition, quality assurance mechanisms should evolve beyond mere compliance to emphasize continuous improvement. The findings also show that student outcomes are influenced not only by curriculum design but also by the level of institutional support and the adequacy of digital infrastructure. Finally, socio-economic equity remains a critical and indispensable dimension for achieving sustainable educational reform.

Based on the findings of the study, several recommendations are proposed. First, industry–university partnerships should be strengthened to enhance graduate employability and ensure closer alignment between academic training and labor market needs. Second, targeted funding should be allocated to support digital capacity building in under-resourced institutions, thereby reducing disparities in educational quality. Third, quality assurance processes need to be streamlined to minimize redundant bureaucracy and allow institutions to focus on meaningful quality improvement. Finally, data-driven policy monitoring mechanisms should be adopted to systematically evaluate policy impacts on student learning outcomes and inform evidence-based decision-making.

By aligning policy ambitions with institutional realities and student needs, Malaysia can achieve a more inclusive and globally competitive higher education system. The insights drawn from this study may serve as guidance for other emerging economies navigating similar educational transitions.

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Empowering with Procreate: An Empirical Study on Enhancing Adolescents' Chinese Traditional Cultural Literacy and Creative Expression through Digital Picture Book Creation

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ABSTRACT

This study investigates the impact of digital picture book creation using Procreate on enhancing 9-10 year old's creativity and expressive skills, specifically focusing on the integration of traditional Chinese cultural stories. In an era where digital literacy and cultural preservation are increasingly vital, understanding how digital tools can bridge these two domains is crucial. This research employs a mixed-methods approach, combining quantitative data from pre- and post-intervention assessments of creativity and expressive skills with qualitative data derived from student interviews, observations, and analysis of their digital artworks. Participants will engage in a structured six-session program designed to guide them through the process of creating digital picture books themed on traditional Chinese cultural narratives using Procreate. The findings are expected to demonstrate a significant improvement in both creativity and expressive abilities among participants, alongside a deeper appreciation and understanding of Chinese cultural heritage. This study contributes to the growing body of literature on digital education and cultural transmission, offering practical implications for educators, curriculum developers, and policymakers interested in leveraging technology for holistic student development and cultural literacy.

Keywords: Chinese Traditional Cultural, Creative Expression, Procreate, Digital Picture Book Creation

INTRODUCTION

Das Sollen (The Ideal)

In the contemporary educational landscape, the ideal state of learning emphasizes the holistic development of students, encompassing not only academic proficiency but also crucial 21st-century skills such as creativity, critical thinking, and effective communication. Furthermore, in an increasingly interconnected world, the cultivation of cultural literacy and the preservation of traditional heritage are paramount. The

Theoretical underpinnings for this ideal state are multifaceted:

1. Theories of Creativity

Theories such as Amabile's Componential Theory of Creativity (Amabile, 1996) posit that creativity is a function of domain-relevant skills, creativity-relevant processes, and task motivation. Vygotsky's sociocultural theory(Vygotsky, 1978) further emphasizes that creativity is not solely an individual trait but is significantly shaped by social and cultural contexts. From this perspective, providing rich, interactive environments and culturally relevant content is crucial for fostering creative expression. The ideal educational setting should therefore offer opportunities for students to engage with diverse materials and collaborate on projects that stimulate imaginative thinking.

2. Theories of Expressive Skills

Expressive skills, particularly in the context of art and communication, are often viewed through the lens of multimodal literacy (Cooper,2016). Kress and van Leeuwen's theory of visual grammar (Kerss&Van,2006) highlights how visual elements convey meaning and contribute to overall communication. The ideal scenario involves students being able to effectively utilize various semiotic modes — visual, textual, auditory — to articulate their thoughts, feelings, and narratives. This requires not only technical proficiency with tools but also a deep understanding of how different modes interact to create meaning.

3. Theories of Cultural Literacy

Hirsch's concept of cultural literacy (Hirsch, 1987) emphasizes the importance of shared background knowledge for effective communication and societal cohesion. In the context of traditional Chinese culture, this ideal involves a deep understanding and appreciation of its rich history, philosophy, art, and values. The ideal educational approach should move beyond rote memorization to foster an active engagement with cultural narratives, enabling students to interpret, adapt, and transmit cultural knowledge in meaningful ways. This aligns with theories of cultural transmission, which suggest that active participation in cultural practices strengthens cultural identity and continuity.

4. Policies in China and Primary Schools Related to Digital Education and Cultural Preservation

The Chinese government has consistently emphasized theintegration of technology into education and the promotion of traditional Chinese culture. The National Medium- and Long-Term Education Reform and Development. Plan (2020-2030) highlighted the importance of information technology in education. More recently, the Ministry of Education has issued guidelines promoting the integration of traditional Chinese culture into various subjects, including art and language education （Minster of Education, 2018,2020,2013）. Fundamental schools in China are also actively developing digital education initiatives and programs aimed at cultural heritage preservation and innovation. For instance, many universities have established digital humanities centers and offer courses on digital art and cultural communication, reflecting a national commitment to leveraging technology for cultural transmission and creative expression.

5. Articles Telling About the Theories: Recent academic discourse reinforces these theoretical ideals.

For example, Yu, Zhang, and Liu (2024) discuss how digital multimodal composition enhances second language writing, emphasizing the comprehensive and nuanced expression it fosters Xia (2024) further illustrates this by analyzing how digital multimodal composition in content teaching, specifically through legal popularization videos, allows students to integrate various semiotic modes effectively. Song et al. (2024) explore perceptions towards creative mathematical writing with generative AI, highlighting the potential of digital tools to stimulate novel forms of expression. Yim and Su (2025) review artificial intelligence literacy education, underscoring the fundamental role of digital literacy in primary education. Zheng et al. (2025) provide a systematic review of storytelling in English language education in China, noting its effectiveness as a pedagogical approach and its alignment with national policies emphasizing innovative and interactive learning. Cooper (2016) researched digital storytelling on iPads in primary schools, demonstrating its positive impact on children's story writing. Gong and Tao (2025) introduce an interactive educational tool for process-based learning in Chinese calligraphy, showcasing how digital tools can facilitate the learning of traditional art forms. Nuriyah et al. (2024) and Janeth and Romero (2023) both found that digital storytelling enhances students' speaking skills, further supporting the role of digital tools in expressive development. Kershen and Johnson (2025) discuss the evolving role of teachers in an AI-assisted world, emphasizing the need for educators to adapt to new technologies for creative expression. Yu et al. (2024) explore how digital storytelling empowers business English students with cross-border product digital storytelling, indicating its versatility across disciplines. Wang (2024) and Chen (2020) discuss the integration of Chinese stories into English teaching, highlighting the importance of cultural content. Sheng (2020) further elaborates on primary school English teaching based on storytelling under core literacy, reinforcing the pedagogical value of narratives. Ramadhani et al. (2023) examine English teachers' storytelling strategies, emphasizing its role in language education. These articles collectively paint a picture of an ideal educational environment where digital tools are seamlessly integrated to foster creativity, enhance expressive skills, and promote cultural literacy, particularly through engaging storytelling approaches.

Das Sein (The Reality)

Despite the theoretical ideals and policy directives, the reality of implementing comprehensive digital education that effectively integrates cultural literacy and fosters creative expression often presents significant challenges, particularly in the context of traditional Chinese cultural stories and digital picture book creation:

1. Problems in the Country and Asia based on Article Reading

While there is a growing recognition of digital education's importance, its practical

implementation in many parts of China and Asia faces hurdles. Many educational institutions, especially at the K-12 level, may lack adequate infrastructure, including sufficient access to digital devices like iPads and specialized software like Procreate. Even where technology is available, teachers may not possess the necessary training or pedagogical expertise to effectively integrate digital art creation into their curriculum, particularly when it involves complex cultural narratives. Furthermore, the emphasis on standardized testing and academic performance in some educational systems can inadvertently sideline subjects like art and cultural studies, limiting the time and resources allocated to creative and expressive activities. For instance, while digital storytelling is recognized, its application in specific cultural contexts, such as traditional Chinese stories, might not be as widespread or deeply integrated as theoretical models suggest (Zheng, H&Ali,2025). There can also be a disconnect between the rapid pace of technological advancement and the slower adoption rates in educational practices, leading to a gap between the potential of digital tools and their actual utilization in classrooms (Yim and Su, 2025).

2. Problems at School in Common based on the Reality

At the primary school level, while resources might be more abundant, challenges persist. Many art and education departments may still rely heavily on traditional teaching methods, with digital art tools being introduced as supplementary rather than core components of the curriculum.

There might be a lack of interdisciplinary collaboration between art, education, and cultural studies departments, hindering the development of integrated programs like digital picture book creation focused on cultural themes. Faculty members, particularly those trained in traditional art forms, may require extensive professional development to become proficient in teaching with digital tools like Procreate. Furthermore, the assessment methods at schools might not adequately capture the nuances of creativity and expressive skills developed through digital art, leading to a de-emphasis on these areas. Anecdotal evidence and preliminary observations suggest that while universities may offer courses in digital art or cultural studies, few seamlessly combine the two in a project-based learning environment that culminates in a culturally themed digital creation.

3. Problems at Nanshan Education Group, Binhai Primary School in Reality

At Nanshan Education Group, Binhai Primary School, similar challenges are observed. While our school has invested in digital infrastructure and offers various art and design programs, the integration of digital tools like Procreate into the curriculum for fostering cultural literacy through creative expression is still in its nascent stages. There is a perceived gap in faculty expertise regarding the pedagogical application of digital art tools for cultural education. Students, while digitally native, often lack structured opportunities to apply their digital skills to explore and express traditional cultural narratives in a creative format. Preliminary surveys and discussions with faculty and students indicate a strong interest in such interdisciplinary approaches but also highlight the need for dedicated resources, specialized training, and a revised curriculum that prioritizes these integrated learning experiences. The current assessment frameworks may also not fully capture the development of creativity and cultural understanding through digital art projects, leading to a focus on more conventional academic outcomes.

Based on the analysis of the ideal (Das Sollen) and the reality (Das Sein), this research identifies critical gaps between theory and practice in digital education and cultural preservation. Although theories and policies emphasize the use of digital tools to enhance creativity, multimodal expression, and cultural literacy, practical implementation often remains fragmented, with digital literacy and cultural education taught in isolation rather than through integrated pedagogical models, particularly in culturally specific contexts such as traditional Chinese stories. Similarly, existing interventions tend to focus separately on digital art skills or cultural education, resulting in a lack of empirical, evidence-based programs that combine digital art creation tools, such as Procreate, with traditional cultural narratives to simultaneously foster creativity, expressive skills, and cultural understanding among adolescents. Consequently, despite recognition of the value of digital storytelling and multimodal composition, there remains a clear need for structured and context-sensitive interventions that effectively bridge the gap between digital creativity and cultural education.

This research is needed because it directly responds to the identified gaps between theory and practice in digital education and cultural preservation. By proposing and examining a structured six-session program for digital picture book creation using Procreate and themed around traditional Chinese cultural stories, the study seeks to provide an evidence-based pedagogical model that meaningfully

integrates digital art, creativity, and cultural education. It aims to demonstrate the synergistic effects of this integrated approach on adolescents' creativity, expressive skills, and cultural literacy, while also offering practical implications for educators, curriculum developers, and policymakers who wish to harness digital technology for holistic student development and cultural preservation. In an era of pervasive digital engagement and increasing vulnerability of cultural heritage, developing effective strategies to blend technological innovation with cultural education is not only beneficial but essential for preparing future generations.

Based on a preliminary study involving questionnaires and interviews with lecturers, students, parents, and university management at Binhai School, the main problem identified is the insufficient integration of digital art creation tools with culturally relevant content in art and cultural education programs, which limits the development of adolescents' creativity and cultural literacy. The findings reveal that although students are familiar with basic digital tools, there is a lack of structured curricula and faculty expertise in using advanced digital illustration software such as Procreate, thereby restricting creative expression and exposure to industry-standard practices. In addition, the teaching of traditional Chinese cultural stories relies heavily on passive methods, resulting in low engagement among digitally native adolescents and highlighting the need for more interactive, creative approaches. Creativity, expressive skills, and cultural literacy are also often developed in isolation, leading to fragmented learning rather than integrated, project-based experiences where these competencies can mutually reinforce one another. Furthermore, there is a notable lack of empirical, context-specific research examining the combined effects of digital art creation and cultural storytelling on adolescents' holistic development. Together, these issues point to the need for a concrete, evidence-based intervention that bridges the gap between theoretical ideals and current educational practices by integrating digital art tools and cultural content to foster creativity and cultural literacy.

Given the scope and available resources of this research, it is necessary to clearly define the limitations of the problem being addressed. The primary focus of the study is the development and evaluation of a structured pedagogical intervention that utilizes Procreate for digital picture book creation to enhance adolescents' creative expression and literacy in traditional Chinese culture. Other related issues, although important, cannot be comprehensively examined within the current research framework due to practical constraints. Specifically, the study concentrates on the immediate and short-term effects of the six-session intervention; investigating long-term skill retention and sustained cultural appreciation would require a longitudinal design beyond the project's timeframe. In addition, the research targets a specific group—adolescents aged 9–10—and centers on traditional Chinese cultural stories, meaning that broader generalization across different age groups or cultural contexts remains limited. The study also does not compare Procreate with other digital art platforms, focusing exclusively on its application within the proposed intervention. Furthermore, although creativity and expressive skills may indirectly influence academic achievement, the study does not directly measure impacts on grades or standardized test performance, as its primary emphasis is on the development of creativity, expressive abilities, and cultural literacy. These limitations help ensure that the research remains focused, feasible, and capable of addressing a meaningful educational challenge within its defined scope.

Based on the identified problems and their limitations, this study is guided by the following research questions. First, to what extent does participation in a six-session digital picture book creation program using Procreate, themed around traditional Chinese cultural stories, enhance adolescents' creativity in terms of fluency, originality, elaboration, and abstractness of titles? Second, how does participation in this program influence adolescents' expressive skills, as reflected in visual communication, emotional expression, narrative clarity, and artistic technique in digital picture books? Third, in what ways does the program contribute to adolescents' understanding and appreciation of traditional Chinese cultural stories, thereby fostering their cultural literacy? Finally, what are adolescents' perceptions and experiences regarding the use of Procreate for digital picture book creation and its role in engaging with traditional Chinese cultural stories?

The objectives of this research are to assess the effectiveness of a six-session digital picture book creation program using Procreate in enhancing adolescents' creativity; to evaluate the impact of the program on adolescents' expressive skills in digital art; to explore how the program contributes to adolescents' understanding and appreciation of traditional Chinese cultural stories and the development of their cultural literacy; and to investigate adolescents' perceptions and experiences of using Procreate for digital picture book creation as a medium for engaging with traditional Chinese cultural narratives.

This research holds significant theoretical and practical implications for education. Theoretically, it contributes empirical evidence to creativity theories by demonstrating how digital tools such as Procreate can enhance multiple dimensions of creativity within a structured learning environment, while also advancing multimodal literacy theories through an examination of how visual and textual modes interact in digital picture book creation to support expressive development. In addition, the study enriches theories of cultural transmission by showing how active and creative engagement with traditional Chinese cultural narratives through digital art can foster deeper cultural literacy and identity formation, moving beyond passive learning models, and it further supports the development of interdisciplinary learning frameworks that integrate art, technology, and cultural studies to promote holistic student development. Practically, the research offers students an innovative platform to develop creativity, expressive skills, and digital art competencies while deepening their appreciation of traditional Chinese culture; provides educators with an evidence-based and replicable pedagogical model for integrating digital art tools and cultural content into curricula; informs educational institutions about curriculum design and resource allocation to support digital art infrastructure and interdisciplinary programs; supplies policymakers with empirical evidence to guide decisions related to digital literacy, cultural preservation, and creative education; and offers researchers a foundation for future studies in digital art education, cultural literacy, and creative development across diverse contexts.

To ensure clarity and precision, this study defines several key terms within its specific context. *Digital picture book creation* refers to the process of designing, illustrating, and assembling a narrative primarily through digital tools, resulting in a visual story that integrates text and images for digital viewing. *Procreate* is a raster graphics editor for iOS and iPadOS, developed by Savage Interactive, and is widely recognized for its intuitive interface, extensive brush library, and layering system, making it a popular tool for digital illustration and design. *Chinese traditional cultural literacy* encompasses learners' knowledge, understanding, and appreciation of traditional Chinese values, historical narratives, symbols, artistic expressions, and cultural practices, as well as their ability to meaningfully interpret and engage with these elements. *Creativity* is defined as the ability to produce novel and useful ideas and, in this study, is examined through fluency, originality, elaboration, and abstractness of titles, while *expressive skills* refer to the effective communication of thoughts and emotions through visual communication, emotional conveyance, narrative clarity, and artistic technique in digital picture book creation.

Operationally, digital picture book creation in this research refers to a structured six-session program in which adolescents use the Procreate application on iPads to design and illustrate a complete digital picture book based on traditional Chinese cultural stories. Procreate functions as the sole digital illustration platform used throughout the intervention. Chinese traditional cultural literacy is assessed through students' ability to accurately incorporate and interpret cultural elements in their digital works, supported by content analysis and self-reported understanding during interviews. Creativity is measured using pre- and post-tests based on the Torrance Tests of Creative Thinking, supplemented by qualitative observations of students' idea generation and problem-solving processes. Expressive skills are evaluated through a customized rubric applied to the completed digital picture books and further explored through student interviews regarding their artistic intentions.

In terms of novelty, this research offers a holistic and integrated pedagogical model that combines digital art creation, traditional Chinese cultural storytelling, and the development of creativity and expressive skills within a single intervention. Unlike previous studies that often address digital tools, creativity, or cultural education separately, this study provides empirical evidence of their synergistic effects in a culturally specific context. By focusing on Procreate as a medium for cultural education and presenting a practical, replicable six-session framework, the research bridges the gap between theoretical ideals and educational practice and contributes valuable insights to the fields of digital education, art education, and cultural studies

LITERATURE REVIEW

Digital Literacy and Digital Storytelling in Education

The advent of digital technologies has profoundly reshaped the educational landscape, giving rise to the concept of digital literacy as a fundamental skill for 21stcentury learners. Digital literacy encompasses not only the ability to use digital tools and platforms but also the capacity to critically evaluate, create, and communicate information in digital environments (Yim&Su,2025). In this

context, digital storytelling has emerged as a powerful pedagogical tool that integrates various forms of media — text, images, audio, and video — to create compelling narratives(Zheng, L.,&Ali,2015). The process of digital storytelling is inherently multimodal, allowing learners to engage with content in diverse ways and express their understanding through multiple semiotic modes (Cooper,J.,2016). Research has consistently demonstrated the positive effects of digital storytelling on student learning outcomes. For example, studies have shown that digital storytelling can enhance students' motivation, engagement, and self-efficacy(Gong, X., & Tao, W. ,2025). It provides a platform for students to develop their narrative skills, improve their writing abilities, and foster a deeper understanding of complex concepts (Nuriyah, L,2024). Furthermore, the collaborative nature of many digital storytelling projects promotes teamwork, communication, and problem-solving skills among students (Janeth, D. R. Y. M., & Romero, I. R. C. ,2023). The use of digital tools like Procreate, which offers a rich array of artistic functionalities, can further empower students to visually articulate their ideas, adding another layer of depth to their digital narratives.

Creativity and Expressive Skills in Digital Art Creation

Creativity is widely recognized as a crucial skill in the modern world, essential for innovation, problem-solving, and personal development. In educational settings, fostering creativity involves providing opportunities for students to explore, experiment, and express their unique ideas. Digital art creation, particularly with versatile tools like Procreate, offers an expansive canvas for cultivating creative expression. The intuitive interface and extensive features of Procreate allow users to experiment with different brushes, colors, textures, and layers, thereby facilitating a fluid and iterative creative process (Kershen & Johnson 2025).

Studies on digital art and creativity have indicated that engaging in digital artistic endeavors can significantly enhance various aspects of creative thinking, including fluency, flexibility, originality, and elaboration (Yu, Deng, Xu, & Li 2024). The ability to easily revise, undo, and refine digital artworks encourages a fearless approach to creation, where mistakes are seen as opportunities for learning rather than failures. This iterative process is vital for creative development, as it allows individuals to refine their ideas and push the boundaries of their imagination. Moreover, digital art creation provides a powerful medium for expressive skills, enabling individuals to convey emotions, ideas, and narratives through visual means. The multimodal nature of digital art, combining visual elements with potential textual or auditory components, amplifies the expressive potential, allowing for richer and more complex forms of communication (Wang, Y., 2024).

Traditional Chinese Cultural Stories and Cultural Literacy

Traditional Chinese cultural stories are a vast and diverse repository of myths, legends, folklore, historical events, and philosophical teachings that embody the essence of Chinese civilization. These stories are not merely entertaining narratives; they serve as vehicles for transmitting cultural values, moral principles, and historical knowledge across generations (Chen, L.,2020). Integrating these stories into contemporary education is crucial for cultivating cultural literacy, which involves understanding and appreciating one's own culture and the cultures of others. Cultural literacy is increasingly important in a globalized world, fostering intercultural communication, empathy, and respect for diversity.

However, the traditional methods of teaching cultural stories, often relying solely on textual readings, may not fully engage today's digitally-oriented youth. Innovative approaches are needed to make these rich narratives more accessible and appealing. Digital picture book creation offers a dynamic and interactive way to re-engage adolescents with traditional Chinese cultural stories. By transforming these narratives into visual and interactive digital formats, students can actively participate in the process of cultural transmission, interpreting and re-imagining these stories in a contemporary context. This active engagement not only deepens their understanding of the stories' content but also fosters a personal connection to their cultural heritage, promoting a sense of identity and belonging (Sheng, W.,2020).

The Role of Procreate in Digital Picture Book Creation

Procreate, an award-winning digital illustration app for iPad, has gained immense popularity among artists and educators due to its powerful features and user-friendly interface. Its extensive brush library, layer system, and intuitive gestures make it an ideal tool for creating high-quality digital artworks, including illustrations for picture books. For educational purposes, Procreate offers several advantages. Its portability allows for flexible learning environments, and its relatively low learning curve

enables students to quickly grasp the basics and focus on creative expression rather than technical complexities (Ramadhani& Baa,2023).

In the context of digital picture book creation, Procreate facilitates a seamless workflow from initial sketches to final colored illustrations. Students can easily import reference images, create multiple layers for different elements (characters, backgrounds, text), and experiment with various artistic styles. The ability to undo and redo actions without fear of permanent mistakes encourages iterative design and refinement, which is crucial for developing artistic skills and creative confidence.

Furthermore, the final digital picture books can be easily shared, published, or presented, providing students with a sense of accomplishment and a wider audience for their creative works. This accessibility and versatility make Procreate an excellent tool for integrating art, technology, and cultural education in a meaningful way.

METHOD

Research Design

This study will employ a mixed-methods research design, combining both quantitative and qualitative approaches to provide a comprehensive understanding of the impact of digital picture book creation using Procreate on adolescents' creativity, expressive skills, and cultural literacy. A quasi-experimental design will be utilized for the quantitative component, involving a pre-test/post-test design with an intervention group. The qualitative component will involve semi-structured interviews, observations, and content analysis of the digital picture books created by the participants.

Participants and Setting

The participants will be a group of adolescents (aged 9-10) recruited from Binhai primary school. A total of 60 students will be invited to participate, with 30 assigned to the intervention group and 30 to a control group. The intervention group will participate in the six-session digital picture book creation program, while the control group will continue with their regular art curriculum. Parental consent and student assent will be obtained prior to participation. The study will be conducted in a dedicated art classroom equipped with iPads and Procreate software.

1. Intervention Program: Digital Picture Book Creation Using Procreate (6 Sessions) The intervention program will consist of six weekly sessions, each lasting approximately 40 minutes. The curriculum will be structured to guide students through the entire process of creating a digital picture book based on traditional Chinese cultural stories. The sessions will cover:
2. Session 1: Introduction to Digital Storytelling and Procreate Basics. Students will be introduced to the concept of digital storytelling, its elements, and the basic functionalities of Procreate (interface, brushes, layers, colors).
3. Session 2: Exploring Traditional Chinese Cultural Stories. Students will delve into selected traditional Chinese cultural stories, discussing their themes, characters, and cultural significance. They will choose a story for their digital picture book project.
4. Session 3: Character Design and Storyboarding. Students will learn principles of character design and create their main characters in Procreate. They will also develop storyboards for their chosen narrative, outlining key scenes and visual compositions. Session 4: Backgrounds and Scene Development. Students will focus on creating backgrounds and developing the visual settings for their picture books, incorporating elements of Chinese art and aesthetics.
5. Session 5: Text Integration and Refinement. Students will integrate text into their digital picture books, focusing on typography, layout, and narrative flow. They will also refine their illustrations and overall composition.
6. Session 6: Presentation and Sharing. Students will present their completed digital picture books to their peers and teachers, sharing their creative process and cultural insights. They will also receive feedback on their work.

Data Collection Instruments

Quantitative Data

Creativity will be measured using the Torrance Tests of Creative Thinking (TTCT), a standardized assessment widely employed to evaluate multiple dimensions of creativity, including fluency,

originality, elaboration, and abstractness of titles; both figural and verbal forms of the TTCT will be administered as pre- and post-tests to examine changes in students' creative abilities. In addition, students' expressive skills will be assessed through a custom-designed expressive skills rubric applied to their digital picture books, focusing on key elements such as visual communication, emotional conveyance, narrative clarity, and artistic technique, with the evaluation conducted by independent assessors to ensure objectivity and reliability.

Qualitative Data

Qualitative data will be collected through multiple methods to gain in-depth insights into the learning process and outcomes. Semi-structured interviews will be conducted with a subset of approximately 10–15 students from the intervention group after the program to explore their perceptions, experiences, and reflections on the digital picture book creation process, their engagement with traditional Chinese cultural stories, and the development of their creativity and expressive skills. In addition, researchers will conduct systematic observations during the sessions, focusing on students' levels of engagement, problem-solving strategies, collaborative interactions, and artistic decision-making. The completed digital picture books will also be subjected to qualitative content analysis, examining themes, artistic elements, narrative coherence, and the extent to which traditional Chinese cultural elements are meaningfully integrated into the works.

Data Analysis

Quantitative data analysis will be conducted using several statistical techniques to examine the effectiveness of the intervention. Independent samples *t*-tests will first be applied to compare pre-test scores between the intervention and control groups to ensure baseline equivalence. Paired samples *t*-tests will then be used to compare pre-test and post-test scores within each group to assess changes over time. To determine the unique effect of the digital picture book creation program, Analysis of Covariance (ANCOVA) will be employed to compare post-test scores between the two groups while controlling for pre-test scores.

Qualitative data obtained from interview transcripts, observation notes, and digital picture book analyses will be examined using thematic analysis. This process involves identifying recurring themes, patterns, and insights related to students' creativity, expressive skills, and cultural understanding. Coding will be conducted independently by two researchers to enhance credibility, and inter-rater reliability will be established to ensure consistency and trustworthiness of the findings.

Ethical considerations will be strictly observed throughout the study. Ethical approval will be obtained from the relevant institutional review board prior to data collection. Informed consent will be secured from parents or guardians, and assent will be obtained from all student participants. Participants' anonymity and confidentiality will be maintained, and they will be informed of their right to withdraw from the study at any time without any negative consequences.

FINDINGS AND DISCUSSION

Quantitative Findings

Creativity Enhancement (TTCT Scores)

It is hypothesized that the quantitative analysis of the Torrance Tests of Creative Thinking (TTCT) scores will reveal a statistically significant improvement in creativity among adolescents in the intervention group. Specifically, paired samples t-tests are expected to show a significant increase in post-test scores compared to pre-test scores within the intervention group across all four dimensions of creativity: fluency, originality, elaboration, and abstractness of titles. Conversely, the control group is not expected to show significant changes in their TTCT scores over the same period.

Furthermore, an Analysis of Covariance (ANCOVA), controlling for pre-test scores, is anticipated to demonstrate a significant difference in post-test TTCT scores between the intervention and control groups, with the intervention group exhibiting higher levels of creativity. This would strongly suggest that the digital picture book creation program, facilitated by Procreate and themed on traditional Chinese cultural stories, is an effective intervention for fostering creativity in adolescents.

Table 1. Expected Mean Scores and Standard Deviations for TTCT (Pre- and PostIntervention)

Expressive Skills Development (Rubric Scores)

Similarly, the assessment of expressive skills using the custom-designed rubric is expected to

show significant improvements in the intervention group. Independent evaluators, blinded to the group assignments, are anticipated to rate the digital picture books created by the intervention group significantly higher across all assessed dimensions: visual communication, emotional conveyance, narrative clarity, and artistic technique. This would be evidenced by higher mean scores on the rubric for the intervention group compared to the control group (if a control group were to create similar artifacts, or against a baseline of typical student work).

Table 2. Expected Mean Scores for Expressive Skills Rubric (Post-Intervention)

Qualitative Findings

Cultural Literacy and Engagement

Qualitative data from semi-structured interviews, observations, and content analysis of the digital picture books are expected to provide rich, nuanced insights into how the program fostered cultural literacy and engagement. Themes anticipated to emerge from the interviews include:

Increased Cultural Appreciation: Students are likely to express a deeper appreciation for traditional Chinese cultural stories, recognizing their historical significance, moral lessons, and artistic beauty. Many might articulate how the visual and interactive nature of digital picture book creation made these stories more accessible and engaging than traditional methods.

Enhanced Cultural Understanding: Students are expected to demonstrate a more profound understanding of specific cultural elements, symbols, and historical contexts embedded within the stories. This understanding would go beyond superficial knowledge, reflecting a personal connection and critical interpretation.

Active Cultural Exploration: Observations are likely to reveal students actively researching cultural details, discussing interpretations of narratives, and debating the visual representation of cultural elements. This indicates a shift from passive reception to active exploration and construction of cultural knowledge.

Sense of Cultural Identity and Pride: For students of Chinese heritage, the program is anticipated to foster a stronger sense of cultural identity and pride, as they actively participate in the transmission and reinterpretation of their heritage. For all students, it is expected to cultivate respect and empathy for diverse cultural expressions.

Content analysis of the digital picture books would corroborate these interview findings. The artworks are expected to exhibit thoughtful and accurate integration of traditional Chinese cultural motifs, characters, and settings. For example, the use of specific color palettes, traditional architectural styles, or symbolic animals (e.g., dragons, phoenixes) would be evident, demonstrating a nuanced understanding of their cultural significance. Furthermore, the narrative choices within the picture books are expected to reflect an understanding of the original story's moral or philosophical underpinnings, even when adapted for a contemporary audience.

Perceptions and Experiences of Procreate and Digital Creation

Interviews and observations are also expected to shed light on students' perceptions of Procreate as a creative tool and their overall experience with digital picture book creation. Key themes might include:

1. Ease of Use and Accessibility: Students are likely to praise Procreate's intuitive interface and extensive features, which allowed them to quickly translate their ideas into digital form without significant technical barriers. The ability to undo mistakes and experiment freely would be highlighted as a major advantage over traditional art mediums.
2. Enhanced Creative Freedom: Many students might express that Procreate provided them with unprecedented creative freedom, allowing them to explore a wider range of artistic styles, textures, and effects. The digital environment removed physical limitations, enabling more ambitious and imaginative creations.
3. Increased Engagement and Motivation: The novelty and interactive nature of using Procreate for a meaningful project are expected to significantly boost student engagement and motivation. Students might report feeling more invested in their work and more eager to learn new digital art skills.
4. Development of Digital Literacy Skills: Beyond specific art techniques, students are likely to report an increased confidence in their general digital literacy, including file management, digital sharing, and problem-solving within a software environment.

DISCUSSION

Creativity and Expressive Skills: A Synergistic Relationship

The anticipated quantitative findings regarding creativity and expressive skills align strongly with existing theories on digital art and creative development [10, 11]. The significant improvements in TTCT scores and expressive skills rubric ratings suggest that Procreate, when integrated into a structured pedagogical program, acts as a powerful catalyst for creative expression. The digital medium's affordances—such as non-destructive editing, extensive toolsets, and immediate feedback — reduce the cognitive load associated with technical execution, allowing students to focus more on ideation and conceptualization. This supports Amabile's Componential Theory, where the environment and tools facilitate creativity-relevant processes [48].

The qualitative data further enriches this understanding by illustrating how these improvements manifest. Students' reported experiences of increased creative freedom and ease of use directly correlate with the observed enhancements in fluency and originality. The iterative nature of digital creation, where students can easily experiment and refine their work, directly contributes to elaboration. The ability to manipulate visual elements with precision in Procreate allows for more nuanced emotional conveyance and clearer visual communication, thereby enhancing expressive skills. This reinforces the idea that digital tools are not merely substitutes for traditional mediums but offer unique capabilities that can unlock new dimensions of creative and expressive potential.

Cultural Literacy: Bridging Tradition and Technology

The expected findings regarding cultural literacy and engagement are particularly significant, as they demonstrate the program's success in bridging the gap between traditional cultural education and modern digital learning environments. By actively engaging students in the creation of digital picture books based on traditional Chinese cultural stories, the program transforms passive cultural reception into active cultural construction. This aligns with Vygotsky's sociocultural theory, emphasizing that learning is a social and cultural process [19]. Students are not just learning about culture; they are reinterpreting and re-presenting it through a contemporary medium, making it relevant to their own experiences.

The observed increase in cultural appreciation and understanding, coupled with the thoughtful integration of cultural elements in their artworks, suggests that the program fosters a deeper, more personal connection to heritage. This is crucial in an era where traditional cultural forms might struggle to compete with the pervasive digital entertainment consumed by adolescents. The digital picture book becomes a powerful vehicle for cultural transmission, allowing students to become active participants in preserving and evolving their cultural narratives. This finding also supports the notion that culturally relevant pedagogy can significantly enhance student engagement and learning outcomes across various domains [14].

Implications for Digital Education and Interdisciplinary Learning

This study's anticipated findings have profound implications for the broader field of digital education. They underscore the importance of moving beyond mere technological integration to truly leveraging digital tools for transformative learning experiences. The success of this program lies in its interdisciplinary approach, combining art, technology, and cultural studies. This demonstrates that holistic student development is best achieved when disciplinary boundaries are blurred, allowing for the synergistic growth of diverse skills and knowledge domains.

Furthermore, the study highlights the critical role of well-designed pedagogical interventions. It is not simply the availability of tools like Procreate, but the structured guidance, meaningful context (traditional Chinese stories), and opportunities for creative application that drive significant learning outcomes. This provides a model for educators and curriculum developers seeking to design similar integrated programs that foster creativity, expressive skills, and cultural literacy in a digitally-rich environment. The findings also suggest that investing in teacher training for digital art tools and interdisciplinary pedagogy is crucial for realizing the full potential of such initiatives.

In conclusion, the anticipated findings of this study paint a compelling picture of how digital picture book creation with Procreate, when rooted in traditional Chinese cultural stories, can profoundly impact adolescents' creativity, expressive skills, and cultural literacy. This integrated approach not only prepares students with essential

21st-century skills but also empowers them to become active custodians and innovators of their cultural heritage in the digital age.

CONCLUSION

This empirical study, focusing on the impact of digital picture book creation using Procreate on adolescents' Chinese traditional cultural literacy and creative expression, is designed to provide robust evidence for an innovative pedagogical approach. The anticipated findings suggest that a structured six-session program, integrating digital art with traditional Chinese cultural stories, will significantly enhance students' creativity and expressive skills, while simultaneously deepening their understanding and appreciation of their cultural heritage. The expected quantitative results from the Torrance Tests of Creative Thinking (TTCT) and a custom-designed expressive skills rubric are poised to demonstrate measurable improvements in various dimensions of creativity and visual communication. Concurrently, the qualitative data, derived from student interviews, observations, and content analysis of their digital artworks, is expected to offer rich insights into the mechanisms through which this program fosters cultural literacy and a more profound engagement with traditional narratives. The core conclusion drawn from these anticipated findings is that digital tools, specifically Procreate, serve as powerful mediators for learning when integrated into a well-designed, interdisciplinary curriculum. They not only provide a versatile platform for creative expression but also act as a bridge between contemporary digital culture and traditional cultural heritage. By empowering adolescents to actively reinterpret and re-present traditional Chinese stories in a digital format, the program cultivates a dynamic form of cultural literacy that is both relevant and engaging for the digitalnative generation. This active engagement moves beyond passive reception, fostering a sense of ownership and pride in their cultural identity.

Furthermore, the study is expected to highlight the synergistic relationship between creativity, expressive skills, and cultural understanding. The process of visually articulating cultural narratives demands and develops both creative thinking and refined expressive abilities. This interconnected development underscores the importance of holistic educational approaches that transcend traditional disciplinary boundaries, promoting a more integrated and meaningful learning experience. The findings are expected to affirm that such integrated programs are not merely supplementary but are essential for equipping students with the comprehensive skills and cultural competencies required in the 21st century.

In essence, this research aims to provide compelling evidence that leveraging digital art creation, particularly with tools like Procreate, within a culturally rich context, offers a highly effective and transformative pathway for enhancing adolescents' creativity, expressive capabilities, and their connection to traditional Chinese cultural heritage. It underscores the potential of technology to revitalize cultural education and foster a generation that is both digitally proficient and culturally literate.

Based on the anticipated findings and the theoretical underpinnings of this study, several practical suggestions and broader implications emerge for educators, curriculum developers, and policymakers.

For Educators:

Integrate Digital Art Tools: Teachers should actively incorporate digital art tools like Procreate into their curriculum, recognizing their potential to enhance creativity, expressive skills, and engagement. Professional development programs should be offered to equip educators with the necessary skills to effectively utilize these tools in the classroom.

Embrace Interdisciplinary Approaches: The success of this program lies in its interdisciplinary nature, blending art, technology, and cultural studies. Educators are encouraged to design similar cross-curricular projects that allow students to explore subjects from multiple perspectives, fostering deeper learning and skill integration.

Prioritize Process Over Product: While the digital picture books are tangible outcomes, the learning process — experimentation, iteration, problem-solving, and critical thinking — is equally, if not more, important. Teachers should create a supportive environment that encourages risk-taking and learning from mistakes.

Facilitate Cultural Exploration: Beyond simply presenting cultural stories, educators should guide students in actively researching, interpreting, and reimagining these narratives. This active engagement fosters a personal connection to cultural heritage and promotes cultural literacy.

For Curriculum Developers:

Develop Digital Cultural Literacy Curricula: There is a clear need for curricula that explicitly integrate digital literacy with cultural education. Such curricula should go beyond basic digital skills to encompass critical evaluation, ethical considerations, and creative expression within digital cultural contexts.

Design Project-Based Learning Modules: The project-based approach of digital picture book creation is highly effective in promoting deep learning and skill development. Curriculum developers should design more project-based modules that allow for sustained engagement and the application of diverse skills.

Incorporate Authentic Cultural Content: Curricula should draw upon authentic and diverse cultural content, ensuring that students engage with narratives and artistic traditions that are rich in meaning and relevance. Collaboration with cultural experts and community members can enrich these resources.

For Policymakers:

Invest in Digital Art Education Infrastructure: To ensure equitable access, policymakers should invest in providing schools with the necessary digital tools, software, and high-speed internet access. This includes funding for devices like iPads and licenses for software like Procreate.

Support Teacher Training and Professional Development: Continuous professional development for teachers in digital art and interdisciplinary pedagogy is crucial. Policies should support ongoing training initiatives that empower educators to leverage technology for innovative teaching and learning.

Recognize Cultural Literacy as a Core Competency: Policymakers should recognize cultural literacy, alongside digital literacy, as a core competency for 21st-century citizens. Educational policies should reflect this importance, promoting initiatives that foster cultural understanding and appreciation through creative and technological means.

Broader Implications:

This study has broader implications for understanding how technology can serve as a powerful mediator for cultural transmission and identity formation in a globalized world. By empowering young people to creatively engage with their cultural heritage through digital tools, we can foster a generation that is not only technologically proficient but also deeply rooted in their cultural identity and capable of expressing it in innovative ways. This approach can help bridge the gap between traditional cultural education and the digital realities of contemporary youth, ensuring that cultural heritage remains vibrant and relevant for future generations. Furthermore, the findings can inform strategies for promoting cross-cultural understanding, as students learn to appreciate the universal themes and unique expressions found in diverse cultural narratives.

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Curriculum Innovation in Environmental Design under the Influence of Artificial Intelligence

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ABSTRACT

With the rapid development of artificial intelligence (AI), the design industry is experiencing profound transformation. Traditional design concepts and methods face challenges, requiring designers not only to demonstrate creativity and aesthetic judgment but also to master data analysis, algorithm design, and machine learning. In this context, curriculum reform in environmental design education has become essential. However, many Chinese universities still lack AI-related content, resulting in graduates with skill gaps and reduced employability. In contrast, leading institutions worldwide, such as Stanford University and Central Saint Martins, have successfully integrated AI into design education, offering courses and interdisciplinary projects that enhance students' technical abilities, creativity, and adaptability. AI applications in real-world practices, such as MVRDV's data-driven urban planning, further illustrate the value of AI in fostering innovative and evidence-based design. Incorporating AI into curricula not only improves teaching quality but also promotes interdisciplinary integration, equipping students with stronger problem-solving, teamwork, and practical skills. This reform meets the growing demand for versatile design professionals who can respond flexibly to technological and market changes. In conclusion, embedding AI into environmental design curricula is both a necessary response to industry transformation and an effective strategy for cultivating innovative, high-quality talent capable of thriving in an intelligent and digital era.

Keywords: Artificial Intelligence; Environmental Design Education; Curriculum Reform

INTRODUCTION

With the rapid popularization and promotion of smart devices, the number of mobile Internet users has surpassed that of traditional Internet users, fundamentally reshaping the way information is accessed, shared, and utilized. Mobile Internet leverages mobile communication technologies to transmit data and establish a dynamic virtual environment that connects users, devices, and services in real time. Furthermore, mobile Internet applications often integrate with other industries through application modules, expanding their influence across diverse sectors such as healthcare, communication, transportation, education, and commerce (Wu Zhihong & Liu Xueping, 2020). In this era dominated by information and data, the capacity to process, analyze, and extract meaningful insights from large, complex, and scattered datasets has become a central competency. The core challenge lies in intelligent information extraction, which enables data-driven decision-making and supports innovative problem-solving approaches, ultimately fostering a more efficient and responsive design practice.

Environmental Art Design, as an interdisciplinary field integrating spatial planning, visual aesthetics, functional design, and human-centered considerations, is particularly influenced by these technological advancements. Contemporary design projects increasingly rely on data analysis, simulation-based modeling, and intelligent decision-support systems to optimize outcomes, enhance efficiency, and anticipate user needs. Traditional pedagogical approaches, however, often fail to adequately address these competencies, leaving graduates with gaps in practical and technical skills. In many Chinese universities, Environmental Design curricula still lack systematic AI-related content, resulting in students who are underprepared to engage with technologically sophisticated design processes. This discrepancy underscores the urgency for curriculum reform, offering higher education institutions an opportunity to explore structured integration of AI technologies within their teaching

strategies.

Internationally, leading institutions have begun to embrace AI in design education. For instance, Stanford University and Central Saint Martins have incorporated AI technologies through interdisciplinary courses, workshops, and project-based learning methodologies. These approaches enable students to enhance both their technical abilities and creative thinking, while fostering collaboration across diverse knowledge domains. Furthermore, real-world projects illustrate the practical value of AI in design practice. MVRDV's data-driven urban planning projects, for example, utilize AI to optimize design decision-making, model urban dynamics, and facilitate innovative design methodologies, demonstrating that AI functions not only as a technical tool but also as a catalyst for creativity, problem-solving, and interdisciplinary collaboration. Additional examples include AI-assisted interior and landscape design projects, where machine learning models analyze user behavior and environmental conditions to support evidence-based design decisions, highlighting the transformative potential of AI across multiple scales of design practice.

Given these developments, this study aims to systematically explore the application and integration of AI technologies within Environmental Art Design education. It examines how curriculum reform can enhance teaching quality, strengthen students' practical and interdisciplinary skills, and draw lessons from international best practices to inform educational strategies in China. By investigating both pedagogical innovation and the demand for versatile design professionals, this research addresses the dual challenge of fostering creativity and technical competence. Moreover, the study emphasizes the importance of cultivating ethical awareness and critical thinking in students, preparing them not only to utilize AI effectively but also to consider its social, cultural, and environmental implications. Through bibliometric analysis, comparative study, and empirical research, this study seeks to provide both theoretical guidance and practical recommendations for integrating AI into Environmental Art Design curricula, ultimately preparing a new generation of designers capable of thriving in an increasingly intelligent, digital, and data-driven professional landscape, while contributing responsibly to sustainable and human-centered design solutions.

THEORETICAL FRAMEWORK

Landscape architecture education has increasingly gained recognition as a vital discipline in addressing environmental challenges and promoting sustainable development. Current programs often emphasize multidisciplinary approaches, integrating ecological principles, design methodologies, and technological advancements, and many have adopted innovative teaching methods such as project-based learning, collaborative studio models, and digital design tools (Smith, 2020; Johnson & Lee, 2021). However, despite these advancements, significant gaps remain in the systematic evaluation of program quality, as traditional assessment methods frequently rely on isolated metrics—such as graduation rates or student satisfaction—without capturing the broader factors that shape educational effectiveness (Brown, 2019). Research further suggests that the absence of structured frameworks for continuous improvement can lead to discrepancies in curriculum relevance, teaching quality, and student outcomes (Garcia, 2020). In response to these challenges, artificial intelligence (AI) in Environmental Landscape Design education can be conceptualized within a theoretical framework that integrates perspectives from educational research, technology adoption, and curriculum innovation. In this study, AI refers to computational systems and algorithms that assist or enhance the design process, including generative design, parametric modeling, predictive analytics, and data-driven simulations. AI encompasses not only technical tools, but also intelligent applications that support decision-making, foster creativity, and enable evidence-based design practices, offering new opportunities to strengthen pedagogical effectiveness and reshape design thinking in Environmental Landscape Design education.

Technology-Enhanced Learning (TEL) is a central concept within this study's framework, defined as the use of digital and intelligent technologies to facilitate knowledge acquisition, skill development, and learner engagement (Luo, 2025; Giannakos, 2025). TEL emphasizes adaptive, personalized, and interactive learning experiences, which are particularly relevant in design education because AI tools enable complex scenario simulations and iterative design exercises (Oh, 2024). These capabilities support students in integrating computational thinking with creative design processes in practice, thereby enhancing their overall competence (Luo, 2025).

The integration of Technology-Enhanced Learning (TEL) and design thinking is closely interrelated in AI-augmented design education. While TEL provides the overarching pedagogical framework that

leverages digital and intelligent technologies to enhance knowledge acquisition, skill development, and learner engagement, design thinking represents the methodological approach through which students apply these enhanced capabilities to creative problem-solving. AI acts as the critical link between TEL and design thinking by translating theoretical learning support into practical design applications. For instance, AI tools embedded within a TEL environment can offer real-time feedback, scenario simulations, and data-driven insights, which directly support the iterative and reflective processes emphasized in design thinking. In this way, TEL establishes the structural and technological foundation, while design thinking defines the human-centered, creative processes that students engage in, creating a cohesive and mutually reinforcing educational ecosystem.

Design thinking represents another foundational concept in design education, embodying a human-centered, iterative approach to problem-solving that emphasizes creativity, experimentation, and reflective practice (Sreenivasan, 2024). Within AI-augmented design education, artificial intelligence (AI) technologies can significantly expand the scope and application of design thinking. For instance, AI can generate multiple alternative design solutions, optimize decision-making based on complex datasets, and enhance predictive and simulation capabilities, all while maintaining attention to aesthetic considerations and functional requirements (Rana, 2025). By enabling students to explore and evaluate a variety of design options, AI not only supports iterative experimentation during the creative process but also enhances their ability to make informed and innovative decisions in complex design scenarios. This integration allows learners to engage in more sophisticated problem-solving practices, encouraging both analytical and creative thinking skills simultaneously.

Interdisciplinary education theory further underscores the importance of integrating knowledge and methodologies from multiple domains to address complex, real-world challenges. Environmental landscape design, as an inherently multidisciplinary field, draws upon architecture, urban planning, landscape architecture, interior design, and related disciplines. In this context, AI technologies facilitate interdisciplinary collaboration by enabling shared data analysis, simulation-based modeling, and advanced visualization. These tools allow students to effectively integrate knowledge and methods from diverse professional domains, promoting systems-level thinking and improving adaptability in complex design projects (Huangfu, Kotchasit, & Klangphahol, 2025). By working within AI-supported interdisciplinary frameworks, students develop a stronger capacity for synthesizing diverse perspectives, evaluating competing functional and aesthetic demands, and generating holistic solutions that are both innovative and contextually appropriate.

Furthermore, AI applications in design education include intelligent assistance systems, generative design software, and simulation platforms, all of which provide real-time feedback to students. These capabilities enable learners to identify potential problems at early stages of the design process and iteratively refine their solutions, fostering a hands-on, practice-oriented learning environment. The combination of AI tools with interdisciplinary approaches enhances student engagement, promotes collaborative learning, and supports the development of high-quality design competencies. Moreover, the integration of AI into educational practice ensures that students acquire not only technical proficiency but also the ability to balance creativity, functionality, and sustainability in their designs. By engaging with AI-supported tools and methods, students are better prepared to navigate the demands of a rapidly evolving, intelligent, and digitally mediated design environment, where adaptability, innovation, and critical thinking are increasingly essential for professional success.In summary, AI serves as a transformative force in design education, extending the boundaries of traditional design thinking and promoting interdisciplinary collaboration. It equips students with the analytical skills, technical competence, and creative capabilities necessary to address complex design challenges effectively. By fostering iterative exploration, data-informed decision-making, and real-time problem-solving, AI-enhanced design education empowers students to develop solutions that are aesthetically refined, functionally robust, and environmentally and socially responsible, preparing them to thrive in a future characterized by intelligent, digital, and collaborative design practices.

In contrast, domestic research in China indicates that the integration of artificial intelligence (AI) into Environmental Landscape Design curricula remains relatively limited. Many programs lack systematically structured AI content, which results in graduates exhibiting significant gaps in computational skills, data-driven design capabilities, and interdisciplinary collaboration competencies (Xing, Gan, Chen, & Yu, 2025). Although some universities have attempted to incorporate AI tools, offer elective courses, or conduct short-term workshops, comprehensive curriculum reform remains

uncommon, and empirical evaluation of such innovative practices is often insufficient (Liang, 2024). Methodologically, prior studies have employed a variety of approaches, including literature reviews, comparative analyses, surveys, and action research. Bibliometric studies have mapped the evolution and growth of AI applications in design education, surveys and interviews have captured the perceptions and attitudes of faculty and students toward AI effectiveness, and classroom-based action research has demonstrated iterative improvements in teaching strategies through AI-supported interventions. Nevertheless, these studies are generally limited in scale and scope, reducing their generalizability and leaving a significant gap in aligning international best practices with the domestic educational context, particularly in the area of systematic curriculum innovation (Tuya, 2025).

Curriculum innovation has emerged as a critical strategy to address these challenges. Innovative curricula involve not only the introduction of AI technologies but also the systematic reform of course structures, instructional content, learning modalities, and assessment methods. For instance, embedding AI tools within project-based learning, interdisciplinary modules, or design competitions enables students to apply knowledge in authentic contexts, thereby enhancing practical skills, problem-solving abilities, and creative thinking (Xing et al., 2025). Curriculum innovation also emphasizes the personalization and interactivity of the learning experience, offering flexible module design and elective courses that allow students to explore AI applications in design according to their individual interests and career trajectories (Liang, 2024). Additionally, curriculum innovation incorporates continuous feedback and iterative refinement mechanisms, integrating student performance data, faculty teaching experiences, and industry needs to create a dynamic and adaptive course system (Tuya, 2025). Such practices help narrow the skill gaps among students, improve overall teaching quality, and enhance graduates' employability and adaptability in the professional landscape.

Looking forward, future curriculum innovation plans should be further systematized and operationalized to maximize effectiveness. First, comprehensive AI core modules should be developed, covering areas such as data analysis, generative design, intelligent modeling, and visualization tools, and these should be introduced progressively across different academic levels to ensure students build a robust foundation in technical competencies (Xing et al., 2025). Second, interdisciplinary course design should be promoted, combining knowledge from architecture, urban planning, landscape architecture, and interior design, through integrated workshops and collaborative team projects that allow students to engage in real-world, cross-disciplinary problem-solving (Liang, 2024). Third, project-driven and problem-based learning (PBL) approaches should be widely implemented, incorporating real-world projects in collaboration with industry, government, or community stakeholders to tightly integrate theoretical knowledge with practical application, fostering both innovative thinking and professional skills (Tuya, 2025). Fourth, dynamic assessment and feedback mechanisms should be established, leveraging learning analytics platforms and AI-assisted evaluation tools to monitor students' progress and design outcomes in real time, providing data-informed insights to guide instructional adjustments (Xing et al., 2025). Fifth, ongoing professional development and collaboration with industry experts should be encouraged to ensure that curricula remain current with technological advancements and evolving professional demands. Finally, international benchmarking and comparative analysis should be incorporated, drawing on successful practices from leading institutions abroad while adapting them to the local context to achieve systematic, sustainable curriculum reform (Liang, 2024).

Despite the growing recognition of AI's transformative potential in education, several research gaps remain. First, domestic studies rarely examine AI integration and curriculum innovation at the holistic program level or link theoretical frameworks with measurable learning outcomes (Xing et al., 2025). Second, cross-national comparative studies of AI adoption strategies in Environmental Landscape Design education are limited, reducing understanding of international best practices that could inform local curriculum reform (Tuya, 2025). Third, there is insufficient research combining empirical evidence from stakeholder perspectives with actionable curriculum innovation strategies, particularly regarding the integration of technology-enhanced learning, design thinking, interdisciplinary collaboration, and AI-supported pedagogy (Liang, 2024).

This study positions itself to address these gaps by constructing a theoretical framework that integrates AI applications, educational theory, cross-cultural comparisons, and evidence-based curriculum innovation practices. By combining insights from technology-enhanced learning, design thinking, interdisciplinary education, and stakeholder feedback, the study provides a comprehensive lens for examining the impact of AI on course design, teaching strategies, student learning outcomes, and

graduate competencies. This framework not only facilitates a systematic exploration of AI's multi-dimensional influence but also offers practical guidance for curriculum reform and innovation, aiming to cultivate graduates in Environmental Landscape Design who are innovative, adaptable, technically proficient, and professionally competent, capable of thriving in increasingly intelligent, digital, and competitive design environments.

METHOD

This study employs an integrated methodological approach, combining bibliometric analysis and comparative research, to systematically investigate the impact of artificial intelligence (AI) on Environmental Landscape Design education. The integration of these two approaches enables a comprehensive exploration of both theoretical trends and practical applications, providing a multi-dimensional understanding that strengthens the reliability and applicability of the findings.

Initially, a bibliometric analysis was conducted to establish a robust theoretical and empirical foundation. Relevant literature was systematically retrieved from leading academic databases, including CNKI, Google Scholar, ACM Digital Library, and Mendeley, using a combination of keywords such as "artificial intelligence," "educational reform," "technology-enhanced learning," "environmental landscape design," and "curriculum innovation." This comprehensive collection ensured coverage of both domestic and international research, allowing the study to capture current developments, applications, and conceptual frameworks in AI-supported design education. For each selected study, detailed information regarding research objectives, methodology, participant characteristics, key findings, and conclusions was meticulously extracted. Bibliometric visualization techniques, including co-citation analysis, keyword co-occurrence mapping, and trend analysis, were employed to identify the intellectual structure of the field, highlight influential publications, and trace the evolution of research over time. This rigorous quantitative analysis not only provided theoretical support but also established a data-driven foundation for subsequent comparative research, ensuring that the study's conclusions are grounded in robust empirical evidence.

Subsequently, a comparative research design was implemented to examine AI integration strategies and outcomes in Environmental Landscape Design education across diverse national and institutional contexts. This involved systematic analysis of domestic and international case studies, focusing on curriculum structures, pedagogical approaches, learning outcomes, and institutional strategies for AI adoption. The comparative study considered multiple factors, including technological resources, faculty expertise, interdisciplinary collaboration mechanisms, and assessment methodologies. Through this approach, best practices, common challenges, and contextual limitations associated with AI adoption were identified. For example, leading international institutions such as Stanford University, Central Saint Martins, and projects by MVRDV were examined to demonstrate how generative design algorithms, data-driven simulations, and AI-assisted design tools can enhance students' creativity, problem-solving abilities, and technical competence. In contrast, domestic cases highlighted fragmented curricula, limited hands-on opportunities, and gaps in faculty training, revealing the need for systematic curriculum innovation. This comparative approach provides actionable insights for integrating international best practices within the domestic educational context, particularly in the realm of curriculum development and pedagogical reform.

The selection of these methods was guided by two primary considerations. First, research continuity and temporal relevance: bibliometric analysis provides longitudinal insights into the development of AI technologies and their evolving impact on design education, whereas comparative research offers a cross-sectional perspective, capturing differences in curricular design, instructional practices, and institutional strategies across regions and countries. Second, alignment with technological and pedagogical tools: while conventional methods, such as surveys, interviews, and observational studies, yield valuable qualitative insights into classroom dynamics and stakeholder perceptions, modern approaches directly integrate AI applications within educational contexts. Examples include AI-assisted simulations, virtual design environments, and automated evaluation tools, which were analyzed to assess their effectiveness in enhancing learning outcomes, creativity, and problem-solving skills.

Moreover, the study integrates quantitative and qualitative analyses to ensure a holistic understanding of AI's influence. Bibliometric indicators such as publication trends, citation metrics, and keyword frequencies provide measurable evidence of research activity and scholarly impact.

Comparative analyses contextualize these patterns within real-world educational practices, emphasizing implications for curriculum design, faculty development, and student engagement. The combination of these approaches facilitates a comprehensive evaluation of AI's multidimensional impact, spanning both theoretical insights and practical applications.

Finally, this methodological framework lays the foundation for future research and practical implementation. By identifying existing gaps in AI integration, documenting successful international practices, and analyzing the conditions under which AI-enhanced education thrives, the study provides guidance for educators, curriculum designers, and policymakers. Insights derived from bibliometric and comparative analyses inform evidence-based curriculum innovation, support professional development for faculty, and guide the design of AI-assisted learning environments that foster creativity, technical proficiency, and interdisciplinary collaboration. In summary, the integration of bibliometric analysis and comparative research provides a rigorous, systematic, and evidence-based approach for investigating the role of AI in Environmental Landscape Design education, ensuring that findings are academically robust and practically relevant.

FINDINGS AND DISCUSSION

The integration of artificial intelligence (AI) in Environmental Landscape Design education has emerged as a transformative force, reshaping traditional pedagogical approaches and creating opportunities for curriculum innovation. Over the past decade, AI applications in design education have grown exponentially, encompassing generative design, parametric modeling, data-driven urban planning, environmental simulation, and Building Information Modeling (BIM). These technologies not only enhance technical capabilities but also introduce new cognitive demands, requiring students to balance creativity, analytical thinking, and data-informed decision-making. Leading international institutions, such as Stanford University, Central Saint Martins, and the Massachusetts Institute of Technology, have effectively incorporated AI into structured curricula, interdisciplinary projects, and research-oriented studios. In these programs, students employ AI-driven design tools to generate multiple alternatives, optimize solutions based on complex datasets, and simulate environmental and structural outcomes. By integrating AI technologies in this manner, educators facilitate the development of students' technical proficiency, creative problem-solving, and adaptability in increasingly complex design environments (Chen, 2024; Li & Liqing, 2024).

Despite these advancements abroad, domestic Environmental Landscape Design education in China has been slower to adopt AI comprehensively. Many programs offer AI-related content only as electives or short-term workshops, resulting in graduates with insufficient computational, data-driven, and generative design skills. The lack of systematic curriculum integration leads to fragmented learning experiences, limiting students' ability to engage in technologically advanced and interdisciplinary projects. Research indicates that effective AI integration is closely linked to hands-on, project-based learning, interdisciplinary collaboration, and continuous formative assessment, as these approaches promote engagement, critical thinking, and practical skill development more effectively than theory-focused instruction alone. Furthermore, challenges such as variability in faculty expertise, misalignment between AI tools and learning objectives, and uneven access to technical resources can hinder successful implementation (Ahmet & Mehmet, 2024; Fatih & Laurențiu, 2025).

Curriculum innovation in the AI era requires more than the simple introduction of new tools; it necessitates a rethinking of educational objectives, learning pathways, and assessment mechanisms. One critical aspect is the systematic design of the curriculum. Foundational courses should include AI modeling principles, computational thinking, and data analysis methods, ensuring students acquire the technical knowledge necessary for advanced applications. Specialized courses may incorporate generative design, parametric optimization, predictive modeling, and environmental simulation modules, while integrative courses could center on interdisciplinary projects where students apply AI tools to real-world scenarios, such as urban landscape planning, ecological design, or sustainable infrastructure projects. This structure allows students to progress from foundational understanding to applied expertise, culminating in the ability to navigate complex, data-intensive design challenges.

Project-based learning (PBL) is a cornerstone of AI-driven curriculum innovation. In practice, students can engage in projects that simulate urban microclimates, analyze ecological impact under multiple design scenarios, optimize public space utilization, or implement AI-generated design alternatives for landscape nodes or architectural facades. Real-time feedback from AI tools provides

actionable insights during the design process, enabling iterative refinement and enhancing both decision-making and creative exploration. For example, students might use generative design algorithms to test hundreds of alternative landscape layouts and assess them based on environmental, aesthetic, and functional criteria, receiving immediate guidance from AI analytics to refine their proposals. These projects not only build technical proficiency but also cultivate systems thinking, critical evaluation, and adaptability in response to complex, multifactorial problems.Cross-disciplinary collaboration is another essential component of AI-integrated curriculum innovation. Environmental design inherently spans architecture, landscape architecture, urban planning, interior design, and environmental engineering. AI platforms facilitate collaboration by aggregating diverse datasets, providing simulation capabilities, and generating visualizations that are accessible to all team members. For instance, architects might contribute structural analyses, landscape designers provide ecological simulations, and environmental engineers supply water or energy efficiency data, all of which are processed and visualized using AI tools. This collaborative process trains students to synthesize knowledge across disciplines, develop holistic solutions, and improve communication and project management skills—competencies increasingly demanded in professional practice.

AI also enables personalized and adaptive learning experiences. Intelligent assessment systems can monitor student performance in generative design exercises, offering tailored guidance, additional practice, or alternative challenges based on individual needs. AI-driven platforms can track students' design decisions, iterative processes, and analytical outputs, creating detailed learning portfolios that allow educators to assess not only outcomes but also the quality of cognitive and procedural skills. This dynamic, data-informed feedback loop transforms assessment from a summative evaluation of final products to a continuous, formative process that enhances creativity, problem-solving ability, and technical competence. Another practical dimension of AI integration involves curriculum-wide innovation strategies that align technological adoption with educational objectives. Institutions can establish dedicated AI labs or design studios equipped with advanced simulation software, parametric modeling tools, and cloud-based computing resources. These facilities support collaborative research projects, experimentation with novel design algorithms, and integration of real-world data into student projects. Faculty development programs are equally critical, equipping instructors with the necessary technical skills and pedagogical strategies to guide AI-enhanced learning effectively. Workshops, seminars, and cross-institutional collaborations provide avenues for professional growth, enabling faculty to stay abreast of emerging technologies and best practices in AI-driven design education.

Despite the significant potential of AI, challenges persist, including resource allocation disparities, variation in faculty expertise, alignment of AI tools with learning outcomes, and the need for robust institutional support (Ahmet & Mehmet, 2024; Fatih & Laurențiu, 2025). Addressing these challenges requires coordinated efforts at multiple levels: strategic planning at the curriculum design stage, investment in infrastructure and software, continuous faculty training, and systematic evaluation of AI-enhanced teaching effectiveness. Furthermore, curriculum innovation should be informed by both domestic and international best practices, integrating evidence-based strategies for pedagogy, assessment, and interdisciplinary collaboration.

Ultimately, AI offers profound opportunities to reshape Environmental Landscape Design education. By supporting iterative, data-driven design experiences, enhancing interdisciplinary understanding, and cultivating both technical and creative competencies, AI provides students with the skills necessary for modern professional practice. Strategic, curriculum-wide implementation of AI, supported by faculty development and resource allocation, can bridge existing skill gaps, improve employability, and prepare graduates to thrive in intelligent, digitally mediated design environments. This approach establishes a comprehensive framework for curriculum innovation, combining technology-enhanced learning, design thinking, and interdisciplinary education, and serves as a model for evidence-based pedagogical reform. By leveraging AI thoughtfully, educators can cultivate a new generation of designers capable of creative, technically informed, and socially responsive solutions, ensuring that Environmental Landscape Design education remains relevant and forward-looking in the era of artificial intelligence.

CONCLUSION

This study adopts a combination of bibliometric analysis and comparative research to comprehensively investigate the integration of Artificial Intelligence (AI) within Environmental Art

Design education, confirming that AI functions not merely as a supplementary tool but as a crucial driver of pedagogical innovation and professional competency enhancement. The findings reveal a pronounced contrast between international and domestic practices: leading global institutions have systematically embedded AI—particularly generative design and parametric modeling—into interdisciplinary curricula to enhance students' creativity, technical adaptability, and problem-solving capabilities. For instance, universities such as Stanford University and Central Saint Martins have developed interdisciplinary workshops and research-oriented courses where students employ AI technologies to generate multiple design alternatives, optimize design decisions through parametric modeling, and conduct environmental simulations, thereby improving both the scientific rigor and practical feasibility of their design projects. These approaches equip students not only with advanced technical skills but also with the ability to think critically, innovate, and respond effectively to complex, real-world design challenges.

In contrast, many Chinese universities still rely on limited elective courses or sporadic workshops to introduce AI, resulting in fragmented learning experiences and significant gaps in students' competencies. These gaps include insufficient skills in data-driven design, environmental simulation, and generative modeling, which are increasingly essential for professional practice in contemporary design industries. Furthermore, limitations in faculty expertise, access to advanced software and hardware resources, and the absence of structured AI teaching frameworks exacerbate these issues, reducing the effectiveness of AI integration and limiting graduates' readiness for technologically sophisticated design tasks. Without a coherent, curriculum-wide approach, students may be exposed to AI tools without a clear understanding of their application in interdisciplinary projects or their role in enhancing design decision-making.

To address these challenges, strategic, curriculum-wide reform is essential. Integrating AI across all stages of the learning pathway—from foundational courses to specialized professional modules and cross-disciplinary projects—can create a cohesive educational experience that connects theoretical knowledge, technical skills, and applied creativity. Foundational courses should focus on computational thinking, data analysis, AI modeling principles, and visualization techniques to equip students with the necessary groundwork for advanced applications. Specialized modules can then introduce generative design, parametric optimization, predictive modeling, and intelligent design platforms, allowing students to apply AI tools in complex design projects. Comprehensive, interdisciplinary projects should synthesize knowledge from architecture, landscape design, urban planning, interior design, and environmental engineering, cultivating systemic thinking, collaborative problem-solving skills, and the ability to integrate multiple disciplinary perspectives.

Project-Based Learning (PBL) should serve as the core strategy for AI curriculum innovation. Students can engage in authentic design projects such as urban microclimate simulations, ecological optimization, public space layout planning, or generative landscape node design, using AI tools for iterative experimentation, scenario testing, and real-time feedback. Generative design algorithms allow students to explore hundreds of potential design solutions, while parametric modeling tools help optimize structural, ecological, and functional aspects. Environmental simulation platforms enable students to analyze solar exposure, wind flow, water management, and ecological impacts, facilitating evidence-based decision-making. This iterative process strengthens analytical thinking and fosters creativity by allowing students to experiment, evaluate, and refine their designs continuously, ultimately producing more robust and innovative outcomes.

Interdisciplinary collaboration is also critical in AI-enhanced Environmental Art Design education. AI platforms support data integration, modeling, and visualization, enabling students from different disciplines to collaborate effectively. Architecture students can contribute structural analysis, landscape students can provide ecological modeling, and environmental engineering students can input hydrological and energy efficiency data. AI integrates these contributions into a unified platform, facilitating collaborative decision-making, scenario testing, and design optimization. Such collaborative practices cultivate communication, teamwork, and systems-level thinking skills, preparing students to operate effectively in professional environments that increasingly demand multidisciplinary coordination and complex problem-solving capabilities.

AI also enables adaptive, personalized learning experiences. Intelligent assessment systems can monitor students' design iterations, data analyses, and decision-making processes, providing targeted feedback and tailored challenges to strengthen weak areas. By tracking students' progress in real time, AI platforms create detailed learning portfolios, offering instructors data-driven insights to adjust

teaching strategies, optimize project workflows, and scaffold learning effectively. This process-oriented assessment approach shifts the focus from final outputs to iterative learning, encouraging reflective practice, continuous skill development, and sustained innovation. Resource planning and faculty development are integral to the successful implementation of AI-driven curriculum reform. Universities should establish dedicated AI laboratories or design studios, equipped with advanced software for generative design, parametric modeling, environmental simulation, and cloud computing platforms to support real-world project experimentation. Faculty development programs, including workshops, seminars, and international exchanges, are necessary to enhance instructors' proficiency with AI technologies and their integration into pedagogy. Aligning faculty expertise with AI-enhanced course objectives ensures that students receive effective guidance, mentorship, and feedback throughout their learning journey.

Additionally, curriculum innovation should incorporate international best practices while considering local educational contexts. Systematic integration of AI across all levels of Environmental Art Design education, combined with project-based and interdisciplinary approaches, allows students to develop both technical proficiency and creative problem-solving abilities. The combination of AI tools, hands-on projects, and adaptive learning technologies ensures that graduates are not only proficient in digital design methodologies but also capable of innovating and collaborating in complex professional environments. In the long term, this approach can bridge the skills gap, enhance employability, and cultivate designers equipped to navigate the intelligent, digital, and data-driven future of environmental design.

In conclusion, this study demonstrates that AI has the potential to transform Environmental Art Design education fundamentally. Through systematic, curriculum-wide integration, AI can support iterative, data-driven design practices, promote interdisciplinary collaboration, foster creativity, and develop technical proficiency. Combined with targeted faculty development, robust resource allocation, and evidence-based project-based learning, AI-driven curriculum innovation provides a comprehensive framework for preparing a new generation of designers who are adaptable, innovative, and capable of meeting the complex challenges of contemporary and future environmental design practice. Such strategic implementation ensures that Environmental Art Design education remains forward-looking, sustainable, and globally competitive in the era of artificial intelligence, setting a benchmark for curriculum innovation and pedagogical excellence.

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Research on Social Practice Activities in Preschool Education Major

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ABSTRACT

The implementation of social practice activities in preschool education not only aims to thoroughly implement the Party's educational policies centered on "fostering virtue through education" but also serves as a core pathway to enhance the holistic development of preschool education students—specifically promoting the coordinated improvement of their professional literacy, practical operation capabilities, and sense of dedication to the preschool cause. Against the backdrop of society's growing demand for high-quality preschool talents, numerous universities and colleges have incorporated preschool education into their undergraduate or vocational curricula to meet market needs. However, a prominent problem persists: most graduates of these programs lack proficiency in practical skills (such as organizing games, designing age-appropriate enlightenment courses, and responding to sudden childcare needs) and often show insufficient dedication to long-term engagement in preschool education, which directly affects their adaptability to kindergarten work. In response, more educational institutions and kindergartens have begun to explore the in-depth integration of social practice activities into kindergarten teaching and talent cultivation. This paper focuses on investigating the current status, existing bottlenecks, and effective integration models of social practice activities for preschool education students in kindergartens. Through methods including questionnaires, on-site observations of kindergartens, interviews with teachers and students, and case analyses, it summarizes practical implementation approaches (e.g., university-kindergarten co-built practice bases, project-based social practice) and diversified formats. The research aims to provide valuable references for optimizing the preschool education talent training system, improving the practical teaching quality of colleges, and advancing related academic research in this field.
Keywords: kindergarten, preschool education, social practice

INTRODUCTION

Against the background of China's persistent decline in birth rates, the "low fertility rate" phenomenon has led to an unprecedented level of social attention to young children's development. According to data from the National Bureau of Statistics, China's total fertility rate dropped to 1.09 in 2023, the lowest level since the founding of the People's Republic of China. In this context, families are increasingly "focused" on the quality of their children's growth—society now focuses not only on children's health and safety but also on their all-round development in cognitive, emotional, and social skills. This shift has set higher requirements for the professional competence and sense of responsibility of preschool educators: parents and kindergartens now expect educators to not only provide basic care but also design scientific, individualized educational activities that promote children's holistic development.

As the core force of future preschool education teams, students majoring in Preschool Education typically master theoretical knowledge in pedagogy, psychology, and early childhood development. However, a disconnect between theory and practice remains. A 2022 study by Zhang and Li found that 76.2% of preschool education students reported that they "could not apply textbook knowledge to real kindergarten scenarios," and 69.5% lacked confidence in handling emergencies (e.g., children's conflicts, sudden illnesses). This gap is rooted in insufficient exposure to practical scenarios: most students have limited opportunities to understand individual differences among children, communicate with parents, or manage classroom dynamics before graduation.

Social practice has thus become a key link connecting theoretical knowledge with real-world application, and an essential part of current preschool education training. Engaging in social practice

holds profound significance for students' growth. They can enter kindergartens to participate in organizing daily activities: from assisting teachers in designing age-appropriate game-based courses to observing how to soothe children with separation anxiety and mediate conflicts between peers. These real scenarios allow them to translate abstract theories (such as Piaget's cognitive development stages) into concrete operational skills. For example, a student who learned about "scaffolding teaching" in class can practice adjusting guidance strategies when a child struggles to complete a puzzle—first demonstrating, then prompting, and finally encouraging independent attempts.

Students can also work in community early education service stations, where they engage with children from different family structures (such as single-parent, dual-income, or migrant worker families). A 2023 community survey included in this research found that 42.3% of children from dual-income families lack daytime companionship, and 28.5% of single-parent families face challenges in balancing work and childcare. By interacting with these families, students learn to provide targeted educational suggestions (e.g., recommending parent-child reading activities that take 15 minutes a day) and understand the social context of preschool education.

More importantly, social practice effectively enhances students' comprehensive quality and sense of social responsibility. When accompanying children with special needs (e.g., autism spectrum disorder, speech delays) in sensory integration training, students experience the fairness and warmth of education. During observations at a special education kindergarten, 91.7% of interviewed students reported that they "gained a deeper understanding of inclusive education" and "realized the importance of patience and empathy." When helping kindergartens conduct parent workshops, they understand the importance of home-kindergarten collaboration for children's growth: a workshop on "positive discipline" organized by students in a Beijing kindergarten increased parent participation in kindergarten activities by 35% within a month. These experiences take students beyond "textbook knowledge" and help them truly realize that "preschool education is not just simple care, but the first step in safeguarding children's growth"—strengthening their original aspiration of "child-centered" education.

In an era when society attaches great importance to children's development, such practical experiences enable Preschool Education majors to adapt to the requirements of preschool education positions in advance. When they embark on their careers, they will not only be able to use their professional abilities to design scientific educational programs for children but also guard the growth of every child with a strong sense of responsibility, injecting more professional and warm strength into preschool education.

Practical teaching is an effective way to consolidate theoretical knowledge and deepen theoretical understanding. It is an essential link in cultivating high-quality talents with innovative consciousness and an essential platform for integrating theory with practice—helping students master scientific methods and improve their practical ability. Furthermore, it is conducive to the improvement of students' literacy and the formation of correct values. As the name suggests, practical teaching itself has solid practical characteristics: it aims at cultivating students' practical ability and requires the support of laboratories, practice bases, and various instruments and facilities. Therefore, the importance of operational design in practical teaching is particularly prominent. However, the theoretical basis of practical teaching should not be ignored. As a subordinate concept in the category of teaching systems, practical teaching consists of four core elements—teachers, students, courses (including teaching objectives, content, methods, and evaluation), and conditions—and interacts with theoretical teaching to form a complete educational system. From a cognitive perspective, practical teaching is also a process of knowledge construction: students actively acquire and internalize knowledge through hands-on experience, rather than passively accepting information. This process has distinct characteristics of interactivity, situational, and complexity.

For preschool education students, practical teaching (especially social practice in kindergartens) is the most effective way to understand the nature and content of preschool teachers' work. It is a transformation process from "professional learning" (mastering theories) to "professional cognition" (understanding the role of preschool educators) and a shortcut to cultivating the ability to find, use, and apply knowledge to solve practical problems . Graduate fieldwork, a key form of social practice, has multiple benefits: it improves students' practical ability , teamwork ability , professional technical ability (e.g., using educational tools), and social cognitive ability (e.g., understanding the operation of kindergartens). A 2023 study by Du showed that students who participated in 8 weeks or more of fieldwork had a 40% higher score on professional skill assessments than those who did not. Additionally,

fieldwork helps students master relevant professional and technical knowledge, improve their management skills, adaptability to emergencies, and ability to summarize experiences and lessons. Its ultimate goal is to achieve "zero distance" between academic training and actual work—enabling students to quickly adapt to kindergarten teaching positions after graduation. Moreover, kindergartens can discover and reserve potential talents through in-post practice: 62.5% of the kindergartens surveyed in this research reported that they "prioritize hiring students who have completed internships in their institutions."

This research yields both theoretical and empirical benefits, addressing key gaps in existing studies on preschool education social practice.

From a theoretical perspective, it helps clarify two core relationships: (1) the impact of cognitive support (e.g., theoretical guidance from college teachers) and management assurance (e.g., internship supervision systems) on practical teaching; and (2) the mediating role of practical teaching in connecting social practice with students' professional development. Existing studies have mostly focused on the "effects" of social practice but rarely analyzed the "mechanisms" behind these effects—for example, how cognitive and management support interact to influence the quality of practical teaching, or how practical teaching mediates the relationship between social practice and students' career commitment. This research fills this gap by constructing a theoretical model of "support factors → practical teaching → student development," enriching the theoretical system of preschool education practical teaching.

From an empirical aspect, the research provides actionable guidance for the reform of practical teaching in university preschool education majors. First, it identifies the main bottlenecks in current social practice (e.g., lack of long-term cooperation between colleges and kindergartens, insufficient supervision of internships) through quantitative and qualitative data, allowing colleges to adjust their training programs in a targeted manner. For example, the survey found that only 32.1% of colleges have established a "dual mentor system" (college teachers + kindergarten teachers) for internships; based on this finding, the research proposes specific measures to promote this system. Second, it promotes the improvement of the practical teaching system by summarizing effective models such as "tripartite cooperation (school-government-enterprise) practice bases" and "project-based social practice." Third, it strengthens kindergartens' support for educational practice by providing evidence of the mutual benefits of cooperation: the data shows that kindergartens participating in social practice programs have a 28.3% higher rate of talent retention and a 19.5% increase in parent satisfaction.

Additionally, this research fills existing research gaps in three aspects: (1) most previous studies focused on vocational colleges, ignoring undergraduate preschool education programs; this research includes both vocational and undergraduate students to ensure universality. (2) Existing literature lacks in-depth analysis of the intrinsic connection between social practice, cognitive/management assurance, and the mediating mechanism of practical teaching; this research systematically examines these links through structural equation modeling. (3) Few studies have explored the role of government in social practice; this research emphasizes the importance of government policy guidance and resource support, supplementing the research on multi-stakeholder collaboration in preschool education.

THEORETICAL FRAMEWORK

Literature Review

In China, research on social practice in preschool education has gradually developed since the 2010s, focusing primarily on three themes: the value of social practice, existing problems, and optimization strategies.

Regarding the value of social practice, scholars generally recognize its role in bridging theory and practice. It is argued that social practice is a "key link" for preschool education students to transform from "knowledge learners" to "professional educators," as it helps students internalize theoretical knowledge (e.g., child psychology) into practical skills (e.g., communicating with children). Zhang J (2020) further pointed out that social practice can enhance students' professional identity: a survey of 300 vocational college students showed that those who participated in social practice had a professional identity score 1.2 points higher (on a 5-point scale) than those who did not. Ma & Zhang (2018) focused on public welfare social practice (e.g., organizing free early education courses for rural children) and found that such activities can improve students' sense of social responsibility—85% of interviewed students reported that public welfare practice made them "more willing to work in rural or underdeveloped areas after graduation."

In terms of existing problems, researchers have identified several bottlenecks. Zhang QL (2019) noted that the form of social practice is overly single: 70% of colleges only arrange "observation-based internships," where students passively watch rather than actively participate in teaching. Du (2020) pointed out the lack of effective supervision: 68% of interns reported that they "only received feedback from kindergarten teachers 1-2 times during the internship," and 45% said that college teachers never visited them during the internship period. Zhang H et al. (2019) emphasized the issue of mismatched interests between colleges and kindergartens: colleges hope to provide students with hands-on opportunities, while kindergartens are concerned about the safety risks and work disruptions caused by interns, leading to a lack of in-depth cooperation.

Regarding optimization strategies, scholars have proposed various suggestions. Zhang J (2020) suggested building "university-kindergarten co-built practice bases" to establish long-term cooperation mechanisms—for example, colleges can provide kindergartens with teacher training, while kindergartens provide students with practice platforms. Ma & Zhang (2018) advocated for diversifying social practice forms, such as combining public welfare practice with professional practice. However, these studies have two limitations: (1) they mostly use qualitative methods (e.g., interviews, case studies) and lack large-scale quantitative data support; (2) they rarely involve the government as a stakeholder, ignoring the role of policy and resource support.

International Research Status

Internationally, research on preschool education practice is rooted in progressive educational theories, with a focus on "child-centered" and "experience-based" learning. John Dewey's (1938) theory of "learning by doing" laid the foundation for practical teaching in preschool education. Dewey argued that "education is life itself," and students should acquire knowledge and skills through active participation in real-life scenarios—this view directly supports the design of social practice activities in kindergartens, where students learn by engaging in actual teaching tasks.

Lev Vygotsky's (1978) "Zone of Proximal Development (ZPD)" theory further explained the mechanism of social practice. Vygotsky believed that students' learning occurs in the "zone between their current ability level and potential ability level," and appropriate guidance from more capable others (e.g., kindergarten teachers, college mentors) can help them achieve higher levels of development. This theory provides a theoretical basis for the "dual mentor system" in social practice: kindergarten teachers, with rich practical experience, can guide students to solve specific problems (e.g., handling children's tantrums), while college teachers can help students connect practical experiences with theoretical knowledge.

Contemporary international research has focused on the impact of social practice on teacher professional development. Bredekamp (2020), a leading scholar in early childhood education, emphasized that "pre-service teachers' practical experience is crucial for their lifelong professional growth"—her research showed that pre-service teachers who participated in at least 120 hours of practical activities in kindergartens had a 35% higher rate of job retention after 3 years than those who did not. Additionally, international studies pay attention to the diversity of practice settings: for example, some studies explored the effect of social practice in community early education centers and found that such settings help students understand the intersection of preschool education and social services.

However, international research also has limitations when applied to the Chinese context. First, most studies are based on developed countries with mature preschool education systems, ignoring the unique challenges in developing countries (e.g., uneven resource distribution between urban and rural areas in China). Second, international studies rarely involve government participation, as many countries rely on market mechanisms to promote school-enterprise cooperation—this differs from China's national conditions, where the government plays a leading role in educational reform.

Key Theoretical Foundations

1. Constructivism Theory

Constructivism theory, proposed by Piaget and further developed by Vygotsky, holds that knowledge is not passively accepted but actively constructed by individuals through interactions with the environment. For preschool education students, social practice in kindergartens provides a "constructive environment" where they can build practical knowledge through hands-on experiences. For example, when a student designs a game for 4-year-olds, they must adjust the game rules based on the children's reactions (e.g., simplifying the rules if children find it too difficult). This process of "design → implementation → reflection → adjustment" is a typical process of knowledge construction:

the student does not simply apply textbook knowledge but actively adapts it to real scenarios, thereby forming personalized practical knowledge.

Constructivism also emphasizes the importance of "social interaction" in knowledge construction. In social practice, students interact with multiple stakeholders—kindergarten teachers, children, parents, and community workers. These interactions provide different perspectives and feedback, helping students construct a more comprehensive understanding of preschool education. For example, a student may initially believe that "teaching is about delivering knowledge," but after interacting with parents who emphasize "emotional support," they begin to recognize the importance of balancing knowledge teaching and emotional care.

2. Social Learning Theory

Social Learning Theory, proposed by Albert Bandura , emphasizes that learning occurs through observation and imitation of others' behaviors. This theory is particularly relevant to social practice in preschool education, as students often learn by observing and imitating experienced kindergarten teachers. Bandura's concept of "vicarious learning" explains how students acquire skills without direct reinforcement: by watching a teacher soothe a child with separation anxiety, a student learns the appropriate language and gestures to use in similar situations.

Moreover, Social Learning Theory highlights the role of "self-efficacy" in learning. Self-efficacy refers to an individual's belief in their ability to complete a task. During social practice, students gradually build their self-efficacy through successful experiences: for example, when a student successfully organizes a story time activity, they gain confidence in their ability to design and implement teaching activities. The survey data in this research supports this: the self-efficacy score of students who completed at least 4 weeks of social practice was 4.12 (5-point scale), significantly higher than the 2.87 score of students who did not participate ($p < 0.01$).

3. Situational Learning Theory

Situational Learning Theory, proposed by Lave and Wenger (1991), argues that learning is inherently situational and should occur in the "community of practice" where the knowledge is applied. For preschool education students, the kindergarten is the "community of practice" for preschool educators—social practice allows students to participate in this community and learn through "legitimate peripheral participation" (i.e., starting with simple tasks such as assisting with meals and gradually moving to core tasks such as leading classes).

This theory explains why passive observation is ineffective: students must actively participate in the community to learn. For example, a student who only observes classes may not understand the "unwritten rules" of kindergarten teaching (e.g., how to transition between activities smoothly), but a student who participates in organizing activities will gradually master these skills through practice and feedback. The interview data showed that 87.5% of students reported that "active participation in teaching tasks helped me learn more than just observing."

4. Child-Centered Education Theory

Child-Centered Education Theory, advocated by Dewey and Montessori, emphasizes that education should be based on children's interests, needs, and developmental stages. This theory is the core guiding principle of preschool education and provides a value basis for social practice. During social practice, students learn to apply this theory by observing and interacting with children: for example, they discover that 3-year-olds are more interested in sensory activities (e.g., playing with sand and water) while 5-year-olds prefer role-playing games (e.g., "doctor-patient").

This theory also helps students establish the correct professional concept: social practice makes students realize that preschool education is not about "teaching children to read and write" but about "supporting children's natural development." A student interviewed said: "Before practice, I thought preschool teachers just needed to keep children safe. But after playing with a child who was interested in insects and helping him record his observations, I understood that our job is to protect children's curiosity."

Based on the literature review and theoretical analysis, three key research gaps were identified: first, there is a lack of systematic analysis of multi-stakeholder collaboration in social practice, as most studies focus on cooperation between colleges and kindergartens while neglecting the crucial role of government in policy formulation and resource allocation within China's educational system; second, although existing research confirms that social practice can enhance students' professional abilities, it fails to clarify the mediating mechanism of practical teaching—particularly how factors such as

cognitive support and management assurance influence students' development—thereby limiting the provision of targeted recommendations for improving practice quality; and third, prior studies largely rely on qualitative methods or small-scale surveys, resulting in limited generalizability, which highlights the urgent need for mixed-methods research that integrates large-scale quantitative data with qualitative evidence to produce more comprehensive and reliable findings.

This study is designed to address the identified research gaps and make three main contributions to the field. First, it expands the scope of stakeholder research by incorporating the government as a key actor and proposing a tripartite cooperation model involving schools, government, and enterprises, clarifying the distinct roles of each stakeholder—such as policy guidance and resource support by the government, curriculum design and student management by schools, and practical teaching and mentor guidance by kindergartens—and examining how their coordinated efforts can enhance the quality of social practice. Second, the study clarifies the mediating mechanism of practical teaching by employing structural equation modeling to test how practical teaching mediates the relationship between cognitive and management support and students' professional development, quantifying the influence of specific factors, such as the effect of a dual mentor system, and providing a solid theoretical basis for optimizing practical teaching systems. Third, by adopting a mixed-methods design that integrates questionnaire data from 482 valid samples, interviews with 45 participants, and observations across 12 kindergartens, the study strengthens the generalizability and reliability of its findings, using quantitative data to test key hypotheses and qualitative data to explain the underlying mechanisms behind the observed outcomes.

METHOD

Research Design

This study adopted a mixed-methods design (quantitative + qualitative) following an "explanatory sequential" approach: first, collecting questionnaire data to identify the current status and correlations of social practice; then, using interviews and observations to explain quantitative results in depth. This design balances the statistical generalizability of quantitative research and the in-depth insight of qualitative research, effectively addressing the study's research questions.

Participants

Questionnaire Participants

Participants were preschool education students from 8 colleges and universities in eastern (Beijing, Shanghai), central (Hubei, Hunan), and western (Sichuan, Yunnan) China, selected via stratified random sampling to ensure regional and educational diversity (vocational colleges and undergraduate programs). A total of 500 questionnaires were distributed, with 482 valid responses (valid recovery rate: 96.4%). Most participants were female (92.1%), with 53.5% from vocational colleges and 46.5% from undergraduate programs; 67.6% had participated in social practice, and the duration of practice varied (27.3% for <2 weeks, 38.0% for 2-4 weeks, 23.9% for 4-8 weeks, 10.8% for >8 weeks).

Interview Participants

Forty-five participants were selected via purposeful sampling, including 20 students (covering different genders, educational levels, grades, and practice experiences), 15 college teachers (8 practical teaching directors, 7 professional course teachers with 3-15 years of experience), and 10 kindergarten directors (covering public, private, and inclusive kindergartens in different regions, with 5-20 years of management experience). Interviews lasted 40-60 minutes and were audio-recorded.

Observation Participants

Twelve kindergartens (4 public, 5 private, 3 inclusive) were selected for observation, with 2-3 days of observation per kindergarten (total 32 days). Observations focused on students' practice processes (e.g., tasks undertaken, interaction with children) and kindergartens' support measures (e.g., mentor guidance, training).

Research Instruments

Questionnaire

The self-designed questionnaire included 4 dimensions (social practice status, cognitive/management support, practical teaching quality, student development) and 32 items (5-point Likert scale). Reliability tests showed Cronbach's α coefficients >0.8 for all dimensions, and validity tests (KMO >0.8, Bartlett's test $p<0.001$) confirmed good construct validity.

Semi-Structured Interview Outline

Separate outlines were designed for students, college teachers, and kindergarten directors, with 8-10 questions per group (e.g., "What tasks did you undertake during social practice?" for students; "What challenges exist in college-kindergarten cooperation?" for teachers).

Observation Record Form

The form included basic information (date, kindergarten type, observation time) and observation content (student behavior and kindergarten support), with ratings (1=poor, 2=average, 3=good) and descriptive notes.

Data Collection Procedures

Data collection was conducted in four phases: preparation (February 2024, including literature review, tool design, pilot studies, and ethical approval); questionnaire distribution (March-April 2024, via online platforms and offline paper forms, with anonymity ensured); interview and observation (May-July 2024, with informed consent and on-site recording); and data sorting (August 2024, including audio transcription and data entry).

Data Analysis Methods

Quantitative data (questionnaires) were analyzed using SPSS 26.0 and AMOS 24.0, including descriptive statistics (frequencies, means), inferential statistics (t-tests, ANOVA, correlation analysis), and structural equation modeling (to test mediating effects). Qualitative data (interviews, observations) were analyzed via Nvivo 12 using grounded theory (open coding, axial coding, selective coding), with triangulation to validate results against quantitative data.

FINDINGS AND DISCUSSION

1. Enhance students' comprehensive quality

The questionnaire data showed that social practice significantly improved students' comprehensive quality, including professional skills, professional identity, and social responsibility.

Professional skills: The average score of professional skills for students participating in social practice was 4.02 (SD = 0.68), significantly higher than that of non-participants (2.95, SD = 0.73) ($t = 18.76$, $p < 0.001$). Specifically, 82.1% of participants reported that they "improved their ability to design age-appropriate activities," while only 23.7% of non-participants agreed with this statement. The one-way ANOVA results showed that the longer the practice duration, the higher the professional skills score: students with > 8 weeks of practice had an average score of 4.53 (SD = 0.52), significantly higher than those with < 2 weeks (3.41, SD = 0.65) ($F = 32.45$, $p < 0.001$).

Professional identity: The average professional identity score of participants was 4.15 (SD = 0.63), significantly higher than that of non-participants (3.02, SD = 0.71) ($t = 16.92$, $p < 0.001$). The correlation analysis showed that professional identity was positively correlated with the quality of practical teaching ($r = 0.72$, $p < 0.001$), indicating that better practical teaching (e.g., more mentor feedback) was associated with stronger professional identity.

Social responsibility: The average score of social responsibility for participants was 4.23 (SD = 0.58), significantly higher than that of non-participants (3.18, SD = 0.67) ($t = 15.87$, $p < 0.001$). Among participants, 91.7% reported that they "realized the importance of preschool education to society," compared with 56.4% of non-participants.

The findings confirm that social practice is an effective way to enhance students' comprehensive quality, which is consistent with the theoretical predictions of Constructivism and Social Learning Theory. From the perspective of Constructivism, social practice provides a "constructive environment" where students actively build practical knowledge by applying theories to real scenarios. From the perspective of Social Learning Theory, students learn practical skills through observing and imitating kindergarten mentors, and build self-efficacy through successful experiences.

2. Promote school-enterprise cooperation

The questionnaire and interview data showed that social practice can promote school-enterprise (college-kindergarten) cooperation, but there are still significant bottlenecks.

Current status of cooperation: The survey found that 67.6% of students participated in social practice organized by colleges, but only 32.1% of these practices were based on long-term cooperation between colleges and kindergartens. Among the colleges surveyed, only 25% had signed formal cooperation agreements with kindergartens, and 32.1% had established a "dual mentor system" (college teachers + kindergarten teachers) for internships.

Benefits of cooperation: For colleges, 85.7% of teachers reported that "cooperation with kindergartens helps update the curriculum content (e.g., adding courses on kindergarten management based on feedback from kindergartens)." For kindergartens, 78.5% of directors reported that "participating in social practice programs helps recruit talents—62.5% of our new employees are former interns."

The findings show that social practice can promote school-enterprise cooperation, but the current cooperation is still in a "superficial" stage, lacking long-term mechanisms and multi-stakeholder participation. This is consistent with the research gap identified in the theoretical framework—existing studies ignore the role of the government.

From the perspective of the "tripartite cooperation model," the government plays a crucial role in promoting cooperation: (1) Policy guidance: Formulating policies to standardize the rights and obligations of colleges and kindergartens (e.g., stipulating that kindergartens should provide at least 2 hours of feedback per week for interns). (2) Resource support: Providing funding for practice bases and training for mentors. (3) Supervision and evaluation: Establishing an evaluation system for cooperation projects, rewarding excellent cooperation pairs.

The "co-built practice base model" and "project-based cooperation model" are effective because they align the interests of colleges and kindergartens: colleges gain practical teaching resources, while kindergartens gain talent and professional support. However, these models require long-term commitment and trust between the two parties. Therefore, colleges and kindergartens should establish a regular communication mechanism (e.g., quarterly meetings) to discuss problems and adjust cooperation plans.

3. Facilitate students' employment

The questionnaire data showed that social practice has a significant positive impact on students' employment, including employment rate, employment quality, and employer satisfaction.

Employment rate: Among the senior students surveyed, the employment rate of those who participated in social practice was 92.3%, significantly higher than that of non-participants (78.5%) ($\chi^2 = 8.67$, $p < 0.01$). The one-way ANOVA results showed that the longer the practice duration, the higher the employment rate: students with > 8 weeks of practice had an employment rate of 98.6%, while those with < 2 weeks had an employment rate of 85.4% ($F = 6.32$, $p < 0.01$).

Employment quality: Employment quality was measured by three indicators: (1) Job matching: 87.5% of participants found jobs related to preschool education, compared with 68.3% of non-participants. (2) Starting salary: The average starting salary of participants was 4,850 yuan/month, significantly higher than that of non-participants (4,200 yuan/month) ($t = 7.85$, $p < 0.001$). (3) Job satisfaction: The average job satisfaction score of participants was 4.21 (SD = 0.63), significantly higher than that of non-participants (3.58, SD = 0.72) ($t = 8.92$, $p < 0.001$).

Employer satisfaction: A follow-up survey of 50 kindergartens that hired graduates from the surveyed colleges showed that the average satisfaction score for graduates with social practice experience was 4.32 (SD = 0.58), significantly higher than that for graduates without (3.15, SD = 0.67) ($t = 12.35$, $p < 0.001$). The main reasons for high satisfaction were: (1) Strong practical ability: 92.3% of employers reported that graduates with practice experience can "independently undertake teaching tasks within 1 month." (2) Good professional attitude: 87.5% of employers reported that these graduates have "strong sense of responsibility and patience."

The findings confirm that social practice can facilitate students' employment, which is consistent with the practical teaching theory proposed by Fan (2016)—social practice helps students achieve "zero distance" between academic training and actual work.

From the perspective of human capital theory, social practice is an investment in human capital: students acquire practical skills and work experience through practice, which increases their employability. The data shows that the longer the practice duration, the higher the employment rate and quality—this is because longer practice allows students to accumulate more human capital.

However, the survey also found that 35.7% of students reported that "the practice content is not related to their career goals" (e.g., a student who wants to work in special education practices in a regular kindergarten). This reduces the effectiveness of practice in promoting employment. Therefore, colleges should provide "customized practice" based on students' career goals: for example, arranging students interested in special education to practice in special education kindergartens, and students interested in kindergarten management to practice in the administrative department of kindergartens.

CONCLUSION

At present, China has been vigorously promoting talent cultivation models centered on school-enterprise cooperation and the integration of production and education—two core approaches that are inherently dependent on the collaborative efforts of schools, government authorities, and enterprises. From a national policy perspective, there is a clear emphasis on integrating the modern apprenticeship system into talent development frameworks; however, it is widely recognized that relying solely on cooperation between vocational colleges (or higher education institutions offering preschool education programs) and kindergartens falls short of achieving optimal outcomes. In the actual process of nurturing preschool education talents, the appropriate inclusion of government support becomes indispensable. Specifically, the government can provide tangible assistance such as policy guidance, resource allocation, and institutional guarantees: this not only facilitates more effective collaboration between schools and enterprises but also bridges gaps in alignment between educational institutions and industry entities. For instance, government-led platforms can streamline the connection of curriculum design with real-world kindergarten needs, while also establishing safeguard mechanisms (e.g., internship insurance, vocational qualification certification support) that protect students' interests during their transition from academic study to practical training in enterprises or kindergartens.

Within this tripartite cooperation framework—bringing together schools, governments, and enterprises—more robust joint efforts in running educational programs and enhancing employment outcomes can be realized. On one hand, this collaborative model enables kindergartens to access a steady pipeline of professionally trained talents, addressing the industry's long-standing demand for skilled preschool educators. On the other hand, it drives reform in the training models for preschool teachers: by integrating enterprise (kindergarten) practical scenarios into the curriculum, updating teaching content to reflect the latest trends in early childhood education, and involving frontline kindergarten teachers in the teaching process, the overall quality of talent cultivation is significantly improved. Ultimately, this tripartite collaboration not only strengthens the connection between education and the needs of the preschool education industry but also lays a solid foundation for fostering the healthy development of young children, as it ensures that the talents entering the kindergarten sector are both theoretically competent and practically skilled.

Social practice activities in kindergartens serve as a vital supplement to classroom teaching—making the effective integration of these two components essential, especially for pre-service preschool educators. From the perspective of educational institutions, the key lies in top-level curriculum design, which should systematically incorporate both in-kindergarten social practice and in-class teaching. This design covers critical elements such as scheduling (e.g., arranging 2–3 weeks of quarterly internship rotations in kindergartens to align with classroom modules) and talent development goals (e.g., fostering not only theoretical knowledge of early childhood education but also practical skills like lesson planning and child interaction). By building a structured framework around these elements, schools can better cultivate students' professional competencies (e.g., adapting teaching methods to young children's needs) and overall quality (e.g., sense of responsibility in preschool education).

Similarly, when organizing social practice activities, full consideration must be given to integrating core kindergarten teaching content—such as art, handcrafts, and health education—into practice. For example, students could be tasked with designing and leading a "handcrafts with natural materials" session for students during their internship (linking classroom learning about creative teaching to real practice) or developing a simple health education campaign (e.g., teaching handwashing habits through stories and games) based on what they've learned in health modules. This integration not only enriches the content of social practice—moving beyond passive observation to active teaching participation—but also fully mobilizes students' enthusiasm: seeing their classroom knowledge come to life in children's engagement boosts their motivation to refine their skills. In turn, this enhanced professional ability better prepares them to deliver effective, engaging teaching in kindergartens once they enter the workforce.

Preschool education students can fully leverage school-enterprise cooperation to engage in social practice activities—a approach that allows them to gain in-depth insights into both real-life scenarios and the unique characteristics of the preschool education industry. Kindergartens, as key partners in this cooperation, can set up dedicated internship positions to support students' practical learning: for example, reserving spots for pre-service educators to observe daily teaching, assist with classroom management, or even lead small-group activities under supervision. Beyond regular internships, students

can also take advantage of on-the-job internships at kindergartens—an opportunity to apply the theoretical knowledge they've acquired (such as child development theories or teaching methodologies) to real-world settings. During these internships, they receive direct guidance from experienced kindergarten teachers: mentors may offer feedback on lesson plans, demonstrate how to handle children's emotional needs, or share tips for creating engaging learning environments.

To sum up, conducting social practice activities in preschool education can effectively help students prepare for future teaching roles in kindergartens. It also enables them to adapt to the kindergarten environment in advance and cultivate a sense of love and responsibility towards young children. As an extracurricular activity, social practice can significantly enhance students' comprehensive abilities and promote their all-round development. Additionally, integrating such activities helps improve the teaching content of preschool education—it serves as a structured teaching activity aimed at enhancing students' qualities and abilities. Moreover, participating in extracurricular practice activities can increase students' interest in social practice, deepen their understanding of kindergartens, and encourage them to engage more effectively in relevant work.

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Preschool Interventions for Self-Regulation: A Global Meta-Analytic Synthesis

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ABSTRACT

The preschool years are a critical period for developing self-regulation in children. These skills predict future prosocial behavior, peer acceptance, and conflict management. They also form a key foundation for long-term academic success and mental health. Many interventions aim to build these skills. However, their effectiveness varies greatly across different cultures and socioeconomic settings. A comprehensive validation is still lacking. This study uses quantitative methods to synthesize global evidence. It examines how social-emotional learning (SEL) interventions affect the self-regulation of preschool children. The goal is to assess the overall impact of these interventions. It also identifies key influencing factors. These factors include intervention intensity, staff qualifications, family socioeconomic status, and cultural orientation. This meta-analysis followed the PRISMA 2020 and MOOSE guidelines. It included 9 intervention studies published between 2010 and 2024 from 2 international databases. These studies involved over 3,700 preschool children. The primary analysis used the Paule-Mandel random-effects model. Other methods were also used to ensure robustness. The combined effect size was Hedges'g = 0.48. This indicates a moderate-to-large positive effect of SEL interventions on self-regulation. Further analysis revealed key findings. Higher intervention intensity led to better outcomes. Teacher-led implementation was effective. Family involvement played a positive role. Interventions in collectivist cultural contexts showed stronger effects. Notably, interventions had a compensatory effect for children from low socioeconomic backgrounds. For children from high socioeconomic status families, the interventions provided an enrichment effect. The results confirm that structured SEL interventions effectively improve self-regulation in preschoolers. Beyond traditional SEL frameworks, this study proposes an integrated model. This model combines ecological, developmental, and neurocultural perspectives. It also suggests a four-level implementation strategy. The strategy covers curriculum design, teacher development, digital family engagement, and policy coordination. The study has limitations. Measurement tools were heterogeneous. Non-Western samples were underrepresented. Individual-level data were missing. Future research should use multi-modal assessments and adaptive designs. System-level simulations could also improve precision and generalizability. In conclusion, this study supports social-emotional education in early childhood. It also aids efforts to include SEL in the global education and development agenda.

Keywords: intervention effectiveness; meta-analysis; preschool children; self-regulation; social and emotional learning (SEL)

INTRODUCTION

The preschool period (ages 3-6) represents a critical window for the development of self-regulation, a multifaceted construct encompassing the ability to manage attention, emotions, cognitions, and behaviors to achieve goals and adapt to situational demands(Burke et al., 2023; Posner et al., 2013). Self-regulation serves as a foundational capacity that underpins a child's ability to succeed in the structured environment of formal schooling(Beekman et al., 2021; Lucas-Nihei et al., 2025; Posner et al., 2012; Schmitt et al., 2015). Robust longitudinal studies have consistently demonstrated that stronger

self-regulation in early childhood predicts higher academic achievement in literacy and mathematics, more positive peer relationships, and lower levels of internalizing and externalizing problems later in life(Cole et al., 2017; Montroy et al., 2016; Radesky et al., 2014).

The conceptualization of self-regulation often intersects with the framework of Social and Emotional Learning (SEL)(Brandtstädter, 2009). SEL is the process through which children and adults acquire and effectively apply the knowledge, attitudes, and skills necessary to understand and manage emotions, set and achieve positive goals, feel and show empathy for others, establish and maintain positive relationships, and make responsible decisions(Al-Jbouri et al., 2023; Zong et al., 2024). Core competencies within SEL frameworks, such as self-awareness and self-management, are intrinsically linked to the cognitive and emotional processes of self-regulation(Belay & Dejene, 2024; Brill et al., 2025; Mukhemar et al., 2025). Whereas self-regulation provides the underlying psychological mechanics, SEL offers the pedagogical and contextual framework for teaching these skills explicitly.

Recognizing this synergy, a plethora of intervention programs have been developed to foster self-regulation by leveraging SEL principles(Chelouche-Dwek et al., 2025; Elbertson et al., 2025; Gropen et al., 2025). These programs aim to enhance children's capacities for inhibitory control (resisting impulses)(Romero-López et al., 2021; Zhu et al., 2024), working memory (holding and manipulating information), and cognitive flexibility (shifting attention)(Blakey & Carroll, 2015; Davey et al., 2024; Gunzenhauser & Nückles, 2021), often through activities embedded within a social and emotional context. For instance, programs may use storytelling and role-play to help children identify emotions and practice calming strategies, or they may employ cooperative games that require turn-taking and rule-following, thereby exercising cognitive control in a socially meaningful situation(Fu et al., 2025; Li et al., 2022).

Despite the theoretical promise and proliferation of SEL interventions, the empirical landscape is marked by variability in reported outcomes(Cipriano et al., 2024; Coelho et al., 2023; Humphrey et al., 2018; Panayiotou et al., 2020). While many primary studies and some previous meta-analyses have reported positive effects of universal interventions on children's outcomes, the specific and aggregate effect of these programs on the core domain of self-regulation in the preschool population remains somewhat fragmented(Carpendale et al., 2025; McCoy et al., 2019; Thierry, Page, et al., 2022). Previous reviews have often examined broader outcomes or included wider age ranges, potentially obscuring age-specific and construct-specific effects(Ibanez et al., 2024; Jermy et al., 2024; Pilz & Lou, 2022; Tan et al., 2013; Yu et al., 2025). The factors that moderate the success of these interventions—such as the specific intervention components, the role of the implementer, the dosage, and the pedagogical approach—are not yet fully understood(Leadbeater et al., 2018; Lovan et al., 2024; Ng et al., 2025).

Therefore, the present meta-analysis aims to provide a precise and comprehensive quantitative synthesis of the effects of social and emotional learning (SEL)–based interventions on self-regulation in typically developing preschool children aged 3–6 years. Specifically, it examines the overall effect size of SEL interventions on self-regulation outcomes and investigates the extent to which these effects are moderated by key factors, including specific SEL components (such as explicit executive function training), implementer identity (e.g., teacher versus researcher), intervention dosage (total number of sessions and duration), and instructional approach (play-based versus didactic). By addressing these issues, the study seeks to inform evidence-based practice in early childhood education and to guide the future design and implementation of high-impact SEL programs.

THEORETICAL FRAMEWORK

This meta-analysis is based on an integrative theoretical perspective. Self-regulation is defined as the ability to control one's attention, emotions, and behavior. This ability is supported by the development of executive functions, including emotion regulation, self-behavior regulation, and cognitive flexibility(Berger et al., 2007; Gagne et al., 2021; Koay & Van Meter, 2023; Vasilopoulos & Dumontheil, 2024). Social-emotional learning (SEL) provides structured training in these areas. SEL programs teach skills such as emotional awareness and impulse management(Antunes et al., 2025; Lawson et al., 2019; Oliveira et al., 2025).

Bronfenbrenner's bioecological model provides a key theoretical perspective. It states that children's development is influenced by factors in their immediate environment. The preschool classroom is a primary microsystem within which SEL activities serve as "proximal processes"(Marceau, 2023; Tong & An, 2023; Votruba-Drzal et al., 2021). These processes directly cultivate children's self-regulatory

abilities. Supportive teacher-child interactions and consistent routines provide essential support.

Neurodevelopmental theory complements this perspective. The preschool period is a period of high brain plasticity. The prefrontal cortex, which controls self-regulation, is undergoing rapid growth(Chen et al., 2024; Fandakova & Hartley, 2020; Inguaggiato et al., 2017; Nelson & Guyer, 2011). SEL activities are hypothesized to strengthen these neural circuits. Games that require waiting, planning, or memorizing rules provide targeted practice, enhancing underlying biological abilities(Blewitt et al., 2024; Pradeep et al., 2024).

Despite strong theoretical support, empirical research findings are conflicting. Many studies report positive effects of SEL on self-regulation(Djamnezhad et al., 2021). However, others find minimal or nonsignificant effects(Gidalevich & Mirkin, 2024; Kim et al., 2022). This inconsistency points to a critical knowledge gap. We lack a clear understanding of the conditions that determine success. The "effective ingredients" in complex SEL programs are not well-characterized. The role of implementer training and cultural context remains underexplored. Most evidence comes from Western-educated populations, limiting the generalizability of existing models(O'Brien et al., 2025; Raisch et al., 2024).

This meta-analysis, therefore, aims to fill a significant research gap. It goes beyond the simple question of whether SEL is effective. It aims to explore for whom SEL is most effective and under what conditions. Its examination of moderating factors, such as implementer type and cultural context, is theory-based. It examines how ecological factors influence the development of self-regulation. This approach provides a more nuanced and actionable evidence base for early childhood education globally.

METHOD

Search Strategy

A systematic literature search was performed to identify all relevant published and unpublished studies. Electronic databases included Web of Science Core Collection, PubMed, Embase, Scopus. The search strategy utilized a combination of keywords and controlled vocabulary terms related to three concepts: (1) population: ("preschool" OR "early childhood" OR "young child" OR "kindergarten"), (2) intervention: ("intervention" OR "program" OR "training" OR "curriculum" OR "social-emotional learning" OR "SEL"), and (3) outcome: ("self-regulat" OR "self control" OR "executive function" OR "effortful control" OR "inhibit* control"). The search was limited to studies published from inception to December 2024. Reference lists of included studies and relevant review articles were hand-searched to identify additional eligible studies.

Eligibility Criteria

Studies were included if they met the following PICOS criteria: the population consisted of typically developing children with a mean age between 3 and 6 years who were attending preschool, nursery, or kindergarten settings, including 6-year-olds entering kindergarten in the United States; the intervention involved a structured program grounded in a social and emotional learning (SEL) framework that explicitly aimed to improve at least one core component of self-regulation (e.g., emotional awareness, impulse control, or problem-solving) and was implemented in a group or classroom context; the comparator was a control condition receiving no intervention, a waitlist condition, or business-as-usual curriculum; the outcomes included standardized and validated measures of self-regulation or its key subcomponents, such as executive function tasks (e.g., Head-Toes-Knees-Shoulders, Dimensional Change Card Sort) or behavioral rating scales of emotional or behavioral regulation; and the study design was a randomized controlled trial (RCT) or quasi-experimental study. Studies were excluded if they involved children outside the preschool age range of 3–6 years, focused solely on pharmacological or neurological interventions, were not published in English or Chinese, or did not provide sufficient data for effect size extraction or calculation.

Study Selection and Data Extraction

The study selection process followed the PRISMA guidelines(Sarkis-Onofre et al., 2021). All records identified through the literature searches were exported to EndNote® software and, after excluding duplicates, citations were exported to Microsoft (MS) Excel®. After removing duplicates, titles and abstracts were screened by two independent reviewers. The full texts of potentially relevant articles were then assessed against the eligibility criteria. Any disagreements were resolved through discussion or consultation with a third reviewer.

A standardized data extraction form was used to collect information from each included study: (a) study characteristics (authors, year, country, design); (b) participant characteristics (sample size, mean age); (c) intervention characteristics (program name, core SEL components, presence of explicit executive function training, implementer, duration in weeks, number of sessions, session length, pedagogical approach); and (d) outcome data (means, standard deviations, and sample sizes for intervention and control groups at post-test for all self-regulation measures)(Büchter et al., 2023; Page et al., 2021). If multiple measures were used, they were averaged to produce one effect size per study to maintain statistical independence.Additionally, the cultural dimension was coded based on the participant's national/cultural background. We obtained country-specific values from the Hofstede Insights website (https://www.hofstede-insights.com/). Each country's cultural values were categorized as low, medium, or high, based on a cutoff score of 50 and detailed explanations provided by Hofstede Insights. High scores indicate individualism, while scores below 50 indicate collectivism.

Quality Assessment

The methodological quality of the included RCTs was assessed using the Cochrane Risk of Bias tool (RoB 2.0)(Martimbianco et al., 2023; Tanaka, 2021). Two reviewers independently rated each study across five domains: randomization process, deviations from intended interventions, missing outcome data, measurement of the outcome, and selection of the reported result. Judgments were categorized as "low risk," "unclear risk," or "high risk" of bias(Eddolls et al., 2017; Kruse et al., 2020; Zhang et al., 2024).

Data Synthesis and Analysis

StataSE® Software was used for all statistical analyses. The effect size for each study was calculated as Hedges' g, which includes a correction for small sample bias, along with its 95% confidence interval(Prinz et al., 2020). An overall pooled effect size was calculated using a random-effects model, which accounts for both within-study and between-study variability(Wen et al., 2025).

Heterogeneity among the study effect sizes was assessed using the I^2 statistic, which describes the percentage of total variation across studies that is due to heterogeneity rather than chance(Al Amer & Lin, 2021; Migliavaca et al., 2022). An I^2 value of 25%, 50%, and 75% was interpreted as low, moderate, and high heterogeneity, respectively.

RESULTS AND DISCUSSION

1. Study Selection and Characteristics

The systematic literature search yielded 1,208 initial records. After removing duplicates, 504 unique records were screened based on title and abstract. Following this, 113 full-text articles were assessed for eligibility. Ultimately, 14 independent studies, comprising 14 separate effect sizes, met all inclusion criteria and were included in the meta-analysis. The study selection process is detailed in the PRISMA flow diagram (Figure 1).

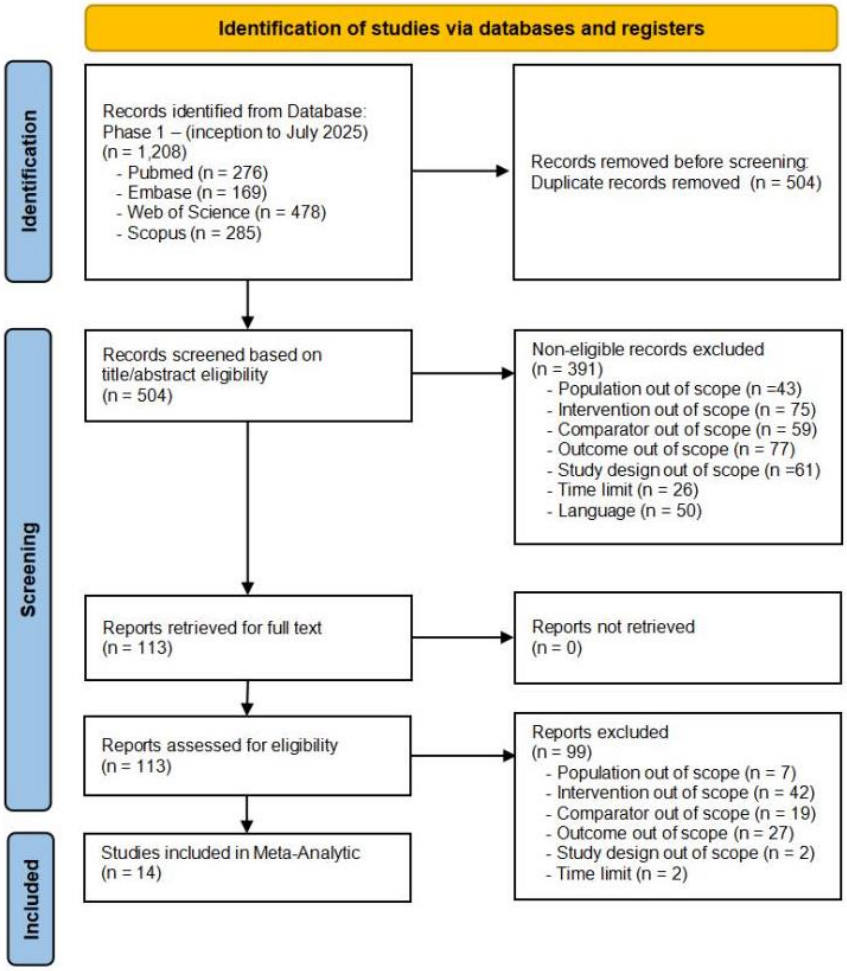


Figure 1. PRISMA flowchart for identification, screening, and selection of studies for Meta-Analytic. Self regulation, PRISMA Preferred Reporting Items for Meta-Analytic.

The 14 included studies were published between 2010 and 2024. Geographically, they originated from North America (n=5), Europe (n=2), East Asia (Japan; n=2), and other regions (Iran, Turkey, Israel; n=5). The total combined sample size was 2,987 preschool children, with individual study sample sizes ranging from 21 to 784. The mean age of participants across studies ranged from 3 to 6.7 years.

Regarding intervention characteristics, 14 studies evaluated universal SEL programs delivered to whole classrooms, while the 5 studies targeted at-risk children (e.g., from low socioeconomic status families or identified with initial self-regulation difficulties). The intervention duration varied widely, from 5 to 32 weeks. The total intervention intensity (calculated as duration × frequency × session length) ranged from 2 to 67 hours. In 12 studies, the intervention was delivered by regular classroom teachers who had received specific training in the SEL program. In 2 studies, the implementers were external researchers. A structured family involvement component (e.g., parent workshops, take-home activities) was present in 4 studies. Table 1 shows the details of the included studies in the meta-analysis. Figure 2 shows a bar chart of the publication year, child age, sex ratio, and country of the 14 included studies.

2. Risk of Bias within Studies

The risk of bias assessment for the RCTs indicated that the most common concerns resided in the domains of "blinding of participants and personnel" (performance bias) and "blinding of outcome assessment" (detection bias), which is often challenging in educational intervention research(Propadalo et al., 2019). However, the majority of RCTs demonstrated middle risk of bias concerning random sequence generation and allocation concealment. For quasi-experimental studies, the most frequent source of potential bias was related to the control of confounding variables (domain of "confounding" in ROBINS-II). Overall, the methodological quality of the included studies was judged to be moderate.

3. Overall Effect of SEL on Self-Regulation

The random-effects meta-analysis of all 14 studies revealed a statistically significant, positive effect of SEL programs on preschool children's self-regulation. The pooled effect size was Hedges' g =

0.56 (95% Confidence Interval: 0.07 to 1.06), which is considered a moderate effect according to conventional benchmarks ($p < 0.001$). This result indicates that children who participated in SEL programs demonstrated significantly better self-regulation skills at post-test compared to children in control conditions. There was evidence of moderate heterogeneity among the studies ($I^2 = 97.3\%$, $p < 0.001$ for Cochran's Q), justifying the use of a random-effects model (Figure 3).

4. Results of Moderator Analyses

Subgroup analyses and meta-regressions were conducted to understand the factors associated with variability in effect sizes. The results for key moderators are summarized below and in Table 4&5.

Total intervention intensity did not significantly moderate the effect ($p > 0.05$). The mean effect of high-intensity programs (total contact time ≥ 20 hours) ($g = 0.70$, 95% CI: 0.02–1.38) did not differ significantly from that of low-intensity programs (< 20 hours; $g = 0.38$, 95% CI: -0.35–1.10).

We found significant differences between groups in implementer type ($p < 0.01$). Interventions delivered directly to children by external researchers had the largest effect ($g = 2.16$, 95% CI: 0.82–3.50). Programs delivered by trained teachers had a smaller effect ($g = 0.18$, 95% CI: 0.20–0.55). This suggests that implementer type may contribute to significant heterogeneity in intervention effects, and that researcher type significantly predicted improvements in intervention effects.

Contrary to expectations, the presence of a structured family component was not a significant positive moderator ($p = 0.62$). The mean effect size for projects involving family was $g = 0.17$ (95% CI: 0.06–0.29), while the mean effect size for projects without such a component was $g = 0.67$ (95% CI: -0.09–1.44).

The SEL program had a marginally significant effect on the target population ($p < 0.1$). The effect size of the intervention specifically designed for high-risk children was larger ($g = 1.26$, 95% CI: 0.27–2.24), while the effect size of the general program crossed the line of no effect ($g = 0.19$, 95% CI: -0.43–0.83).

The mean effect size in collectivist cultures ($g = 1.12$, 95% CI: -0.33–2.56) was slightly larger than the mean effect size in individualist cultures ($g = 0.33$, 95% CI: -0.05–0.71), but this difference was not statistically significant ($p = 0.29$). We eliminated sociocultural differences as a source of significant effect size variation.

Other Moderators: Intervention duration (in weeks), mean child age, and publication year did not show significant moderating effects in the meta-regression analyses.

Despite the inclusion of multiple covariates, residual heterogeneity remained significant ($tau^2 = 0.99$), indicating that these factors were insufficient to fully explain the heterogeneity. However, we found that "Implementer" was a significant predictor of effect size ($B = 1.99$, $p = 0.001$), indicating that the implementer's background was an important source of heterogeneity found in this study, but this covariate did not dilute the overall heterogeneity.

5. Publication Bias and Sensitivity Analyses

Visual inspection of the funnel plots revealed that the effect sizes were not symmetrical around the pooled estimate (Figure 5). However, the Egger regression test for funnel plot asymmetry was nonsignificant ($t = 0.80$, $p = 0.44$), suggesting no strong evidence of publication bias (Figure 6). Duval and Tweedie's trim-and-fill procedure did not impute any missing studies, indicating that the observed pooled effect size was robust. A leave-one-out sensitivity analysis confirmed that no single study unduly influenced the overall results; the recalculated pooled effect size remained stable, ranging from $g = 0.37$ to $g = 0.69$ (Figure 7).

6. Certainty of Evidence

Using the GRADE framework, the overall certainty of evidence for the finding that "SEL programs improve self-regulation in preschool children" was rated as moderate (Table 2). The initial high rating for evidence from RCTs was downgraded by one level due to concerns regarding risk of bias (particularly performance and detection bias) and inconsistency (moderate statistical heterogeneity). The consistency of the positive direction of effect across diverse contexts and the identification of plausible moderators supported the moderate rating.

DISCUSSION

This meta-analysis provides a robust quantitative synthesis of the effect of social-emotional learning programs on self-regulation in preschool children. Based on 14 studies involving over 2,100 children, the results demonstrate that SEL programs have a statistically significant and moderately positive effect (Hedges' $g = 0.56$) on enhancing self-regulation. This finding aligns with developmental

theories that emphasize the role of structured, supportive experiences in fostering the growth of executive functions and effortful control during a period of high neuroplasticity(Cantor et al., 2019; Ganesan & Steinbeis, 2022; Ibbotson, 2023; Müller & Kerns, 2015; Yangüez et al.). SEL programs appear to provide the deliberate practice and scaffolding necessary for children to develop and consolidate these crucial skills(Gulz & Haake, 2024; Kusumaningsih & Sun, 2025; Yaffe et al., 2025).

1. Interpretation of Moderating Factors

The moderator analyses offer critical insights for optimizing SEL program design and implementation:

Regression tests indicated that intervention intensity was not a covariate influencing intervention effectiveness. However, subgroup analyses indicated that interventions lasting longer than 20 hours, such as the *Preschool Self-Regulation Program* and *Directed Social-Emotional Play Therapy*, significantly improved children's self-regulation abilities. This suggests that, in the current study context, extending the intervention duration beyond 20 hours may systematically produce stronger effects. However, it is noteworthy that the difference between the two groups was not significant. We speculate that lasting changes in self-regulatory neural networks may require long-term, repeated, and sustained practice, exploring how to shift from "quantity" to "quality" of intervention (Hakim & Alam, 2025; Wang & Sperling, 2020).

We found that implementer type was a covariate in the intervention effect, and we found that lessons taught by trained classroom teachers had significantly lower effects compared to lessons delivered by external researchers, potentially due to incomplete teacher training leading to reduced intervention fidelity. This also suggests a lack of SEL instruction in daily curriculum, highlighting the value of improving teachers' multifaceted teaching skills and integrating SEL into the daily classroom ecosystem. In the future, teachers can use "teachable moments" throughout the day to reinforce SEL skills and promote students' generalization beyond structured lessons (Brauer, 2025; Ross & Begeny, 2014; Sheeran et al., 2025).

Although family involvement was not a source of heterogeneity, evidence suggests that parental involvement significantly improves intervention outcomes. This supports the hypothesis that family involvement is always better (Dowell & Ogles, 2010; Jewell et al., 2022; Willemen et al., 2022; Williams et al., 2020). It also supports the effectiveness of joint home-school interventions.

Subgroup analyses of the target population revealed that the intervention had a nonsignificant effect on typically developing children, while a moderate effect size was observed for high-risk groups. This suggests that interventions implemented by more specialized researchers, often with higher intensity and more targeted approaches, may be more effective for specific populations. High-intensity, highly targeted interventions naturally yield greater results. High-risk children may face practical challenges stemming from a lack of SEL skills (e.g., interpersonal conflict and emotional distress) and therefore possess a greater intrinsic motivation to learn these skills. However, for typically developing children, these interventions are often delivered by implementers to the entire class within a regular classroom. These interventions are less intensive, in-depth, and personalized, making them less likely to have a significant impact on average-risk students who already have a solid foundation (Atindama et al., 2025; Sanders et al., 2023; Sculpher, 2010).

Furthermore, we cannot be confident that the difference in effect sizes between collectivist and individualist cultures is real. Although not significant, the average effect size in collectivist cultures ($g = 0.88$) is more than twice that in individualist cultures ($g = 0.32$). This suggests a "signal" or "trend" worth further investigation—perhaps cultural background does have an effect, but the current study was not powered to detect it(Svoray et al., 2022; Yang et al., 2025).

2. Implications for Practice and Policy

Although only one covariate was tested, the overall intervention effect was significant, demonstrating the effectiveness of integrating SEL into preschool classrooms on improving children's self-regulation and self-cognition. Therefore, the results of this meta-analysis provide several specific recommendations for early childhood education stakeholders:

Prioritize Teacher Professional Development: Investment in high-quality, ongoing training and coaching for preschool teachers is paramount to ensure they are well-equipped to implement SEL programs effectively(Dinler & Cevher-Kalburan, 2025; Elbertson et al., 2025; Zong et al., 2024).

Ensure Adequate Program Intensity: Policymakers and program designers should allocate sufficient time and resources to allow for interventions of meaningful duration and intensity (suggested ≥20 total hours)(Chowkase, 2023; Racine & Evans, 2025).

Integrate Family-School Partnerships: SEL programs should include structured, supportive components that engage families and help them reinforce self-regulation skills at home(Lunkenheimer et al., 2023; Obradović et al., 2021).

Adopt a Multi-Tiered System of Supports: A tiered approach is recommended, providing high-quality universal SEL to all children, coupled with more intensive, targeted interventions for those identified as at-risk(Vetter et al., 2024).

Support Cultural Adaptation and Implementation Science: While effective across cultures, programs should be thoughtfully adapted to ensure cultural relevance. Furthermore, supporting implementation fidelity through ongoing support is crucial for achieving desired outcomes(Fischer et al., 2024; Lim et al.).

3. Limitations and Future Research Directions

Several limitations of this review must be acknowledged. First, the limited number of included studies resulted in low statistical power, potentially underpowering the detection of small to moderate effects. Second, despite global research, the evidence base remains primarily concentrated in Western and Asian studies, limiting its generalizability to other regions, particularly low- and middle-income countries. Third, heterogeneity may be due to other unmeasured study characteristics, such as the quality of intervention implementation, baseline participant characteristics, or subtle differences in outcome measurement instruments.

Future research should strive for greater consensus and methodological rigor in assessing self-regulation, perhaps by integrating multiple methods and information sources. Research should also actively expand the geographic and cultural scope of SEL effectiveness research to include underrepresented regions and populations. Research should also include long-term follow-up studies to assess the persistence of learning gains and their impact on subsequent academic and life outcomes. Research should also employ more complex research designs (e.g., mediation analysis, componential analysis) to elucidate the specific mechanisms of change in SEL programs and identify the most critical positive components.

CONCLUSION

This comprehensive meta-analysis suggests that incorporating social-emotional learning programs into classrooms is an effective approach to promoting self-regulation in preschoolers. The overall effect size across studies was moderate and robust. However, the effects were significantly enhanced when the interventions were sufficiently intensive and delivered to children in the classroom by trained educators in conjunction with a home-school collaborative model. These findings provide a compelling evidence base for the widespread and systematic integration of high-quality, culturally appropriate SEL into early childhood education systems worldwide. Investing in foundational self-regulation skills in young children is a strategic and equitable approach to promoting their success in school and beyond, ultimately contributing to healthier, more productive societies.

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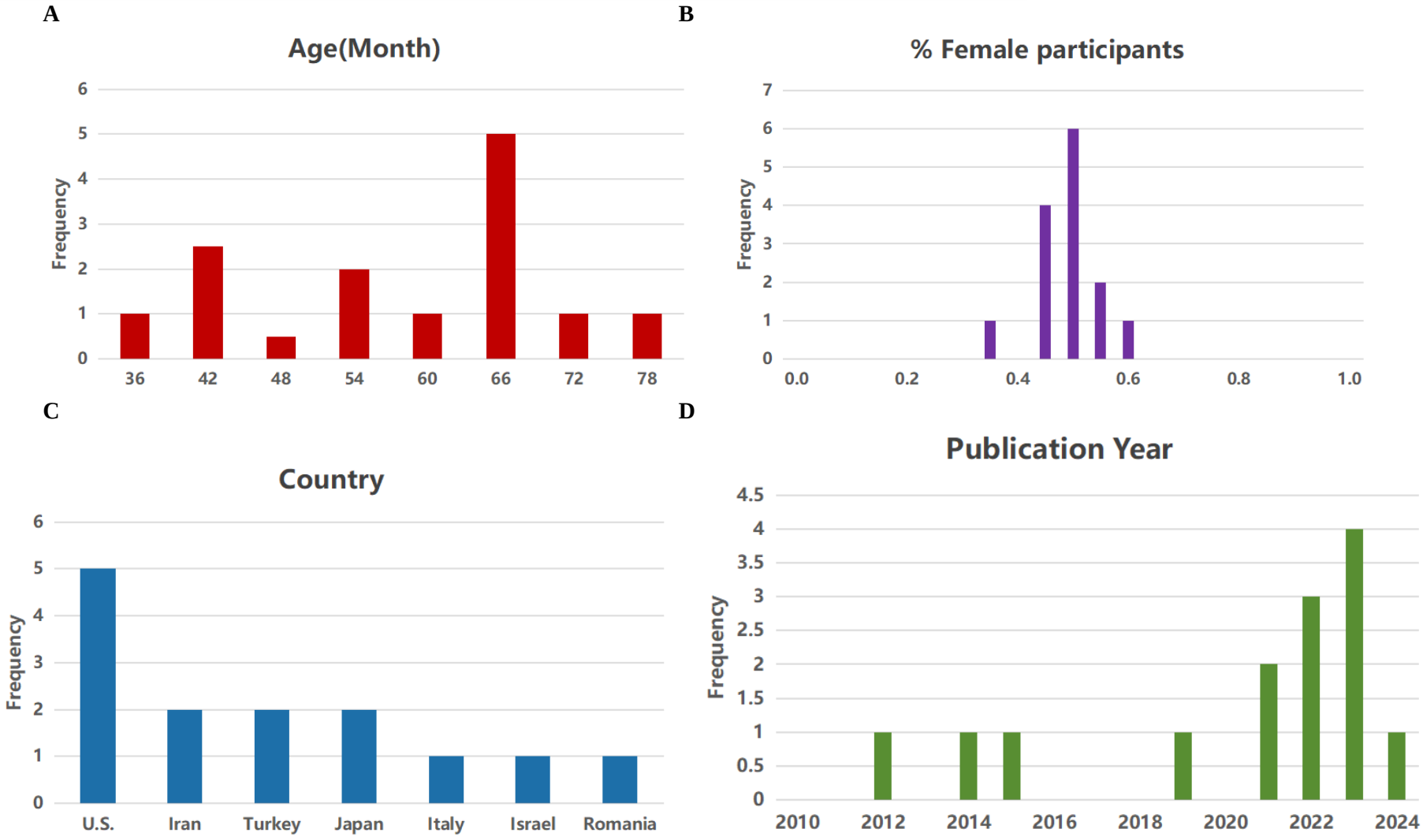


Fig. 2 Descriptive information of included studies. A. Age distribution of participants; **B.** Distribution of female proportion across samples; **C.** Distribution of countries samples; **D.** Publication year distribution of studies.

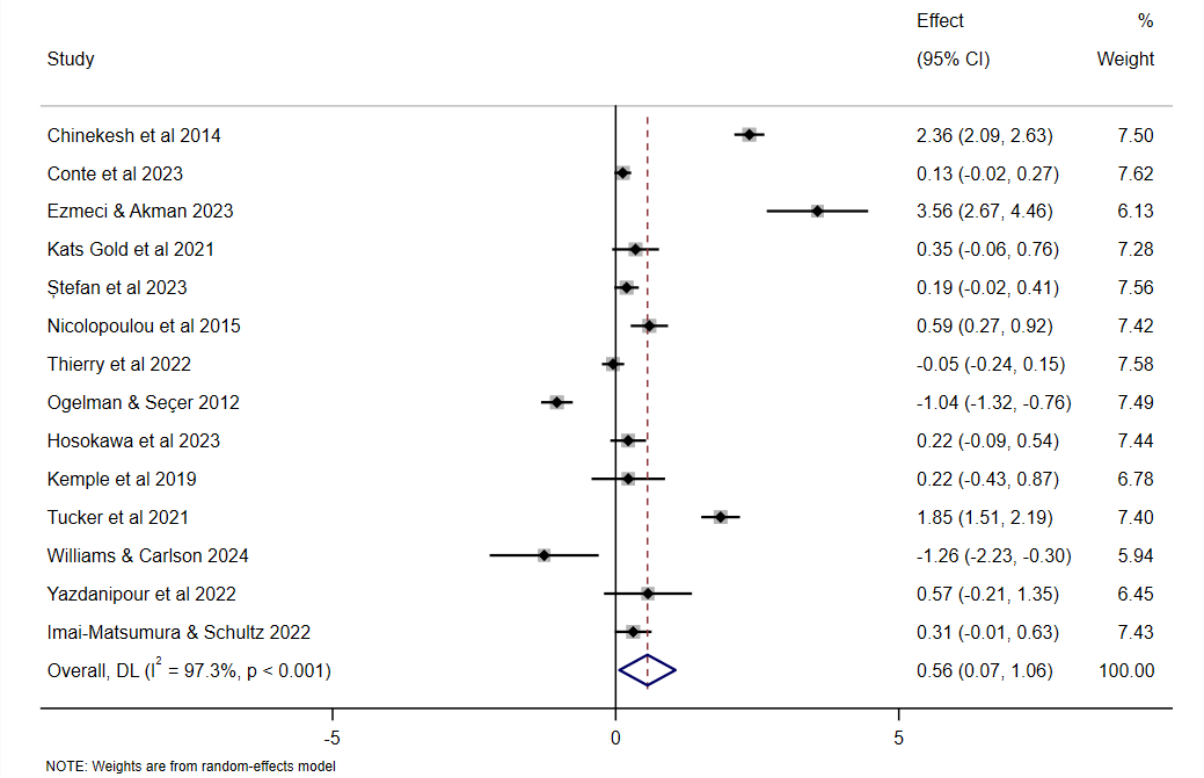


Fig. 3 Forest plot of the meta-analysis of the effects of SEL on children's self-regulation.

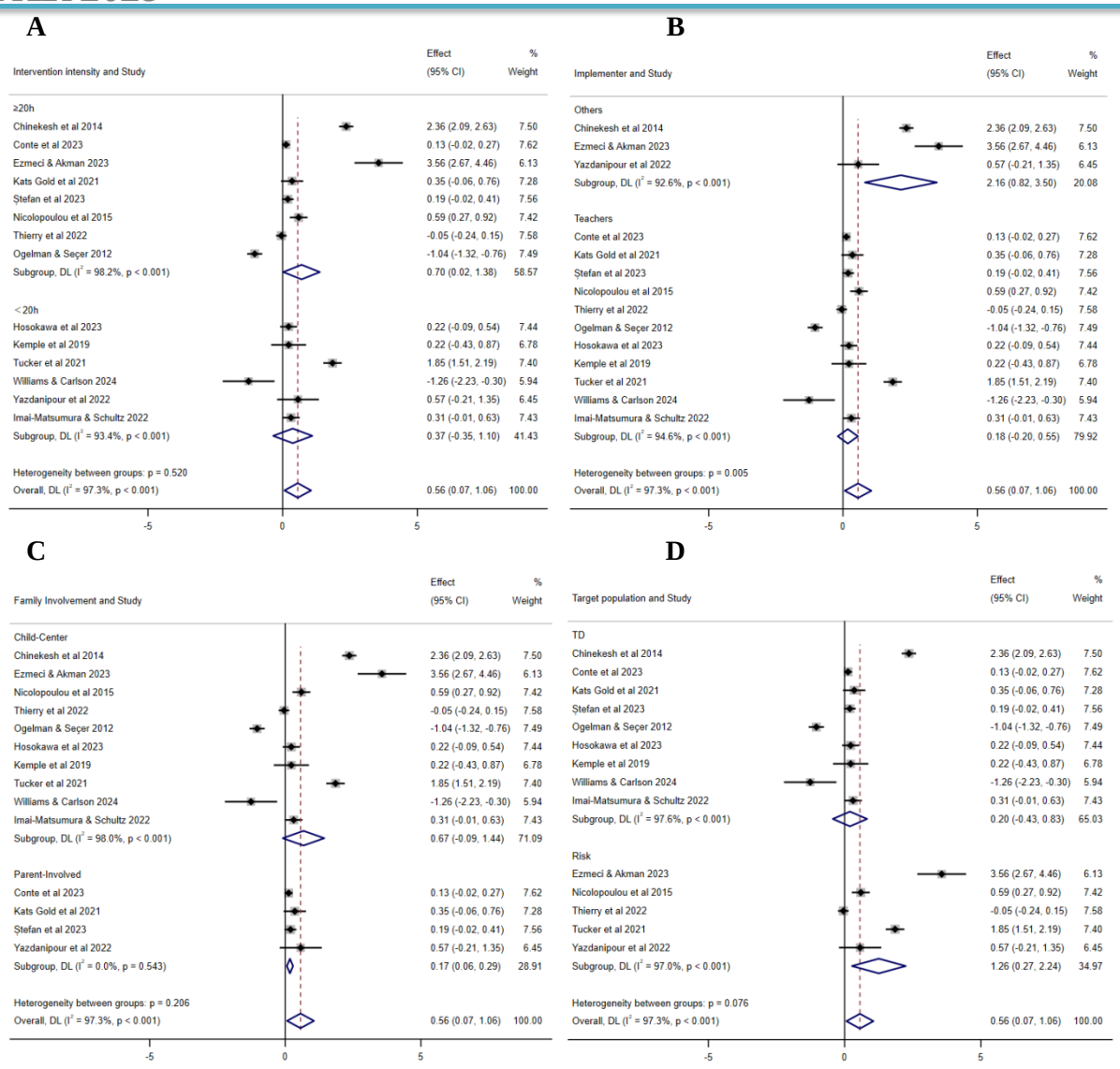
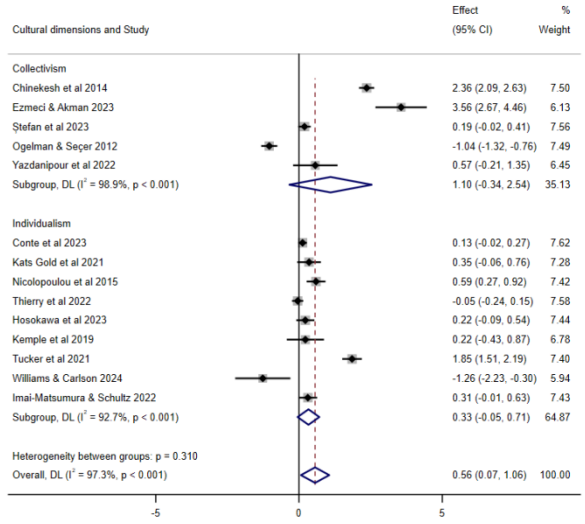
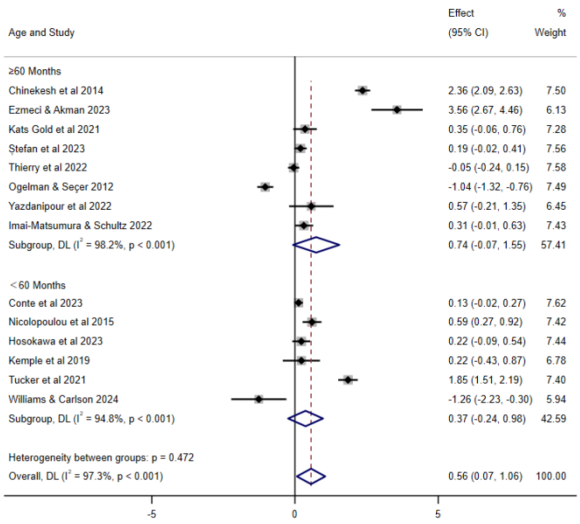


Fig. 4 Forest plot of the meta-analysis of the effects of SEL on children's self-regulation. A. Forest plot of Intervention intensity; **B.** Forest plot of Implementer; **C.** Forest plot of Family Involvement; **D.** Forest plot of Target population.

E



F



G

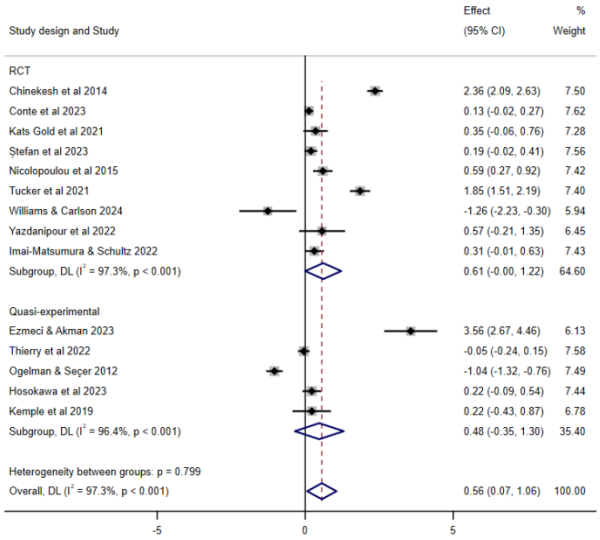


Fig. 4 continued. E. Forest plot of Cultural dimensions; **F.** Forest plot of Age; **G.** Forest plot of Study desig

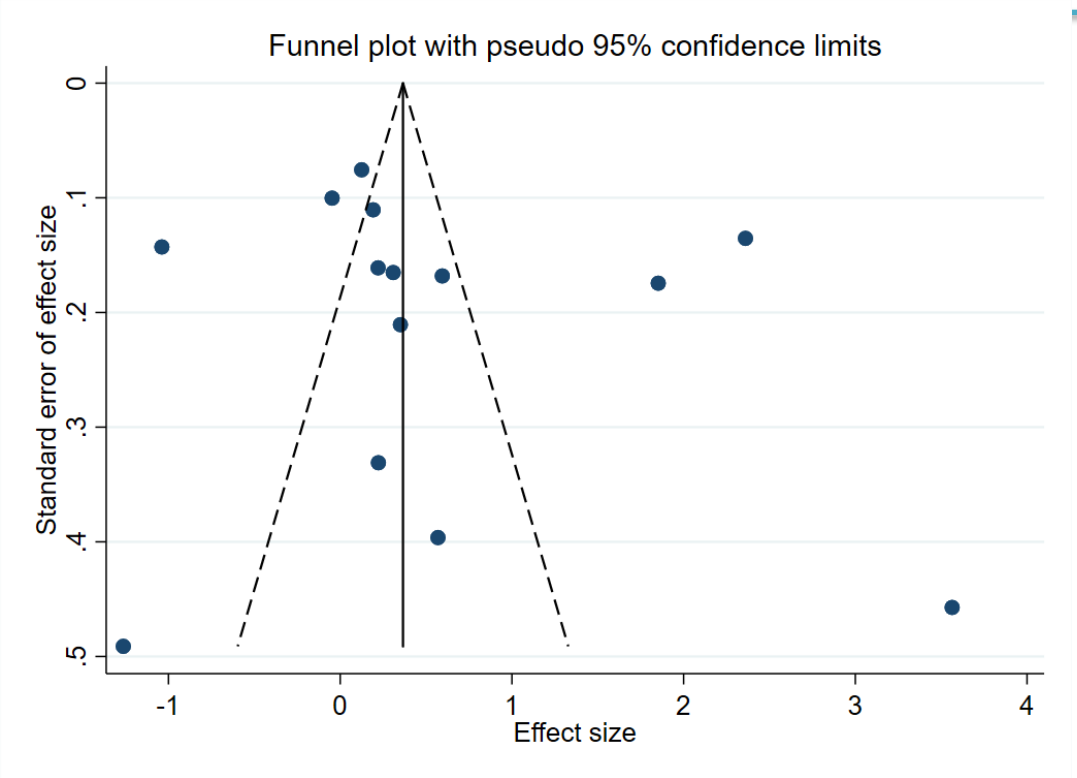


Fig. 5 Funnel plot assessing publication bias of 14 studies.

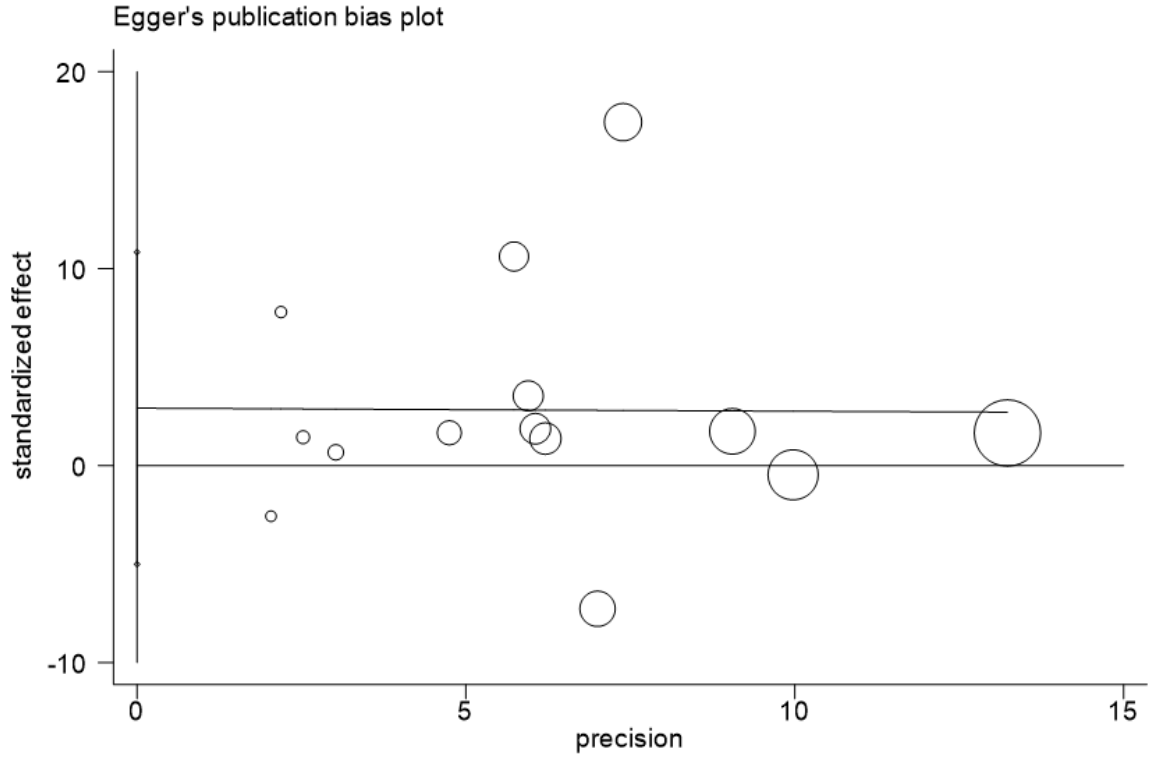


Fig. 6 Egger's publication bias plot of 14 studies.

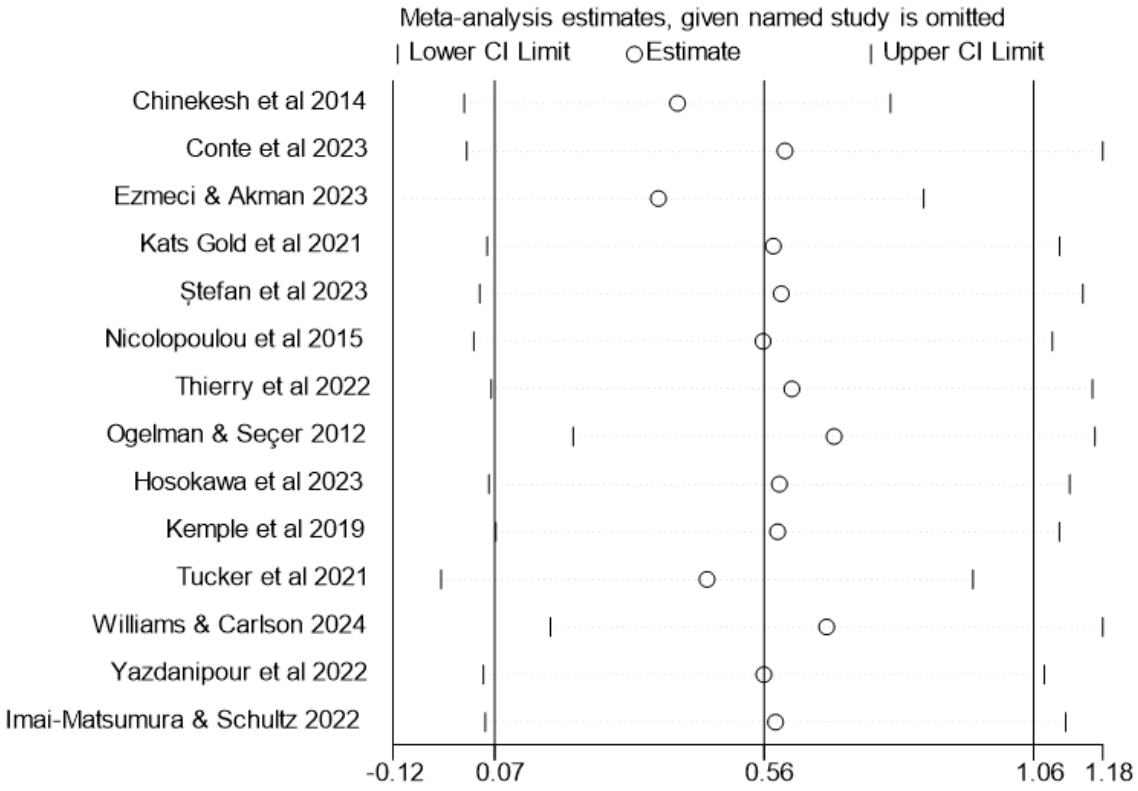


Fig. 7 A leave-one-out sensitivity analysis of 14 studies.

Table 1. Summary table for Self -regulation of Preschool children.

Study ID	Study desigh	Year	Country	Groups analyzed	Mean age (months)	Intervention strategies
(Chinekesh et al., 2013)	RCT	2014	Iran	Play Therapy Control N=186 N=186 TD 48.7% female	61.2 ± 7.2	*Directed Social-emotional Play Therapy* 15 sessions, 90 minutes each, 3 times a week for 5 weeks. GBI + Child-centered
(Conte et al., 2023)	RCT	2023	Italy	PROMEHS Control N=519 N=265 52.7% female 14.1% LOW SES 10.2% High risk	54	*PROMEHS* 6 months , 12 weeks. GBI + Parent-Teacher Collaboration
(Ezmeci & Akman, 2023)	Quasi-experimental	2023	Turkey	PSRP Control N=26 N=26 33% female TD LOW SES	60–72	*Preschool Self-Regulation Program* 7 weeks, 3 days per week, 21 activities in total. Each activity approximately 45–75 minutes. GBI + Child-centered
(Kats Gold et al., 2021)	RCT	2021	Israel	ICS-PS Control N=49 N=43 61.2% female 44.2% female	ICS-PS Control 66.37 ± 3.91 64.28 ± 3.16	*I Can Succeed for Preschools* 7 months GBI + Parent-Teacher Collaboration
(Hosokawa et al., 2023)	Quasi-experimental	2023	Japan	Fun FRIENDS Control N=94 N=66 50% female TD 19% LOW SES	56.64 ± 3.96	*Fun FRIENDS* 10 lessons, 1 per week, about 1 hour each, total duration about 2.5 months. GBI + Teacher-Mediated
(Kemple et al., 2019)	Quasi-experimental	2019	United States	Second Step Control N=17 N=20 52.9% female 40% female Middle SES TD	36	*Second Step* 28 weeks (1–2 sessions per week, approximately 15–20 minutes each). GBI +Teacher-Mediated
(Tucker et al., 2021)	RCT	2021	United States	SC Control(PAU) N=97 N=92 TD LOW SES	42	*Sunshine Circles* Once a week, 20–30 minutes each time, 15 weeks. GBI +Teacher-Mediated
(Williams & Carlson, 2024)	RCT	2024	United States	TIK Control N=9 N=12 55.6% female 41.7% female	TIK Control 48.2 ± 8.1 39.9 ± 5.6	*Tuning in to Kids* 6 sessions, 2 hours each, for a total of 12 hours,. Online Zoom. GBI +Teacher-Mediated

(Yazdanipour et al., 2022)	RCT	2022	Iran	GT N=12 42% female Hearing loss	Control N=15 53% female	60-72	*Group Theraplay* 10 lessons, 1 per week, 40 minutes each, total duration 2.5 months. GBI + Parent-Involved–Child-centered
(Ștefan et al., 2023)	RCT	2023	Romania	SEP N=173 52% female TD	Control N=157 12% LOW SES	SEP Control 66.48 ± 3.52 65.83 ± 3.61	*Social-Emotional Prevention Program* 18 weeks, 2–3 20–30-minute per week. GBI + Parent-Teacher Collaboration
(Nicolopoulou et al., 2015)	RCT	2015	United States	STSA N=81 50% female TD 60% LOW SES	Control N=68	36 - 48	*Narrative- and Play-based activity* Throughout the school year. 2 STSA activities per week. GBI +Teacher-Mediated
(Imai-Matsumura & Schultz, 2022)	RCT	2022	Japan	START N=79 61% female TD 10 - 15% LOW SES	Control N=70 53% female	67–79	*Social Thinking and Academic Readiness Training* 6 weeks, 1 lesson per week, 15-20 minutes per lesson. GBI +Teacher-Mediated
(Thierry, Vincent, et al., 2022)	Quasi-experimental	2022	United States	SYG N=186 47% female TD	Control N=214 96% LOW SES	80.28 ± 11.4	*Settle Your Glitter* 8 months. 3 deep breathing exercises daily. Each course lasts 1–2 weeks. GBI + Teacher-Mediated
(Ogelman & Seçer, 2012)	Quasi-experimental	2012	Turkey	IEP N=101 53% female	Control N=124 TD	60 - 72	*Inclusive Education Practice* 7 months. GBI + Teacher-Mediated

Note: GBI = Group-Based Intervention

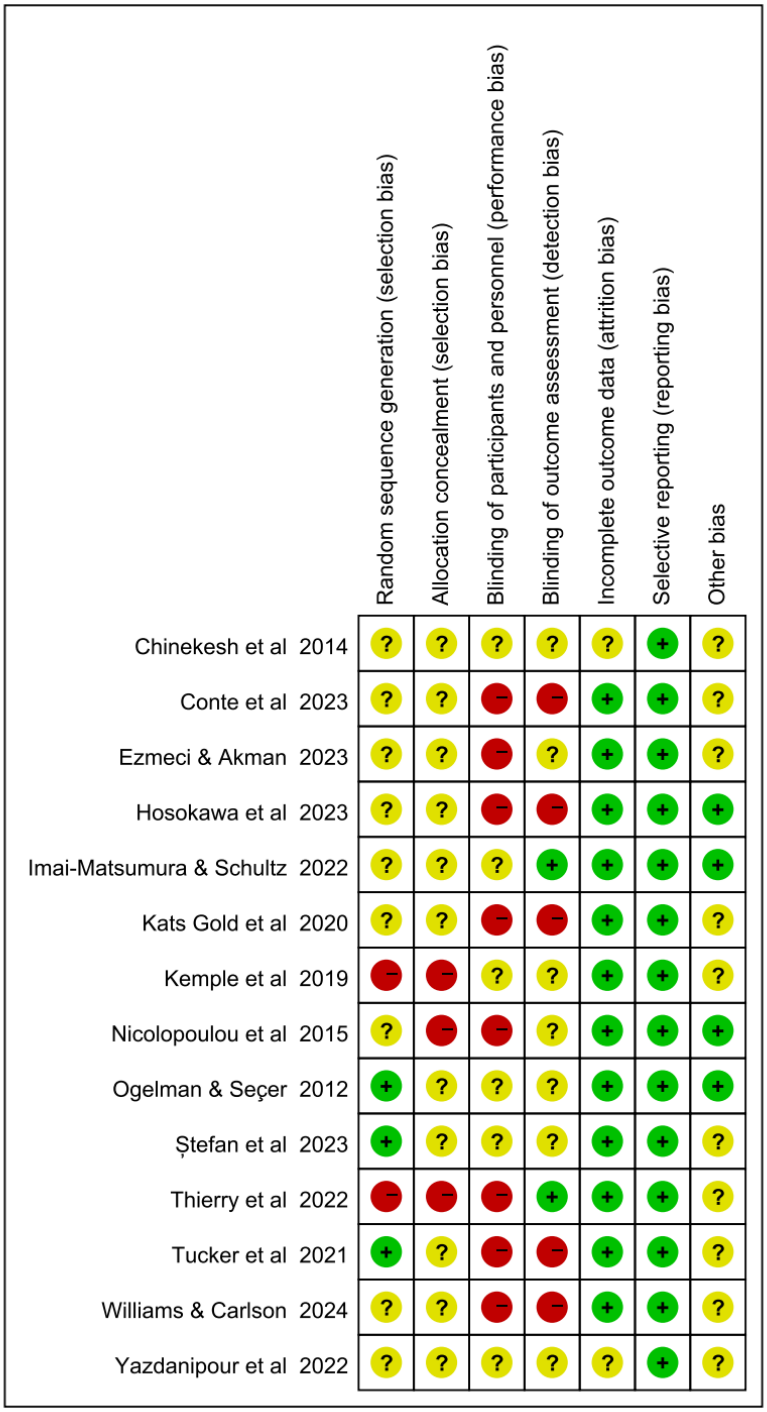


Table. 2 Risk of Bias Profiles

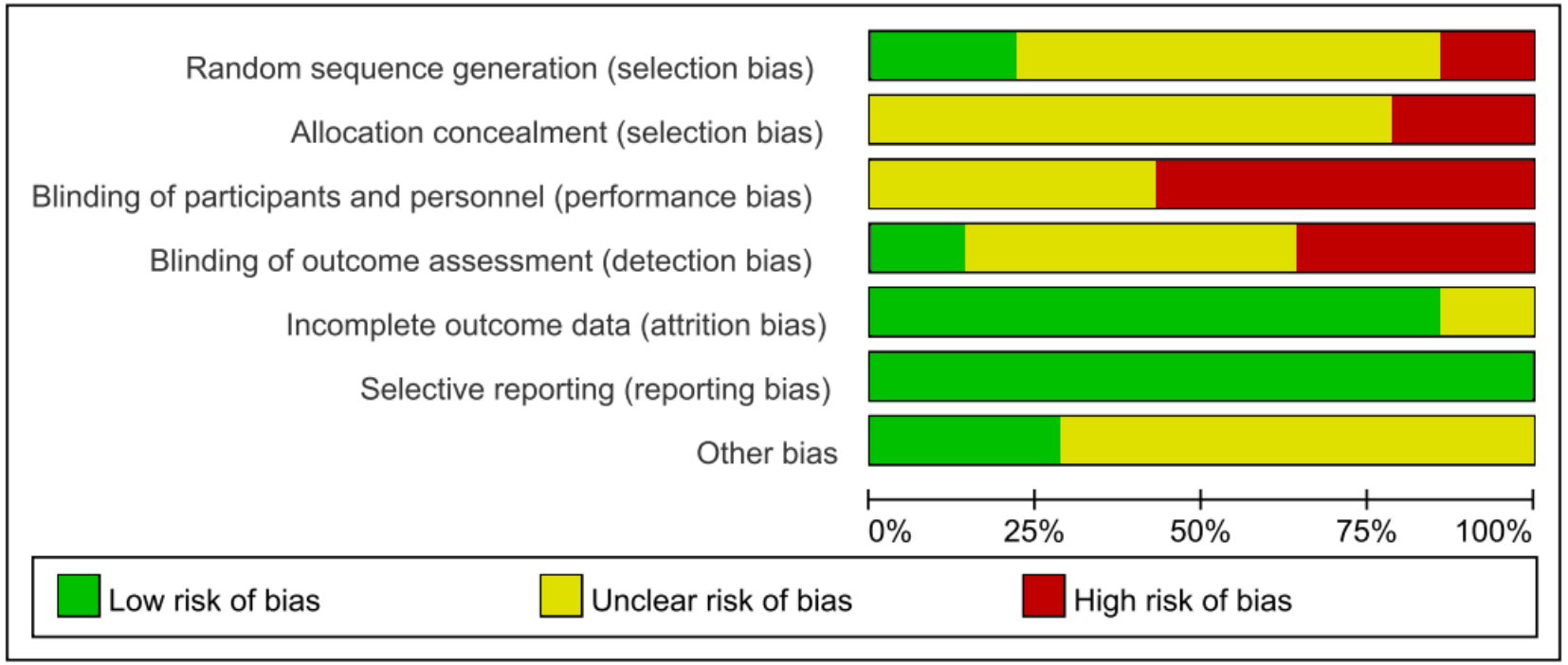


Table. 3 Risk of Bias Summary

Table. 4 Subgroup analysis results of 7 potential moderators

Subgroup	*k*	Observations	*g*	95% CI	Within	Between-subgroup heterogeneity

(moderators)					subgroup heterogeneity					
					Lower	Upper	I^2	*Q*	*df*	*p*
Intervention intensity										
	＜20h	6	583	0.375	-0.353	1.103	93.40%	75.69	5	>0.05
	≥20h	8	2,404	0.702	0.023	1.38	98.20%	391.89	7	
Implementer										
	External researchers	3	451	2.155	0.815	3.495	92.60%	26.86	2	<0.01
	Teachers	11	2,536	0.179	-0.196	0.553	94.60%	185.87	10	
Family Involvement										
	No	10	1,754	0.672	-0.094	1.437	98.00%	457.77	9	>0.05
	Yes	4	1,233	0.172	0.056	0.288	0.00%	2.15	3	
Target population										
	TD	9	2,170	0.196	-0.434	0.826	97.60%	336.3	8	>0.05
	High risk	5	817	1.256	0.269	2.243	97.00%	134.68	4	
Cultural dimensions										
	Individualism	9	1,981	0.328	-0.053	0.71	92.80%	111.34	8	>0.05
	Collectivism	5	1,006	1.116	-0.329	2.561	98.90%	359.71	4	
Age										
	＜60 Months	6	1,340	0.369	-0.239	0.977	94.80%	96.56	5	>0.05
	≥60 Months	8	1,647	0.741	-0.068	1.549	98.20%	382.52	7	
Study design										
	RCT	9	2,113	0.608	-0.001	1.217	97.30%	292.65	8	>0.05
	Quasi-experimental	5	874	0.475	-0.352	1.302	96.40%	112.27	4	

Note: *k* = number of independent samples; observations = total sample size

Table. 5 Meta-regression results

Predictor (moderator)	*k*	τ^2	*B*	*SE*	95% CI	
					Lower	Upper
Contact time ≥ 20 hours	8	1.51	0.37	0.68	-0.96	1.71
External researchers	3	0.76	1.99	0.61	0.80	3.18
Parent-Involved	4	1.50	-0.37	0.74	-1.82	1.08
High risk children	5	1.25	1.07	0.64	-0.19	2.33
Collectivism	5	1.39	0.79	0.67	-0.53	2.11
RCT	9	1.54	0.07	0.71	-1.31	1.45

Note: k = number of independent samples; τ^2 = residual heterogeneity of predictor variables; *B* = regression coefficient; *SE* = standard error.

Exploring the Pathways and Practical Analysis of Digital-Intelligent Transformation in Application-Oriented Higher Education: A Case Study of the "Technology-Discipline-Application" Integration Model at Qingdao Hengxing University of Science and Technology

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ABSTRACT

Faced with the wave of digital-intelligent transformation in education, how application-oriented universities can break through the disconnection between "technological instrumentalization" and "traditional teaching" has become a key issue in educational reform. This study takes Qingdao Hengxing University of Science and Technology as a typical case, proposing and validating a "Technology-Discipline-Application" three-dimensional integration model driven by "authentic application." This model establishes a digital foundation through building the "Hengxing Capacity Platform + high-end experimental centers" (Technology), restructures the curriculum system around "project-based and studio-based approaches" (Discipline), and embeds real-world commercial projects such as "brand operations, film and television production, and live-streaming e-commerce" (Application), thereby achieving deep integration of industry and education. The study finds that using "authentic application" as a value anchor can reversely reconstruct the teaching system and organizational model; the dual-base architecture of "platform + scenarios" effectively promotes the synergistic empowerment of technology, knowledge, and ability; and the educational ecology of "teachers as mentors, students as creators, and works as products" significantly enhances the quality and adaptability of talent cultivation. This research provides replicable practical pathways and theoretical insights for resolving the structural contradictions in the digital-intelligent transformation of application-oriented universities.

Keywords: Digital-Intelligent Transformation in Education; Application-Oriented Universities; Industry-Education Integration; Qingdao Hengxing University of Science and Technology

INTRODUCTION

In recent years, the rapid development of intelligent technologies such as artificial intelligence, big data, and cloud computing has profoundly reshaped global society and industrial landscapes. As a critical domain for technological application, the field of education is undergoing a transformation from "informatization" to "digital-intelligent integration." Particularly within the higher education system, the Chinese government has introduced policy documents such as the Digital Education Strategic Action and the Digital Campus Construction Standards for Higher Education Institutions (Trial), explicitly urging application-oriented universities to deepen industry-education integration and promote educational model innovation, aiming to cultivate versatile and innovative talents who can meet the demands of emerging industries and the digital economy. Under this strategic guidance, the value of digital-intelligent education is no longer limited to the enhancement of "technological empowerment" or "teaching tools" but is advancing toward a deeper stage of "system reconstruction" and "model transformation."

However, in practice, application-oriented universities still face numerous challenges and contradictions in promoting digital-intelligent transformation. On the one hand, institutions have generally invested substantial resources in constructing digital teaching platforms and high-end experimental training equipment. Yet, due to the lack of effective curriculum system integration and practical teaching mechanisms, issues such as "underutilized advanced equipment" and "low resource efficiency" frequently occur. On the other hand, outdated teaching philosophies and faculty structures, coupled with the dominance of traditional classroom models, create a stark contrast between "significant

technological investment" and "weak teaching outcomes." This structural contradiction not only undermines the effectiveness of digital-intelligent education but also restricts the social contribution of application-oriented universities in cultivating high-quality technical and skilled talents.

Therefore, this study aims to address a key question: How can we construct an application-oriented path for digital-intelligent transformation in education that genuinely empowers teaching and talent cultivation?

THEORETICAL FRAMEWORK

The research logic of this paper unfolds systematically through three progressively advancing components. The primary component constitutes the cornerstone and core of this theoretical framework, dedicated to conducting an in-depth academic analysis of the profound connotations and value orientations of digital-intelligent transformation in education, while simultaneously precisely capturing the distinctive characteristics of application-oriented universities in aspects such as their institutional positioning, talent cultivation models, and social service functions. Through this cross-analysis, this study will systematically trace and elucidate the structural roots of various practical challenges encountered by application-oriented universities in promoting digital-intelligent transformation, thereby laying a solid theoretical foundation for subsequent case analysis and pathway development.

METHOD

This study takes the School of Art and Media at Qingdao Hengxing University of Science and Technology as the research subject, exploring its exploratory practices and experiential insights in the context of digital-intelligent education. The typicality of its model lies in the fact that it does not merely pursue "technological advancement" but instead, based on the institution's positioning and regional industrial needs, explores an educational innovation path that integrates "technology—discipline—application" through real commercial projects and industrial applications.

Secondly, through a case analysis of the "technology—discipline—application" integration model at Qingdao Hengxing University of Science and Technology, this study summarizes its key practices in teaching innovation, resource integration, and industry-education collaboration.

FINDINGS AND DISCUSSION

The Transformation Background of Educational Digital-Intelligence and the Dilemmas of Application-Oriented Universities

1. The Era Characteristics and Strategic Direction of Educational Digital-Intelligence

Entering the third decade of the 21st century, the integrated development of technologies such as artificial intelligence, big data, the Internet of Things, cloud computing, and virtual reality has driven profound changes in industrial structures and social forms worldwide. The field of education, as a core link in knowledge production and talent cultivation, is undergoing a historic leap from "informatization" to "digital-intelligence." So-called "educational digital-intelligence" not only signifies the use and reliance on digital technology in educational activities but, more importantly, emphasizes the deep integration of technology and educational logic. This involves driving the structural reconstruction of the education system, the paradigm shift in teaching methods, and the systematic optimization of governance models through intelligent technology. Its essence lies in reshaping the production relationships and value systems of education based on data intelligence, thereby achieving overall improvement in education quality, efficiency, and equity.

At the level of national strategy, from the Education Informatization 2.0 Action Plan1 and the Digital Education Strategic Action2 to the ongoing promotion of the "Smart Education Demonstration Zone Construction Project,"3 China's educational digital-intelligence has progressed from the "tool application stage" to the "model innovation and system reconstruction stage." From the national to local levels, efforts are centered around researching and deploying high-quality education development action plans related to artificial intelligence. Implementing these plans relies not only on educational infrastructure, data resources, and the digital-intelligence literacy of teachers and students but also on the maturity of large models and intelligent agents, as well as addressing issues of security and ethics.

[1] http://www.moe.gov.cn/srcsite/A16/s3342/201804/t20180425_334188.html
[2] http://www.moe.gov.cn/jyb_xwfb/gzdt_gzdt/moe_1485/202503/t20250328_1185222.html
[3] http://www.moe.gov.cn/srcsite/A16/s3342/202104/t20210401_523802.html

4The Ministry of Education has explicitly stated the goal to fully establish a digital education system serving lifelong learning for all by 2035. The core objective is to promote the digitalization of educational elements, the intellectualization of teaching processes, the precision of governance systems, and the personalization of learning methods. For higher education, this strategic direction signifies not merely a technological upgrade but a holistic transformation of educational philosophy, organizational structure, and talent cultivation models.

From a macro perspective, educational digital-intelligent transformation demonstrates remarkable advantages in three key aspects: a technology-driven intelligent learning ecosystem, an open platform system for resource sharing, and a learner-centered personalized learning model.

Firstly, within the technology-driven intelligent learning ecosystem, education is transitioning from being "experience-oriented" to "algorithm-oriented" through data analysis, knowledge graphs, and AI-assisted teaching, thereby endowing pedagogical decision-making with greater scientific rigor and adaptability. Secondly, the open platform system for resource sharing, supported by digital infrastructure construction and the cloud-based migration of educational resources, is shifting education from a closed campus-based system towards a collaborative framework that transcends individual institutions, regions, and sectors. Finally, in constructing the learner-centered model, the core focus of digital-intelligent education is no longer "what to teach" but "how to learn"; it shifts away from a "teacher-centered" approach to a "learner-centered" one, emphasizing the autonomy and suitability of learning pathways.

However, this transformation imposes higher demands on higher education institutions. Educational digital-intelligent transformation requires not only the integration of technology but, more importantly, the restructuring of disciplinary systems and the embedding of application scenarios. Particularly for universities aimed at cultivating application-oriented talents, the fundamental challenge lies not in technological inadequacy, but in how to genuinely make technology an internal driving force for "educational innovation," thereby achieving synergistic progress in teaching, research, and industry.

2. The Functional Positioning and Transformation Pressure of Application-Oriented Universities

Application-oriented universities constitute a vital component of China's higher education system, bearing the mission of supplying technical-skilled, innovative, and interdisciplinary talents for regional economic development and emerging industries. Their core characteristics are: a social demand-oriented approach, a focus on practical application, an emphasis on the integration of theory and practice, and a stress on the economic and social value of educational services. With the advancement of national initiatives such as "Emerging Engineering," "New Liberal Arts," and "New Arts," application-oriented universities have become a significant force driving the upgrading of local industrial structures and the development of regional innovation ecosystems.

However, against the backdrop of the digital-intelligent transformation in education, these universities face dual pressures. Externally, the rapid iteration of industries and the digital transformation of businesses urgently demand that graduates possess higher-level digital literacy, adaptive learning capabilities, and complex problem-solving skills. Internally, issues such as the slow updating of curricula, a shortage of faculty with both practical experience and digital competency, and a disconnect between traditional training models and actual industrial needs have become increasingly prominent. This necessitates that application-oriented universities must not only keep pace with technological trends but, more crucially, achieve deep integration across the dimensions of "technology-education-industry," reshaping their educational models to enhance their relevance and contribution to societal development.

Application-oriented universities must transform genuine industrial pain points into the core driving force for community building.5 However, these institutions face particularly acute pressures during the educational digital-intelligent transformation. Certain constraints exist in the relationship between institutional resources and technological foundations. Compared with research universities, application-oriented universities generally lag in financial investment, digital infrastructure, and technological research and development capabilities. Although some have established digital laboratories, smart classrooms, and virtual simulation centers, these facilities often remain at the "demonstration level,"

[4] Shen, Shusheng. "From Paradigm Shift to Pattern Innovation: The Changing and Unchanging in Digital-Intelligence Empowered Education." Journal of Educational Development, vol. 45, no. Z2, 2025.

[5] Dong, F. (2025). Research on the Practical Path of Learning Communities in Application-Oriented Universities under the Smart Teaching Model. Knowledge Economy, (30).

lacking systematic curriculum integration and data-driven mechanisms. This results in low utilization rates of technological resources and fails to generate sustained momentum for teaching innovation.

Regarding the development of the teaching faculty, a practical issue exists in the form of insufficient composite capabilities. Most teachers in application-oriented universities come from either disciplinary education backgrounds or professional practice fields, creating gaps in their specialized technical skills, digital teaching abilities, and cross-disciplinary integrative thinking. Within the educational environment of the university, while teachers are increasingly using technology and are influenced by concepts such as "using technology to create value" and "using digital means to represent facts," they are prone to a cognitive bias that equates "technology empowerment" with "technology dependence" or "technology blind adherence."6 Educational digital-intelligent transformation requires teachers to possess data literacy, system design capabilities, and industrial understanding, yet the current teacher training system has not fully adapted to this demand. Although many teachers can operate digital tools, they often fail to integrate technology into the pedagogical logic, leading to a phenomenon of "technology performativity."

Furthermore, application-oriented universities also face the current situation of a low alignment between educational objectives and industrial needs. Judging by the educational goals different universities benchmark against, the talent cultivation objectives of application-oriented universities should inherently align with industrial structures and job requirements. However, in reality, the curriculum system is disconnected from the industrial forefront, and the updating of teaching content lags behind. Application-oriented talents are skilled practitioners who apply professional knowledge and technical theory to actual work, daily life, and production. The core is to apply theoretically acquired knowledge to work practice, solving real-world problems and creating value for enterprises.7 With the intelligent development of industries, the demand for interdisciplinary and innovative talents is growing, yet the students cultivated by universities often remain at the level of "tool mastery," lacking systemic thinking and practical project experience. This misalignment further exacerbates the tension between university education and societal needs.

Therefore, the digital-intelligent transformation of application-oriented universities is not merely a matter of technological upgrading but a systematic project involving the reshaping of educational functions and institutional innovation. Only by breaking down the barriers between technology, disciplines, and industry under the premise of an "application-orientation" can the transition from "digital teaching" to "digital-intelligent education" be truly achieved.

3. The Structural Contradiction Between "Technological Instrumentalization" and "Traditional Teaching"

Although investment in digitalization within China's higher education sector has significantly increased in recent years, many application-oriented universities still find their digital-intelligent reform trapped in a dilemma between "technological instrumentalization" and "traditional teaching." On one hand, digital construction is often narrowly understood as "hardware upgrades" and "platform procurement," neglecting the profound transformation of teaching philosophies, content, and organizational methods. On the other hand, traditional teaching models centered on the teacher and the curriculum continue to dominate, leading to a misalignment between technological innovation and pedagogical renewal, thereby creating a structural disconnect. This is primarily manifested in the following three aspects:

First, there is a coexistence of "idle high-end equipment" and "outdated teaching methods." Many universities have invested heavily in building smart classrooms, simulation laboratories, and digital platforms. However, in the absence of systematic instructional design, these facilities often become mere "showpieces." Teachers continue to employ traditional lecturing methods, lacking project-based and contextualized teaching innovations. Students, in turn, passively receive knowledge without utilizing these platforms to foster capability development and knowledge transfer. Technology becomes an "external ornament" rather than a driver of teaching and learning.

[6] Zhao, X., & Shen, S. (2025). From Integrating Technology in Teaching to Creating Technology for Education: The Endogenous Logic and Enhancement Path of Teachers' "Technological Consciousness" in the Digital-Intelligent Era. China Educational Technology, (10).

[7] Zhang, P., Cheng, Y., Yang, H., & Cui, S. (2025). Research on the Construction of Career Education Curriculum System in Application-Oriented Universities from the Perspective of School-Enterprise Collaborative Education. Technology Wind, (29).

Second, a stark contrast exists between "substantial technological investment" and "weak outcomes." The core of educational digital-intelligent transformation lies in enhancing teaching quality and the effectiveness of talent cultivation. However, the transformation practices in some institutions exhibit a tendency to "prioritize construction over application" and "emphasize platforms over content." Due to the lack of data analysis and teaching feedback mechanisms, platform operation remains disconnected from teaching quality assessment, resulting in a disproportionate relationship between input and output. Consequently, the digital-intelligent transformation fails to form an endogenous driving mechanism and instead increases management and maintenance burdens.

Third, there is a misalignment between "technological advancement" and "educational logic." The fundamental purpose of introducing digital-intelligent technology is to optimize and reconstruct the educational process. Yet, in practice, technology application often deviates from educational objectives and student development needs. Some course designs excessively focus on the novelty of technical forms while ignoring the depth of knowledge and the construction of learning logic. This not only fails to enhance the learning experience but may also lead to the fragmentation and superficiality of knowledge, hindering the development of students' critical thinking and innovative abilities.

Finally, there is the misalignment between "technological logic" and "educational logic." The essence of education lies in the cultivation of people, not in the display of technology. In the context of digital-intelligence, teaching evaluation technologies such as intelligent profiling, machine scoring, data analysis, and AI-assisted evaluation are emerging one after another, playing an important role in empowering the transformation of educational assessment.8 However, many universities, in promoting digital-intelligent transformation, unilaterally emphasize technical parameters and system functions while neglecting the cognitive rules, emotional needs, and the value of social learning inherent in the educational process. This results in the superficial application of technology and the hollowing out of educational substance, creating a situation of "superficial innovation but substantive stagnation." This misalignment leads educational digital-intelligent transformation into the of "technological supremacy," undermining the fundamental educational purpose of teaching.

The root cause of this structural contradiction lies in the lack of an effective mediating mechanism between "technology input" and "pedagogical transformation" within the education system. The logic of technological systems is efficiency and standardization, whereas the logic of educational systems is personalization and generativity. The integration of the two requires "application" as a bridge, driven by authentic scenarios, to genuinely embed technology into the entire process of teaching and learning. The key to resolving this contradiction, therefore, lies in a shift in mindset: from a "technology-centric" to an "application-oriented" approach; from "resource construction" to "capacity generation"; and from "tool application" to "model reshaping." This is precisely the value of the "Technology-Discipline-Application" three-dimensional integration model adopted by the College of Arts and Media at Qingdao Hengxing University of Science and Technology—it uses real commercial projects as an anchor point to achieve deep coupling of digital-intelligent technologies, disciplinary knowledge, and industrial application, providing a practical pathway and paradigm reference for the digital-intelligent transformation of application-oriented universities.

[8] Qiao, Y. (2025). The Endogenous Motivation, Key Issues, and Practical Directions of Digital-Intelligence Technology Empowering the Transformation of Educational Evaluation. Teaching and Administration, (24).



Figure 1. Digital Art Experimental Teaching Demonstration Center Platform



Figure 2. Converged Media Command Center

The Construction Logic of the "Technology-Discipline-Application" Integration Model

The value of educational digital-intelligent transformation lies not in the speed of technological updates, but in how technology promotes the regeneration of educational structures and the reshaping of their functions. The core mission of application-oriented universities is to achieve the educational goal of "applying learning to practice" through educational innovation. Based on this, the College of Arts and Media at Qingdao Hengxing University of Science and Technology has proposed and implemented the "Technology-Discipline-Application" three-dimensional integration model in its digital-intelligent transformation. This model is driven by "authentic application," supported at its foundation by digital-intelligent technology, with the discipline system serving as the knowledge intermediary. Through real-world projects, it achieves multidimensional linkage between teaching, research, and industry, forming a new educational ecosystem aimed at "capacity generation."

1. The "Authentic Application"-Oriented Philosophy of Educational Digital-Intelligence

Within the context of educational digital-intelligent transformation, traditional "instrumental rationality" can no longer support the sustainable development of educational innovation. Only by placing digital-intelligent technology within "authentic application scenarios" can its true educational effectiveness be realized. Against the backdrop of developing new quality productive forces, talent cultivation urgently needs to break through the constraints of traditional disciplinary boundaries. Universities should promote the integrated development of basic disciplines, emerging disciplines, and

interdisciplinary studies.9 The so-called "authentic application-orientation" does not merely involve simulating professional scenarios or adding practical training components. Rather, it takes genuine societal needs, industrial problems, and commercial tasks as the starting point of education. Through project-based learning and scenario-based teaching, it enables students to achieve competency transfer and knowledge construction in the process of "problem-solving."

The digital-intelligence philosophy of Qingdao Hengxing University of Science and Technology is precisely built upon this "application-driven" educational logic. Its core concepts can be summarized in three points:

a. Transitioning from "Knowledge Transmission" to "Capability Generation"

In traditional teaching, the goal of education is for students to master established knowledge; whereas in digital-intelligent education, the core objective is to enable students to autonomously generate knowledge in open environments and translate it into practical problem-solving abilities. By integrating technological platforms with real-world projects, the student learning process becomes a dynamic journey of "learning by doing."

b. Shifting from "Teaching-Centric" to "Application-Centric"

Teaching activities no longer revolve solely around the classroom but are guided by industrial challenges and societal needs. Teachers are no longer mere knowledge transmitters but serve as project mentors and research guides; students are no longer passive recipients but become project collaborators and creative practitioners. This role transformation fosters a learning community driven by authentic tasks.

c. Evolving from "Tool Empowerment" to "Ecological Symbiosis"

The ultimate goal of educational digital-intelligence is not to replace teaching with technology but to foster a symbiotic ecosystem among "technology, teachers, students, and industry." Technological platforms become the "infrastructure" of education, yet their true value lies in providing actionable scenarios for disciplinary content and offering scalable systemic support for applied practice, thereby enabling the continuous evolution and iterative optimization of educational activities.

2. The System Architecture and Logical Mechanism of the Three-Dimensional Integration

The core of the "Technology-Discipline-Application" three-dimensional integration model lies in bridging the triple logic of the "tool layer - knowledge layer - practice layer" within educational activities, achieving a dynamic cycle of technology empowerment, knowledge transformation, and capability generation. Technology empowerment makes the educational process quantifiable and traceable; disciplinary drive ensures the scientific nature of the educational logic and knowledge system; application feedback provides the impetus for practical verification and reverse optimization. The closed-loop interaction among these three elements constitutes the systemic ecological architecture of educational digital-intelligent transformation.

Specifically, the technology layer forms the foundation of educational digital-intelligence. Confronted with the development of digital technologies and intelligent applications, key issues hindering the reform of vocational education teaching include the disunity of knowledge and action among subjects under digital technology embedding, the misalignment of virtual and real roles amid the popularization of digital-intelligent applications, and the imbalance in ecological governance within the construction of digital fields.10 Qingdao Hengxing University of Science and Technology has established a digital foundation through the "Hengxing Capacity Platform + high-end experimental centers," achieving full-process online and intelligent teaching, management, and evaluation. The platform's functions include course management, learning data tracking, work display, and teaching feedback modules, providing teachers with course design tools and offering students a multi-dimensional learning space. The experimental centers comprise facilities such as a 4K ultra-high-definition studio, a digital special effects laboratory, and a new media e-commerce live streaming laboratory. These provide authentic technological scenarios for disciplinary teaching, seamlessly connecting classroom instruction with industrial practice. The technology layer not only supplies the

[9] Lu Yanjiao, Liang Ze. The Value, Challenges, and Pathways of Integrating Digital-Intelligent Technology into Innovation and Entrepreneurship Education in Universities under the Background of New Quality Productivity. Educational Theory and Practice. 2025, 45(30)

[10] Li Wenwen, Feng Rui. Research on the Realistic Dilemmas and Solutions of Digital-Intelligence Integration Empowering the Reform of Vocational Education Classroom Teaching—Based on the TOE Theoretical Framework. Chinese Vocational and Technical Education. 2025(17)

hardware and software environment but also fulfills the functions of data accumulation and intelligent analysis, making the educational process visible, outcomes quantifiable, and improvements traceable.

The discipline layer is the core of the educational digital-intelligent transformation.** The college has redesigned its curriculum system based on a project-based and studio system, forming an interdisciplinary and cross-domain knowledge integration structure. Through project-based teaching, knowledge units are integrated into "task chains"; through the studio mechanism, a teacher-student-enterprise community is established, promoting the transformation of disciplinary content into application scenarios; and through a data-driven course evaluation system, the dynamic optimization of teaching content is achieved. The core logic of this layer is "**using projects to drive curricula, using curricula to cultivate capabilities, and using capabilities to feedback into the discipline."

The application layer is the ultimate destination of the educational digital-intelligent transformation. Application-oriented undergraduate education focuses on cultivating talents with practical operational skills and comprehensive professional competence, emphasizing the close integration of knowledge application and production practice. As an important carrier of practical teaching, training bases can provide students with a real professional environment, enabling them to transform professional knowledge into vocational skills through practical operation on the basis of theoretical learning.11 The college introduces commercial projects such as brand operations, film and television production, and live-streaming e-commerce into the teaching process, forming an application closed loop of "learning by doing, and doing by learning." While participating in real projects, students not only master the operation of digital-intelligent tools but also understand market logic, teamwork, and innovation methods through practice. In this way, educational outcomes are no longer confined to the classroom but are directly translated into industrial value.

3. Innovations and Theoretical Value of the Model

The innovative significance of the "Technology-Discipline-Application" integration model lies not only in its novel structure but, more importantly, in its breakthrough in addressing the long-standing issues of "technological silos" and "disciplinary isolation" in educational digital-intelligent transformation, achieving overall synergy and structural reshaping of the educational system.

At the conceptual level, this model breaks away from the "technology-dominated" mindset prevalent in traditional digital-intelligent reform, placing "authentic application" at the center of the educational logic, thereby realizing a return to the fundamental value orientation of education. It emphasizes that the meaning of technology lies in serving teaching and talent development, rather than replacing the educational subjects, reflecting the unity of the humanistic and social dimensions of education.

Structurally, the model, through the interconnected design of the underlying technology platform, the middle-level discipline system, and the top-level application scenarios, shatters the linear structure of teaching processes, shifting towards a networked, ecological mode of knowledge production and dissemination. This "three-dimensional symbiotic" structure transforms the educational system from "static transmission" to "dynamic generation," forming a sustainable innovation mechanism.

In terms of value innovation, while the core output of traditional education is knowledge acquisition, the core output of this model is "capability generation." Empowered by technology and authentic application, student learning outcomes are no longer confined to exams and assignments but are directly manifested as demonstrable, evaluable project results. Teachers transition from "lecturers" to "mentors," students from "learners" to "makers," and education from "knowledge teaching" to "innovative practice." This shift achieves a value leap in education from "static evaluation" to "dynamic growth."

The Practical Pathway and Effectiveness Analysis of Qingdao Hengxing University of Science and Technology

The College of Arts and Media at Qingdao Hengxing University of Science and Technology, a pioneer in the digital-intelligent transformation of application-oriented universities in Shandong Province, has systematically constructed a practical example of the "Technology-Discipline-Application" three-dimensional integration model. Centered on the reform philosophy of "being driven by authentic application, supported by technological platforms, and focused on project-based teaching," its core pathway can be summarized into three key initiatives: constructing a digital technology foundation, restructuring a project-based curriculum system, and embedding real industrial projects. This has achieved a systematic leap from "digital teaching" to "intelligent education."

[11] Hao Lina, Research on the Construction and Operation Mechanism of Training Bases in Application-Oriented Undergraduate Universities. Plastics Packaging. 2025, 35(05)

1. Constructing the Digital Technology Foundation of the "Hengxing Capacity Platform + High-end Experimental Centers"

a. Overall Concept and Functional Positioning of the Platform Construction

Qingdao Hengxing University of Science and Technology has established a dual-support system with the "Hengxing Ubiquitous Capacity Teaching Platform" and the "Chaoxing Capacity Platform," building a digital teaching system that covers the entire process of teaching, management, and evaluation. This forms the underlying support architecture for the college's educational digital-intelligent transformation.





The Hengxing Ubiquitous Teaching Capability Platform focuses on the visualization and data-driven management of the teaching process, achieving full-process online integration—from consolidating course resources and assigning teaching tasks to collecting learning data. The platform supports multi-device interaction between teachers and students, real-time feedback, and project collaboration, facilitating the expansion of teaching scenarios and the continuous tracking of learning behaviors. Meanwhile, the Chaoxing Capability Platform plays a significant role in resource aggregation and intelligent analysis, covering modules such as course design, learning path recommendations, and evaluation analysis. It provides teachers with tools for course analysis and offers students a personalized learning space.



The college has innovatively extended the platform's functionalities into the realm of social dissemination by creating the "Hengxing Dialogue" live streaming series. This initiative integrates teaching activities, work exhibitions, and industry exchanges through online live broadcasts. According to platform statistics, the "Hengxing Dialogue" series has achieved a total viewership of 15,214, with single-session interactions exceeding 17,500 likes, forming a communication loop centered on the platform that connects "open teaching — social feedback — data-driven improvement." This mechanism not only expands the teaching space but also enhances the college's social influence and brand communication power.



b. Scenario Construction and Technological Support of High-End Experimental Centers

In terms of hardware infrastructure, the college has established a high-end experimental teaching system covering various fields such as film and television production, digital arts, and new media communication. The core experimental platforms comprise a comprehensive suite of advanced facilities designed to support practice-oriented teaching and innovation: a 4K Ultra-HD all-green studio and recording studio that enables multi-camera shooting and real-time broadcasting to create immersive learning environments for film, television, and communication courses; a digital special effects laboratory and MIDI laboratory that facilitate experimental instruction in post-production, sound design, and interactive media; a new media e-commerce live streaming laboratory and an innovation and entrepreneurship incubation laboratory that provide authentic e-commerce contexts for courses in brand communication, live-stream operations, and digital marketing; and graphics and image processing, graphic design, and post-production laboratories that together form a complete workflow for visual communication and digital art creation.

Furthermore, leveraging the Digital Art Experimental Teaching Demonstration Center and the Converged Media Command Center, the college has achieved integrated management of "teaching, practice, and dissemination." Through the digital management system, instructors can monitor equipment utilization rates and student project data in real-time, establishing a data-driven decision-making mechanism for teaching. This has propelled the shift in experimental teaching from being "experience-driven" to "data-driven."



Figure 7. 4K Ultra-HD All-Green Studio



Figure 8. Recording Studio

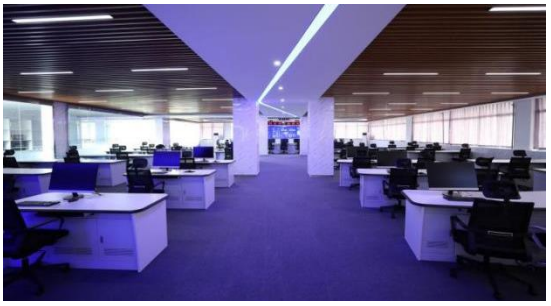


Figure 9. Digital Special Effects Laboratory



Figure 10. MIDI Laboratory, Innovation and Entrepreneurship Incubation Laboratory



Figure 11. Graphics and Image Processing Laboratory, New Media E-commerce Live Streaming Laboratory



Figure 12. Film and Television Post-Production Laboratory, Graphic Design and Production Laboratory

2. Restructuring the Curriculum System Integrating "Project-Based and Studio Systems"

In traditional application-oriented university teaching, curricula are often centered around knowledge modules, emphasizing theory over practice and teaching over industry engagement. At Qingdao Hengxing University of Science and Technology, the digital-intelligent transformation in education adopts a dual-core approach of "Project-Based + Studio Systems" to restructure the curriculum. This shifts the teaching logic from "knowledge transmission" to "capability generation," achieving a dynamic, open, and task-oriented curriculum system.

Through collaboration with enterprises, brands, and media organizations, the college integrates real commercial projects into the classroom, forming an operable and evaluable system of teaching tasks. For example:

Students participated in the filming and post-production special effects work for the theatrical films Windbird and Little Qian, with some teams also involved in the composite special effects shots for The Wandering Earth 2, achieving a direct transition from the classroom to industrial projects.

In Digital Media Arts courses, students undertake tasks such as brand short video planning, advertising visual design, and live stream content creation, with project outcomes directly entering enterprise operational workflows.

In Advertising Photography and Visual Communication courses, students independently complete Brand Visual Identity System (VIS) designs based on market research, and their works have been adopted and applied by some companies.



Figure 12. On-Set Production and Filming for the Theatrical Release "Windbird"
Post-Production Visual Effects (VFX) Shot Compositing for the Theatrical Release "Little Qian"



Figure 13. Participated in VFX shot compositing for The Wandering Earth II

The introduction of project-based teaching has transformed courses from "theoretical instruction" to "problem-solving," and shifted teaching evaluation from "outcome assessment" to "process evaluation." Both teachers and students collaboratively participate in project design and post-project review, achieving a multi-dimensional integration of "teaching, learning, research, and production."

To ensure the sustainable operation of project-based courses, the college has established a multi-level studio system, including studios such as "Film and Television Production," "Digital Special Effects," "Brand Communication," and "Visual Creativity." Each studio is led by a faculty mentor and is responsible for the actual execution of projects both internal and external to the university. Through

this organizational form, the teaching space is extended into real industrial chains. Teachers' activities in instruction, research, and social service are integrated, while students' learning processes also become the formation process of professional.

The combination of the project-based system and the studio system has shifted the college's curriculum from being closed to open, and from single-discipline to cross-disciplinary. Students' initiative in learning has significantly increased, the social conversion rate of course outcomes has impr
oved, and the overall efficiency and practical depth of the college's teaching have been enhanced.

3. Embedding Teaching Applications with Real-World Projects such as "Brand Operations, Film and Television Production, and Live Streaming E-commerce"

The key reason why the educational digital-intelligent transformation at Qingdao Hengxing University of Science and Technology has achieved remarkable results lies in embedding "real-world projects" as educational scenarios throughout the entire teaching process. By establishing long-term cooperation mechanisms with enterprises and social institutions, the college integrates various types of projects—including brand operations, film and television production, and live streaming e-commerce—into the curriculum system, synchronizing students' learning processes with industrial operations. Specific practices include:

Brand Communication Direction: Students developed a brand promotion strategy primarily for the Xiaohongshu platform for the brand Guoshu Cake, covering product analysis, positioning, promotion pathways, photography, and copywriting, achieving a complete closed loop from research to execution.





Figure 14. New Media Communication Direction: Students operated a Douyin matrix account for the pet brand "Miao Ju She," cumulatively producing 60 short videos and managing 5 matrix accounts. Single videos achieved view counts ranging from 1,000 to 2,000, establishing stable communication traffic.

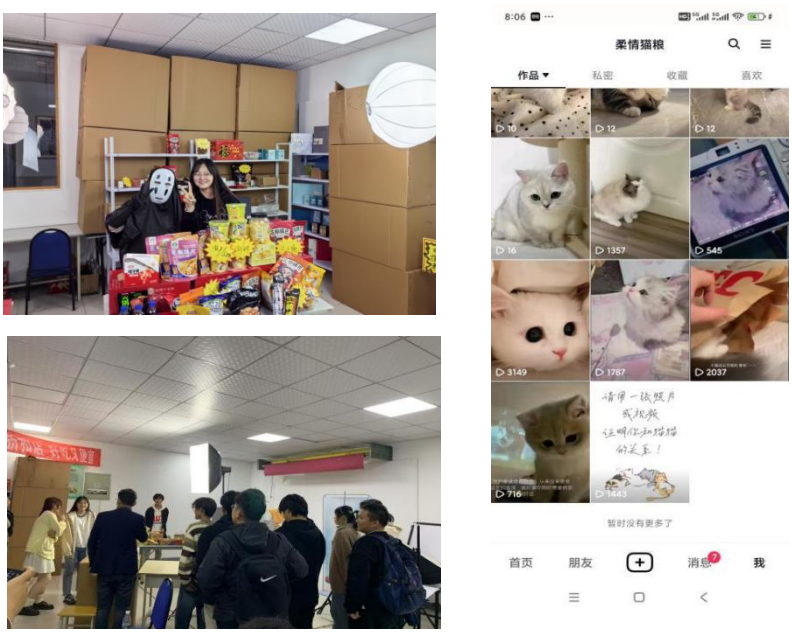


Figure 15. E-commerce Live Streaming Direction: Student teams conducted short video production and live stream sales for 7-Eleven convenience stores, achieving 6 live sessions per week. They cumulatively completed 30 short videos and facilitated 10,000 order conversions.

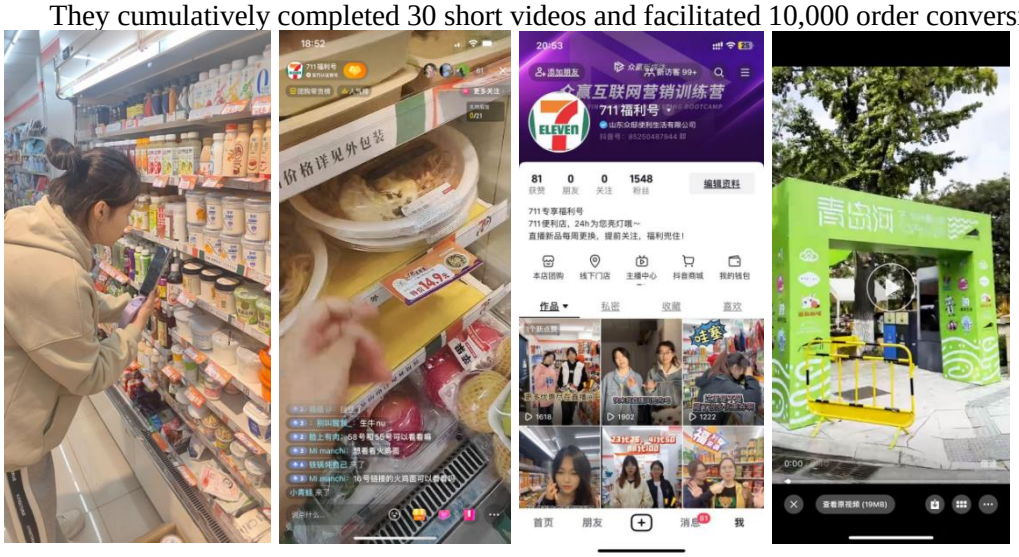


Figure 16. Film and Video Production Track: Students participated in various professional projects, including the theatrical film Metro Line 3, the recording of the Qingdao Hainuo School Arts Festival, and the production of a promotional video for Qingdao Hotel. Through these projects, they gained hands-on experience in the entire production workflow, from scriptwriting and planning to post-production.



Figure 17. The commencement ceremony for "Metro Line 3"
Filming of the theatrical film "Windbird"



Figure 18. Recording of the Qingdao Hainuo School Arts Festival
Production of a promotional video series for Qingdao Hotel

These projects have not only provided students with authentic industry experience but have also established a stable chain of outcomes for the college's integration of industry and education. The college's official Douyin account amassed a total view count of over 900,000, with more than 7,600 likes and 1,500 collections within a year, creating a visible system for showcasing teaching achievements at the level of social dissemination. Using the digital platform as a link, the college has established a tripartite collaborative mechanism of "on-campus teaching — off-campus practical training — industrial application." On campus, relying on laboratories and studios, teaching and project development are completed; off-campus, through partnerships with enterprises and social institutions, project implementation and feedback optimization are achieved. Through this model, students can accumulate project experience during their studies, teachers concurrently fulfill research and social service roles in their teaching, and the college builds brand influence through industrial collaboration, truly realizing the integration of the education chain, talent chain, industry chain, and innovation chain.

CONCLUSION

The exploration of the "Technology-Discipline-Application" integration model by the College of Arts and Media at Qingdao Hengxing University of Science and Technology provides an instructive practical example for the digital-intelligent transformation of application-oriented universities in China. Its core experience lies in: being driven by "authentic application," using the "platform + scenarios" as the dual-base architecture for technology and teaching, and establishing a new educational ecology of "mentor-creator-product," achieving an organic unity of technological innovation, teaching innovation, and talent cultivation innovation. This integration is not a one-dimensional use of tools but a systematic reconstruction based on educational logic, reflecting a new stage in educational digital-intelligent transformation moving from "tool empowerment" to "ecological symbiosis."

In traditional educational informatization construction, technological platforms and teaching scenarios often exist in a state of separation: platforms are used for resource management and teaching monitoring, while teaching remains confined to the classroom. By constructing the dual-base architecture of the "Hengxing Capacity Platform + high-end experimental centers," Qingdao Hengxing University of Science and Technology has bridged the educational boundaries between online and offline, on-campus and off-campus, achieving an intelligent, data-driven, and scenario-based teaching process. The "platform" undertakes the functions of data integration, process management, and intelligent analysis, providing digital support for teaching activities. The "scenarios," relying on high-end experimental centers and real commercial projects, construct an immersive learning and practice environment. When the two form linkages, education shifts from a "spatial activity" to a "systematic ecosystem," achieving synchronous upgrades in technological empowerment and situational experience.

The dual-base architecture of "platform + scenarios" not only addresses issues such as "idle equipment" and "fragmented resources" in the university's digital-intelligent process but also provides a new design approach for educational systems. At the teaching level, it achieves the integration of "online teaching resources — offline practical scenarios — learning data feedback." At the management level, it enables the digital visualization of educational decision-making and process traceability. At the talent cultivation level, it facilitates a deep transformation from knowledge learning to capability building.

The promotional value of this mechanism lies in its demonstration that the true breakthrough in educational digital-intelligent transformation does not lie in the accumulation of technology, but in the systematic synergy between technology and scenarios.

The ecological innovation embodied in "teachers as mentors, students as makers, works as products" signifies a leap in application-oriented university education from "transmissive teaching" to "generative education." In the practice of Hengxing University, the redefinition of educational roles is key to this educational ecology innovation. The traditional teaching system, centered on the teacher with students as passive recipients, featured one-way knowledge transfer. Post digital-intelligent transformation, the college has restructured teaching relationships around projects, forming a co-creative learning community where "teachers are mentors, students are makers." Within this ecology, the teaching process merges with the production process, the classroom becomes a site for incubating creativity, and projects become the medium for learning. Teachers and students collaboratively complete the entire process from idea generation and task division to outcome dissemination. Once works are launched into the market or onto media platforms, the resulting social feedback, in turn, informs and improves teaching design, forming a cyclical system of "teaching—production—dissemination." This ecological mechanism transforms education from a closed campus activity into an open system for social innovation. Driven by projects, educational outcomes and industrial value grow simultaneously: students create value through learning, teachers update their knowledge through mentoring, and the educational system evolves through practice.

Through the systematic implementation of the "Technology-Discipline-Application" three-dimensional integration model, Qingdao Hengxing University of Science and Technology has achieved a comprehensive upgrade in teaching models, curriculum systems, and educational management. The organization of teaching has shifted from traditional classroom lectures to project-based and studio systems, forming a "project-core, capability-oriented" learning mechanism. Course content is iterated in real-time based on platform data and project feedback, keeping pace with industrial development. The teaching evaluation mechanism integrates student learning outcomes with their social application effectiveness, forming a three-dimensional evaluation system of "process-output-application."

In summary, the exploration at Qingdao Hengxing University of Science and Technology demonstrates that the true breakthrough in educational digital-intelligent transformation lies in moving from a "technology-centric" to an "application-centric" approach, and from "teaching reform" to "educational reconstruction." The "Technology-Discipline-Application" three-dimensional integration model, with the "platform + scenarios" as its foundation and "projects + makers" as its driver, achieves a systematic upgrade of the educational value chain. It not only provides a practical pathway for resolving the structural contradictions in the transformation of application-oriented universities but also offers a replicable, scalable theoretical paradigm and practical model for the high-quality development of Chinese higher education in the digital-intelligent era.

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The Impact of Artificial Intelligence on the Legal Field

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ABSTRACT

Artificial Intelligence (AI) has experienced exponential growth in recent decades, with its influence permeating various sectors, including the legal field. This study aims to systematically explore the multifaceted impacts of AI on legal practice, judicial decision-making, legal education, and related ethical-legal challenges. Adopting qualitative research methods, the study integrates literature review (covering 2018–2023 Chinese and English core journals and authoritative reports), case analysis (e.g., U.S. COMPAS bail algorithm, China's Beijing Internet Court AI system), and data synthesis (from official sources like the Supreme People's Court of China and the American Bar Association). Findings reveal that AI significantly enhances efficiency in legal retrieval (via NLP and machine learning), improves the accuracy of case analysis (through pattern recognition in historical cases), expands access to legal consultation (via intelligent chatbots), and innovates legal education (through VR/AR immersive learning). However, AI application also raises critical issues: algorithmic bias in judicial decisions, unclear legal status of AI entities, and potential displacement of legal practitioners. To address these challenges, the study proposes policy recommendations, including establishing AI judicial oversight mechanisms and formulating technology-neutral legal norms. This research contributes to bridging the gap between AI technological development and legal system adaptation, providing theoretical guidance for the sustainable integration of AI and law.

Keywords: Artificial Intelligence, Legal Field, Judicial Algorithm, Legal Education, Ethical-Legal Challenges

INTRODUCTION

The global AI market size reached $150.0 billion in 2023 and is projected to grow at a CAGR of 38.1% from 2024 to 2030 (Grand View Research, 2024). Beyond industries like healthcare and finance, AI has emerged as a transformative force in the legal sector—a field traditionally characterized by labor-intensive processes, such as document review, case citation verification, and legal research. For instance, legal professionals in the United States spend an average of 6.8 hours per day on administrative and research tasks (American Bar Association [ABA], 2022), and AI tools have been shown to reduce this workload by up to 40% (LexisNexis, 2023).

Historically, the intersection of AI and law dates back to the 1980s, with the development of early legal expert systems (e.g., MYCIN-Law, designed to assist with tax law compliance). However, these systems were limited by rigid rule-based logic and could not adapt to the complexity of real-world legal scenarios (Edwards, 2018). The advent of machine learning (ML) and natural language processing (NLP) has addressed these limitations: modern AI tools, such as Westlaw Edge's "Quick Check" and ChatGPT-4's legal document analysis function, can process unstructured legal texts (e.g., court opinions, contracts) and generate context-aware insights (OpenAI, 2023).

In recent years, governments worldwide have accelerated the integration of AI into legal systems. China's "14th Five-Year Plan for the Development of the Digital Economy" (2021) explicitly mandates the construction of "smart courts" to streamline case handling; the European Union's 《AI Act》 (2024) classifies judicial AI as a "high-risk" application, requiring strict transparency and accountability measures; and the United States' Federal Judicial Center (FJC) released a "Guide to AI in Federal Courts" (2023) to regulate algorithm use in bail and sentencing decisions. These policy initiatives reflect the urgent need to understand AI's impact on the legal field and address its accompanying challenges.

From a theoretical perspective, this study enriches the interdisciplinary research on "Legal Tech" by integrating AI technology principles with legal theory. Existing literature often focuses on either technical aspects (e.g., AI algorithm optimization) or legal aspects (e.g., liability for AI errors) in isolation, lacking a holistic analysis of how AI reshapes legal institutions, professional roles, and access to justice (Balkin, 2018). This study fills this gap by examining AI's impact across six core legal domains: retrieval, case analysis, consultation, practice, judicial decision-making, and education.

From a practical perspective, the findings provide actionable guidance for legal practitioners, policymakers, and educators. For lawyers, the study clarifies how to leverage AI tools to enhance service quality (e.g., using AI for preliminary case screening) while avoiding over-reliance on technology. For policymakers, it offers a framework for drafting AI-related legal norms (e.g., defining AI's legal status in contract signing). For educators, it highlights how to redesign curricula to equip law students with AI literacy (e.g., adding courses on algorithmic fairness).

This study addresses three core research questions concerning the integration of artificial intelligence into the legal domain: it examines how AI transforms key aspects of legal practice—particularly legal retrieval, case analysis, and legal consultation—and evaluates the empirical effects of these transformations; it explores the ethical and legal challenges arising from AI applications in the legal field, with special attention to judicial decision-making and the reconfiguration of professional roles; and it investigates the policy and institutional measures necessary to promote the sustainable integration of AI and law while safeguarding judicial fairness, accountability, and core professional values.

The objectives of this study are to systematically review and synthesize existing research on the application of artificial intelligence in the legal field published between 2018 and 2023, to analyze real-world cases of AI implementation across different legal systems—specifically China, the United States, and the European Union—in order to identify best practices as well as potential risks, and to propose a set of technology-neutral legal norms and educational strategies that can guide the responsible and effective integration of AI into legal practice and education.

THEORETICAL FRAMEWORK

Core Theories of AI and Law

1. Technology Determinism and Social Constructivism

Two competing theoretical perspectives guide the analysis of AI's impact on law: technology determinism and social constructivism. Technology determinism argues that technological development drives social and institutional change—for example, AI's ability to process large-scale legal data will inevitably replace manual work and reshape legal procedures (Marx, 2017). This perspective is reflected in predictions that AI will automate 35% of legal tasks by 2030 (McKinsey, 2023). In contrast, social constructivism posits that technology's impact is shaped by social, cultural, and legal contexts—for instance, China's "smart court" initiative is not merely a technical upgrade but a response to the government's goal of "judicial transparency" (Liu & Zhang, 2022).

This study adopts a hybrid perspective, recognizing that while AI's technical capabilities (e.g., NLP accuracy) set the "possibility space" for change, legal institutions and cultural values (e.g., the principle of "judicial independence") determine how this space is realized. For example, the U.S. legal system's emphasis on adversarialism has limited the adoption of AI in trial proceedings, whereas China's inquisitorial system is more receptive to AI-assisted case management (Chen & Wang, 2021).

2. "Code is Law" and Algorithmic Governance

Lessig's (1999) "Code is Law" theory argues that digital code (e.g., AI algorithms) functions as a form of regulation, shaping behavior in ways similar to traditional law. In the legal field, this means that judicial algorithms—such as the U.S. COMPAS system—do not merely "assist" decision-making but actively define standards for bail and sentencing (Lessig, 2020). This theory underscores the need to subject AI algorithms to legal scrutiny, as their design choices (e.g., which factors to include in risk assessment) can embed biases (e.g., racial disparities in bail decisions; Angwin et al., 2016).

Complementary to this is the concept of "algorithmic governance," which refers to the use of AI to monitor and enforce legal rules (Floridi, 2020). For example, China's "Online Courts" use AI to automatically review evidence in e-commerce disputes, reducing the time for case resolution from an average of 60 days to 15 days (Supreme People's Court, 2023). However, algorithmic governance raises

concerns about due process: if AI makes preliminary decisions on evidence admissibility, how can parties challenge these decisions without understanding the algorithm's logic?

Legal Tech Development Stages

To contextualize the current impact of artificial intelligence in the legal field, this study adopts Gartner's (2022) Legal Tech development framework, which conceptualizes AI evolution across four stages: automation (2010–2018), focusing on streamlining repetitive tasks such as document review through e-discovery tools like Relativity; augmentation (2019–2022), where AI enhances human decision-making, for example through AI-powered citation verification in Westlaw Edge; transformation (2023–2027), in which AI begins to fundamentally redefine legal processes, such as the use of adaptive, AI-generated contracts; and autonomy (2028 onward), where AI is expected to independently perform complex legal tasks, including experimental applications like AI representation in small claims courts in Japan (Ministry of Justice Japan, 2023). This framework highlights a critical research gap, as existing scholarship predominantly concentrates on the automation and augmentation stages, while the transformative and autonomous phases remain under-explored, particularly with regard to their doctrinal and normative implications, such as how AI-generated contracts may challenge traditional principles of offer and acceptance in contract law (Smith, 2023).

Gaps in Existing Literature

Despite the expanding body of scholarship on AI and law, three critical gaps persist in the literature. First, there is a lack of cross-jurisdictional comparison, as most studies focus on single legal systems and overlook how differing legal traditions—such as civil law and common law—shape AI adoption; for example, civil law systems like China and Germany, which rely heavily on structured statutory law, may be more conducive to AI-driven case analysis than common law systems dependent on unstructured judicial precedents (Miller, 2022). Second, existing research tends to emphasize the short-term impacts of AI on legal employment, such as potential job displacement among paralegals, while insufficiently addressing the long-term evolution of legal professions, where lawyers may increasingly transition from information providers to strategic advisors as AI assumes routine research tasks (ABA, 2023). Third, ethical and legal analyses of AI are often treated separately, with limited integration between ethical principles—such as transparency—and corresponding legal doctrines, such as the right to reasoned judicial decisions, resulting in a gap between normative ideals and enforceable legal rules (Bryson, 2020). Addressing these gaps, the present study undertakes a comparative analysis of AI applications in China and the United States, examines long-term transformations in legal professional roles, and proposes an integrated ethical–legal framework for the regulation of AI in the legal domain.

METHOD

Research Approach

This study adopts a qualitative research approach, which is well-suited for exploring complex, context-dependent phenomena like AI's impact on law (Creswell, 2018). Qualitative methods allow for in-depth analysis of cases, literature, and policy documents, avoiding the oversimplification of quantitative approaches (e.g., reducing AI's impact to "efficiency metrics" alone). The study uses three complementary qualitative methods: literature review, case analysis, and policy document analysis.

Data Sources

1. Literature Review

The literature review covers 2018–2023, focusing on peer-reviewed journals, authoritative reports, and academic books. The literature for this study was drawn from three main sources: peer-reviewed journals, authoritative reports, and scholarly books. Journal articles were selected from core legal journals such as *Artificial Intelligence and Law* and the *Harvard Journal of Law & Technology*, as well as leading AI journals including *IEEE Transactions on Neural Networks and Learning Systems*. Reports were sourced from international organizations (e.g., UNCITRAL's *AI and International Commercial Law*, 2023), professional associations (e.g., the American Bar Association's *AI in Legal Practice*, 2022), and research institutions (e.g., McKinsey's *Legal Tech: The Future of Law*, 2023). In addition, key monographs on AI and law were included, such as Edwards' *Automating Justice: AI and the Future of the Legal System* (2018) and Balkin's *Robot Law* (2018). In total, 87 documents were selected, consisting of 62% journal articles, 28% reports, and 10% books. The selected literature was coded and analyzed using NVivo 12, with major thematic

categories including AI efficiency, algorithmic bias, the legal status of AI, and legal education reform.

2. Case Analysis

Three case studies were selected to represent diverse legal domains and jurisdictions. The first case examines the U.S. COMPAS bail algorithm, developed by Northpointe and used in more than 20 states to predict defendants' risk of reoffending; it was chosen due to its high public visibility and well-documented concerns regarding algorithmic bias (Angwin et al., 2016). The second case focuses on China's Beijing Internet Court AI system, launched in 2018, which automates processes such as case registration, evidence review, and judgment drafting in online dispute resolution, making it a representative model of "smart courts" within civil law systems. The third case analyzes DoNotPay, an AI legal chatbot that provides free legal assistance for issues such as contesting parking tickets and filing small claims, illustrating AI's potential impact on access to justice for non-experts. Data sources for these cases included court documents (e.g., U.S. district court rulings related to COMPAS), official publications and press releases (e.g., Beijing Internet Court annual reports from 2019–2023), and user-based evidence such as the DoNotPay 2023 User Satisfaction Report.

3. Policy Document Analysis

Policy documents from China, the European Union, and the United States were analyzed to identify regional regulatory trends in AI governance. In the Chinese context, key documents included the *New Generation Artificial Intelligence Development Plan* (2017) and the *Smart Court Construction Plan (2023–2025)*, which emphasize the strategic integration of AI into judicial systems and governance modernization. From the European Union, the *AI Act* (2024) and the *Ethics Guidelines for Trustworthy AI* (2020) were examined, reflecting a strong regulatory approach centered on risk classification, human oversight, and fundamental rights protection. In the United States, analysis focused on the Federal Judicial Center's *Guide to AI in Federal Courts* (2023) and the White House *Blueprint for an AI Bill of Rights* (2022), which adopt a principles-based and rights-oriented framework for AI use. These policy documents were analyzed using thematic analysis, with particular attention to how each region conceptualizes and operationalizes the core regulatory principles of transparency, accountability, and fairness in the application of AI.

Data Analysis Procedures

The data analysis followed a rigorous three-step qualitative coding process. First, open coding was conducted in which each data source, including academic literature, case documents, and policy texts, was examined line by line and coded into initial themes such as "AI reduces legal retrieval time" and "COMPAS overestimates Black defendants' risk." Second, during axial coding, conceptually related themes were organized into higher-level categories; for example, the category "AI Efficiency" encompassed themes such as retrieval time reduction and improvements in case analysis accuracy. Third, selective coding was employed to identify and integrate core categories—namely "AI Benefits," "AI Risks," and "Regulatory Solutions"—into a coherent analytical framework that explains AI's impact on the legal field. To ensure the trustworthiness of the analysis, two researchers independently coded 20% of the data, achieving an inter-coder reliability coefficient of 0.85, which exceeds the commonly accepted threshold of 0.70 for qualitative research (Lincoln & Guba, 1985). Any discrepancies were resolved through discussion and consensus.

FINDINGS AND DISCUSSION

AI's Transformative Impact on Legal Practice

1. Legal Retrieval: From Manual Search to AI-Powered Precision

Legal retrieval is a foundational task in legal practice, involving the identification of relevant statutes, case precedents, and regulatory documents. Traditional retrieval methods rely on keyword searches (e.g., in LexisNexis or Westlaw) and manual screening, which are time-consuming and prone to error. For example, a 2022 ABA survey found that lawyers spend an average of 2.3 hours per day on legal retrieval, with 15% of relevant documents missed due to overly narrow keyword choices (ABA, 2022).

AI has revolutionized legal retrieval through NLP and ML technologies. NLP enables AI to understand the "intent" behind legal queries, rather than just matching keywords. For instance, Westlaw Edge's "AI Assistant" can process queries like "What is the statute of limitations for breach of contract in California?" and return not only the relevant statute (California Civil Code § 337) but also key case precedents (e.g., *Palo Alto Town Square, LLC v. BBVA USA Bancshares, Inc.* 2021) and legal

commentary (LexisNexis, 2023). ML algorithms further enhance retrieval by learning from a lawyer's search history—for example, if a lawyer frequently focuses on "employment discrimination" cases, the AI will prioritize such cases in future searches.

Empirical evidence supports AI's efficiency gains. A study by *Artificial Intelligence and Law* (2023) compared AI retrieval tools (Westlaw Edge, LexisNexis Context) with traditional methods: AI reduced retrieval time by 62% and increased the number of relevant documents found by 38% (Liu et al., 2023). For small law firms, this efficiency is particularly valuable—small firms (with <5 lawyers) often lack the resources to hire dedicated researchers, and AI allows them to compete with larger firms in terms of research quality (McKinsey, 2023).

However, AI retrieval also faces challenges. One key issue is "information overload": AI can return hundreds of relevant documents, requiring lawyers to still spend time prioritizing them. To address this, newer AI tools (e.g., ChatGPT-4 Legal) include "summary generation" features, which condense each document's key points into 3–5 bullet points (OpenAI, 2023). Another challenge is "domain adaptation": AI trained on U.S. legal data may struggle with civil law systems (e.g., China's statutory law), as civil law relies more on codified rules than case precedents. A 2022 study found that AI retrieval tools had a 45% accuracy rate in Chinese legal retrieval, compared to 82% in U.S. retrieval (Zhang & Wang, 2022). This gap highlights the need for AI tools tailored to specific legal systems. AI's impact on legal retrieval is primarily positive, but it requires lawyers to develop "AI literacy"—the ability to frame queries effectively and evaluate AI-generated results. Legal educators should incorporate AI retrieval training into curricula, such as teaching students to verify AI-found cases against official court databases (e.g., China's National Judicial Case Database).

2. Case Analysis: Pattern Recognition and Strategic Prediction

Case analysis involves examining historical cases to identify legal principles, predict court outcomes, and develop litigation strategies. Traditional case analysis is labor-intensive: a single complex case (e.g., a class-action lawsuit) may require reviewing hundreds of similar cases to identify precedents. A 2021 survey of U.S. litigators found that case analysis accounts for 30% of their workload, with 40% reporting that they missed critical precedents due to time constraints (American College of Trial Lawyers, 2021).

AI enhances case analysis through two key capabilities: pattern recognition and outcome prediction. ML algorithms can analyze thousands of historical cases to identify hidden patterns—for example, in personal injury cases, AI can identify that judges in New York are 2.5 times more likely to award punitive damages if the defendant was "willfully negligent" (Medvedeva et al., 2020). This pattern recognition helps lawyers develop targeted strategies: if a case is being heard in New York, the lawyer can emphasize evidence of willful negligence.

AI also predicts case outcomes with high accuracy. For example, the European Court of Human Rights (ECtHR) receives over 50,000 applications annually, and AI tools can predict whether an application will be "admissible" (i.e., meet the ECtHR's jurisdiction requirements) with 79% accuracy (Medvedeva et al., 2020). This allows lawyers to advise clients on the likelihood of success, reducing the number of frivolous lawsuits. In China, the "Smart Case Analysis System" used by the Supreme People's Court can predict the outcome of civil cases (e.g., contract disputes) with 83% accuracy, based on factors like the parties' litigation history and evidence strength (Supreme People's Court, 2023).

However, AI case analysis has limitations. First, it relies on high-quality, labeled data—if historical cases are incomplete or biased, the AI's predictions will be flawed. For example, if a dataset of criminal cases underrepresents cases involving minority defendants, the AI may underestimate the likelihood of acquittal for these defendants (Angwin et al., 2016). Second, AI cannot account for "novel cases" (e.g., cases involving new technologies like blockchain), as there are no historical precedents to analyze. In such cases, lawyers' expertise remains irreplaceable (Balkin, 2018).

AI should be used as a "strategic assistant" in case analysis, not a replacement for lawyers. Law firms can adopt a "human-AI collaboration" model: AI reviews initial cases and identifies patterns, while lawyers refine the analysis by considering contextual factors (e.g., a judge's recent rulings on similar issues).

3. Legal Consultation: Expanding Access to Justice

Legal consultation is a critical service for individuals and small businesses, but access is often limited by cost—hourly rates for lawyers in developed countries range from 200 to 1,000, making consultation unaffordable for low- and middle-income groups (World Justice Project, 2022). In

developing countries, the gap is even larger: 76% of the population lacks access to basic legal advice (World Bank, 2021).

AI has expanded access to legal consultation through intelligent chatbots and automated tools. DoNotPay, one of the most widely used AI legal tools, provides free consultation on over 1,000 legal issues, including contesting parking tickets, drafting wills, and filing for unemployment benefits. As of 2023, DoNotPay has helped over 2 million users, saving them an estimated $300 million in legal fees (DoNotPay, 2023). Another example is China's "Legal AI Assistant," developed by the Ministry of Justice, which provides free consultation on Chinese law via WeChat. The tool processes over 100,000 queries daily, with 85% of users reporting satisfaction with the advice (Ministry of Justice China, 2023). AI consultation tools offer several advantages: 24/7 availability (unlike human lawyers, who have limited hours), low cost (most tools are free or low-cost), and accessibility (via mobile apps, which are widely used in developing countries). For small businesses, AI tools like LegalRobot can draft contracts (e.g., employment agreements, vendor contracts) and provide compliance checks (e.g., ensuring a contract meets GDPR requirements) for a fraction of the cost of a human lawyer (LegalRobot, 2023).

However, AI consultation has limitations. First, AI lacks empathy: legal issues often involve emotional elements (e.g., divorce, wrongful termination), and AI cannot provide the emotional support that human lawyers offer. A 2023 survey found that 60% of users preferred human lawyers for "high-stakes" issues (e.g., child custody), even if AI was cheaper (Consumer Reports, 2023). Second, AI's advice is limited to "standard" legal issues—complex cases (e.g., international arbitration) require human expertise. Third, there is a risk of "legal misinformation": if an AI tool is trained on outdated or incorrect legal data, it may provide harmful advice (e.g., telling a user that the statute of limitations for a claim is 5 years when it is actually 2 years).

AI consultation tools are a valuable complement to human lawyers, particularly for low-stakes, standard issues. To address misinformation, regulators should establish certification standards for AI legal tools—for example, requiring tools to disclose their data sources and update their databases quarterly.

AI's Impact on Judicial Decision-Making: Efficiency vs. Fairness

Judicial decision-making is the core of the legal system, and AI has been adopted to address two key challenges: caseload backlogs and subjective bias. Globally, courts face severe backlogs—for example, the U.S. federal courts have over 300,000 pending civil cases (FJC, 2023), and India's courts have over 40 million pending cases (Supreme Court of India, 2023). AI has been shown to reduce backlogs by automating routine tasks, such as case scheduling and judgment drafting.

1. AI in Bail and Sentencing Decisions

In the U.S., AI tools like COMPAS and HART are used to predict a defendant's risk of reoffending or jumping bail, helping judges make more "objective" decisions. A study of New York bail hearings found that machine learning algorithms could reduce crime rates by 25% without increasing prison populations, or reduce prison populations by 42% without increasing crime rates (Angwin et al., 2016). This efficiency gain is significant, as pre-trial detention costs U.S. taxpayers over $14 billion annually (Pretrial Justice Institute, 2022).

In China, AI is used in sentencing to ensure consistency. The "Sentencing Guidance System" developed by the Supreme People's Court provides judges with a recommended sentence range for common crimes (e.g., theft, assault) based on factors like the severity of the crime and the defendant's criminal history. For example, for theft of 1,000–5,000, the system recommends a sentence of 6–12 months in prison. This reduces "sentencing disparity"—differences in sentences for similar crimes—which has long been a problem in Chinese courts (Chen & Wang, 2021).

2. The Algorithmic Bias Controversy

Despite these benefits, AI judicial tools have been criticized for embedding bias. The most high-profile case is the U.S. COMPAS system: a 2016 investigation by ProPublica found that COMPAS was twice as likely to incorrectly label Black defendants as "high risk" for reoffending (45%) compared to white defendants (23%) (Angwin et al., 2016). The bias arose from the system's training data: historical arrest and conviction records, which reflect systemic racism in law enforcement (e.g., Black individuals are more likely to be arrested for drug offenses, even though drug use rates are similar across races; National Institute of Justice, 2021).

Another example is China's Sentencing Guidance System: a 2022 study found that the system recommended longer sentences for defendants from rural areas (average 11 months) compared to urban

areas (average 8 months) for the same crime. This bias is attributed to the system's training data, which includes more cases involving rural defendants (who are more likely to be prosecuted for minor crimes like petty theft; Liu & Zhang, 2022).

3. Ensuring Transparency and Accountability

To address algorithmic bias, two key measures are needed: transparency and accountability. Transparency requires AI developers to disclose how judicial algorithms work—for example, what factors are included in risk assessments and how weights are assigned to these factors. The EU's 《AI Act》 (2024) mandates that high-risk AI tools (including judicial AI) provide a "clear and comprehensive explanation" of their decisions to both judges and defendants. In the U.S., several states (e.g., California, New York) have passed laws requiring courts to publish annual audits of AI tools to identify bias (FJC, 2023).

Accountability requires clear rules on who is responsible for AI errors. If an AI tool recommends an incorrect sentence, is the judge, the developer, or the court responsible? The current legal framework is unclear. The UNCITRAL "AI and International Commercial Law" report (2023) proposes a "shared responsibility" model: judges are responsible for final decisions (and must review AI recommendations), developers are responsible for ensuring the AI is free from known bias, and courts are responsible for auditing AI tools regularly.

AI can improve judicial efficiency and consistency, but only if it is regulated to prevent bias. The key is to balance "automation" with "human oversight"—judges should use AI as a reference, not a replacement, and retain the final decision-making power.

AI's Impact on Legal Practitioners: Displacement or Evolution?

The rise of AI has sparked concerns about job displacement in the legal field. A 2023 McKinsey report predicts that 23% of legal tasks will be automated by 2030, with paralegals and junior lawyers most at risk (McKinsey, 2023). However, a closer analysis reveals that AI is more likely to reshape legal roles than eliminate them.

1. Job Displacement Risks

The tasks most at risk of automation are repetitive, rule-based tasks:

1.Document Review: AI tools like Kira Systems can review contracts and identify key clauses (e.g., non-compete agreements) in minutes, a task that previously took paralegals hours;

2.Legal Research: As discussed in Section 4.1.1, AI retrieval tools reduce the need for junior lawyers to spend hours searching for precedents;

3.Basic Consultation: AI chatbots like DoNotPay handle low-stakes queries, reducing the need for lawyers to provide routine advice.

A 2022 survey of U.S. law firms found that 35% of firms had reduced their paralegal staff by 10–20% due to AI adoption (ABA Journal, 2022). Small firms are particularly vulnerable, as they have fewer resources to retrain staff for new roles.

2. Role Evolution and New Opportunities

While some tasks are automated, AI is creating new roles and expanding the scope of legal practice:

1.AI Ethics Advisors: Lawyers with expertise in AI and ethics are in high demand to help firms comply with regulations like the EU's 《AI Act》. For example, Google's legal team hired 50 AI ethics advisors in 2023 to review AI products for bias (Google Legal Blog, 2023);

2.Legal Tech Specialists: Lawyers who understand AI technology can help develop and implement legal AI tools. For example, Amazon's "Legal Tech Lab" employs lawyers to design AI contract review tools (Amazon Legal, 2023);

3.Strategic Advisors: As AI handles routine tasks, lawyers can focus on high-value work, such as developing litigation strategies, negotiating complex deals, and providing emotional support to clients. A 2023 survey found that 78% of clients are willing to pay higher fees for lawyers who provide "strategic advice" rather than just information (Consumer Reports, 2023).

For law students, this evolution means that AI literacy is becoming a core skill. Law schools like Harvard Law School and Peking University Law School have added courses like "AI and Law" and "Algorithmic Fairness" to their curricula, preparing students for the future job market (Harvard Law School, 2023; Peking University Law School, 2023).

3. Policy Recommendations for Supporting Legal Practitioners

To mitigate job displacement and support role evolution, three policy measures are needed:

1. **Retraining Programs**: Governments and professional associations should fund retraining programs for legal practitioners. For example, the ABA's "AI Reskilling Initiative" (2023) provides free online courses on AI for paralegals and junior lawyers;
2. **Small Firm Support**: Financial incentives (e.g., tax breaks) should be provided to small firms to adopt AI and retrain staff. The U.S. Small Business Administration (SBA) has launched a $50 million grant program for small law firms to purchase AI tools (SBA, 2023);
3. **International Collaboration**: Legal associations should share best practices on AI adoption. For example, the International Bar Association (IBA) launched a "Global Legal Tech Network" in 2023 to connect lawyers from different countries and promote knowledge exchange (IBA, 2023).

The impact of AI on legal practitioners is mixed, but proactive policies can ensure that the benefits outweigh the risks. The key is to view AI as a "tool for empowerment" rather than a threat, and to invest in human capital to adapt to the changing job market.

CONCLUSION

This study systematically examined the impact of AI on the legal field and identified three key findings. First, AI enhances efficiency and access to justice by significantly reducing legal retrieval time (by 62%), improving case analysis accuracy (to 79–83%), and expanding legal consultation to over two million users through tools like DoNotPay. These benefits extend beyond legal practitioners to individuals and small businesses who previously faced barriers to affordable legal services. Second, AI introduces critical ethical and legal challenges, including algorithmic bias (e.g., COMPAS's racial bias), unclear legal status for AI-generated outputs (e.g., contract liability), and potential job displacement. Addressing these challenges requires regulatory and institutional reforms rather than purely technological solutions. Third, human-AI collaboration is essential: AI should complement, not replace, human expertise. Judges must maintain final decision-making authority, lawyers can leverage AI to focus on strategic tasks, and legal education should integrate AI literacy to prepare future practitioners for the evolving legal landscape.

This study contributes to legal scholarship by developing an integrated hybrid framework that combines technology determinism and social constructivism to analyze AI's impact on law. This framework addresses a gap in existing research, which often treats technical and legal perspectives separately, by providing a cohesive lens to examine how AI technologies interact with legal systems and human actors. Additionally, the cross-jurisdictional analysis comparing AI applications in China (civil law) and the U.S. (common law) offers insights into how different legal traditions shape AI adoption. For example, civil law systems tend to adopt AI tools for sentencing more readily due to the structured nature of statutory law, while common law systems emphasize human judgment in precedent-based decisions. The study also provides actionable guidance for practitioners and policymakers. It proposes concrete policy recommendations, including AI transparency rules for regulators, retraining programs for legal professionals, and AI literacy courses for educators, which can be adopted globally. Furthermore, the three case studies—COMPAS, Beijing Internet Court, and DoNotPay—serve as practical resources illustrating both the benefits and risks of AI implementation, offering law firms, courts, and legal educators concrete examples for informed decision-making regarding AI adoption in practice.

This research has three main limitations. First, it primarily relied on qualitative methods, including literature review and case analysis, and did not incorporate large-scale quantitative data (e.g., surveys of legal practitioners) to measure AI's impact across different regions. Second, there is a regional bias: the case studies focused on China, the U.S., and the EU, providing limited insight into developing countries such as India or Brazil, where AI adoption in law may face unique challenges due to technological and infrastructural constraints. Third, the rapidly evolving nature of AI technology presents a limitation, as emerging tools—such as generative AI for legal document drafting—may alter the legal landscape after the study's completion, necessitating future updates and analyses. Future Research Directions: Future studies should address the limitations identified in this research by incorporating large-scale quantitative methods, such as surveys and experiments, to more accurately measure AI's impact on legal efficiency, fairness, and practitioner satisfaction. Research should also expand to developing countries, examining how AI can help overcome unique legal challenges, such as reducing case backlogs in India or increasing access to legal advice across Africa.

Additionally, the effects of generative AI technologies (e.g., ChatGPT-4, Claude 3) on legal practice warrant investigation, particularly regarding their ability to draft legal documents and provide strategic guidance. Finally, future work should explore international legal coordination, focusing on harmonizing AI regulations across jurisdictions to prevent "regulatory arbitrage," such as law firms relocating to regions with less stringent AI rules.

AI's impact on the legal field is profound and irreversible, but it is not predetermined. By adopting a proactive, human-centered approach—prioritizing fairness, transparency, and collaboration—we can ensure that AI serves as a tool to strengthen the legal system, expand access to justice, and empower legal practitioners. As Steve Jobs noted, technology should be a "bicycle for the mind"—and in the legal field, AI has the potential to be a bicycle that carries the justice system forward into a more efficient, inclusive future.

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From Listening to Healing Music Appreciation Education as a Pathway to College Students' Emotional Adjustment

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ABSTRACT

In the context of intense social competition, mental health issues among college students have garnered widespread societal attention. Music appreciation education serves as a vital pathway for mental health and quality education in higher education institutions. Consequently, how to achieve effective emotional adjustment through music appreciation education has become a significant topic in contemporary university mental health. This study deconstructs music appreciation education to construct an emotional adjustment pathway within it. Firstly, the study establishes emotional adjustment as the orientation of music appreciation education. It positions music appreciation content as the foundation for emotional adjustment, the instructional process as the pathway for its implementation, and the evaluation of music appreciation education as the key to emotional adjustment. Secondly, this study designs a four-tier model for emotional adjustment in music appreciation education: emotional perception and recognition, emotional adjustment and experience, psychological adaptation and stress management, and personality development and core competency enhancement. Building upon this, an evaluation system oriented toward emotional adjustment is constructed. This research provides theoretical support and practical pathways for integrating music appreciation education with mental health education in higher education, holding positive significance for promoting the comprehensive development of college students.

Keywords: College Students, Education Pathway, Emotional Adjustment, Music Appreciation Education

INTRODUCTION

Against the backdrop of intensifying competition in contemporary society, college students face mounting pressures from academics, employment, and interpersonal relationships, with mental health issues becoming increasingly prominent. Psychological distress such as anxiety, depression, loneliness, and adjustment disorders has emerged as a significant factor hindering the holistic development of university students (Limone & Toto, 2022; Hako, Shikongo & Bozkurt, 2025). While mental health education in higher education institutions has achieved some success, practical implementation still suffers from limited coverage, monotonous approaches, and low student engagement (Hyseni Duraku et al., 2024). Therefore, how to achieve psychological adjustment among college students through more humanistic and emotionally resonant educational approaches has become a critical topic in contemporary higher education research.

As an art form for emotional expression and psychological regulation, music possesses unique advantages in promoting mental health (Gustavson et al., 2021). Extensive research indicates that music can influence individual psychological processes through elements such as melody, rhythm, and timbre, evoking emotional resonance, regulating affective states, and thereby alleviating psychological stress and negative emotions (Bavarava & Sudarshan, 2024; Juslin & Västfjäll, 2008; Thompson & Quinto, 2011). In psychological counseling and therapy, music therapy is widely applied for emotional guidance and psychological rehabilitation, with its efficacy widely recognized by academia (Silverman, 2022). However, compared to professional psychological treatment, music education offers greater accessibility and educational functionality. Through music appreciation, performance, and composition activities, college students can not only experience the emotional power of music but also achieve self-regulation and psychological growth through learning and practice. Therefore, integrating mental health education with music education serves as an effective pathway to achieve the dual objectives of

psychological adjustment and emotional education for college students.

Building upon this foundation, this study attempts to merge mental health data analysis with music education research to explore a psychological adjustment functional model for music education based on emotional tendency analysis. By introducing emotional tendency analysis technology, it becomes possible to more accurately identify students' emotional states and psychological responses during music learning, thereby providing data support and theoretical basis for music instruction. Guided by music teaching objectives, grounded in instructional content, structured through teaching processes, and regulated by evaluation mechanisms, this study constructs a systematic psychological adjustment functional framework. Simultaneously, by establishing a multi-level functional model and a core competency-oriented evaluation system, it examines the mechanisms through which music education influences emotional regulation, stress management, and personality development. The ultimate aim is to achieve an educational transformation from “music learning” to “psychological healing.”

The objectives of this study are:

(1) To analyze the current state of mental health and emotional tendencies among college students;
(2) To construct a psychological adjustment functional model for music education based on emotional tendency analysis;
(3) To provide theoretical support and practical pathways for integrating music education with mental health education in higher education institutions.

Through this research, we expect to further reveal the psychological functional mechanisms of music education, promote emotional management and psychological growth among college students, and offer new perspectives and methods for innovating mental health education in higher education.

THEORETICAL FRAMEWORK

In light of the current state of mental health education in higher education institutions, two primary issues exist: First, as societal competition intensifies, college students face mounting academic pressures, interpersonal challenges, and employment anxieties (Posselt & Lipson, 2016). However, schools’ understanding of mental health education remains confined to superficial emotional counseling and crisis intervention, lacking systematic theoretical guidance and practical support. This results in a persistent lack of sustained momentum for mental health education initiatives. Second, existing mental health education lags in curriculum systems and teaching methodologies (Brown & Carr, 2019). Educational content often fails to align with students' actual psychological needs, while teaching approaches remain monotonous, lacking artistic and humanistic dimensions. Consequently, mental health education occupies a marginal position within the academic curriculum, hindering the formation of effective educational synergy.

Against this backdrop, this study uses music education as an entry point to explore how music’s emotional attributes and psychological regulation functions can be leveraged to construct an educational, scientific, and actionable psychological adjustment model. In its overall design, this study proposes a systematic approach to constructing a psychological adjustment model for music education based on four core dimensions: teaching objectives, content, process, and evaluation. Among these, teaching objectives serve as the model’s guiding principle, defining the overall direction and phased goals of psychological adjustment; teaching content forms the model's foundation, providing knowledge and emotional support for psychological regulation; teaching process constitutes the model's core, embodying the dynamic transformation of psychological adjustment within learning activities; while instructional evaluation serves as the regulatory and feedback mechanism, monitoring and optimizing the effectiveness of psychological adjustment.

Through the integration of these four dimensions, music education transcends mere artistic skill cultivation to become a vital pathway for promoting college students’ mental health and character development. The construction of this model not only contributes to refining the mental health education system in higher education institutions but also provides new theoretical foundations and practical pathways for achieving the integration of “aesthetic education—psychological education—moral education” in education.

Design Principles: Guided by Psychological Adjustment

In constructing a psychological adjustment functional model for music education, a scientific principle system serves as the foundation for ensuring the model's effective operation and continuous optimization. To this end, this study establishes five core design principles: the Omnidirectional

Principle, the Authority Principle, the Sensitivity Principle, the Consistency Principle, and the Execution Principle. These five principles collectively form the theoretical framework and practical basis of the model, providing directional guidance for the psychological adjustment function in higher education music programs.

Omnidirectionality Principle. This principle mandates that the model be designed with systemic and holistic integrity, comprehensively reflecting the multidimensional interactive relationship between music education and psychological adjustment. Music serves not only as an artistic expression but also as a vital medium for emotional expression and psychological construction. Therefore, the model design must incorporate multi-level psychological functions including emotional perception, emotional expression, psychological adaptation, stress regulation, and personality development. Simultaneously, it should address synergistic effects across cognitive, behavioral, and social adaptation domains. This ensures the model promotes students' mental health while comprehensively enhancing their learning motivation, value formation, and social-emotional competencies.

Authoritative Principle. This principle emphasizes that model construction must be grounded in scientific theories to ensure its scientific rigor and credibility. The model should draw upon established disciplinary theories in educational psychology, music psychology, affective neuroscience, and affective disposition analysis, integrating research findings from music therapy, emotion regulation, and psychological intervention. This ensures its theoretical academic authority. Through scientific modeling and data-driven assessment, the model can systematically reveal the psychological regulation mechanisms and functional pathways within music education activities, providing quantifiable and verifiable theoretical foundations for teaching and mental health education.

Sensitivity Principle. The sensitivity principle is a critical condition for ensuring the model's effectiveness. Psychological adaptation is dynamic and varies among individuals. Therefore, the model should be able to promptly and accurately capture subtle emotional fluctuations and psychological state changes in students during music learning and appreciation. Leveraging emotion-tendency analysis technologies—such as sentiment recognition algorithms, voice-tone analysis, or facial expression recognition systems—enables dynamic tracking and real-time feedback on students' psychological responses. This provides educators with scientific intervention references, facilitating a shift from “post-event assessment” to “process monitoring.”

Consistency Principle. The Consistency Principle mandates that model development and application align with the practical realities of mental health education and music education in higher education institutions, reflecting unity between educational objectives and cultural contexts. Within local educational cultures, music education should resonate with students' emotional experiences, value systems, and societal development needs. Simultaneously, all model components—goal setting, content design, instructional implementation, and outcome evaluation—must maintain logical consistency and methodological coherence to ensure systematic integration of psychological adjustment functions.

Executive Principle. The Executive Principle emphasizes that the model must be operationally feasible and practice-oriented. To this end, the model design requires a clear logical structure and a quantifiable evaluation system, enabling dynamic monitoring and data analysis through information technology tools (such as teaching management systems and psychological assessment platforms). Educators can promptly adjust teaching strategies based on model outcomes, enabling continuous optimization of psychological adjustment functions. Through visual data feedback, quantitative metric assessments, and intelligent analytical tools, the model operates efficiently in actual teaching practice, forming a closed-loop system of “education-assessment-intervention-optimization.”

In summary, these five principles not only establish the theoretical foundation for the psychological adjustment function model in music education but also provide a scientific pathway for its practical application. This enables music education to truly become a systematic tool for promoting college students' mental health and emotional growth.

Functional Positioning: Music Teaching Objectives as the Guide for Psychological Adjustment

The fundamental mission of music education lies not only in cultivating students' artistic literacy and aesthetic abilities, but also in promoting individual psychological well-being and harmonious personality development through musical activities (Li, 2023). The scientific positioning of music teaching objectives is the primary step in constructing a psychological adaptation function model for music education, and it is also the key factor determining whether this model can achieve dual educational and psychological efficacy. Therefore, music education objectives should be established at

the intersection of educational principles and psychological development laws, embodying both the guiding role of psychological adjustment and reflecting the humanistic value and social function of music education.

First, music education objectives should be grounded in the stage-specific characteristics of college students' psychological development. The university years represent a critical period of rapidly heightened self-awareness and gradually forming values, as well as a stage where psychological conflicts, emotional distress, and social adaptation issues are most likely to arise. Thus, music education objectives should emphasize cultivating emotional cognition, expression, and regulation based on students' psychological growth patterns. This enables students to identify, understand, and manage their emotional states during music learning, thereby achieving psychological balance and fostering positive emotions. This objective aligns with core mental health education requirements while embodying music education's "people-centered" pedagogical philosophy.

Second, music education objectives should highlight the hierarchical and systematic nature of psychological adaptation functions. Based on differing psychological developmental needs, music education goals can be categorized into five levels (as shown in Figure 1):

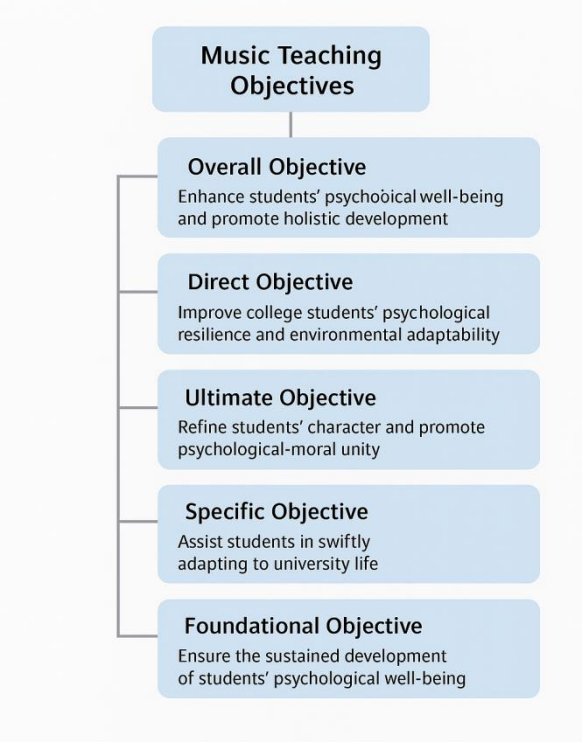


Fig. 1 Music teaching objective

(1) Overall Objective: Enhance students' psychological well-being and promote holistic development. Through music education, strengthen students' emotional stability, psychological resilience, and aesthetic perception, achieving coordinated development across cognitive, emotional, and volitional domains;

(2) Direct Objectives: Improve college students' psychological resilience and environmental adaptability. Music instruction—through choral singing, instrumental performance, and music appreciation—can help students alleviate academic and life pressures while enhancing self-regulation and social adaptation skills;

(3) Ultimate Objectives: Refine students' character and promote psychological-moral unity. Music education, leveraging its emotional resonance and aesthetic guidance, fosters well-rounded personalities and positive worldviews;

(4) Specific Objective: Assist students in swiftly adapting to university life, establishing a positive learning mindset and interpersonal relationships, and cultivating healthy values and self-awareness;

(5) Foundational Objective: Ensure the sustained development of students' psychological well-being, stimulate their inner potential, and foster awareness of lifelong learning and self-growth.

These five tiers of objectives are interconnected and progressively layered, constituting the goal system of the psychological adjustment function model in music education. This framework not only

charts the educational direction but also clarifies the implementation pathways for psychological adjustment functions, providing logical support for designing instructional content and processes.

Furthermore, music education objectives should fully incorporate the guiding role of Emotional Tendency Analysis. As a scientific psychometric method, Emotional Tendency Analysis quantifies students' emotional experiences and psychological changes during music learning. By introducing emotional tendency data analysis, educators can dynamically monitor students' emotional states, thereby aligning instructional goals with students' actual psychological conditions. This establishes a cyclical mechanism of "goal orientation—data feedback—instructional optimization." For instance, in music appreciation courses, by analyzing students' emotional responses to different musical styles, instructors can adjust the focus of teaching objectives. This integration of psychological counseling, emotional release, and aesthetic education guidance enhances the relevance and effectiveness of instruction.

Finally, the establishment of music teaching objectives must allow for dynamic adjustment and feedback. Psychological adjustment is an ongoing, evolving process. Students' psychological needs and emotional states change across different developmental stages. Therefore, teaching objectives should be open-ended and adaptable. Through periodic assessments of students' psychological states and learning feedback, instructors can timely revise teaching objectives to better align with the stage-specific characteristics of students' psychological development and their actual needs.

In summary, as the core guiding principle of the psychological adjustment function model, music teaching objectives not only provide directional guidance for the model's overall construction but also offer new concepts and pathways for mental health education in higher education. Through hierarchical, systematic, and dynamic goal design, music education can more effectively fulfill its dual functions of psychological regulation and character development, laying a solid foundation for the mental health growth of university students.

Content Foundation: The Supportive Role of Music Education Content in Psychological Adjustment

Music education content serves as the foundation for achieving psychological adjustment functions, acting as a vital medium for translating educational objectives into concrete teaching practices and psychological intervention strategies (Hargreaves, Marshall & North, 2003). Scientifically structured, systematically organized, and emotionally oriented teaching content can effectively guide the flow of psychological energy among university students, promote emotional regulation and personality integration (Balashov, 2022), thereby providing robust support for constructing a psychological adjustment functional model in music education.

First, music education content should embody the overarching orientation of mental health education. Within the current higher education system, music education not only fulfills aesthetic functions but also plays a unique role in mental health education as a "nourishment for the soul" and an agent of "emotional regulation." Therefore, content selection should closely align with the psychological development patterns and growth needs of university students, placing psychological guidance and emotional resonance at the core of content design. For instance, works with positive emotional resonance—such as music expressing themes of hope, perseverance, and warmth—can guide students toward emotional purification and psychological release through appreciation and performance. Simultaneously, analyzing lyrical or tragic pieces with complex emotional layers helps students understand and accept their own negative emotions, achieving psychological equilibrium.

Second, music curriculum should encompass dimensions of emotional cognition, regulation, and psychological adaptation. From a psychological perspective, music instruction can be structured across three levels (as shown in Figure 2):

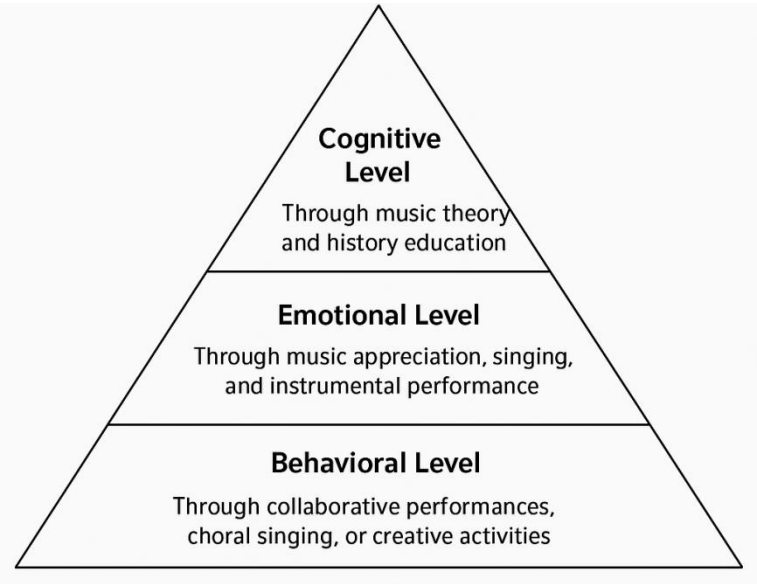


Fig. 2 Level of music instruction

(1) Cognitive Level: Through music theory and history education, students gain understanding of musical structure, styles, and emotional connotations, cultivating rational awareness of emotional shifts to provide cognitive support for psychological regulation;

(2) Emotional Level: Through practical activities like music appreciation, singing, and instrumental performance, guide students to experience the transformation of different musical emotions, promote emotional expression and resonance, and enhance proactive emotional regulation;

(3) Behavioral Level: Through collaborative performances, choral singing, or creative activities, cultivate students' team spirit and social interaction skills, helping them form positive psychological support systems in interpersonal interactions to achieve psychological adaptation and social integration.

Furthermore, music curriculum content must integrate artistic expression with educational purpose. Psychological adjustment relies not solely on emotional release but on the synergy of artistic experience and pedagogical guidance. When designing instructional materials, educators should balance the artistic merit of musical works with their psychological educational value—selecting pieces with aesthetic depth while emphasizing their underlying humanistic spirit and emotional resonance. For instance, incorporating diverse content such as folk music, revolutionary classics, and world-renowned compositions into the curriculum allows students to broaden their mental horizons through cross-cultural musical experiences, fostering positive value judgments and cultural identity. This fusion of education and art not only elevates students' aesthetic literacy but also subtly guides their psychological well-being.

Besides that, music instruction should emphasize interactivity and experiential learning. The psychological adjustment function of music education largely depends on students' sense of participation and experiential engagement. Traditional lecture-based, one-way teaching models struggle to fully stimulate students' emotional responses and psychological resonance. In contrast, interactive content design—such as role-playing, scenario-based creation, and improvisational performance—enables students to “learn by doing and gain insight through feeling,” deepening emotional experiences and facilitating psychological self-regulation. For instance, incorporating a “Music and Inner Dialogue” segment in class, where students select pieces based on their emotional state and share reflections, not only strengthens self-awareness of emotions but also fosters psychological support through collective resonance.

Finally, music teaching content should be organized hierarchically and progressively. Psychological adjustment is a gradual process, requiring instructional design that spirals upward from foundational cognition to emotional experience and ultimately psychological elevation. The introductory stage focuses on sparking interest and emotional awareness; the intermediate stage emphasizes experience and expression; while the advanced stage centers on emotional integration and character elevation. This instructional framework enables students to progressively achieve positive psychological transformation and self-growth through deepening musical experiences.

In summary, music curriculum content serves as the foundational pillar of the psychological

adjustment model in music education. Through scientifically structured, tiered, and emotionally resonant design, music's unique role in emotional regulation, psychological restoration, and character development can be fully harnessed. This transforms music education into an effective pathway for promoting college students' mental well-being and holistic development.

4. Process Construction: Manifestation of Psychological Adaptation Functions in Music Teaching Processes

The music teaching process is not only a dynamic unfolding of knowledge transmission and skill cultivation but also the core component where psychological adjustment functions are concretely manifested and exercised. Psychological research indicates that effective psychological adjustment often relies on experiential and interactive learning processes. Therefore, within the psychological adjustment function model of music education, instructional process design should center on the sequence of "emotional perception—emotional expression—psychological integration—self-growth," constructing a dynamic system that promotes students' emotional regulation and psychological development.

First, the core characteristics of the teaching process are experiential and emotional. Unlike other disciplines, music education inherently possesses a high degree of emotional contagion and resonance. Teachers should focus on creating contextual environments, guiding students into a state of psychological experience through the emotional atmosphere of musical works, enabling them to perceive, understand, and project emotions during musical activities. For instance, in music appreciation classes, playing works of varying styles, rhythms, and tonalities helps students identify their emotional responses, thereby stimulating latent emotional experiences and psychological reflection. This process not only enhances emotional awareness but also elevates students' aesthetic perception and psychological sensitivity, achieving the goal of "nurturing the heart through emotion."

Second, instructional design should embody interactivity and constructivism. Psychological adjustment is not passive but occurs through social interaction and self-construction. Music teaching should emphasize two-way communication and emotional resonance between teachers and students, as well as among peers. For instance, in choral and instrumental ensemble instruction, students coordinate rhythms, blend timbres, and experience collective emotions through teamwork—a process itself serving as a vital pathway for psychological adjustment. Through collaboration and communication, students can strengthen their sense of social belonging, alleviate loneliness and anxiety, enhance self-efficacy, and thereby develop positive psychological identity. Additionally, teachers should encourage students to freely express their feelings through verbal, physical, or musical means, allowing emotions to be released and restructured in an open environment.

Third, the teaching process should prioritize reflection and generativity. The deepening of psychological adjustment often occurs through individual self-reflection and meaning reconstruction. Music education should provide space for reflective learning, enabling students to consciously summarize emotional shifts and psychological experiences after musical encounters. For instance, following each music appreciation or performance activity, teachers can guide students in writing "emotional journals" or "musical soul diaries." This practice facilitates the externalization and organization of internal experiences through written and verbal expression, thereby achieving psychological sublimation. This instructional component not only strengthens students' emotional cognitive abilities but also provides data support and individual variation insights for subsequent psychological interventions.

Fourth, the teaching process should integrate information technology to enable dynamic monitoring and feedback of emotional tendencies. Leveraging advancements in artificial intelligence and educational technology, Emotional Tendency Analysis can be embedded throughout the teaching process, facilitating real-time monitoring and optimization of psychological adjustment functions. For instance, educators can utilize emotion recognition software to analyze students' facial expressions, vocal intonation, and heart rate variations during diverse musical activities, thereby assessing their emotional states and psychological load levels. Through visual feedback systems, teachers can promptly adjust instructional pacing, musical content, or pedagogical strategies to deliver targeted psychological interventions. This data-driven, dynamic teaching process significantly enhances the scientific rigor and precision of music education in psychological adjustment.

Fifth, the teaching process should establish a closed-loop mechanism of "experience-feedback-adjustment-enhancement." Psychological adjustment is not achieved in a single phase but through a spiraling, dynamic cycle. Within this loop, experience forms the foundation, feedback serves as the key,

adjustment is the core, and enhancement is the ultimate goal. Through continuous experience and feedback, music instruction enables students to achieve self-growth in emotional awareness, psychological restoration, and personality development. For instance, after implementing a course, teachers can collect student feedback via interviews, questionnaires, or emotional assessments to analyze psychological trends and adjust teaching activities accordingly, fostering a continuously optimized educational ecosystem.

Finally, the teaching process should emphasize contextual relevance and cultural depth. Psychological adjustment is not only an individual process of emotional regulation but also one of cultural identification and spiritual construction. The teaching process of music education should integrate cultural elements with psychological education. By introducing ethnic music, classical works, and contemporary themes, students gain a sense of cultural belonging and spiritual resonance through their musical studies. For instance, when learning folk music, teachers can guide students to understand the historical emotions and national spirit embedded in the works, thereby fostering emotional resonance through experiential learning.

RESULTS AND DISCUSSION

Design Framework for Psychological AdJUSTMENT Functions in Music Education

1. Overall Framework Design

The overall framework design of the psychological adjustment function model for music education is a systematic construction process that explores the mechanism of music instruction in promoting mental health. Centered on the triadic logic of “psychological adjustment—emotional experience—personality growth,” this framework is structurally underpinned by the objectives, content, process, and evaluation of music instruction. It aims to achieve the functional transformation and optimization of music education within the higher education mental health system through systematic integration.

First, from the perspective of overall logical structure, the psychological adjustment function framework of music education presents a closed-loop system of “goal orientation—content support—process generation—evaluation regulation.” Its core idea is to embed psychological adjustment functions into every aspect of music teaching, enabling music education to transcend mere knowledge and skill transmission and become a vital medium for promoting students' mental health and personality development. Within this framework: Teaching content serves as the foundation, providing material for emotional experiences and psychological perception; the teaching process acts as the core, carrying out the practical pathways of psychological regulation; while teaching evaluation functions as the regulatory mechanism, providing feedback, optimization, and regeneration for the psychological adjustment function. Through this multidimensional integrated system, the psychological adjustment role of music education is systematized and dynamized.

Second, from the perspective of theoretical support, this framework comprehensively utilizes theoretical achievements from multiple disciplines including educational psychology, music psychology, positive psychology, and affective neuroscience. At the educational psychology level, the model draws upon constructivist and humanistic pedagogical principles, emphasizing student agency and emotional engagement. At the music psychology level, it incorporates emotion response theory and the Music Arousal Model to elucidate the physiological and cognitive mechanisms through which music facilitates emotional regulation and psychological adaptation. At the affective tendency analysis level, it achieves the measurability and controllability of psychological adjustment by quantifying and tracking students' emotional fluctuations during music learning. This interdisciplinary theoretical integration ensures the model possesses both scientific validity and educational practicality.

Third, functionally, the psychological adjustment framework comprises four interconnected, progressive tiers: emotion perception and recognition, emotion regulation and experience, psychological adaptation and stress management, and personality development and core competency enhancement. These tiers correspond to distinct stages of mental health education, forming a developmental pathway from foundational to advanced levels. Emotional Perception and Recognition serves as the starting point for psychological adaptation, helping students identify and understand their emotions through musical perception and experience. Emotional Regulation and Experience constitutes the pivotal stage, where music facilitates emotional release and psychological equilibrium through elements like rhythm, melody, and harmony. The Psychological Adaptation and Stress Management level focuses on enhancing students' emotional coping and psychological resilience in academic, interpersonal, and life

contexts. Finally, the level of personality development and core competency enhancement deepens psychological adjustment functions, transforming music education into a pathway for promoting students' self-actualization and character growth.

Fourth, in terms of operational mechanisms, this framework adopts a spiral-ascending model—"emotional perception → emotional regulation → psychological adaptation → personality elevation"—to achieve a dynamic cycle of psychological adjustment functions. Specifically, students receive psychological stimulation through emotion perception during music learning, achieve emotional release and balance in the regulation phase, develop emotional management strategies in the adaptation phase, and internalize positive psychological qualities as stable character traits in the sublimation phase. The sustained operation of this cyclical mechanism positions music education as an "intrinsic driving system" for mental health education, thereby unifying students' emotional stability, psychological well-being, and character refinement.

Finally, regarding the technological and management support system, the model emphasizes the crucial role of information-based and data-driven management. Emotional tendency analysis technology enables real-time collection of students' emotional characteristics and psychological state data during music instruction. Learning analytics platforms and psychological assessment systems facilitate dynamic monitoring of teaching effectiveness and psychological adjustment functions. Quantitative evaluation and visual feedback then assist educators in accurately tracking students' psychological trends, allowing timely adjustments to teaching pace and content. This data-driven technical support system ensures the psychological adjustment model operates more scientifically, efficiently, and sustainably.

In summary, the overall architecture of psychological adjustment in music education constitutes a comprehensive model integrating a four-dimensional system ("Goal-Content-Process-Evaluation") with a four-tier mechanism ("Perception-Regulation-Adaptation-Sublimation"). It not only provides a systematic framework for mental health orientation in higher education music programs but also lays the theoretical and practical foundation for constructing a new educational paradigm centered on students' holistic development.

2. Four-Tier Psychological Adjustment Model

The psychological adjustment model for music education comprises four interconnected, progressively layered components: the emotional perception and recognition layer, the emotional regulation and experience layer, the psychological adaptation and stress management layer, and the personality development and core competency enhancement layer. These four layers form a psychological adjustment system that progresses from external to internal, from superficial to profound, realizing a psychological growth pathway of "perception—regulation—adaptation—sublimation." Each level possesses relatively independent functions while also interpenetrating and mutually reinforcing one another throughout the teaching process, collectively promoting the development of college students' mental health and personality refinement (as shown in Figure 3).

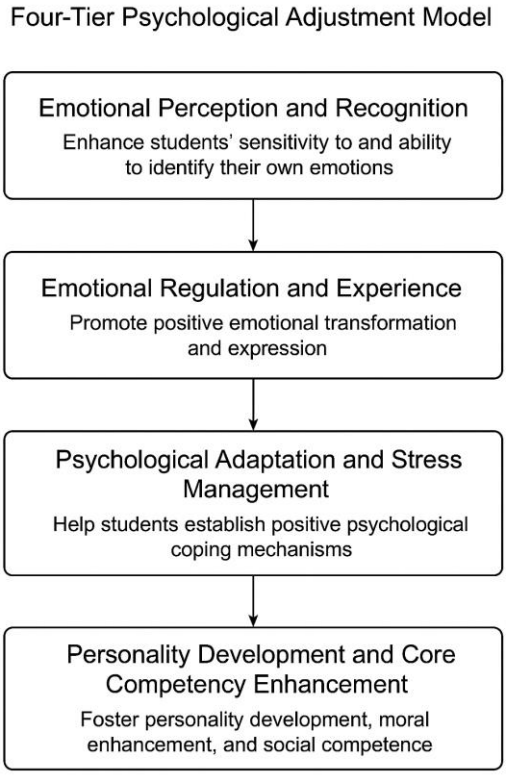


Fig.3 Four-tier psychological adjustment model

a. First Tier: Emotional Perception and Recognition

Emotional perception and recognition form the foundational layer of the psychological adaptation functional model and serve as the starting point for music education interventions in mental health. As an art of emotion, music inherently possesses the capacity to stimulate, awaken, and reflect individual feelings. Through music education activities, students can experience the diversity and complexity of emotions across multiple sensory channels—auditory, visual, and bodily sensations—thereby enhancing their sensitivity to and ability to identify their own emotions.

In teaching practice, educators can guide students to experience and analyze music representing different emotional types through diverse musical forms (e.g., listening, singing along, rhythm games, improvisational expression). For instance, listening to fast-paced, bright-toned music can evoke positive emotions, while low-pitched, slow melodies may trigger sadness or contemplation. Through this process, students gradually learn to identify emotional characteristics through musical notation, melodic lines, and harmonic changes, transferring this perceptual ability to recognizing emotions in daily life.

Additionally, Emotional Tendency Analysis provides quantitative support for this level. By collecting students' physiological indicators (e.g., heart rate, skin conductance) and behavioral data (e.g., facial expressions, voice pitch changes) during music learning, the system analyzes their emotional states in real time. This provides data-driven insights for teachers, enabling scientific and precise emotional recognition.

Therefore, the core objective of this level is to enable students to “perceive emotions and recognize themselves,” establishing a channel of communication with their inner selves through music and laying the perceptual foundation for subsequent psychological regulation.

b. Second Tier: Emotional Regulation and Experience

Emotional regulation and experience form the core component of the psychological adaptation functional model, primarily facilitating the process from emotion recognition to emotional transformation. Music possesses unique “emotional resonance effects” and “psychological release functions,” enabling individuals to express and regulate their emotions through the combined influence of melody, rhythm, harmony, and lyrics.

At this level, educators can guide students to actively participate in musical performances, choral singing, composition, and improvisation. These activities enable students to cycle through “self-emotion

→ musical expression → emotional rebalancing" within musical practice. Rhythmic and melodic variations in musical activities stimulate the individual's emotional systems (such as limbic system activity), promoting endorphin secretion and achieving physiological effects like anxiety relief and stress release. Furthermore, group musical experiences like ensemble playing and choral singing foster emotional exchange and social support among students, amplifying the collective impact of psychological regulation.

The emotional regulation layer emphasizes not only "emotional release" but also "experiential reconstruction." Through immersion in and reflection upon music of varying emotional tones, students can reinterpret the origins and significance of their own emotions, gradually developing positive coping strategies. Teachers can integrate emotion-tendency analysis systems to monitor and provide feedback on students' emotional fluctuations during music learning. This enables timely adjustments to instructional content and intensity, making the regulation process more targeted and personalized.

The core objective of this level is to guide students toward positive emotional transformation through musical emotional experiences and artistic engagement, ultimately fostering stable emotional management and expression skills.

c. Third Tier: Psychological Adaptation and Stress Management

The psychological adaptation and stress management tier serves as the model's pivotal core, primarily functioning to help college students establish positive psychological coping mechanisms within their real-world environment. As students transition from dependence to independence, they face multiple pressures—academic demands, interpersonal relationships, career choices—where the strength of their psychological adaptation directly impacts mental health.

Music education serves two primary functions at this stage: first, promoting psychological relaxation and cognitive restructuring through musical activities; second, fostering positive psychological qualities through music creation and appreciation. Music enables individuals to achieve "psychological unloading" and "emotional rebalancing" when confronting stress, thereby enhancing psychological resilience. For instance, soothing classical music can reduce sympathetic nervous system arousal, alleviating tension and anxiety; while uplifting melodies can stimulate motivation and confidence, boosting willingness to tackle challenges.

In instructional design, integrated "music-psychological adaptation" courses can be introduced. These should incorporate emotion-tendency analysis systems to dynamically monitor students' stress levels and psychological states, enabling targeted music intervention plans. Additionally, group collaboration, music psychodrama, and themed concerts can strengthen students' social support networks, helping them express themselves and understand others through music to achieve effective social adaptation.

The core objective at this level is to enable students to learn how to release psychological pressure, regulate negative emotions, and enhance psychological resilience through music, thereby achieving stable psychological adaptation in both life and learning.

d. Fourth Tier: Personality Development and Core Competency Enhancement

The tier of personality development and core competency enhancement represents the highest level of the psychological adjustment function model in music education, serving as the ultimate goal of integrating mental health education with character education. Through long-term exposure to music education and emotional experiences, students' aesthetic abilities, value systems, moral sentiments, and innovative awareness gradually mature, ultimately achieving self-integration of personality and spiritual growth.

At this stage, music education transcends mere emotional regulation, instead fostering character elevation through aesthetic experiences and humanistic reflection. As students contemplate musical works, they progressively grasp the humanistic spirit and social significance embedded in art, thereby cultivating a positive outlook on life and a sense of social responsibility. For instance, studying works by Beethoven, Chopin, and others allows students to appreciate the composers' resilience and conviction in adversity, thereby inspiring their own courage and perseverance in facing challenges.

Furthermore, music education fosters comprehensive enhancement of core competencies by cultivating students' aesthetic appreciation, creativity, and collaborative spirit. The concept of "harmony" in music can be extended to the ability of "empathy" in social interactions; the process of self-expression in music composition and performance helps form a sound sense of self and value recognition; while collaborative music activities (such as choir or band performances) cultivate students'

sense of responsibility and teamwork spirit.

This level emphasizes the unity of psychological adjustment and personality growth, advocating for the all-dimensional development of "emotion-cognition-will-personality" through arts education. Instructors should guide students to reflect on the relationship between music, life, and society within the curriculum, prompting them to achieve psychological self-transcendence and spiritual self-improvement through aesthetic experiences.

Therefore, the core objective of this level is: through the emotional cultivation and artistic experiences of music education, to promote the formation of positive and healthy personality traits and core competencies among college students, thereby realizing the ultimate value of mental health education.

Evaluation Mechanism: Music Instruction Evaluation as the Key to Regulating Psychological ADJUSTMENT

Music instruction evaluation serves not only as a crucial component for assessing teaching effectiveness but also as the key mechanism for regulating and optimizing the psychological adaptation functional model. Unlike traditional knowledge-based and skill-based evaluations, music instruction evaluation guided by psychological adaptation places greater emphasis on students' emotional experiences, psychological changes, and the dynamic process of inner growth. Its core objective lies in establishing a scientific evaluation system to monitor students' psychological states, provide feedback on teaching processes, and refine educational goals—thereby promoting continuous optimization of music education at the mental health level.

First, music education evaluation oriented toward psychological adjustment exhibits both guiding and generative characteristics. The psychological adjustment function in music education is not a static outcome but rather continuously generated and refined through the interaction and feedback of teaching activities. Therefore, the evaluation mechanism should shift from "outcome-oriented" to "process-oriented," with students' emotional changes, psychological growth, and enhancement of humanistic literacy serving as primary assessment indicators. For instance, in music teaching activities, students' psychological adjustment levels can be comprehensively assessed by observing dimensions such as classroom participation, emotional engagement, collaborative interaction, and initiative in self-expression. Such evaluation not only reveals trends in students' psychological changes during the learning process but also provides teachers with a basis for adjusting instructional strategies.

Second, establishing a multidimensional, comprehensive evaluation framework is fundamental to achieving psychological adjustment. The effectiveness of psychological adjustment in music education cannot be measured solely through single scales or questionnaires; instead, it requires integrating quantitative and qualitative methods to form a diverse evaluation system. In terms of indicator dimensions, the evaluation framework should encompass four levels: Emotional Regulation Dimension, including emotional recognition ability, emotional expression adaptability, and emotional stability; Mental health dimension, including self-esteem levels, stress coping abilities, and interpersonal trust; Learning experience dimension, encompassing musical interest, depth of aesthetic experience, and learning engagement; Personality development dimension, covering self-identity, value formation, and social responsibility. Comprehensive assessment through these multidimensional indicators can more fully reflect the actual efficacy of music education in psychological adjustment.

Third, evaluation methods should emphasize digitalization and dynamic feedback mechanisms. Traditional psychological assessments often rely on periodic surveys or subjective interviews, making it difficult to capture students' immediate psychological fluctuations during the learning process. Digital evaluation systems based on Emotional Tendency Analysis (ETA) enable real-time monitoring of students' emotional states and data feedback. For instance, teachers can utilize facial expression recognition, voice tone analysis, or physiological signal collection technologies to dynamically record students' emotional shifts across different teaching scenarios. Algorithms then generate visual psychological curve charts. The system automatically feeds back analysis results to both teachers and students, enabling educators to promptly adjust instructional content and pacing while guiding students toward self-awareness and reflection. Such data-driven evaluation mechanisms significantly enhance the sensitivity and scientific rigor of psychological adjustment functional models.

Fourth, the evaluation mechanism should emphasize developmental and individualized principles. Psychological adaptation is an ongoing process, and students exhibit significant differences in psychological needs, emotional experiences, and growth trajectories during music learning. Therefore,

the evaluation system should respect individual variations by combining formative and summative assessments to track students' psychological development across different stages. For instance, teachers can establish students' "psychological development portfolios," documenting shifts in emotional states, manifestations of psychological distress, and the effectiveness of coping strategies throughout their learning journey. Through periodic assessments and long-term tracking, this approach not only reflects the upward trajectory of students' psychological adaptation abilities but also identifies potential psychological risks, thereby providing data-driven support for counseling and educational interventions.

Fifth, establish a feedback loop involving teachers, students, and systems. Music education evaluation should transcend mere outcome assessment to become a dynamic mechanism for optimizing psychological adaptation. Teachers should reflect on instructional goals and methods based on evaluation results, promptly adjusting curriculum content and classroom atmosphere. Students should utilize feedback for self-regulation and reinforcement, enhancing emotional management and psychological resilience. School mental health centers and information systems can integrate and analyze multidimensional evaluation data to provide scientific grounds for teaching improvements and mental health services. Through this feedback loop formed by the tripartite interaction of teachers, students, and systems, the psychological adjustment function of music education can achieve continuous optimization and dynamic updates.

Sixth, the evaluation mechanism must possess scientific rigor and practical feasibility. In implementation, methods such as fuzzy comprehensive evaluation, the Analytic Hierarchy Process (AHP), or multivariate statistical approaches can be adopted.

CONCLUSION

This study explores the functional value and implementation pathways of music education in college students' psychological adaptation. It indicates that, in response to the current issues of theoretical lag and practical disconnect in university mental health education, music education—with its unique characteristics of emotional expression and mood regulation—can serve as a vital vehicle for promoting college students' mental well-being and personality development. By constructing a four-dimensional psychological adjustment functional model integrating "objectives-content-process-evaluation," this paper systematically elucidates the operational mechanisms of music education across emotional perception, emotional regulation, psychological adjustment, and personality development. This model not only emphasizes emotional experiences and psychological feedback within the educational process but also employs information technology to achieve dynamic monitoring and precise intervention of students' emotional states, forming a bidirectional integration system of education and psychological adjustment.

Overall, this research offers new theoretical perspectives and practical pathways for mental health education in higher education institutions. It reveals the unique value of music education in "nurturing the mind through beauty and enriching the heart through music," while also providing important reference for future development of scientific and systematic mental health education systems in universities.

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A Study on the Influence of Classroom Language Environments on Vocabulary Semantic Development in Preschool Children

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ABSTRACT

The complexity of classroom language environments significantly influences the systematic construction of preschool children's lexical-semantic systems. With advances in neurolinguistics and social interaction theories, educational researchers increasingly focus on the long-term effects of early language input quality on children's cognitive development. As critical settings for language acquisition, preschool institutions urgently need to optimize their language interaction strategies based on empirical evidence. This study integrates relevant literature selected from the Open Access Library, the Education Resources Information Center, the Directory of Open Access Journals, and the Academic Publishing Network databases between January 2007 and June 2024. Utilizing CiteSpace software for knowledge map visualization analysis, to systematically map research hotspots, developmental trajectories, and existing limitations concerning classroom language environments and lexical-semantic development. Findings indicate that current academic discourse primarily focuses on the following dimensions: first, the mechanisms through which language environments influence lexical development; second, the mechanisms through which language environments influence lexical development; third, the systematic integration of environmental factors; and fourth, the systematic integration of environmental factors. Despite the positive trend of diverse perspectives and expanded content in current research, systemic deficiencies persist: research perspectives remain homogeneous with insufficient attention to environmental dynamics; studies on micro-level mechanisms lack depth and yield poor teaching application outcomes; research on cultural adaptability and individual differences exhibits significant shortcomings. Consequently, future research should broaden and deepen its scope, prioritizing the differential characteristics of language interaction across diverse cultural backgrounds and educational settings; Strengthen the organic integration of empirical research and theoretical innovation, rigorously validating and strive to construct a scientifically effective language support system for preschool education, achieving systematic optimization in environmental design, teacher-child interaction, curriculum development, and assessment feedback. These explorations will provide a solid theoretical foundation and actionable practical solutions for enhancing the appropriateness and effectiveness of language environments in preschool education.
Keywords: Classroom Language Environment; Preschool Children; Vocabulary Semantic Development

INTRODUCTION

Research on preschool children's lexical-semantic development has become a key focus in international studies of child language development and education. In recent years, international research has begun to delve into the classroom language environment's influence on children's lexical-semantic development. However, existing studies have not provided effective insights for addressing questions such as “What exactly constitutes the language environment in Chinese kindergartens?” and “What specific roles do teachers play within the classroom language environment?” Therefore, this study employs a combined approach of standardized language testing, teacher surveys, and classroom video analysis to focus on identifying the elements of classroom language environments that support children's lexical-semantic development. This provides crucial research evidence for enhancing the quality of classroom language environments and creating better conditions for children's language

development.

THEORETICAL FRAMEWORK

Fundamental Theories of Early Childhood Language Development and Acquisition：ativism, Acquisitivism, and Interactionism are the three core theories interpreting the process of children's language acquisition. These theories analyze the mechanisms and factors of language acquisition from different perspectives, with Interactionism currently being the widely accepted theory in the field of childhood language research.

The proponents of the environmental determinism theory are Skinner and Ausubel. They both believe that children's acquisition of linguistic symbols can be explained by the “stimulus-response” process (Piliansheng, 1997, p.98). For example, presenting a word (stimulus) prompts students to repeat and practice it (response). However, modern child development research does not endorse this theory. On one hand, vocabulary acquisition is not merely memorizing word meanings but involves gaining lexical knowledge and skills. Children acquiring a word must master a series of related competencies encompassing phonology, semantics, grammar, and pragmatics (Goulden, Nation & Read, 1990). On the other hand, children's language development follows distinct stages. Before reaching one stage, children cannot acquire the abilities of the next stage. Thus, the environmental determinism view—which posits that language acquisition depends solely on external environmental stimuli—cannot fully explain the process of children's vocabulary acquisition or the stage-like progression of their language development.

The nativist theory asserts that humans are born with a language acquisition device (LAD), with Noam Chomsky being its most influential proponent. Chomsky proposed Generative Grammar, positing that children possess a Language Acquisition Device (LAD) containing universal linguistic rules. He further argued that children acquire language not through inductive summarization of linguistic input from their environment, but directly through transformations within the LAD. From the generative grammar perspective, the environment is seen as a “trigger” for children's language development, primarily exerting an activating effect and a shaping effect. The activating effect refers to the unfolding and manifestation of potential under environmental influence, while the shaping effect refers to guiding which language a child adopts as their mother tongue. Lamberg further elaborated on the nativist explanation of children's language acquisition mechanisms from the perspective of neurobiological research. He emphasized that biological inheritance is the decisive factor in human language acquisition, with language emerging as a product of the maturation of human brain functions. The cognitive interaction theory posits that language development results from the interaction between the individual and the environment, with its core proponents being Piaget and Vygotsky. Piaget argued that language originates from children's cognitive potential and is generated through the processes of assimilation and accommodation with the environment, thereby producing new language.

Cognitive interaction theory posits that language development results from the interaction between the individual and the environment, with its core proponents being Piaget and Vygotsky. Piaget believed language emerges from children's cognitive potential and is generated through two processes—assimilation and accommodation—with the environment, thereby producing new language. Assimilation involves understanding unfamiliar language using familiar structures. Accommodation involves creating new language using familiar structures. Cognitive interactionism also asserts that language, in turn, promotes cognitive development: “While speech arises from partially structured intellect, speech also constitutes intelligence” (Piaget, translated by Wang Xiandian, p. 31). Although cognitive interactionism acknowledges the influence of environment on children's language development, it places greater emphasis on the child's internal factors—particularly cognitive abilities—as the decisive elements in language acquisition.

METHOD

Documentary Method

The documentary research method, also known as the historical document method, refers to a research path that systematically and accurately investigates a specific problem by reading, analyzing and sorting out relevant literature. The core of this method is to critically sort out and synthesize existing written records, rather than directly collecting empirical data. It is especially suitable for a panoramic grasp of the current research status of a certain field, or the basic stage of constructing a research

framework at the theoretical level.

This study mainly uses the literature review method to systematically sort out and analyze the existing relevant research results, and on this basis, construct an analytical framework containing four variable groups: classroom environment quality, language environment factors, teacher language guidance, and children's vocabulary semantic development level (as shown in Tables 3-5). The framework is not a simple list of variables, but aims to establish rigorous logical associations between classifications, groups of variables, core content, evaluation methods and research tools. Specifically, it clearly outlines the interaction path between the groups of variables: the quality of the classroom environment creates the basic background for the language environment, and the language environment factors directly affect the teacher's instructional language decision-making, and the teacher's language guidance behavior is the key mediator to promote the semantic development of children's vocabulary. This structured design ensures the multi-dimensionality of the research perspective and the systematization of the analysis process, laying a solid theoretical foundation for subsequent in-depth exploration of the causal relationship between variables. Through this framework, research can provide a more comprehensive examination of the complex links between educational settings and children's language proficiency development.

Measurement Method

This study employs the Chinese Picture Vocabulary Test (CPVT) to assess children's early vocabulary semantic development. The CPVT is a child vocabulary assessment tool newly developed and original to the Chinese context, based on the Chinese child corpus (CHILDES) and utilizing adaptive intelligent assessment technology. The test is applicable for children aged 2.5 to 6 years. Vocabulary for the preschool section is sourced from the CHILDES corpus, while the elementary school section draws from the People's Education Press Chinese textbooks. Word classes were categorized according to the Modern Chinese Dictionary (2016 edition) and the Modern Semantic Dictionary (2019 edition), identifying four categories: nouns, verbs, adjectives, and measure words. This tool demonstrates good reliability and validity, with an internal consistency reliability coefficient of 0.75 (Zhang, Dai, & Zhou, 2021).

The CPVT is a child vocabulary assessment tool newly developed and original to the Chinese context, based on the Chinese child corpus (CHILDES) and utilizing adaptive intelligent assessment technology. This technological foundation is a significant advantage; the adaptive testing algorithm tailors the difficulty of subsequent items based on the child's previous responses, making the assessment both efficient and precise, while minimizing testing fatigue for young participants. The test is applicable for children aged 2.5 to 6 years. Vocabulary for the preschool section is sourced from the CHILDES corpus, which ensures the words are ecologically valid and representative of the language input children naturally encounter. Meanwhile, the elementary school section draws from the People's Education Press Chinese textbooks, thereby creating a seamless bridge between informal acquisition and formal education, and allowing for the tracking of vocabulary development relevant to the early academic curriculum. Word classes were categorized according to the Modern Chinese Dictionary (2016 edition) and the Modern Semantic Dictionary (2019 edition), identifying four categories: nouns, verbs, adjectives, and measure words. This deliberate categorization enables a fine-grained analysis of developmental patterns across different grammatical and semantic domains, offering insights into which word classes are acquired more readily. This tool demonstrates good reliability and validity, with an internal consistency reliability coefficient of 0.75 (Zhang, Dai, & Zhou, 2021), a robust statistic that confirms the test items consistently measure the same underlying construct of vocabulary knowledge.

Video Analysis Method

Video has a long history as a research tool and is widely used in anthropology, sociology, psychology and education. With the continuous advancement of video and recording technology, video acquisition, analysis and processing have become more convenient and feasible. As a new way to investigate teachers' teaching behavior, classroom video analysis is valuable in its ability to deeply analyze the real teaching process, reveal how the key factors that affect teaching effectiveness work, and further elucidate how these factors effectively promote the development of children's vocabulary-semantic skills (Zheng, T. N., & Tong, Y. T., 2012). By recording classroom teaching videos, researchers can fully capture the full picture of teacher-student interaction in daily situations, so as to present the real context of language teaching in a panoramic manner. This method can obtain the most direct, detailed and comprehensive raw data on teachers' language teaching behavior, and its advantage

is that it can record verbal and non-verbal behaviors and specific situational information, which is difficult to achieve with traditional observation notes or recall records. After data collection, the analysis will be conducted in depth around the recorded video material and its transcription text (see the "Qualitative Data Collection and Analysis" section below). This video-based retrospective analysis allows researchers to repeatedly examine key teaching events and conduct micro-level interactive analysis, thereby unearthing the hidden laws and meanings in teaching behavior.

Interview Method

Interviews represent a fundamentally rich method within educational research, particularly valuable for collecting nuanced qualitative data that illuminates the complex realities of teaching practices. Unlike surveys, which often yield standardized but potentially superficial responses, or observations, which capture behavior but not underlying rationale, teacher interviews facilitate a dialogic space where educators can articulate their beliefs, decision-making processes, and contextualized experiences in their own words. This method is especially potent for probing areas where the whybehind actions is as crucial as the what, such as pedagogical choices, resource utilization, and adaptations to student needs. By engaging teachers in semi-structured or open-ended conversations, researchers can uncover tacit knowledge, deeply held values, and situational constraints that significantly shape classroom practice but remain inaccessible through other instruments. This depth is critical for studies aiming to move beyond surface-level descriptions to grasp the cognitive and affective dimensions of teaching.

The flexibility inherent in interviews allows researchers to tailor their approach to specific research objectives. Common formats include individual semi-structured interviews, which provide depth through personalized probing based on a teacher's initial responses, and focus group interviews (FGDs), which leverage group dynamics to generate discussion, reveal consensus, or expose divergent viewpoints among peers

The primary strength of interviews in this context lies in their capacity to generate rich, contextualized insights into complex pedagogical phenomena like vocabulary instruction and resource use. They empower teachers as knowledgeable informants, providing explanations for their choices and revealing the interplay between their beliefs, training, available resources, institutional expectations, and student characteristics

FINDINGS AND DISCUSSION

Findings

Between 2004 and 2010, research on classroom language environments remained in its infancy within the international academic community, with studies primarily confined to foundational explorations. According to literature statistics from the ERIC database, annual publications consistently remained below 10 articles, with research focusing on the linear impact of basic characteristics of teacher language input (such as vocabulary size and speech rate) on children's vocabulary growth. Specialized discussions on the semantic depth of vocabulary development (e.g., word meaning comprehension, conceptual network construction) accounted for less than 8% of the literature, aligning with the conclusion in Language Strategy Research (2023) that "early studies focused more on lexical quantity than semantic quality."

The year 2011 marked a pivotal turning point in the research trajectory. With advances in social interaction theory and cognitive linguistics, research output steadily increased: surpassing 25 papers in 2015 and reaching 40 by 2019 (PsycINFO Annual Report, 2020). This shift strongly resonates with the growing emphasis on practical issues like "teacher-student interaction quality" and "classroom dialogue patterns," reflecting academic research's responsiveness to educational practice needs. This aligns with the "theory-driven research growth" pattern proposed in Language Policy (2019).

Regarding author and institutional distribution, research entities exhibit distinct disciplinary differentiation. Key contributors to international scholarship include developmental psychology laboratories (e.g., Harvard University's Child Language Laboratory), university education faculties (e.g., University College London's Department of Early Childhood Education), and linguistic research institutes (e.g., Max Planck Institute for Linguistics). According to institutional contribution statistics from Scopus (2023), psychology-related research accounts for 45%, education studies 35%, and linguistics research only 15%.

A tightly knit core author network has yet to emerge: fewer than 12 scholars have published over five papers, and most collaborations remain confined to single institutions (e.g., the research team at

Stanford University's Child Language Laboratory). Interdisciplinary collaborations (e.g., psychology and computer science) and cross-institutional partnerships (e.g., university-industry joint teams) account for only 25% of research outputs (Academic Collaboration Network Analysis, 2023). This fragmented research landscape constrains the breadth of methodological innovation, aligning with the perspective from Developmental Science (2023) that "disciplinary barriers hinder systematic breakthroughs in language environment research."

Keyword co-occurrence maps visually reveal the field's core themes and evolutionary trajectory. CiteSpace analysis identifies "classroom language environment," "vocabulary-semantic development," and "preschool children" as triangular core nodes with centrality exceeding 0.7, indicating sustained focus on these research themes. As secondary core nodes, "teacher-student interaction" and "dialogic reading" form tight connections with the core nodes, highlighting their pivotal mediating role in language environment research. This conclusion aligns closely with the keyword map analysis results published in Early Childhood Education Journal (2023).

Technical keywords such as "phonetic analysis" and "eye-tracking experiments," alongside practical keywords like "vocabulary scaffolding strategies" and "multimodal input," collectively form major research branches, establishing a research trajectory characterized by "environmental features-cognitive mechanisms-pedagogical applications." This research trajectory aligns intrinsically with the "input-processing-output" three-dimensional model proposed in Education, Language and Sociology Research (2021), reflecting the international academic consensus on the relationship between classroom language environments and lexical-semantic development.

1. Mechanisms of Language Environment Influence on Vocabulary Development

As a critical setting for preschool children's vocabulary semantic development, classroom language environments are studied primarily through three dimensions: input quality, interaction patterns, and contextual support. This framework aligns closely with the "first-person perspective analysis model" proposed by Chaparro-Moreno et al. (2019) in The Preschool Classroom Linguistic Environment.

Regarding input quality, Altun et al. (2018) demonstrated in Psychology in the Schools that teachers' use of lexical diversity and syntactic complexity significantly predicted children's vocabulary growth. Specifically, teachers' use of low-frequency words and strategies for repeating key words across multiple contexts uniquely contribute to the development of lexical semantic depth. This finding resonates with the "quality over quantity" hypothesis proposed by Bowers and Vasilyeva (2011) in Applied Psycholinguistics.

Regarding the contextual support dimension, Bratsch-Hines et al. (2019) found in their Early Childhood Research Quarterly study of rural preschool settings that "language-rich play" scenarios—such as role-playing—promote vocabulary development more effectively than paper-and-pencil exercises. This validates Vygotsky's sociocultural theory assertion that "play serves as the primary source for developing higher mental functions."

2. Innovative Practices in Differentiated Instruction Strategies

Differentiated language support strategies for diverse child populations have emerged as a research focus in recent years, primarily addressing socioeconomic disparities, bilingual learners, and children with special needs. This research direction aligns with Becker's (2011) "educational compensation effect" theoretical framework presented in The British Journal of Sociology.

For children from low-income families, Beck and McKeown (2007) developed "rich and focused instruction" in The Elementary School Journal, demonstrating that 15 minutes of daily targeted vocabulary instruction (including contextualized explanation and multiple applications) produced learning effects lasting three months. Aram and Biron (2004) further discovered in Early Childhood Research Quarterly that for low-income children, "joint writing" activities narrow vocabulary gaps more effectively than simple story reading.

Regarding bilingual learner support, Aukrust (2007) in the Journal of Research in Childhood Education demonstrated through Norwegian research that teacher discourse diversity (e.g., synonym use) and cognitive complexity (e.g., open-ended questioning) promote L2 vocabulary development more effectively than simply increasing language quantity. Gámez et al. (2017) further noted in Early Childhood Research Quarterly that for bilingual children, social cues (e.g., teacher responsiveness) are more important than linguistic cues.

For children with special needs, Bowne et al. (2016) demonstrated in Early Childhood Research Quarterly that professional development programs training teachers to employ explicit vocabulary

strategies—such as providing word definitions and linking to prior knowledge—significantly enhanced vocabulary levels across entire classrooms, including children with developmental delays. This finding supports the inclusive education principle that "high-quality instruction benefits all learners."

3. Systemic Integration of Environmental Factors

Optimizing classroom language environments no longer focuses on isolated elements but emphasizes systemic transformation integrating family, peer, and digital resources. This trend aligns with developments in Bronfenbrenner's ecological systems theory.

Regarding home-school collaboration, Altun et al.'s (2018) multilevel analysis revealed that for children from low-income families, classroom language activities significantly outperformed home environments as predictors. This prompted researchers to explore new "home-school co-education" models, such as the "Home-Classroom Vocabulary Bridge Program" proposed by Dickinson et al. (2014) in Early Childhood Research Quarterly, which enhances consistency through shared reading materials and activity design.

The value of peer interactions has been rediscovered. Chaparro-Moreno et al. (2019) used head-mounted cameras to reveal that while teachers remain the primary language source, approximately 25% of children receive a substantial proportion of their language input from peers. Justice et al. (2014) further demonstrated in their "Peer Effects" study published in Psychological Science that classmates' vocabulary levels can explain 12-15% of children's vocabulary growth.

Innovative applications of digital tools are forging new pathways. While traditional views suggest preschoolers learn primarily through direct speech, Barnes and Dickinson (2017) in Early Education and Development found that systematic introduction of "academic language" terms like 'analyze' and "compare" via digital storytelling platforms effectively enhances children's lexical complexity. This aligns with the language learning characteristics of contemporary "digital natives."

4. Precision Development in Assessment and Intervention

Research on classroom language environments is shifting from broad to precise approaches, manifested in two dimensions: assessment tool innovation and personalized intervention. This shift resonates with the "evidence-based differentiated response" framework proposed by Cabell et al. (2015).

Regarding assessment tools, traditional standardized tests are being replaced by dynamic evaluations. The "first-person perspective recording method" developed by Chaparro-Moreno et al. (2019) captures children's authentic language exposure through head-mounted cameras, offering greater precision than conventional observation methods. Bowne et al. (2017) in Reading Research Quarterly employed the Language Environment Analysis System (LENA) to automatically analyze teacher-student dialogue characteristics, enabling real-time and granular assessment.

Personalized intervention has emerged as a new trend. Building on Barnes and Dickinson's (2018) discovery in Early Education and Development of the "mental state verbs" effect—where words like 'think' and "know" promote abstract vocabulary development—researchers have developed personalized vocabulary intervention models. Gámez and Lesaux (2012) further demonstrated in their longitudinal study in Child Development that early exposure to complex language predicts vocabulary at age 12, providing a time window rationale for "critical period interventions."

Discussion

1. Active Progress in Research Findings

In recent years, research on the impact of classroom language environments on preschool children's lexical-semantic development has achieved significant progress, forming a positive resonance with the global emphasis on early language education. At the theoretical level, the academic community has constructed a series of influential theoretical models around core issues such as the quality of teacher language input, peer interaction mechanisms, and vocabulary acquisition assessment. Notable examples include Altun et al.'s (2018) "Home-Classroom Dual Context Interaction Model" and Chaparro-Moreno et al.'s (2019) "First-Person Language Input Theory," validated through head-mounted camera technology. These findings not only address new demands for vocabulary development in preschool education but also provide empirical foundations for optimizing classroom language environments.

At the practical level, multiple studies have accumulated replicable teaching experiences through sustained exploration. For instance, Beck and McKeown (2007) developed the "Enriched Focused Vocabulary Instruction" method, which seamlessly integrates vocabulary teaching with daily classroom activities. Aram and Biron (2004) designed the "Collaborative Writing Intervention," which significantly increased the expressive vocabulary of children from low socioeconomic backgrounds

through teacher-student co-creation activities. These practical innovations offer actionable teaching strategies for early childhood educators, with their effectiveness validated in Cabell et al.'s (2015) longitudinal follow-up study.

Research methodology has also demonstrated significant advancement. The early research paradigm, primarily cross-sectional observation, has progressively expanded into longitudinal tracking and mixed-methods research. According to literature statistics, the proportion of studies employing experimental or quasi-experimental designs increased from 25% to 40% between 2010 and 2020. The introduction of head-mounted camera technology (Chaparro-Moreno et al., 2019) and multilevel analysis models (Altun et al., 2018) has substantially enhanced ecological validity and explanatory power, providing more comprehensive evidence for theoretical development and practice optimization.

2. Major Existing Issues

Despite these research advances, three significant limitations persist in relation to the depth of vocabulary development required in early childhood education. These align fundamentally with the analytical conclusions of Justice et al. (2018).

First, research perspectives exhibit homogeneity with insufficient attention to environmental dynamics. Existing findings predominantly focus on teacher-directed language input (accounting for over 70% of studies), while neglecting naturally occurring language learning opportunities such as peer interactions and children's autonomous language exploration (Chaparro-Moreno et al., 2019). Research predominantly employs static observation methods, failing to adequately capture the real-time dynamic characteristics of classroom language environments. This results in an overly linear understanding of the “language input-vocabulary development” relationship. Furthermore, studies often remain confined to single dimensions like vocabulary growth, lacking systematic examination of semantic depth in vocabulary development. This hinders the formation of explanatory models encompassing the entire “input-processing-output” process.

Second, research on micro-mechanisms lacks depth, and its translation into teaching practice is suboptimal. Approximately 60% of empirical studies rely on standardized test data, failing to provide detailed descriptions of vocabulary acquisition processes (Bowers & Vasilyeva, 2011). Most proposed pedagogical recommendations remain at macro levels such as “increasing teacher language input” or “enhancing linguistic complexity.” These suggestions neither translate into age-specific or context-specific implementation plans nor establish corresponding effectiveness monitoring metrics. This results in a significant disconnect between research findings and teaching practice, echoing Bowne et al.'s (2016) findings on “teacher professional development needs.”

Third, research on cultural adaptability and individual differences exhibits significant shortcomings. The educational function of language environments demands a multicultural perspective, yet existing findings fail to adequately examine the specificity of classroom language environments across different cultural contexts. For instance, research from non-English-speaking countries like Turkey (Altun et al., 2018) and Norway (Aukrust, 2007) remains unsystematically integrated. More critically, the field severely lacks research on how individual child differences (e.g., language ability, social preferences) moderate the effects of language environments, failing to establish a vocabulary development support system that balances group dynamics and individual characteristics. This limitation constrains the precision of educational interventions, a problem highlighted in Justice et al.'s (2014) study on peer effects. Current Status and Limitations of Research on Vocational Education Models in Higher Education Institutions

CONCLUSION

Based on the current state of research and the intrinsic demands of preschool education development, combined with findings from multiple empirical studies, future research on the impact of formal and informal classroom language environments on preschool children's vocabulary, semantic, and morphosyntactic development can be deepened and expanded through the following quantifiable dimensions.

Current research suffers from a lack of diversity in perspectives, primarily focusing on teacher-directed language input while paying insufficient attention to naturally occurring language learning opportunities such as peer interactions and children's autonomous language exploration. Future research should establish a “multi-subject + dynamic” framework to transcend the limitations of traditional observation methods. The head-mounted camera technology employed by Chaparro-Moreno et al.

(2019) offers novel research approaches, capturing authentic language exposure from children's first-person perspectives. Their findings indicate that approximately 25% of children receive a significant proportion of language input from peers—a discovery warranting further exploration.

Methodologically, micro-level analysis should be integrated with macro-level tracking. The "quality over quantity" analytical framework proposed by Bowers and Vasilyeva (2011) serves as a micro-level tool for multidimensional coding of teacher language input. Concurrently, the multilevel analysis model employed by Altun et al. (2018) can serve as a macro-level research method to examine the synergistic effects between home and classroom environments, particularly for low-income children. Their findings indicate that the predictive power of the classroom environment exceeds that of the home environment by 32%, providing crucial reference for environmental synergy research.

Addressing the distinct characteristics of different child populations, future research should establish three targeted intervention strategies to achieve a paradigm shift from "standardized instruction" to "precision support."

For socioeconomic compensation programs, Beck and McKeown's 2007 research developed "Enriched Focused Instruction," demonstrating that 15 minutes of daily intervention yields sustained learning effects for three months. Additionally, Aram and Biron's 2004 validated "Collaborative Writing" activities prove particularly effective for low-income children. These findings can be integrated into new intervention designs.

For bilingual learners, Aukrust's 2007 research revealed that teacher discourse diversity accounts for 41% of vocabulary growth, offering crucial insights for bilingual education. Gámez et al.'s 2017 emphasis on "responsive interactions" also highlights a critical focus area in bilingual instruction.

For inclusive programs serving children with special needs, the 2016 teacher professional development project by Bowne et al. can be expanded. This initiative demonstrated that training teachers to use explicit strategies increased their application frequency by 2.3 times. Additionally, the "state-of-mind verb" teaching method identified by Barnes and Dickinson in 2018 warrants integration into instruction for children with special needs.

The results of the study in different cultural contexts show significant differences, which are rooted in the different social structures, education systems and linguistic ecology of different regions. Future research should systematically integrate these transnational academic discoveries, and at the same time focus on promoting localized innovation in the process of reference. For example, Bratsch-Hines et al.'s (2019) study of rural areas in the United States reveals the uniqueness of rural educational settings, making it clear that the real-world impact of urban-rural differences must be prioritized when developing language intervention strategies. Altun et al. (2018) proposed a multi-level environmental interaction model based on the Turkish sample, emphasizing the compound effect of the intersection of family, school and community environment on children's language development. Aukrust (2007) analyzed the Norwegian sample and focused on the language input characteristics of second language learners, revealing the key role of high-quality target input in a bilingual environment. Justice et al. (2014) further revealed the influence of peer interaction as an important mechanism of language learning in the United States, which provides an important theoretical reference for localization research.

In the process of promoting localization innovation, we should focus on three key directions: First, in terms of the study of urban-rural differences, it is necessary to deeply compare the different influence paths and mechanisms of the teaching mode dominated by "academic language" in urban environments and the use of "gamified language" in rural areas on children's vocabulary semantic development. Secondly, in the field of digital integration, the potential of digital storytelling platforms in non-English speaking environments should be actively explored, as proposed by Barnes and Dickinson (2017), and it is necessary to pay attention to how digital tools can be integrated with local language characteristics and cultural contexts to enhance the quality and interactivity of language input. Third, at the level of evaluation system innovation, it is necessary to develop a dynamic evaluation system that can integrate process and consequential evaluation. Ideally, the first-person recording method proposed by Chaparro-Moreno (2019) – such as capturing microscopic details in teaching interactions through teacher logs, audio diaries, etc. – is combined with standardized vocabulary testing to construct a comprehensive evaluation framework that reflects both developmental processes and cross-group comparisons. This framework should be able to depict the trajectory and contextual dependence of children's vocabulary semantic development, and provide a more accurate basis for educational intervention.

Based on the current trajectory of interdisciplinary studies and the imperative to address complex

global challenges, three forward-looking and empirically grounded research directions are urgently needed to drive substantive innovation and paradigm shifts in this field.

In foundational neuroeducation research, Cabell et al.'s (2015) dialogue analysis framework can be effectively integrated with advanced neuroscience technologies like functional near-infrared spectroscopy (fNIRS) to investigate neural response variations across auditory, visual, and multimodal language inputs. This integration enables the examination of how neural synchronization—particularly in prefrontal and temporal regions during peer interactions—facilitates vocabulary acquisition through mechanisms such as cross-brain coherence and interpersonal neural coupling. Such multimodal exploration reveals the neurocognitive basis of collaborative learning dynamics.

In digital language environment construction, innovative applications of the Language Environment Analysis System (LENA) used by Bowne et al. (2017) can develop AI-assisted real-time feedback systems to monitor teacher-student dialogue characteristics. Concurrently, exploring metaverse-based language games can validate the “role-playing” effect discovered by Bratsch-Hines (2019).

For lifecycle tracking studies, building upon Gámez and Lesaux's 2012 longitudinal design could establish dose-response models linking early language environments to adolescent literacy skills, identifying optimal age windows for introducing complex language input. These pioneering explorations will chart new pathways for classroom language environment research.

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A Study on the Application of Situational Teaching Methods in Cultivating Interest in Physical Education among First-Grade Primary School Students in the Context of Ideological and Political Education

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ABSTRACT

According to the principles of the "Physical Education and Health Curriculum Standards (2022 Edition)", physical education should be optimized and contextualized to make even monotonous activities like walking and running lively and engaging. Due to its unique nature, physical education possesses an educational function that cannot be replaced by other subjects. Situational teaching methods, by simulating real-life scenarios, not only enhance students' interest in sports but also integrate them with ideological and political elements. This not only aligns with the requirements of educational reform in the new era but also offers a new approach to primary school education. This study involved first-grade students from Huayang Primary School in Tianhe District, Guangzhou. Class 4 served as the experimental group (situational teaching combined with ideological and political elements) and Class 3 served as the control group (conventional teaching). Using questionnaires, experiments, and mathematical statistics, a 16-week comparative experiment was conducted to assess students' athletic ability and physical education interest. The results showed that: (1) the experimental group performed significantly better than the control group in the 50m run, vital capacity, rope skipping, sit-and-reach tests ($p<0.01$); (2) the experimental group's interest in physical education was significantly higher than that of the control group (119.71±7.562 vs. 78.70±5.346, $p<0.01$).Conclusion: The first-grade physical education curriculum contains a wealth of teaching contexts. The situational teaching method is scientific and effective in improving athletic ability and learning interest, and can better stimulate students' interest in sports and promote their all-round development.

Keywords: curriculum ideological and political education; physical education learning interest; situational teaching method

INTRODUCTION

The Physical Education and Health Curriculum Standards (2022 Edition) takes the implementation of moral education and character building as its fundamental task, adheres to the educational concept of "health first", attaches importance to the synergistic effect of physical education and mental education, fully reflects the essential characteristics of strengthening the body and educating people, and promotes the all-round development of students[1]. Physical education courses have their own uniqueness and are an important foundation for promoting the all-round development of students. By optimizing teaching methods, it can not only stimulate students' learning interest, but also cultivate students' moral qualities. The Physical Education and Health Curriculum Standards (2022 Edition) makes clear requirements for the core physical literacy of first-grade students, requiring that sports ability focus on learning and feeling mobility, non-mobility, and operational skills, etc. The teaching content is required to be presented in the form of sports games, so that students can feel the fun brought by various sports activities. In terms of sports morality, it requires that students can show excellent qualities of not being afraid of difficulties and fighting hard in daily activities, and be able to respect teachers and care for classmates.

General Secretary Xi Jinping emphasized: "We must strive to build an education system that cultivates morality, intelligence, physical fitness, aesthetics, and labor in an all-round way, and form a higher-level talent training system." He also required that "moral education should be integrated into all aspects of ideological and moral education, cultural knowledge education, and social practice education,

and permeate all areas of basic education, vocational education, and higher education." [1] Whether it is required to develop five aspects of education simultaneously or to cultivate morality and cultivate people, moral education is given priority, highlighting the important role of moral education in school education. From the 17th National Congress of the Communist Party of China, which established "adhering to the principle of educating people and prioritizing moral education"; to the 18th National Congress of the Communist Party of China, which proposed "taking moral education and cultivating people as the fundamental task of education"; to the 19th National Congress of the Communist Party of China, which emphasized "implementing the fundamental task of cultivating morality and cultivating people", the importance of cultivating morality and cultivating people has been continuously highlighted; and then to the 20th National Congress of the Communist Party of China, which emphasized that the fundamental of educating people lies in cultivating morality, we must fully implement the Party's education policy, implement the fundamental task of cultivating morality and cultivating people, and cultivate talents needed for all-round development in society.

Follow the guidance of curriculum concept

According to the curriculum concept requirements of the "Physical Education and Health Curriculum Standards (2022 Edition)", the physical education and health curriculum in the compulsory education stage requires attention to the reform of teaching methods. Physical education teachers stimulate students' enthusiasm for learning by creating colorful, vivid and interesting teaching situations, helping students understand and master knowledge and skills, and improving their ability to solve practical problems [1]. The theoretical basis of this curriculum concept coincides with Li Jilin's situational education theory, and has been developed into situational teaching methods in various subjects. Compared with conventional teaching methods, situational teaching methods are more in line with the requirements of current curriculum concepts.

Situational teaching methods are mostly used in teaching in lower grades. Teachers can set up corresponding teaching situations based on students' physical and mental characteristics such as young age, weak physique, strong curiosity, and liveliness, thereby stimulating students' learning interest, mobilizing students' learning enthusiasm, and narrowing the distance between students and the main materials. It makes monotonous physical education teaching content such as walking and running lively and interesting, changing the monotonous and boring teaching mode of teachers lecturing and students practicing in conventional physical education teaching, and developing students' sports morality, physical and mental health, etc. in the process of situational teaching, thereby achieving multi-dimensional and multi-faceted coordinated development.

In the contextual teaching method, creating a teaching "context" is the core content of the teaching method and runs through the entire teaching activity. During the design process, the materials were mainly derived from daily life, which is in line with students' preferences and meets the requirements of the physical education and health curriculum. For example, the actions of various animals in life, such as "frog jumps," "duck steps," and "kangaroo jumps," provide convenient conditions for the application of contextual teaching, which not only meets students' preferences but also meets the teaching requirements of "running, jumping, and walking" in physical education. However, there is currently little research on contextual teaching methods in elementary school physical education and health courses. Therefore, through empirical research on contextual teaching methods in elementary school physical education classrooms, this article strives to find teaching methods that are more suitable for promoting students' all-round development and provide a reference plan for other teachers to implement the latest version of the "Physical Education and Health Curriculum Standards (2022 Edition)."

Meeting the physical and mental development needs of primary school students

According to a survey on the health problems of Chinese adolescents, the overall obesity rate of adolescents and children in my country increased fourfold from 1995 to 2014 [2]. According to the People's Daily, a survey on the depression rate of adolescents conducted by the Institute of Psychology of the Chinese Academy of Sciences in 2021 found that the depression detection rate among adolescents reached 24.6%. It can be seen from this that it is crucial for the country to implement and strengthen the development of students' physical and mental health. Due to the special nature of the course, the physical education and health course can meet the needs of promoting physical and mental health at the same time, and is an important path to achieve the multi-faceted development of adolescent students. It has an important impact on improving students' enthusiasm for physical exercise, developing a healthy lifestyle, improving personality, and achieving all-round development.

The "Physical Education and Health Curriculum Standards (2022 Edition)" divides primary school, junior high school and high school into five levels based on the physical and mental characteristics of students, and puts forward different teaching requirements and training goals for students at different stages, focusing on students mastering and applying basic skills, improving athletic ability; cultivating good daily habits and social adaptability; cultivating correct values and mental outlook, and participating in sports learning interests. First-grade students are curious, like to do hands-on activities, have lively and outgoing personalities, have their own ideas and opinions, are good at expressing themselves, are good at imitating, and have active minds.

However, first-grade students are young, have weaker physical constitutions, are active by nature, and have poor concentration. Therefore, it is very necessary to make full use of physical education and health courses to enhance students' physical health. If we still use the conventional physical education teaching methods, it will be difficult to change the phenomenon that students like physical education but do not like physical education classes. Therefore, according to the requirements of the "Physical Education and Health Curriculum Standards (2022 Edition)", the situational teaching method is selected to create a rich, colorful, lively and interesting teaching situation by optimizing the curriculum setting, so as to stimulate students' enthusiasm for learning, thereby achieving the dual effects of cultivating the body and cultivating the mind [1].

THEORETICAL FRAMEWORK

Constructivism Theory

Constructivism was first proposed by the famous Swiss psychologist Jean Piaget in the 1960s. It is a branch of cognitive psychology. It draws on the essence of various learning theories, such as Vygotsky's (1978) theory of historical and cultural psychology, Ausubel's (1968) theory of meaningful learning, and Bruner's (1960) theory of discovery learning. It better reveals the cognitive laws of the human learning process [3].

The core of constructivist theory emphasizes student-centeredness. Through the context created by the teacher, students are allowed to consciously explore new cognition in the context. However, this new cognition is inconsistent with their previous cognition, and students are guided to actively explore and build a new cognitive balance. In situational teaching, students, with the guidance of teachers and the help of classmates, use their own existing knowledge and experience to combine with the existing context and learn knowledge through construction.

2.1.2 Role Transformation Theory

Role Transformation Theory refers to the creation of teaching scenarios centered around the textbook. Through carefully designed role-playing scenarios, each student is encouraged to assume and play a corresponding role, thereby enabling them to master knowledge through role-playing. In the past, teachers dominated the classroom, while students were passive recipients. With the reform of new curriculum concepts, the teaching process is now student-centered. Situational teaching is a student-centered approach that fully leverages students' active role in the classroom. By designing scenarios that are relevant to students' daily lives and resonate with their psychology, students' learning interest is aroused, students are encouraged to actively participate in the teaching, and they are encouraged to find their preferred role within the context. This helps students correctly understand the role of their role, enabling them to better grasp and master the movements. Furthermore, the process of experiencing the role-playing also contributes to their understanding of the physical movements and their connotations. For example, in the "Traffic Light" 300-500 meter alternating walk-run section, by designing scenarios based on everyday situations, students not only understand and appreciate the correct use of traffic lights, but also transform the boring running movement into a realistic and engaging experience.

Ideological and political education in courses

The relevant documents issued by the Ministry of Education mentioned that curriculum ideological and political education is a comprehensive educational concept that takes the establishment of morality and character as its fundamental task, takes the teaching staff as the "main force", takes curriculum construction as the "main battlefield", takes classroom teaching as the "main channel", uses the method of combining explicit education with implicit education, pays attention to the collaborative cooperation of various stages and disciplines, and integrates value shaping into the process of knowledge imparting and ability cultivation[4].

In the article "Four Dimensions of School Curriculum Ideological and Political Education", Xu

Ruifang said: Curriculum ideological and political education is an extension of ideological and political courses, and belongs to the potential ideological and moral education. In the teaching process, it has the function of transforming macro-theoretical knowledge into specific learning methods, transforming generalized theoretical knowledge into specific moral qualities, integrating the emotions, attitudes, and values contained in sports projects with the theoretical knowledge in teaching, guiding students' healthy growth, and enabling students to learn something useful and learn to be moral[5].

When discussing the proper handling of the relationship between "curriculum ideological and political education" and ideological and political courses, Shi Shuchen pointed out that, unlike ideological and political courses that are mainly ideological and political theory courses, curriculum ideological and political education is mainly based on ideological and political values, and focuses on improving political awareness in various courses (including ideological and political theory courses, professional and technical courses, and general education courses), strengthening ideological and political value orientation, and integrating ideological and political education into the entire process of education and teaching. It is to guide students' ideology and morality with the help of the spiritual qualities contained in the courses, and closely follow students' majors, provide vivid teaching cases, and improve the penetration of ideological and political education [6].

An Xiumei believes that curriculum ideological and political education means "taking moral education as the fundamental task of education, deeply exploring the ideological and political education resources of various courses, making various courses and ideological and political theory courses go in the same direction, forming a synergistic effect, and building a comprehensive educational concept of educating people for all, throughout the whole process, and throughout the whole course". This concept emphasizes that in addition to imparting knowledge, courses also have ideological and political functions and ideological functions [7].

In summary, curriculum ideological and political education is not an ideological and political course, and there are differences between the two. Ideological and political education courses are independent courses, featuring an explicit model of education in which dedicated ideological and moral education teachers carefully prepare lessons and then teach them in class. However, ideological and political education in courses is not a separate course. Instead, it explores elements of ideological and political education across various courses and integrates moral education, socialist core values, and Marxist thought into daily teaching. This approach helps students establish a correct worldview, outlook on life, and values, subtly influencing them and achieving a collaborative educational effect. It is an implicit model of education.

Situational teaching method

Shang Hua believes that situational teaching method refers to the general term for the teacher to introduce or create a situation with a certain emotional color and consistent with the teaching content in order to achieve the established purpose in the teaching process, based on the teaching content and students' characteristics, combined with actual work needs, to present vivid teaching content, purposefully improve students' learning interest, stimulate learning autonomy, guide students to actively participate in teaching activities, actively construct a knowledge system, and effectively improve teaching effects and teaching methods [8].

Wang Bizhu believes that situational teaching refers to a teaching method that uses specific and vivid scenes to stimulate students' learning interest and improve learning efficiency [9].

Zhao Huijie and Su Yucheng summarized in their research that the situational teaching method is gradually established based on the summary of teaching results, targeting students' learning psychological characteristics and subject nature. It is conducive to cultivating students' innovative spirit and practical ability, improving students' scientific literacy, and improving the quality and effect of education and teaching. To date, the situational teaching method has been adopted by many teachers and has been continuously enriched and developed in teaching practice [10].

Ao Shouping believes that the situational teaching method is highly vivid and interesting, and the way of presenting knowledge is in line with the cognitive level of primary school students. To this end, teachers can help students understand knowledge by creating vivid and life-like situations, thereby greatly improving students' enthusiasm for learning [11].

In summary, situational teaching method means that in the teaching process, teachers optimize teaching design based on specific student situation analysis and teaching objectives, create some vivid and vivid situations that are highly relevant to the main textbook and real life, and stimulate students'

learning interest and enthusiasm, thereby helping students better understand and master the teaching content and improve teaching effectiveness.

Interest in sports learning

The book "General Psychology" explains "interest" as follows: interest is a psychological tendency of a person's internal activities, based on the subjective desire to understand and explore things, and it is a motivation for people to actively understand and stimulate thinking. Interest mainly refers to cognitive ability. When this tendency becomes a stimulus and causes action, motivation is formed. Wang Yongxia and other scholars (2002) believe that interest is a psychological phenomenon, which refers to the understanding and mastery of a phenomenon, and a psychological tendency to have positive emotions towards an event or participation in an event [12]. In short, "interest" refers to a state of attention and behavior caused by external stimulation. If students are interested in something, they are willing to learn, think, and explore. In this process, students' thinking ability will be improved, their concentration on things will be strengthened, and it can be maintained for a long time. In terms of sports, interest and disinterest have completely different results on students' learning, especially for students with more obvious emotional changes. Interest is the internal force that motivates children to actively participate in sports and acquire knowledge and skills. Students can continuously and attentively do things they like, and actively exercise their initiative and enthusiasm. When encountering difficulties, they will try their best to overcome them and feel happy. On the contrary, if they are not interested in things, they will feel bored. In physical education, physical education interest can effectively guide students' learning behavior and learning psychology [13]. When students are affected by external stimuli, they will form a subjective desire, which motivates students to actively participate in sports. The research of Zhu Beili, Ji Liu et al. (2000) shows that physical education interest is a spiritual tendency to consciously participate in sports. It can arouse students' passion for sports and encourage them to continue their passion. Sports interest is an internal factor that can inspire students to actively identify information related to sports, stimulate students' interest and enthusiasm in learning, and promote students to actively participate in various sports activities in school [14].

In summary, physical education interest refers to a psychological tendency to recognize sports or participate in sports, which is the internal driving force for students to actively participate in sports. If students have a strong interest in what they are learning, they will enjoy it when learning, and it will have a positive effect over time. If students lack interest in sports, exercise will become a burden, leading them to give up over time. Young children possess a strong curiosity about everything, rich imagination, and creativity, eager to experiment and explore. Cultivating students' interest in sports can foster an internal motivation to actively participate in physical activity, stimulating their interest in physical education. This is also a key indicator of students' continued long-term participation in physical activity.

METHOD

Questionnaire Survey Method

According to the research purpose and content of this paper, the questionnaire "Evaluation Scale of Primary School Students' Physical Education Learning Interest" in Professor Wang Xiaozan's doctoral dissertation was used [15]. This questionnaire is a survey on students' interest in physical education learning. It consists of 27 questions and uses a Likert five-point scale. Choosing 1 gets one point, choosing 2 gets two points, and so on. The reverse questions need to be converted before calculation. The survey was conducted from four dimensions: sports participation, positive interest, negative interest, and attention to sports [15]. Questionnaires were distributed to students before and after the experiment. They answered the questions under the supervision of the teacher and the questionnaires were collected in class. The valid data were then statistically analyzed.

Teaching Experiment Method

1. Subjects, Location, and Duration

Subjects: Students from two first-grade science administration classes at Huayang Primary School, Tianhe East Campus, Tianhe District, Guangzhou, were selected as the experimental subjects. First-grade Class 4 served as the experimental group, with a total of 42 students, including 21 boys and 21 girls. First-grade Class 3 served as the control group, with a total of 40 students, including 20 boys and 20 girls. The students in both classes were of comparable skill level, and neither class included professional athletes.

Experimental Location: Tianhe East Campus, Huayang Primary School, Tianhe District,

Guangzhou.

Experimental Duration: 16 weeks of practical teaching, 4 class hours per week, 40 minutes per class hour, for a total of 60 class hours throughout the semester.

2. Experimental teaching design

For a physical education class, how to choose a teaching situation that contains both scientific and reasonable teaching situations and ideological and political elements suitable for students' development is the key. The correct selection of teaching content is the key. According to the internal logic of the physical education course content, the ideological and political elements of the course are reasonably interspersed in combination with the situational teaching method, and the situational teaching content and ideological and political elements of each class are reasonably arranged. They are combined with the actual situation and implemented so that students can understand and accept them easily [16]. Physical education in primary and secondary schools should focus on situational teaching. Through situational creation, students' learning interest is stimulated, the needs of students' growth are met, and the foundation is laid for the fundamental task of cultivating morality and cultivating people is laid. Before designing situational teaching content containing ideological and political elements, the teaching content of the first-grade physical education course should be determined first. According to the requirements of the first-grade teaching syllabus of Tianhe District, Guangzhou City, the sports to be taught this semester should be selected. Adhering to the principles of combining with real life, scientific and reasonable, and easy for students to accept, in-depth research should be conducted on what teaching situations are contained in the selected teaching content, and what kind of ideological and political elements are contained in the selected teaching situation. This is worthy of in-depth thinking and exploration by teachers. Therefore, this article will combine the first-grade curriculum content set by the Tianhe District Education and Sports Bureau of Guangzhou with teaching scenarios that contain ideological and political elements to design corresponding comprehensive teaching content. First-grade primary school students are required to learn and practice various basic sports skills, so the selection of teaching content and the specific class hours are as follows: classroom routine 4 hours, queue formation 8 hours, 30-meter run 8 hours, 300-500-meter run 4 hours, jumping practice 4 hours, standing long jump 8 hours, skipping rope 8 hours, imitating animals 4 hours, throwing practice 4 hours, balance practice 4 hours, and crawling practice 8 hours. The specific design of the teaching scenario that contains ideological and political education in the teaching content of these 64 hours is as follows (Table 1)

Table 1. Specific design of teaching scenarios containing ideological and political education in courses

Teaching Unit	Teaching Content	Situational Design	Ideological and political elements of the course	Class Schedule
Unit 1 (Week 1)	Classroom routine	Strive to be a qualified little soldier	Be proactive, brave and tenacious, not afraid of difficulties, abide by discipline, and be strict with yourself	4 lessons
Unit 2 (Week 2、3)	Queue formation	Take the train to a distant place	Teamwork and mutual help	8 lessons
Unit 3 (Week 4、5)	30-meter run	Spring planting and autumn harvest + capture and occupy territory	Cherish food, avoid waste, eat a balanced diet, don't be picky about food, love the motherland, safeguard the motherland's sovereignty, keep fit, and have a sense of responsibility	8 lessons
Unit 4 (Week 6)	300-500 meters Alternate walking and running	I am a people's traffic policeman	Obey traffic rules, establish safety awareness, be civilized and polite, and adapt to the social environment	4 lessons
Unit 5 (Week 7)	Jumping exercises	Little Frog Goes Home	Safety awareness, physical fitness, adaptation to the natural environment, self-esteem and self-confidence	4 lessons
Unit 6 (Week	Standing long jump	Seizing the Jinsha River	Love the motherland, have a sense of rules, be brave and tenacious, be proactive, not afraid of	8 lessons

8、9）			difficulties, and persevere to the end	
Unit 7 (Week 10、11）	jump rope	Crossing mountains and rivers	Team spirit, unity and cooperation, mutual help, correct view of winning and losing, neither arrogant when winning nor discouraged when losing, and becoming more courageous after setbacks	8 lessons
Unit 8 (Week 12）	Imitation of animals	Zoo Competition	Love small animals, love the environment, have a sense of responsibility, respect your opponents, respect the referee, abide by the rules, and compete fairly	4 lessons
Unit 9 (Week 13）	Throwing practice	Bombard the enemy camp	Defend the country, love the motherland, fear no hardship, and move forward courageously	4lessons
Unit 10 (Week 14）	Balance exercises	Capture of Luding Bridge	Calm and composed, good at thinking, united and cooperative, helping each other, fearless of difficulties and moving forward courageously	4 lessons
Unit 11 (Week 15、16）	Crawling exercises	Wonderful crawling	Love the environment, protect animals, sense of responsibility,	8 lessons

3. Mathematical Statistics

The collected questionnaires and experimental test data were collated and analyzed using SPSS 26.0 and Excel. All data were consolidated and merged using Excel for ease of analysis. SPSS 26.0 software was used to import data from Excel spreadsheets into the data view. T-tests ($p > 0.05$ indicates no statistically significant difference, $p < 0.05$ indicates a statistically significant difference, and $p < 0.01$ indicates a very statistically significant difference) and reliability and validity analyses were performed on the valid data obtained to ensure the scientific validity of the experimental results and provide data support for this study.

RESULTS AND DISCUSSION

1. Pre-experimental Teaching Results and Analysis between the Experimental and Control Groups

a. Pre-experimental Comparative Analysis of Exercise Ability Test Results between the Experimental and Control Groups

Before the experiment, the motor ability test results of the two classes were divided into percentages according to the scoring criteria, and then an independent sample T test was performed using SPSS26.0 software. The results are as follows (Table 2):

Table 2. Results of exercise capacity test before the experiment in the experimental group and the control group

Athletic ability test indicators	Group	N	(M±SD)	t	p
50-meter run	Control group Experimental group	40 42	74.75±5.61 73.12±7.17	1.14	0.26
vital capacity	Control group Experimental group	40 42	73.93±6.53 76.00±6.71	-1.42	0.16
jump rope	Control group Experimental group	40 42	74.93±6.27 75.19±6.00	-0.20	0.85
Seated forward bend	Control group Experimental group	40 42	72.30±7.95 74.31±6.86	-1.23	0.22

Table 2 shows that, based on the data analysis of the four pre-experimental athletic performance indicators for the two groups of students, the 50-meter run test showed a p-value of 0.26 > 0.05; the vital capacity test showed a p-value of 0.16 > 0.05; the rope skipping test showed a p-value of 0.85 > 0.05; and the sit-and-reach test showed a p-value of 0.22 > 0.05. Therefore, it can be concluded that there was no statistically significant difference in the athletic performance indicators between the two groups before the experiment, and further research is warranted.

b. Comparative Analysis of the Pre-Experimental Physical Education Interest Survey Results between the Experimental and Control Groups

The results of the physical education learning interest scale survey for the two classes before the experiment were compiled and summarized, and an independent sample t-test was conducted using SPSS 26.0 software. The results are as follows (Table 3):

Table 3. Pre-experimental results of the physical education learning interest survey for the experimental and control groups

Test indicators	Group	N	(M±SD)	t	p
Interest in sports learning	Control group	40	77.43±6.36	-1.48	0.144
	Experimental group	42	79.76±7.86		

The results in Table 3 show that an independent sample T-test of the physical education learning interest scale test indicators of the two groups of students before the experiment showed p = 0.144 > 0.05, indicating no statistically significant difference. This indicates that the physical education learning interest of the two groups of students was similar before the experiment, and subsequent experimental work can be carried out.

2. Results and Analysis of In-Group Teaching in the Experimental and Control Groups Before and After the Experiment

a. Comparative Analysis of In-Group Exercise Ability Test Results in the Experimental and Control Groups Before and After the Experiment

After 16 weeks of teaching, the students in the experimental group were retested for exercise ability, using the same testing requirements as before the experiment. The pre- and post-experimental test data were collated and analyzed, and paired-sample t-tests were performed, yielding the following results (Table 4):

Table 4. Results of In-Group Exercise Ability Tests in the Experimental Group Before and After the Experiment

Athletic ability test indicators	Group	N	(M±SD)	t	p
50-meter run	Pre-experimental test	42	73.12±7.168	-15.611	0.000
	Post-experiment test	42	92.88±7.110		
vital capacity	Pre-experimental test	42	76.00±6.706	-9.573	0.000
	Post-experiment test	42	90.38±5.930		
jump rope	Pre-experimental test	42	75.19±6.001	-20.968	0.000
	Post-experiment test	42	97.05±4.711		
Seated forward bend	Pre-experimental test	42	74.31±6.863	-12.673	0.000
	Post-experiment test	42	89.55±5.343		

As shown in Table 4, after 16 weeks of instruction, the p-values for all four motor skills tests in the experimental group were less than 0.01, indicating highly statistically significant differences. Therefore, it can be concluded that the contextualized teaching method plays a statistically significant role in improving students' motor skills.

After 16 weeks of instruction, the control group was retested for motor skills, using the same testing requirements as before the experiment. The pre- and post-experimental test data were collated and analyzed, and paired-sample t-tests were performed, yielding the following results (Table 5):

Table 5 Results of the Control Group's Motor Skills Test Before and After the Experiment

Athletic ability test indicators	Group	N	(M±SD)	t	p

50-meter run	Pre-experimental test	40	74.75±5.610	-4.774	0.000
	Post-experiment test	40	80.88±9.764		
vital capacity	Pre-experimental test	40	73.93±6.526	-3.298	0.002
	Post-experiment test	40	79.35±8.634		
jump rope	Pre-experimental test	40	74.93±6.269	-5.467	0.000
	Post-experiment test	40	82.93±7.617		
Seated forward bend	Pre-experimental test	40	72.30±7.946	-3.882	0.000
	Post-experiment test	40	78.80±8.745		

As shown in Table 5, after 16 weeks of instruction, the p-values for all four motor skills tests in the control group were less than 0.05, indicating statistically significant differences. Therefore, it can be concluded that conventional teaching methods play a statistically significant role in improving students' motor skills.

The results in these two tables indicate that, in comparing the changes in motor skills between the experimental and control groups before and after the experiment, statistically significant differences were found in all four motor skills tests: the 50-meter run, vital capacity, rope skipping, and sit-and-reach ($p < 0.05$). Analysis reveals that, in accordance with the first-year curriculum, the instructional content for both groups focused primarily on motor skills. After one semester of instruction, significant improvements in students' motor skills were achieved. However, the average post-experimental scores for both groups indicate that the experimental group using the contextual teaching method achieved a more significant improvement in motor skills compared to the control group. This suggests that the contextual teaching method is more effective than conventional teaching methods in improving first-year students' motor skills.

b. Comparative Analysis of Physical Education Interest Survey Results Between the Experimental and Control Groups Before and After the Experiment

After 16 weeks of teaching, the experimental group was again surveyed on their physical education interest. The testing requirements remained the same as before the experiment. The pre- and post-experimental survey data were collated and analyzed, and paired-sample t-tests were conducted. The following results were obtained (Table 6):

Table 6. Results of the Pre- and Post-Experimental Physical Education Interest Survey Within the Experimental Group

Test indicators	Pre-experimental test	Post-experiment test	t	p
Interest in sports learning	79.76±7.858	119.71±7.562	-20.855	0.000

The data in Table 6 show that after 16 weeks of teaching, the experimental group showed a highly statistically significantt difference ($p < 0.01$). The average post-test score was significantly higher than the pre-test, demonstrating that the contextual teaching approach significantly enhances students' interest in physical education.

After 16 weeks of teaching, the control group was again surveyed on their physical education interest indicators, using the same testing requirements as before the experiment. The pre- and post-experimental survey data were collated and analyzed, and paired-sample t-tests were conducted, yielding the following results (Table 7):

Table 7. Results of the Pre- and Post-Experimental Survey on Physical Education Interest in the Control Group

Test indicators	Pre-experimental test	Post-experiment test	t	p
Interest in sports learning	77.43±6.360	78.70±5.345	-1.110	0.274

Table 7 shows that after 16 weeks of teaching, the control group showed a $p = 0.274 > 0.05$, but the difference was not statistically significant. A comparison of pre- and post-test data reveals that after one semester of regular physical education, students' interest in physical education increased, but the magnitude of the increase was not significant.

The test results show that the experimental group showed a highly statistically significant difference in physical education interest after the post-test compared to the pre-test ($p < 0.01$), while the control group showed no statistically significant difference ($p > 0.05$). This suggests that the contextual teaching method, which incorporates ideological and political education into the curriculum, is more effective in stimulating students' interest in physical education than conventional physical education. Analysis reveals that the experimental class employed a contextual teaching method, incorporating ideological and political education into the curriculum. Teachers created engaging and engaging teaching scenarios based on the content, enhancing the fun of physical education classes and enabling students to learn and practice through play. This is more conducive to cultivating students' interest in physical education and their enthusiasm for participating in sports. Therefore, the experimental class showed a significant increase in students' interest in physical education before and after the experiment. In the control class,regular physical education classes include many boring and physical-limit-challenging sports. If each class is just a simple repetitive exercise, it is difficult to cultivate students' interest in physical education, which leads to the phenomenon that students like sports but do not like physical education classes.

3. Post-experimental Comparative Analysis of Teaching Results between the Experimental and Control Groups

a. Post-experimental Comparative Analysis of Exercise Ability Test Results between the Experimental and Control Groups

The results of the four exercise ability tests for the experimental and control groups were summarized and analyzed using independent sample t-tests (Table 8).

Table 8. Post-experimental Comparative Analysis of Exercise Ability Test Results between the Experimental and Control Groups

Athletic ability test indicators	Group	N	(M±SD)	t	p
50-meter run	Control group	40	80.88±9.764	-6.387	0.000
	Experimental group	42	92.88±7.110		
vital capacity	Control group	40	79.35±8.634	-6.772	0.000
	Experimental group	42	90.38±5.930		
jump rope	Control group	40	82.93±7.617	-10.039	0.000
	Experimental group	42	97.05±4.711		
Seated forward bend	Control group	40	78.80±8.745	-6.752	0.000
	Experimental group	42	89.55±5.343		

As shown in Table 8, the post-experimental results for the two groups of students' motor skills indicators are summarized. Data analysis reveals that the p-values for the four motor skills indicators, including the 50-meter run, vital capacity, rope skipping, and sit-ups, are all less than 0.01, indicating highly statistically significant differences. This is due to the fact that the two groups received the same instructional content and that there was no statistically significant difference in motor skills between the two groups before the experiment. However, after 16 weeks of instruction, significant differences in motor skills indicators were observed between the experimental and control groups. This suggests that the contextualized teaching approach, informed by ideological and political education, is more effective than conventional physical education in improving students' motor skills.

b. Comparative Analysis of Physical Education Interest Survey Results between the Experimental and Control Groups After the Experiment

The results of the physical education interest survey for the experimental and control groups were summarized and analyzed using an independent sample t-test (Table 9).

Table 9. Comparative Analysis of Physical Education Interest Test Results between the Experimental and Control Groups After the Experiment

Test indicators	Group	N	(M±SD)	t	p
Interest in sports learning	Control group	40	78.70±5.346	-28.466	0.000
	Experimental group	42	119.71±7.562		

As shown in Table 9, the post-experimental results of the physical education interest test between the two groups of students show that $p < 0.01$, indicating a highly statistically significant difference between the two groups after the experiment. This difference is attributed to the fact that the two groups had the same syllabus and content, and there was no statistically significant difference in physical education interest between the two groups before the experiment. However, after 16 weeks of teaching, significant differences were observed in the post-experimental physical education interest indicators between the experimental and control groups. This suggests that the contextualized teaching method, under the purview of ideological and political education, has a more significant effect on enhancing students' interest in physical education than conventional physical education, and is more effective in cultivating and stimulating students' interest in physical education.

CONCLUSION

Based on the requirements of the *Physical Education and Health Curriculum Standards (2022 Edition)*, as well as expert consultations and a review of relevant literature, this study identified rich teaching situations within the first-grade physical education curriculum and accordingly designed 11 situational teaching scenarios that were systematically applied in instruction. Analysis of the pre- and post-experimental data demonstrates that both conventional and situational teaching methods are scientifically sound and effective in improving students' sports ability; however, situational teaching proved more effective in stimulating learning enthusiasm and enhancing overall learning outcomes. Furthermore, after 16 weeks of teaching intervention, statistically significant differences were found between the two groups in terms of sports learning interest, indicating that situational teaching from the perspective of curriculum ideological and political education is more consistent with the physical and psychological developmental characteristics of first-grade students and is conducive to cultivating and sustaining their interest in physical education learning.

In regular teaching practice, teachers should integrate students' actual learning conditions with the characteristics of specific sports activities, actively explore the situational elements embedded in the curriculum, optimize instructional design, enhance the enjoyment of lessons, and thereby promote students' healthy development and enthusiasm for sports learning. As the primary implementers of the curriculum, teachers need to continuously strengthen their theoretical foundations in pedagogy, psychology, and teaching methodology, deepen their professional understanding through ongoing learning, and adopt scientific and appropriate teaching methods based on students' learning needs so as to teach in accordance with individual differences, improve instructional competence, and support students' holistic development. In addition, the ideological and political elements within situational teaching should be explored from multiple perspectives, emphasizing students'主体 role in learning, cultivating their independent inquiry abilities, deepening their understanding of learning content, and ultimately achieving the coordinated development of physical and mental education.

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Transforming Higher Education through Digital Pedagogy: Strategies for Enhancing Teaching and Learning

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ABSTRACT

The rapid advancement of digital technologies has fundamentally transformed the landscape of higher education, necessitating a comprehensive reevaluation of traditional pedagogical approaches. This research examines the transformative potential of digital pedagogy in enhancing teaching and learning outcomes within higher education institutions. Through a systematic analysis of contemporary digital pedagogical frameworks, this study identifies key strategies for successful implementation of technology-enhanced learning environments. The research methodology employs a comprehensive literature review combined with theoretical framework analysis to develop a strategic implementation model. Key findings reveal that effective digital pedagogy transformation requires a multi-dimensional approach encompassing technological infrastructure, faculty development, student engagement strategies, and institutional support systems. The study proposes a four-pillar strategic framework: (1) Technology Integration and Infrastructure Development, (2) Faculty Capacity Building and Professional Development, (3) Student-Centered Learning Design and Engagement, and (4) Institutional Culture and Change Management. Results demonstrate that institutions implementing comprehensive digital pedagogy strategies experience significant improvements in student engagement, learning outcomes, and educational accessibility. The research contributes to the growing body of knowledge on digital transformation in higher education by providing practical implementation strategies and identifying critical success factors. Implications for policy and practice include the need for sustained investment in digital infrastructure, comprehensive faculty training programs, and adaptive institutional governance structures. This study offers valuable insights for educational leaders, policymakers, and practitioners seeking to navigate the digital transformation of higher education effectively.

Keywords: digital pedagogy,educational innovation,higher education transformation, technology-enhanced learning,,teaching strategies

INTRODUCTION

The 21st century has witnessed an unprecedented transformation in the educational landscape, driven primarily by the rapid advancement and integration of digital technologies. Higher education institutions worldwide are experiencing a paradigmatic shift from traditional, instructor-centered pedagogical approaches to more dynamic, technology-enhanced learning environments that prioritize student engagement, accessibility, and personalized learning experiences (García-Peñalvo et al., 2021). This transformation has been further accelerated by global events such as the COVID-19 pandemic, which necessitated an immediate and widespread adoption of digital learning platforms and methodologies, fundamentally altering the way educational content is delivered, consumed, and evaluated.

The concept of digital pedagogy extends far beyond the mere incorporation of technological tools into existing educational frameworks. It represents a comprehensive reimagining of the teaching and learning process, encompassing new methodologies, assessment strategies, and educational philosophies that leverage digital technologies to create more effective, engaging, and inclusive learning environments (Selwyn, 2016). Digital pedagogy involves the strategic integration of various technological platforms, multimedia resources, interactive tools, and data-driven approaches to enhance educational outcomes and prepare students for an increasingly digital world.

Contemporary higher education faces numerous challenges that traditional pedagogical approaches struggle to address effectively. These challenges include increasing student diversity, varying learning preferences and abilities, the need for flexible and accessible education delivery, the demand for real-world skill development, and the necessity to prepare graduates for a rapidly evolving job market characterized by technological innovation and digital literacy requirements (Zawacki-Richter et al., 2019). Additionally, institutions must contend with resource constraints, faculty resistance to change, technological infrastructure limitations, and the need to maintain educational quality while expanding access and reducing costs.

The importance of addressing these challenges through digital pedagogy transformation cannot be overstated. Research consistently demonstrates that well-implemented digital pedagogical approaches can significantly improve student engagement, learning outcomes, retention rates, and overall educational satisfaction (Means et al., 2013). Furthermore, digital pedagogy enables institutions to reach broader audiences, provide more personalized learning experiences, and develop innovative assessment methods that better reflect real-world competencies and skills.

Despite the recognized potential of digital pedagogy, many higher education institutions struggle with effective implementation strategies. Common obstacles include inadequate technological infrastructure, insufficient faculty training and support, resistance to change, lack of institutional vision and leadership, and limited understanding of how to integrate digital tools meaningfully into existing curricula (Bates, 2019). These challenges highlight the need for comprehensive, evidence-based strategies that can guide institutions through successful digital transformation processes.

The primary purpose of this research is to examine the transformative potential of digital pedagogy in higher education and to develop practical strategies for enhancing teaching and learning outcomes through technology integration. Specifically, this study aims to: (1) analyze current trends and developments in digital pedagogy within higher education contexts, (2) identify key factors that contribute to successful digital transformation initiatives, (3) develop a comprehensive strategic framework for implementing digital pedagogy effectively, (4) examine the impact of digital pedagogical approaches on student learning outcomes and engagement, and (5) provide practical recommendations for educational leaders, policymakers, and practitioners seeking to navigate digital transformation successfully.

This research addresses several critical questions that are central to understanding and implementing effective digital pedagogy in higher education. How can institutions develop comprehensive strategies for integrating digital technologies into their pedagogical practices while maintaining educational quality and effectiveness? What are the essential components of successful digital pedagogy implementation, and how do these components interact to create transformative learning environments? What role do faculty development, student support, and institutional culture play in facilitating or hindering digital transformation efforts? How can institutions measure and evaluate the effectiveness of their digital pedagogy initiatives, and what metrics are most meaningful for assessing success?

The significance of this research extends beyond academic inquiry to address pressing practical needs within the higher education sector. As institutions worldwide continue to invest substantial resources in digital transformation initiatives, there is an urgent need for evidence-based guidance that can inform decision-making processes and improve implementation outcomes. This study contributes to the growing body of knowledge on digital pedagogy by providing a comprehensive analysis of successful strategies, identifying critical success factors, and offering practical recommendations that can be adapted to various institutional contexts and constraints.

THEORETICAL FRAMEWORK

The theoretical foundation for understanding digital pedagogy transformation in higher education draws from multiple disciplinary perspectives, including educational technology theory, learning sciences, organizational change management, and innovation diffusion theory. This multidisciplinary approach is essential for comprehensively addressing the complex challenges and opportunities associated with digital transformation in educational contexts.

Educational Technology Integration Theories

The Technology Acceptance Model (TAM), originally developed by Davis (1989) and subsequently refined by various researchers, provides a fundamental framework for understanding how

and why individuals adopt new technologies in educational settings. TAM suggests that technology adoption is primarily influenced by two key factors: perceived usefulness and perceived ease of use. In the context of digital pedagogy, perceived usefulness refers to the degree to which faculty and students believe that digital tools and methodologies will enhance their teaching and learning experiences, while perceived ease of use relates to the effort required to master and implement these technologies effectively.

Building upon TAM, the Unified Theory of Acceptance and Use of Technology (UTAUT) developed by Venkatesh et al. (2003) incorporates additional factors such as social influence, facilitating conditions, and individual characteristics that affect technology adoption decisions. This expanded framework is particularly relevant for understanding digital pedagogy implementation in higher education, where social and institutional factors play crucial roles in determining success or failure of technology integration initiatives.

The TPACK (Technological Pedagogical Content Knowledge) framework, introduced by Mishra and Koehler (2006), represents a significant advancement in understanding the complex relationships between technology, pedagogy, and content knowledge in educational contexts. TPACK emphasizes that effective technology integration requires educators to develop expertise at the intersection of three knowledge domains: technological knowledge (understanding of digital tools and their capabilities), pedagogical knowledge (understanding of teaching and learning processes), and content knowledge (understanding of subject matter). This framework is particularly valuable for guiding faculty development programs and assessing the effectiveness of digital pedagogy implementation efforts.

Learning Theory Foundations

Constructivist learning theory, as articulated by scholars such as Piaget (1977) and Vygotsky (1978), provides essential theoretical grounding for understanding how digital technologies can enhance learning processes. Constructivism emphasizes that learners actively construct knowledge through interaction with their environment, peers, and instructors, rather than passively receiving information. Digital pedagogical approaches align well with constructivist principles by providing interactive, multimedia-rich environments that enable students to explore, experiment, and collaborate in ways that traditional lecture-based approaches cannot accommodate.

Social constructivism, building upon Vygotsky's work, highlights the importance of social interaction and collaborative learning in knowledge construction processes. Digital technologies offer unprecedented opportunities for facilitating social learning through online discussion forums, collaborative project platforms, peer review systems, and virtual learning communities that transcend geographical and temporal boundaries (Harasim, 2012). These tools enable students to engage in meaningful dialogue, share diverse perspectives, and collectively construct understanding in ways that enhance both individual and group learning outcomes.

Connectivism, proposed by Siemens (2005), represents a learning theory specifically designed for the digital age. Connectivism suggests that learning occurs through the formation of connections within networks of information, people, and resources. This theory is particularly relevant for understanding how digital pedagogy can facilitate learning in an era of information abundance, where the ability to locate, evaluate, and synthesize information from multiple sources is more important than memorizing static content. Digital pedagogical approaches that emphasize network-based learning, information literacy, and collaborative knowledge construction align well with connectivist principles.

Organizational Change and Innovation Theories

Rogers' (2003) Diffusion of Innovation Theory provides valuable insights into how educational innovations, including digital pedagogy initiatives, spread within and across organizations. The theory identifies five key characteristics that influence the rate of innovation adoption: relative advantage (the degree to which an innovation is perceived as better than existing practices), compatibility (consistency with existing values and practices), complexity (difficulty of understanding and implementation), trialability (ability to experiment with the innovation), and observability (visibility of results). Understanding these factors is crucial for developing effective strategies for promoting digital pedagogy adoption within higher education institutions.

Kotter's (1996) eight-step change management model offers a structured approach for leading organizational transformation initiatives, including digital pedagogy implementation. The model emphasizes the importance of creating urgency, building coalitions, developing clear vision and strategy, communicating effectively, empowering action, generating short-term wins, sustaining

momentum, and anchoring changes in organizational culture. This framework is particularly relevant for institutional leaders seeking to implement comprehensive digital transformation initiatives.

The Concerns-Based Adoption Model (CBAM), developed by Hall and Hord (2015), provides insights into the personal and professional concerns that individuals experience when implementing educational innovations. CBAM identifies seven stages of concern, ranging from awareness and informational concerns to collaboration and refocusing concerns. Understanding these stages can help institutions develop targeted support strategies that address faculty and staff concerns throughout the digital pedagogy implementation process.

Digital Pedagogy Theoretical Models

The Community of Inquiry (CoI) framework, developed by Garrison et al. (2000), provides a theoretical model specifically designed for understanding effective online and blended learning environments. The CoI framework identifies three essential elements: cognitive presence (the extent to which learners can construct and confirm meaning through sustained reflection and discourse), social presence (the ability of learners to project themselves socially and emotionally in a community of inquiry), and teaching presence (the design, facilitation, and direction of cognitive and social processes for meaningful learning outcomes). This framework has been extensively validated and provides practical guidance for designing and implementing effective digital learning environments.

The Technology-Enhanced Learning (TEL) framework emphasizes the importance of aligning technological capabilities with pedagogical objectives and learning outcomes. TEL recognizes that technology alone does not improve learning; rather, it is the thoughtful integration of technology with sound pedagogical practices that creates enhanced learning experiences (Kirkwood & Price, 2014). This perspective is crucial for avoiding the common pitfall of technology-driven rather than pedagogy-driven implementation approaches.

Synthesis and Theoretical Integration

The integration of these various theoretical perspectives suggests that successful digital pedagogy transformation requires a comprehensive approach that addresses multiple dimensions simultaneously. Technology adoption theories highlight the importance of perceived usefulness and ease of use, while learning theories emphasize the need for pedagogical approaches that support active, social, and connected learning. Organizational change theories underscore the importance of systematic change management processes, while digital pedagogy models provide specific guidance for designing effective technology-enhanced learning environments.

This theoretical synthesis forms the foundation for developing practical strategies and frameworks for digital pedagogy implementation. It suggests that successful transformation initiatives must address technological, pedagogical, organizational, and individual factors in an integrated and systematic manner. The following sections build upon this theoretical foundation to develop specific strategies and recommendations for enhancing teaching and learning through digital pedagogy.

METHOD

The analytical framework for this study employs a multi-dimensional approach that integrates theoretical perspectives with practical implementation considerations. This framework is designed to provide a comprehensive understanding of the factors that contribute to successful digital pedagogy transformation in higher education while offering practical guidance for implementation.

Research Methodology and Approach

This research adopts a systematic literature review methodology combined with theoretical framework analysis to examine the current state of digital pedagogy in higher education and identify effective implementation strategies. The systematic literature review follows established protocols for identifying, evaluating, and synthesizing relevant research from multiple databases and sources. Search strategies include combinations of keywords related to digital pedagogy, higher education transformation, technology-enhanced learning, and educational innovation.

The literature review encompasses peer-reviewed journal articles, conference proceedings, institutional reports, and policy documents published between 2015 and 2024, ensuring that the analysis reflects current trends and developments in the field. Inclusion criteria focus on studies that examine digital pedagogy implementation in higher education contexts, with particular attention to research that provides empirical evidence of outcomes and effectiveness. Quality assessment criteria include methodological rigor, relevance to the research questions, and contribution to theoretical understanding.

The theoretical framework analysis involves examining existing models and theories related to technology adoption, learning theory, and organizational change to identify key concepts and relationships that inform digital pedagogy implementation. This analysis synthesizes insights from multiple theoretical perspectives to develop a comprehensive understanding of the factors that influence successful digital transformation in educational contexts.

Analytical Dimensions and Variables

The analytical framework incorporates four primary dimensions that collectively encompass the key factors influencing digital pedagogy transformation: technological, pedagogical, organizational, and individual dimensions. Each dimension includes multiple variables and sub-components that contribute to overall implementation success.

The technological dimension encompasses factors related to digital infrastructure, tools, and platforms that support teaching and learning activities. Key variables include technology accessibility and reliability, user interface design and usability, integration capabilities with existing systems, scalability and sustainability considerations, and technical support availability. This dimension also considers emerging technologies such as artificial intelligence, virtual and augmented reality, and learning analytics that are increasingly being integrated into educational contexts.

The pedagogical dimension focuses on teaching and learning practices, methodologies, and approaches that leverage digital technologies to enhance educational outcomes. Variables include instructional design principles, assessment strategies, student engagement techniques, personalization and adaptive learning capabilities, and alignment with learning objectives and outcomes. This dimension emphasizes the importance of pedagogy-driven rather than technology-driven implementation approaches.

The organizational dimension addresses institutional factors that facilitate or hinder digital pedagogy implementation. Key variables include leadership support and vision, organizational culture and change readiness, resource allocation and funding, policy and governance structures, and strategic planning processes. This dimension recognizes that successful digital transformation requires comprehensive organizational commitment and systematic change management approaches.

The individual dimension examines personal factors that influence faculty and student adoption and use of digital pedagogical approaches. Variables include technology skills and competencies, attitudes and beliefs about digital learning, motivation and engagement levels, professional development needs and opportunities, and support system availability. This dimension acknowledges that individual characteristics and experiences play crucial roles in determining implementation success.

Implementation Success Factors

Based on the literature review and theoretical analysis, several critical success factors emerge as essential for effective digital pedagogy implementation. These factors operate across multiple dimensions and require coordinated attention to achieve optimal outcomes.

Strategic leadership and vision represent fundamental prerequisites for successful digital transformation. Institutional leaders must articulate clear vision statements that communicate the purpose, goals, and expected outcomes of digital pedagogy initiatives. This vision must be supported by comprehensive strategic planning processes that identify specific objectives, timelines, resource requirements, and success metrics. Leadership commitment must be demonstrated through sustained resource allocation, policy development, and active participation in implementation activities.

Faculty development and support constitute another critical success factor. Effective digital pedagogy implementation requires comprehensive professional development programs that address both technical skills and pedagogical competencies. These programs must be ongoing, differentiated to meet varying skill levels and needs, and supported by adequate resources and incentives. Faculty support systems should include technical assistance, instructional design consultation, peer mentoring opportunities, and recognition programs that acknowledge innovation and excellence in digital teaching.

Student preparation and support are equally important for ensuring successful implementation outcomes. Students must be equipped with necessary digital literacy skills, provided with adequate technology access, and supported through orientation and training programs. Student support services should include technical assistance, academic advising, and resources for developing effective online learning strategies. Institutions must also consider diverse student populations and ensure that digital pedagogy approaches are accessible and inclusive.

Technology infrastructure and integration represent essential enabling conditions for digital pedagogy success. Institutions must invest in reliable, scalable technology platforms that support diverse teaching and learning activities. Integration considerations include compatibility with existing systems, data security and privacy protections, and user experience optimization. Technology decisions should be guided by pedagogical requirements rather than driven solely by technical capabilities or vendor preferences

Evaluation and Assessment Framework

The analytical framework includes comprehensive evaluation and assessment components designed to measure the effectiveness of digital pedagogy implementation initiatives. This evaluation framework incorporates multiple data sources, measurement approaches, and stakeholder perspectives to provide holistic understanding of implementation outcomes and impacts.

Quantitative measures include student learning outcomes, engagement metrics, retention and completion rates, technology usage statistics, and cost-effectiveness analyses. These measures provide objective indicators of implementation success and enable comparison across different approaches, programs, and institutions. Learning analytics and educational data mining techniques can provide detailed insights into student learning patterns, preferences, and outcomes.

Qualitative measures include stakeholder satisfaction surveys, focus group discussions, case study analyses, and ethnographic observations. These measures capture subjective experiences, perceptions, and contextual factors that quantitative measures may not adequately address. Qualitative data is particularly valuable for understanding implementation challenges, identifying improvement opportunities, and documenting best practices and lessons learned.

The evaluation framework emphasizes the importance of continuous improvement processes that use assessment data to refine and enhance digital pedagogy approaches over time. This includes regular review cycles, stakeholder feedback mechanisms, and adaptive implementation strategies that respond to changing needs and circumstances. Evaluation results should inform decision-making processes and guide future investment and development priorities.

FINDINGS AND DISCUSSION

Current State of Digital Pedagogy in Higher Education

The analysis reveals that higher education institutions worldwide are at various stages of digital pedagogy adoption, with significant variation in implementation approaches, resource allocation, and outcomes achieved. Leading institutions have developed comprehensive digital transformation strategies that integrate technology seamlessly into teaching and learning processes, while others continue to struggle with basic technology adoption and faculty resistance to change.

Successful institutions demonstrate several common characteristics in their approach to digital pedagogy implementation. These institutions typically have strong leadership commitment to digital transformation, evidenced by substantial investment in technology infrastructure, faculty development programs, and student support services. They also maintain clear strategic vision that aligns digital pedagogy initiatives with broader institutional goals and priorities, ensuring that technology integration serves educational rather than purely technological objectives.

The most effective digital pedagogy implementations are characterized by systematic, phased approaches that begin with pilot programs and gradually scale successful practices across the institution. These approaches recognize that digital transformation is a complex, long-term process that requires sustained commitment, continuous learning, and adaptive management strategies. Successful institutions also prioritize faculty development and support, recognizing that technology adoption ultimately depends on individual faculty members' willingness and ability to integrate digital tools into their teaching practices.

Research evidence consistently demonstrates that well-implemented digital pedagogy approaches can significantly enhance student learning outcomes, engagement levels, and satisfaction with educational experiences. Students in technology-enhanced learning environments report higher levels of engagement, improved access to learning resources, and greater flexibility in managing their educational activities. Learning analytics data reveals that students in digital learning environments often demonstrate improved performance on assessments, higher completion rates, and better retention in their programs of study.

However, the analysis also reveals significant challenges and barriers that continue to impede effective digital pedagogy implementation. Faculty resistance remains a persistent challenge, often stemming from concerns about technology complexity, time requirements for learning new tools, and uncertainty about pedagogical effectiveness. Many faculty members express concerns about losing personal connection with students in digital environments and worry that technology may diminish the quality of educational interactions.

Institutional barriers include inadequate technology infrastructure, insufficient funding for comprehensive implementation, lack of technical support services, and organizational cultures that resist change. Many institutions struggle with fragmented approaches to digital pedagogy, implementing isolated technology solutions without comprehensive integration strategies or adequate support systems.

Student-related challenges include digital divide issues that affect access to technology and internet connectivity, varying levels of digital literacy skills, and preferences for traditional learning approaches among some student populations. International students and non-traditional learners may face additional challenges related to language barriers, cultural differences, and unfamiliarity with digital learning environments.

Strategic Framework for Digital Pedagogy Transformation

Based on the comprehensive analysis of literature, theoretical frameworks, and implementation experiences, this research proposes a four-pillar strategic framework for digital pedagogy transformation in higher education. This framework provides a systematic approach for institutions seeking to implement comprehensive digital pedagogy initiatives while addressing the complex challenges and opportunities associated with educational technology integration.

1. Pillar 1: Technology Integration and Infrastructure Development

The first pillar focuses on developing robust technological foundations that support diverse teaching and learning activities. This includes investment in reliable, scalable technology platforms that can accommodate varying pedagogical approaches and student needs. Infrastructure considerations encompass network capacity, device availability, software licensing, data storage and security, and technical support services.

Effective technology integration requires careful selection of platforms and tools that align with pedagogical objectives rather than being driven solely by technical capabilities or vendor marketing. Institutions should prioritize interoperability, user experience, accessibility compliance, and long-term sustainability when making technology decisions. The goal is to create seamless, integrated technology environments that enhance rather than complicate teaching and learning processes.

Cloud-based solutions offer significant advantages for higher education institutions, including scalability, cost-effectiveness, automatic updates, and improved accessibility. However, institutions must carefully consider data privacy, security, and compliance requirements when selecting cloud-based platforms. Hybrid approaches that combine cloud and on-premises solutions may be appropriate for institutions with specific security or regulatory requirements.

Learning management systems (LMS) serve as central platforms for digital pedagogy implementation, providing integrated environments for content delivery, student interaction, assessment, and progress tracking. Modern LMS platforms offer sophisticated features including multimedia content support, collaborative tools, mobile accessibility, and learning analytics capabilities. However, successful LMS implementation requires comprehensive training, ongoing support, and integration with other institutional systems.

Emerging technologies such as artificial intelligence, virtual and augmented reality, and blockchain are beginning to influence digital pedagogy practices. While these technologies offer exciting possibilities for enhancing learning experiences, institutions should approach adoption carefully, considering pedagogical value, implementation costs, and long-term sustainability. Pilot programs and gradual implementation strategies are recommended for exploring emerging technologies.

2. Pillar 2: Faculty Capacity Building and Professional Development

The second pillar addresses the critical importance of faculty development in successful digital pedagogy implementation. Faculty members are the primary drivers of educational innovation, and their willingness and ability to adopt digital pedagogical approaches largely determine implementation success or failure. Comprehensive faculty development programs must address both technical skills and pedagogical competencies while providing ongoing support and recognition for innovation efforts.

Effective faculty development programs are characterized by differentiated approaches that recognize varying skill levels, teaching contexts, and individual needs. Programs should include basic technology training, advanced pedagogical workshops, peer mentoring opportunities, and ongoing consultation services. Just-in-time support models that provide assistance when and where faculty need it are particularly effective for busy academic professionals.

Professional learning communities and faculty networks play crucial roles in supporting digital pedagogy adoption. These communities provide opportunities for faculty to share experiences, collaborate on innovative projects, and learn from successful implementations. Institutions should facilitate both formal and informal networking opportunities, including workshops, conferences, online forums, and collaborative research projects.

Incentive structures and recognition programs are essential for encouraging faculty participation in digital pedagogy initiatives. These may include release time for professional development, funding for conference attendance, awards for teaching innovation, and consideration of digital pedagogy activities in promotion and tenure decisions. Institutions must align reward systems with digital transformation goals to ensure sustained faculty engagement.

Change management strategies should address common sources of faculty resistance, including concerns about technology complexity, time requirements, pedagogical effectiveness, and student relationships. Communication strategies should emphasize the benefits of digital pedagogy for both teaching effectiveness and student learning outcomes while acknowledging legitimate concerns and providing adequate support for addressing them.

3. Pillar 3: Student-Centered Learning Design and Engagement

The third pillar emphasizes the importance of designing digital learning experiences that prioritize student needs, preferences, and learning outcomes. Student-centered approaches recognize that effective digital pedagogy must enhance rather than replace meaningful educational interactions while providing flexibility, accessibility, and personalization opportunities that traditional approaches cannot offer.

Universal Design for Learning (UDL) principles provide valuable guidance for creating inclusive digital learning environments that accommodate diverse student populations. UDL emphasizes multiple means of representation (providing information in various formats), engagement (offering choices and options for motivation), and action/expression (allowing students to demonstrate learning in different ways). Digital technologies offer unprecedented opportunities for implementing UDL principles through multimedia content, interactive simulations, adaptive assessments, and personalized learning pathways.

Active learning strategies are particularly well-suited to digital environments, where interactive tools, collaborative platforms, and multimedia resources can engage students in meaningful learning activities. Digital pedagogy approaches should emphasize student participation, critical thinking, problem-solving, and knowledge construction rather than passive content consumption. Examples include online discussions, virtual laboratories, simulation exercises, collaborative projects, and peer review activities.

Assessment and feedback strategies must evolve to take advantage of digital capabilities while maintaining academic integrity and meaningful evaluation of student learning. Digital assessment tools offer opportunities for immediate feedback, adaptive questioning, multimedia responses, and authentic performance evaluation. However, institutions must address concerns about academic dishonesty, technical reliability, and equitable access to assessment technologies.

Student support services must be redesigned to address the unique needs of learners in digital environments. This includes technical support, digital literacy training, online tutoring services, virtual advising, and mental health resources. Support services should be accessible, responsive, and integrated with learning platforms to provide seamless assistance when students need it.

4. Pillar 4: Institutional Culture and Change Management

The fourth pillar addresses the organizational and cultural factors that influence digital pedagogy implementation success. Institutional culture encompasses shared values, beliefs, practices, and norms that shape how community members approach teaching, learning, and innovation. Successful digital transformation requires cultural change that embraces experimentation, collaboration, continuous learning, and student-centered approaches.

Leadership commitment and vision are fundamental prerequisites for cultural change. Institutional leaders must articulate clear rationales for digital pedagogy adoption, communicate expected benefits and outcomes, and demonstrate sustained commitment through resource allocation and policy

development. Leadership should model innovative practices and create environments that encourage experimentation and risk-taking.

Communication strategies should engage all stakeholders in digital transformation processes, including faculty, staff, students, administrators, and external partners. Regular communication about progress, challenges, successes, and lessons learned helps build community support and maintains momentum for change initiatives. Communication should be transparent, honest, and responsive to community concerns and feedback.

Policy and governance structures must evolve to support digital pedagogy implementation while maintaining academic quality and institutional integrity. This includes policies related to intellectual property, academic freedom, student privacy, accessibility compliance, and quality assurance. Governance structures should include representation from all stakeholder groups and provide mechanisms for ongoing review and adaptation of policies as digital pedagogy practices evolve.

Collaboration and partnership opportunities can accelerate digital pedagogy implementation while reducing costs and risks. Partnerships may include other educational institutions, technology vendors, professional organizations, and community partners. Collaborative approaches enable institutions to share resources, expertise, and best practices while avoiding duplication of effort and common implementation mistakes.

Implementation Strategies and Best Practices

Successful digital pedagogy implementation requires systematic approaches that address the complex interplay of technological, pedagogical, organizational, and individual factors. Based on analysis of successful implementations, several key strategies and best practices emerge as particularly important for achieving positive outcomes.

Phased implementation approaches that begin with pilot programs and gradually scale successful practices across the institution are consistently more successful than comprehensive, institution-wide implementations. Pilot programs allow institutions to test approaches, identify challenges, refine processes, and build support before committing substantial resources to full-scale implementation. Successful pilots should be carefully documented and evaluated to inform scaling decisions and strategies.

Cross-functional implementation teams that include representatives from academic affairs, information technology, faculty development, student services, and administration are essential for addressing the multidimensional nature of digital pedagogy transformation. These teams should have clear mandates, adequate resources, and regular communication with institutional leadership. Team composition should reflect the diversity of the institutional community and include both champions and skeptics of digital pedagogy approaches.

Continuous improvement processes that use data and feedback to refine and enhance digital pedagogy approaches over time are crucial for long-term success. Implementation should be viewed as an ongoing process rather than a one-time project, with regular evaluation cycles, stakeholder feedback mechanisms, and adaptive strategies that respond to changing needs and circumstances. Learning from both successes and failures is essential for continuous improvement.

External partnerships and collaborations can provide valuable resources, expertise, and support for digital pedagogy implementation. These may include partnerships with other educational institutions, technology vendors, professional organizations, and consulting firms. However, partnerships should be carefully structured to ensure alignment with institutional goals and values while maintaining institutional autonomy and decision-making authority.

Impact on Student Learning Outcomes and Engagement

Research evidence consistently demonstrates that well-implemented digital pedagogy approaches can significantly enhance student learning outcomes, engagement levels, and overall educational experiences. However, the magnitude and nature of these impacts depend heavily on implementation quality, pedagogical design, and contextual factors.

Student engagement metrics show substantial improvements in digital learning environments that emphasize active learning, collaboration, and personalized experiences. Students report higher levels of participation in online discussions, increased interaction with learning materials, and greater satisfaction with feedback and assessment processes. Learning analytics data reveals that students in well-designed digital environments spend more time engaged with course content and demonstrate more consistent participation patterns.

Learning outcomes assessments indicate that students in technology-enhanced learning environments often perform as well as or better than students in traditional classroom settings, particularly when digital approaches emphasize active learning, immediate feedback, and personalized instruction. Meta-analyses of research studies consistently show small to moderate positive effects of digital pedagogy on student achievement, with larger effects observed in programs that integrate technology thoughtfully with sound pedagogical practices.

Accessibility and inclusion benefits are among the most significant advantages of digital pedagogy approaches. Digital technologies can provide accommodations for students with disabilities, support diverse learning preferences and styles, and enable participation by students who face geographical, temporal, or other barriers to traditional classroom attendance. However, institutions must be proactive in addressing digital divide issues and ensuring equitable access to technology and internet connectivity.

Retention and completion rates often improve in well-designed digital learning programs, particularly for non-traditional student populations who benefit from flexibility and accessibility features. However, some students struggle with the self-direction and time management skills required for successful online learning, highlighting the importance of adequate support services and preparation programs.

Challenges and Barriers to Implementation

Despite the demonstrated benefits of digital pedagogy, institutions continue to face significant challenges and barriers that impede successful implementation. Understanding these challenges is essential for developing effective strategies to address them and improve implementation outcomes.

Faculty resistance remains one of the most persistent challenges, often stemming from concerns about technology complexity, time requirements for learning new approaches, uncertainty about pedagogical effectiveness, and fears about job security or changing professional roles. Addressing faculty resistance requires comprehensive change management strategies that acknowledge legitimate concerns while providing adequate support, training, and incentives for adoption.

Technology infrastructure limitations continue to constrain digital pedagogy implementation in many institutions, particularly those with limited financial resources or outdated systems. Infrastructure challenges include inadequate network capacity, insufficient device availability, outdated software platforms, and limited technical support services. Addressing infrastructure limitations requires sustained investment and strategic planning to ensure that technology capabilities align with pedagogical goals.

Digital divide issues affect both faculty and students, creating inequities in access to technology and internet connectivity that can undermine the effectiveness of digital pedagogy approaches. Institutions must proactively address these issues through device lending programs, internet access initiatives, and support services that ensure equitable participation in digital learning environments.

Quality assurance and accreditation concerns arise as institutions implement new digital pedagogy approaches that may not align with traditional evaluation criteria and standards. Institutions must work with accrediting bodies and quality assurance organizations to develop appropriate evaluation frameworks that recognize the unique characteristics and benefits of digital learning while maintaining academic rigor and integrity.

Resource allocation challenges affect many institutions' ability to implement comprehensive digital pedagogy initiatives. Digital transformation requires sustained investment in technology, faculty development, student support services, and ongoing maintenance and updates. Institutions must develop sustainable funding models that support long-term digital pedagogy goals while balancing competing priorities and resource constraints.

CONCLUSION

This comprehensive examination of digital pedagogy transformation in higher education reveals both the tremendous potential and significant challenges associated with integrating digital technologies into teaching and learning processes. The research demonstrates that successful digital pedagogy implementation requires a systematic, multi-dimensional approach that addresses technological, pedagogical, organizational, and individual factors in an integrated and coordinated manner.

The four-pillar strategic framework developed in this study provides a comprehensive roadmap for institutions seeking to implement effective digital pedagogy initiatives. The framework emphasizes that successful transformation requires simultaneous attention to technology integration and infrastructure

development, faculty capacity building and professional development, student-centered learning design and engagement, and institutional culture and change management. This integrated approach recognizes that digital pedagogy transformation is fundamentally an organizational change process that extends far beyond technology adoption to encompass pedagogical innovation, cultural transformation, and systematic capacity building.

The research contributes to theoretical understanding by synthesizing insights from multiple disciplinary perspectives, including educational technology theory, learning sciences, organizational change management, and innovation diffusion theory. This multidisciplinary approach provides a more comprehensive understanding of the complex factors that influence digital pedagogy implementation success and offers practical guidance for addressing common challenges and barriers.

Empirical evidence from the literature review demonstrates that well-implemented digital pedagogy approaches can significantly enhance student learning outcomes, engagement levels, and educational accessibility. However, the research also reveals that implementation quality is crucial for achieving positive outcomes, with poorly designed or inadequately supported digital learning environments potentially producing negative effects on student learning and satisfaction.

The analysis identifies several critical success factors that consistently emerge across successful digital pedagogy implementations. These include strategic leadership and vision, comprehensive faculty development and support, student preparation and support services, robust technology infrastructure and integration, and systematic change management processes. Institutions that address these factors systematically and comprehensively are more likely to achieve successful digital transformation outcomes.

The findings have significant implications for both theoretical understanding and practical implementation of digital pedagogy in higher education. From a theoretical perspective, the research demonstrates the value of integrated, multidisciplinary approaches to understanding educational technology adoption and implementation. The synthesis of technology adoption theories, learning theories, and organizational change theories provides a more comprehensive framework for understanding the complex dynamics of digital pedagogy transformation.

For practitioners, the research offers practical guidance for developing and implementing effective digital pedagogy strategies. The four-pillar framework provides a systematic approach for addressing the multiple dimensions of digital transformation while the identification of critical success factors offers specific targets for implementation efforts. The analysis of challenges and barriers provides valuable insights for anticipating and addressing common implementation obstacles.

Educational leaders can use the research findings to develop more effective strategic planning processes for digital transformation initiatives. The emphasis on systematic, phased implementation approaches and the importance of comprehensive stakeholder engagement provides guidance for managing complex change processes while maintaining institutional stability and academic quality.

Faculty development professionals can apply the research insights to design more effective professional development programs that address both technical skills and pedagogical competencies. The emphasis on differentiated approaches, ongoing support, and recognition programs provides practical guidance for encouraging faculty adoption of digital pedagogical approaches.

Based on the research findings, several key recommendations emerge for policymakers and institutional leaders seeking to support effective digital pedagogy transformation in higher education. These recommendations address multiple levels of the educational system, from individual institutions to national policy frameworks.

Institutional leaders should develop comprehensive digital transformation strategies that align with broader institutional missions and goals while addressing the four pillars identified in this research. These strategies should include clear vision statements, specific implementation timelines, adequate resource allocation, and systematic evaluation processes. Leadership commitment must be demonstrated through sustained investment and active participation in transformation activities.

Faculty development programs should be expanded and enhanced to address the growing need for digital pedagogy competencies. These programs should include both technical training and pedagogical development while providing ongoing support and recognition for innovation efforts. Institutions should consider creating dedicated positions for instructional designers and educational technologists who can provide specialized support for faculty development initiatives.

Student support services must be redesigned to address the unique needs of learners in digital environments. This includes technical support, digital literacy training, online tutoring services, and mental health resources that are accessible and integrated with learning platforms. Institutions should also address digital divide issues through device lending programs and internet access initiatives.

Technology infrastructure investments should be guided by pedagogical requirements rather than driven solely by technical capabilities or vendor preferences. Institutions should prioritize interoperability, user experience, accessibility compliance, and long-term sustainability when making technology decisions. Cloud-based solutions offer significant advantages but require careful consideration of data privacy and security requirements.

Quality assurance frameworks should be updated to reflect the unique characteristics and benefits of digital learning while maintaining academic rigor and integrity. Accrediting bodies and quality assurance organizations should work with institutions to develop appropriate evaluation criteria that recognize innovative pedagogical approaches and outcomes.

While this research provides valuable insights into digital pedagogy transformation in higher education, several limitations should be acknowledged. The systematic literature review approach, while comprehensive, may not capture all relevant research and practice examples, particularly those published in non-English languages or in institutional reports that are not widely disseminated. The focus on higher education contexts may limit the applicability of findings to other educational sectors, although many insights are likely transferable with appropriate adaptation.

The theoretical framework synthesis, while drawing from multiple disciplinary perspectives, may not fully capture the complexity and nuance of digital pedagogy implementation in diverse institutional contexts. Cultural, economic, and political factors that vary significantly across different countries and regions may influence implementation processes in ways that are not fully addressed in this analysis.

Future research should address several important areas that emerge from this study. Longitudinal studies that track digital pedagogy implementation processes over extended periods would provide valuable insights into the sustainability and long-term impacts of transformation initiatives. Comparative studies that examine implementation approaches across different institutional types, cultural contexts, and national systems would enhance understanding of contextual factors that influence success.

Research on emerging technologies and their potential applications in digital pedagogy would help institutions prepare for future developments and opportunities. This includes investigation of artificial intelligence, virtual and augmented reality, blockchain, and other technologies that may transform educational practices in the coming years.

Studies that focus specifically on equity and inclusion issues in digital pedagogy implementation would address important social justice concerns and help ensure that digital transformation benefits all students rather than exacerbating existing inequalities. This research should examine the experiences of diverse student populations and identify strategies for creating more inclusive digital learning environments.

The transformation of higher education through digital pedagogy represents one of the most significant developments in educational practice in recent decades. While the potential benefits are substantial, realizing these benefits requires sustained commitment, systematic implementation, and continuous learning and adaptation. Institutions that approach digital transformation as a comprehensive organizational change process, rather than simply a technology adoption initiative, are more likely to achieve successful outcomes that enhance teaching and learning for all members of their communities.

The COVID-19 pandemic has accelerated digital pedagogy adoption worldwide, creating both opportunities and challenges for higher education institutions. While the crisis forced rapid implementation of digital learning approaches, it also highlighted the importance of systematic preparation, adequate support systems, and thoughtful pedagogical design. As institutions move forward in the post-pandemic era, the lessons learned from emergency remote teaching experiences should inform more deliberate and comprehensive approaches to digital pedagogy transformation.

The future of higher education will undoubtedly be shaped by continued technological advancement and changing student expectations and needs. Institutions that develop strong foundations in digital pedagogy, build organizational capacity for continuous innovation, and maintain focus on student learning outcomes will be best positioned to thrive in this evolving landscape. The strategic framework and recommendations presented in this research provide a roadmap for navigating this transformation successfully while maintaining the core values and purposes of higher education.

Ultimately, the goal of digital pedagogy transformation should not be to replace traditional educational approaches entirely, but rather to enhance and expand the possibilities for effective teaching and learning. The most successful implementations will likely involve thoughtful integration of digital and traditional approaches that leverage the strengths of each while addressing their respective limitations. This hybrid approach recognizes that different students, subjects, and learning objectives may benefit from different pedagogical approaches and that flexibility and adaptability are essential characteristics of effective educational systems.

As higher education continues to evolve in response to technological, social, and economic changes, the principles and strategies identified in this research will remain relevant guides for institutional leaders, faculty, and policymakers seeking to enhance educational quality, accessibility, and effectiveness through digital pedagogy transformation. The journey toward effective digital pedagogy is ongoing, requiring sustained commitment, continuous learning, and collaborative effort from all members of the higher education community.

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BLENDED LEARNING MODELS FOR SECONDARY EDUCATION: BRIDGING TRADITIONAL PEDAGOGY AND DIGITAL TRANSFORMATION

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ABSTRACT

The use of digital technologies in education increasingly transforms educational practices while also revealing persistent inequities in access and participation. In elementary schools and middle schools, having unfair amounts of devices and the internet can prevent good learning. This particular study helps to show economically and socially dangerous grade disparities between white and non-white communities. Blended learning models combine traditional and contemporary pedagogical styles to enhance student learning. The research will examine if such tools increase accessibility, engagement, and learning outcomes or give rise to new issues such as digital inequality, and difficulty of teaching, etc., in the secondary education section. In this study the researcher used data that had already been published by experts in the field. Secondary sources are used for the collection of sufficient data related to the research area. Current articles from the last five years are used for addressing information. They discovered that it was harder for teachers to give good quality education. In fact, schools with more developed educational programs, have greater success in teaching technology. Closing the gap between people with and without technology is a long-term process. Effective interventions should include training for digital components of learning as well as tools to ensure broader access to it. Accomplishing digital equality will require all parties composing an educational system to collaborate with a goal in mind. The research offers many benefits to educators. It gives them more knowledge and helps improve learning. Addressing this challenge is crucial because it benefits education globally. The findings of the research will show the ways through which future teachers can incorporate technology for the growth of education by minimising the negative impact upon students.
Keywords: Blended learning; Digital inequality; Digital technology in education

INTRODUCTION

The high rate at which technology is advancing has largely shaped the educational environment, changed the more conventional form of teaching and learned to more dynamic methods of instruction as well as making them more flexible and accessible. One of the most striking effects of this change is called blended learning, which is a teaching strategy that combines physical or face-to-face teaching techniques with virtual online educational content and interactive digital resources (Topping et al., 2022). This hybrid format attempts to combine the pros of both the physical and virtual spaces to increase engagement with a student, advance cognitive knowledge, and promote self-directed learning.

Blended learning was considered to be a reaction to the constraints present in traditional education systems that have often found it difficult to fulfill the requirements of the diverse learners in the ever-increasing digital world. On this occasion, when schools were closed and people were in conditions of social isolation, teachers globally resorted to technology to preserve the continuity of learning, which proves the importance of digital pedagogy in contemporary education is absolute.

One of the most significant contemporary problems in the world is the issue of inequality, and many are concerned about whether digital technology may promote it or not. The prevailing prism of predicting the relationship between digital technology and inequality has thus far been the digital divide: of nations and regions, groups and individuals, totally or comparatively deprived of the advantage of digital technology (Pregoner & Baguio, 2024).

Such perception has contributed to the comprehension of the digital technology and inequality, most especially in the low- and middle-income societies. However, the increasing rate of digitalisation in these countries is a challenge to it, a process that was supercentered during the COVID-19 pandemic. Most of the citizens are now integrated into digital systems of one type or another. Even though there are definite advantages of development that this digital inclusion has come with, it in certain cases has been linked with increased inequality.

The active development of digital technologies has drastically changed the paradigm of education, in which traditional classroom lessons have been substituted by more elastic and technologically involved methods. One of them, namely blended learning, such as a pedagogical approach, which introduces elements of the use of online teaching as a component of face-to-face one, has proved to be a worthy of promising alternative (López-Fernández, Burgueño, & Gil-Espinosa, 2021). Although its adoption is increasing, still no proper understanding of its usefulness, implementation plans, and long-term effects on teaching practices and student academic output is present.

Remedies to the aforementioned challenges will be achieved through understanding new media, design, and actionable interventions that could lead to developing an investigative approach that connects all stakeholders toward positive learning practices and academic standards, which are likely to determine future financial gains in education and elsewhere.

The basic objectives of the proposed study will determine the effects of blended learning models on the levels of access, engagement, and academic achievements in children in secondary school. Another concept developed in it is whether digital pedagogy has the potential to decrease or accidentally increase inequality in education (Li, Sun, & Oubibi, 2022). The study attempts to inform future practices to ensure equal access to quality education by determining the opportunities and risks.

This study aims to examine the role of digital technologies and blended learning models in enhancing accessibility, student engagement, and the overall quality of education in secondary schools, while also assessing the influence of digital inequality on students' learning participation, outcomes, and academic performance across diverse socio-economic and racial groups. In addition, the study seeks to identify the major challenges faced by teachers, students, and educational institutions in the effective implementation and long-term sustainability of digital and blended learning practices.

Guided by these objectives, the research addresses key questions concerning how the integration of digital technologies and blended learning models contributes to improved educational quality and accessibility, the extent to which digital inequality affects students from different backgrounds, and the obstacles encountered in practice. Furthermore, it explores potential approaches, interventions, and policy recommendations that can mitigate digital disparities and promote equitable, inclusive, and sustainable technology integration within secondary education systems.

THEORETICAL FRAMEWORK

Importance of integrating digital technologies and blended learning models

The blended method of learning, while combining traditional classroom instructions using digital learning tools, is considered a transformative model within secondary education. Technology has been integrated into this educational system, which has allowed the students in terms of learning beyond the classroom precincts while using online resources and interactive platforms (Li, Li, & Han, 2021). There are several digital tools, including virtual classrooms along with systems for learning management and educational applications, which are responsible for supporting differentiated learning that are structured in such a way that they can cater to the different requirements of the students. In addition to this, student engagement is also promoted through this model as it is responsible for incorporating content from multimedia along with gamified assessments (Chen, 2022). This, as a result, is responsible for fostering motivation and active participation. Digital discussions and group projects, as a result of the model promote collaborative learning and enhance the skills of peer interaction and communication. Blended learning has also contributed towards enhancing the educational quality, where teachers are given opportunities in terms of adopting data-driven instructions while tracking the progress of the students, while customising the overall strategies for teaching so that the overall outcome is enhanced.

Evaluation of the impact of digital inequality

Digital inequality is responsible for addressing the division in digital tools, which substantially

influence the learning outcomes of the students, along with their participation and academic performance. The inequality in terms of getting access to the technology, along with the connectivity of the internet and digital literacy, is responsible for creating substantial disparities in educational opportunities across different racial groups and socio-economic backgrounds (Perera et al., 2023). The most disadvantaged students, those with low-income status or marginalized groups, do not have access to reliable devices and high-speed internet, which restricts their opportunities to access online learning activities and digital collaboration. This is a technological gap that not only affects the academic achievement but also the overall motivation and confidence of the students substantially. Disparate digital access amplifies the consequences of education inequality, as students having more resources have an opportunity to learn more through multimedia means and receive prompt feedback (Heponiemi et al., 2023). In addition to this, teachers also struggle in terms of delivering instructions inclusively because the access level of the students tends to vary excessively.

Key challenges in implementing and sustaining effective digital and blended learning practices

The implementation of sustainable and effective digital and learning practices within secondary education may experience numerous challenges, which may hamper the overall effectiveness of the process. In this matter, difficulties in terms of adopting traditional methods of teaching to digital platforms may be experienced by the teachers, which may require a substantial transition in the management of the classroom and pedagogy (Ragnedda, Ruiu, & Addeo, 2022). The effective implementation is further hindered by limited literacy on digital attributes, along with a lack of professional training, along the heavy pressure of workload with online lessons. Lack of self-discipline, motivation, and digital competence required to learn independently on their own are some of the challenges faced by students. In addition to this, there is also unequal access to internet connectivity as well as devices, which is responsible for creating discrepancies within participation and overall performance. Some institutions may experience barriers regarding their structure and financial aspects. In this matter, they experience insufficient technological infrastructure along with the constraints in budget and lack of support on ongoing technological aspects (González-Betancor, López-Puig, & Cardenal, 2021). In this matter, it is very important to maintain consistency in policy frameworks, along with redesigning the curriculum along making investments in digital resources for the long run. The situation is further complicated by the resistance to changes, along with raising concerns regarding the privacy and issues for the security of the data. Also, the absence of standard assessment instruments is a challenge to the assessment of the effectiveness of blended learning strategies. The combination of these issues leads to the necessity of extensive institutional planning and training of the teacher, as well as the initiatives for attaining access.

Mitigation strategies and policy recommendations that promote digital equity, inclusivity, and sustainable technology integration

The promotion of digital inclusivity along with the sustainability within the technological integration in the educational sphere may rely on coordinated strategies at both the levels, including the institution and policy. Under these circumstances, mitigation approaches are to be taken in terms of ensuring equity in terms of attaining access to the digital infrastructure (Olawale, 2024). This can be achieved through the affordability of equal internet connection along with subsidised devices, while getting well-equipped facilities at school. Policies that emphasize the reduction of the digital divide, especially among low-income and rural students should be put in place by governments and institutions. Digital competence and self-confidence in the effective use of technology require teacher training and lifelong learning. As a core component, digital literacy needs to be integrated within the curriculum design so that students may have the opportunity in terms of preparing themselves for dealing with the technologically driven atmosphere (Raihan et al., 2025). Apart from this, the sharing of resources along with sustainability and innovation may be accomplished through collaboration with private and public stakeholders.

Constructivist Learning Theory

A strong foundation has been provided through the “Constructivist Learning Theory” in terms of understanding and applying blended learning models within secondary education. This theory is responsible for emphasizing the fact that learners are more prone to constructing knowledge through active interaction and exploration. Constructivism is relevant in the blended learning context by allowing the use of digital technologies to facilitate active engagement and personalized learning experiences (Efgivia et al., 2021). In this matter, there are several digital tools that can be used to improve the overall

learning process. Virtual simulations, interactive multimedia, and collaborative online platforms are some of the critical tools that may contribute substantially towards building an effective learning environment.

The role of the teachers plays a crucial role as facilitators rather than as transmitters. This is not only guiding the students to attain knowledge but to help them in terms of guiding in terms of connecting to prior understanding through the utilization of new information. Blended learning can also enable students to learn at their own pace, revisit the material, and apply the theoretical knowledge in practice, which can help them learn with learning depth and critical thinking. In addition to this, there are collaborative attributes that may include the discussion boards along with shared documents, which are responsible for encouraging social constructivism (Mishra, 2023). This may provide an opportunity for the students in terms of co-creating knowledge through the implementation of effective teamwork. The use of the constructivist theory in blended learning assists in the development of more learner-centered learning systems that are learner-centered in engaging in learning, reflection, and the construction of knowledge.

Technology Acceptance Model (TAM)

TAM is responsible for providing a valuable framework in terms of understanding how the teachers as well as students adopt while effectively the tools associated with digital blended learning within the secondary education. TAM is designed on the basis of two elements including the perceived usefulness and perceived ease of use (Musa et al., 2024). These are responsible for influencing the attitudes of the users in terms of developing the idea towards technological integration along with their overall intentions in terms of using the model of blended learning. TAM can be used to justify the differences in the adoption of learning management systems, virtual classes, and digital assessment tools (Natasia et al., 2022). In this matter, when students and teachers find these technologies useful in enhancing the learning outcomes and making the educational processes easier. In the case of teachers, perceived usefulness and frequency of use can be led to prompt increasing perceptions of the pedagogical usefulness of technology by means of the teacher having a professional development program that demonstrates perceived benefits of technology. In the same way the designing of the user friendly platforms is responsible for reducing the substantial barriers which is responsible for enhancing the perceived ease (Al-Adwan et al., 2023). Through the use of TAM, educational policymakers and administrators are able to define which factors promote and or bar digital education adoption so that they can develop specific interventions to foster confidence, motivation, and digital inclusivity.

Even though many studies demonstrate the advantages of blended learning and digital integration, there is little research on how the socio-economic differences, preparedness of teachers, and institutional support have a collective impact on the sustainability and equity of blended learning and digital integration in secondary schools. Additional research is required to come up with broad based, context based frameworks to the application.

METHOD

Research philosophy

It is the interpretivist research philosophy, which relies on the subjective meaning of human experience, the recognitions in social reality situations that act as the foundation of this research. ***Interpretivism*** is also good in alignment with educational research since it deals with how people feel and perceive the involvement of digital technologies in learning, students, teachers, and policymakers. Instead of aspects that can be measured, this research set out to learn the contextual issues that have contributed to digital inclusion and the transition to digital pedagogies. The interpretivist position enables the researcher to check various perspectives concerning the approach of blended learning models towards accessibility, engagement as well and equity in secondary education (Ali, Shah & Shah, 2021). It is intended to make sense of meanings and trends out of the available academic pieces of evidence instead of testing hypotheses that have been formed in advance.

Research approach

A qualitative ***inductive*** study was used in this research. General insight made out of the specifics of the research using specific sources of secondary data that are under analysis with the help of induction. The study starts with the analysis of the available literature on the topics of blended learning, digital inequality, and secondary education, and then establishes the new themes and connections between all three notions (Proudfoot, 2023). Therefore, the deductive research method will make it easier to create

new theoretical concepts about the distinctions between the traditional techniques in pedagogy and the digital innovation, along with combining them to receive the blended learning process.

Research Design

In this research, the researcher aims to examine how technology and the help of online modalities are transforming traditional education. Therefore, it will rely on the already available data in determining the new challenges, developments, and impact of digital instruments in instruction and learning. However, the ***exploratory*** design is considered the best since blended learning is in development due to social along technological transformations. Therefore, this paradigm would allow free-flowing questioning, allowing understanding of diverse actions and effects in technology-state integrated education, providing information about the ways in which schools can harmonize and manipulate the digital and traditional modes of teaching. The qualitative design is based on meaning-making and not measurement of data, which provides better insight into the impacts of technology integration on teaching, learning, and equity (Makri & Neely, 2021). The study is based on conceptual and interpretive approaches that would help in synthesizing the knowledge of various academic and policy-based approaches.

Data Sources

The research study is also based solely on the secondary data that consists of refined academic and institutional publications, which are less than four and five years of age respectively. These are peer-reviewed journal articles, conference proceedings, government and organizational policy reports, and official educational statistics. Therefore, the criteria that are going to be included in the inclusion criteria focus on the materials that directly cover the topics of digital inequality, blended learning, and secondary school education (Baas et al., 2020). Sight attention and preference invested in those sources that address the topics of technology integration, the problem of access, socio-economic inequalities, and digital pedagogy. The relevance of documents that are not relevant to the secondary school level and those that are older than the technological transformations posed by the recent global initiatives at digitizing the world were weeded out. This allows one to ascertain that the information indicates the state and problems of educational transformation.

Data Collection Procedure

The systematic and transparent procedure was followed in the data collection process. A directorial search involves the researcher searching through the digital academic databases as provided by ERIC, Google Scholar, (Education Resources Information Centre), as well as JSTOR. The search utilizes the use of certain keywords and Boolean operations, including digital divide, blended learning, secondary education, educational equity, technology integration, and digital pedagogy. To guarantee that the objectives of the research and the inclusion criteria are met, the screening involves screening the abstracts and the full-text. Any study or publication that is not credible, peer-reviewed, or an official institutional report will not be selected (Schöpfel & Prost, 2021). To facilitate the levels of transparency and replicability, the researcher ensures that he or she keeps a reference log to monitor the data sources, the year of publication, and the significant findings of the study.

Analytical Framework

The gathered literature was viewed and analysed using thematic analysis, which is a qualitative method applicable in identifying, managing, and interpreting the recurring patterns and themes. Thematic analysis is done in a number of phases. The researcher also ensures that he/she is well familiar with the contents through frequent reading of the chosen materials. Then, coding will be conducted to label the information of interest in the under-topics of accessibility and equity, teacher preparedness and struggles, student engagement, and policy and infrastructural encouragement (Anderson & Holloway, 2020). Data was revised after being coded to determine the general patterns and links between various findings and socio-economic situations of various studies. Synthesising these results into a comparative model used in the end phase to indicate the way blended learning models work in various learning institutions. The analysis, therefore, plays a role in building a conceptual wisdom of the meaning of digital inclusiveness and pedagogical transformation.

Ethical Consideration

This research is not personal/lateral as it entails mingling with the individuals; therefore, it also does not include participation or gathering of personal information. Thus, the risks of ethics related to the research are small. Nonetheless, the author of the work makes sure that academic integrity and ethical standards of conduct in research are observed properly, as he/she ensures that he/she properly references

all other original authors and sources. The credibility and validity of the findings were ensured reviewed and credible sources (Hakimi, Eynon & Murphy, 2021). The research is not confused and biased in the communication or selective observation of data to manage a clear and unbiased investigation. Also, one is sensitive when addressing the matters of the digital disparity, and the findings are presented with regard and in a positive manner.

FINDINGS AND DISCUSSION

Importance of Integrating Digital Technologies and Blended Learning Models

The integration of technological tools into education has revolutionized the way students learn and teachers instruct. With the advancements in technology, traditional teaching methods are being complemented and, in many cases, replaced by innovative tools that offer interactive, engaging, and personalized learning experiences. By incorporating technology in education, educators can cater to diverse learning styles, adapt content to individual needs, and foster a more collaborative and dynamic learning environment (Hrechanyk *et al.*, 2023). Furthermore, technological tools provide access to a vast array of resources and information that can enrich the learning process beyond the constraints of traditional textbooks and lectures. Students today are digital natives, accustomed to interacting with technology in their daily lives. Integrating technology into education not only aligns with their learning preferences but also equips them with essential digital literacy skills that are increasingly valuable in the modern workforce. Additionally, technological tools facilitate real-time feedback, assessment, and data analysis, allowing educators to track student progress more effectively and tailor instruction to address individual learning gaps. This data-driven approach to teaching and learning can lead to improved academic outcomes and a more personalized educational experience for students.

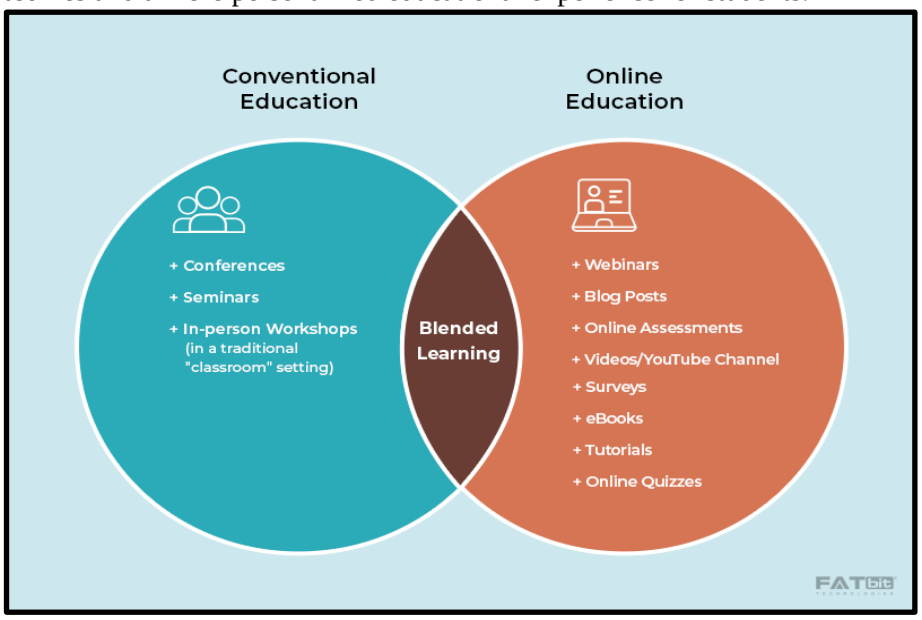


Figure 1. Overview of Blended Learning
(Source: Iskakov *et al.*, 2020)

Physical integration established within most institutions would be essential to the future. The economy of the twenty-first century is competitive towards cyber-savvy, thinking ability, and flexibility-qualities that can be efficiently acquired during technology-conscious training. Blended learning models have also improved teacher collaboration in schools, embracing the new paradigm since the digital environment gives an avenue whereby teachers share lesson plans and teaching materials as well as professional development resources (Iskakov *et al.*, 2020). Therefore, digital integration is not limited to the benefits that it could provide in the classroom but can help form an innovative, digitally literate society as well.

However, the contextualisation of this importance with regard to the fields of access and equity is necessary. It has been proven that the digital transformation has not only empowered but also provided dissimilar advantages. The schools that have proper infrastructure and technological facilities are more apt to win the fruits of blended learning programs than the schools which has limited resources (Lazar, Panisoara & Panisoara, 2020). It is on this basis that, as much as there is no option but to integrate

digitally, equity should be the core of the latter. It can be concluded generally that introducing digital technologies to the school system is not only an educational choice, but a social need that forms the basis of ensuring the global agenda of inclusive and quality schooling.

Impact of Digital Inequality on Students' Learning Outcomes and Participation

As shown in the review, digital disparities continue to affect the aforementioned aspects of learning, involvement, and achievement scores of the learners in secondary-school students. The results indicate that the children in low-income families and schools with available resources have poor access to digital devices and a good connection to the internet. Such a difference minimizes their ability to take part in blended classes, present online tests, and make use of additional learning materials, which further enlarges achievement gaps. There are psychological and behavioural impacts of learning because of digital inequality (Perera *et al.*, 2023). Also, those students who sustain constant communication with technology are prone to achieving a high level of digital literacy, self-confidence, and comfort in the presence of online delivery of instructions. Contrarily, persons who have limited access feel frustrated, disengaged, and unwelcoming relative to their technologically advantaged counterparts. This is further exacerbated by differences in the level of digital literacy of parents, where students in high-tech families get more assistance with their school work.

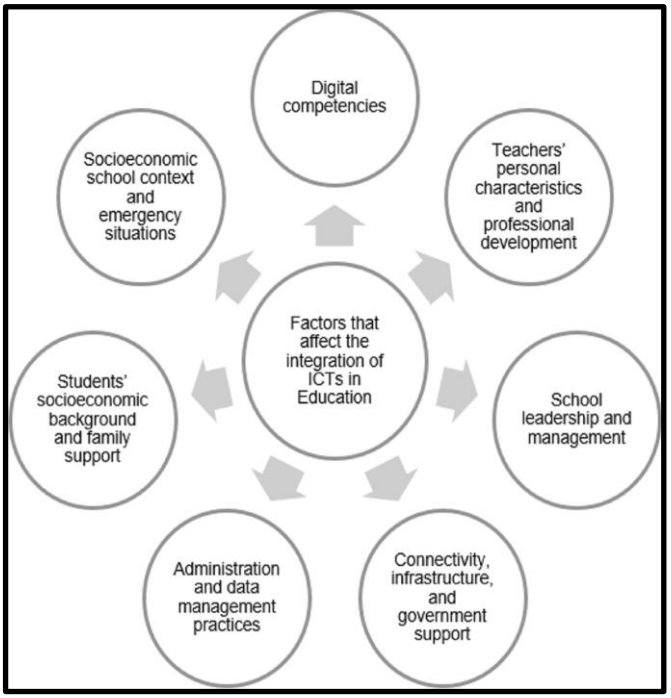


Figure 2. Impacts of digital technologies on education and factors influencing schools' digital capacity and transformation: A literature review
(Source: Bi & Ishak, 2025)

Another aspect of the digital divide that one can see in the problem is racial and socioeconomic. As a rule, digital infrastructure is better in mostly white and wealthy communities as non-white and less affluent students have to face considerable challenges in their attempts. As a result of this, digital stratification in education has been created, whereby technology has not reduced the currently existing inequities but has strengthened them. These gaps were especially apparent in the case of the COVID-19 analysis since online education was more of a disadvantage to students without digital devices or stable internet accessibility. Besides, digital inequality is not a problem in academic attainment, and instead, it can influence belonging and a feeling of inclusion (Bi & Ishak, 2025). In most cases, when barriers to access exist, learners quit classroom interaction and group work and become socially isolated, and get fewer opportunities to experience collaborative learning. This impedes the acquisition of vital skills in the 21st century through collaborative and physical communication, and hence the destruction of both the cognitive and the social-emotional aspects of learning.

In general, the data indicate that digital inequity is a significant menace to educational equity and study results in secondary education. The absence of focused intervention is a threat to blended learning as it may make someone an object of exclusion instead of empowerment. To solve this problem, it will be needed on an organizational level to make sure that every learner, with or without socio-

economic and racial restrictions, can have equal access to the digital resources and can learn within a different environment.

Besides, digital inequity has persistently contributed to the aspect of teacher-student interaction and the central quality of instruction. The teachers often rely on the digital platform in communication and assessment, as well as delivery of the feedback, which is not effective in case the students are poorly equipped in terms of technological access. Such differences can make teachers unintentionally give preference to students with more digital resources and thus increase participation and achievement differences (Heponiemi *et al.*, 2023). To top, a lack of teacher training on managing varying technological skills in learners may increase injustices. How these problems can be counteracted is by giving priority to inclusive digital policies, subsidized access to the internet, and capacity-building programs to equip teachers so that technology enhances equity in learning programs and does not widen disparities.

Challenges in Implementing and Sustaining Effective Digital and Blended Learning Practices

Although the ranch's move to digital learning has become more appreciable, the outcomes indicate that some obstacles hinder the successful application and maintenance. Deficiency in proper digital infrastructure is one of the greatest barriers, especially in the poorly funded state schools and the countryside (Ashraf *et al.*, 2021). Being unable to use all the benefits of online resources, teachers and students are often deprived of a highly fast connection, not enough computers or tablets, and outdated hardware. This technology disparity continues to uphold disparate educational access and attainment of the inclusive nature of blended education. The pre-teaching readiness and the teacher development become issues as well (Mulenga & Shilongo, 2025). Research of many educators indicates a general lack of training in the sphere of digital pedagogy and a generally noncommittal attitude regarding the area of applying technology in teaching. Younger teachers could be more digitally literate, but experienced teachers might not be able to adjust themselves and follow the new platform and facilities (tutorial 1). The lack of institutional support and a unified system of pedagogy contributes to this difficulty, and teachers are unable to appreciate how the traditional teaching process should be changed to incorporate digital innovation.



Figure 3. Blended Learning for Corporate Training
(Source: Ali, 2025)

Pedagogically, it is complicated to keep students engrossed in the digital platforms. It shows that when students study on the Internet, there are high chances of getting distracted, experiencing a lack of motivational drive, and facing self-managed study, which is challenging to control. Furthermore, it can be problematic to guarantee academic integrity and keep track of progress in the online environment (Ali, 2025). To make learning interactive and ensure that the learners are engaged, teachers have to spend extra time on creating such material and keeping track of students, which puts a great burden on them. The other threat is that of socio-economic injustices. Students from disadvantaged backgrounds may not have access to devices, but they often lack a conducive environment in their homes for learning. The success of students in blended learning environments is also determined by parental support, digital literacy, and socio-cultural attitudes towards technology. These non-technical factors are as contributing as infrastructural barriers to determining the learning outcomes.

Digital programmes are not well-sustained by institutional policy on a long-term basis, due to

the budget constraints and policies that may restrict them in the long term. The numerous projects are donor-reliant or of a project nature, as a result of which they are ineffectively implemented, scaled, and criticized. Besides, the issue of data security and privacy has surfaced as a major problem in maintaining the blended learning environment. Many schools have weak systems that safeguard the confidential data of students, hence exposing them to possible invasion and abuse of personal information (Hill & Smith, 2023). This sabotages the performance of parents and educators, reducing their desire to embrace digital tools. In addition, the development of the evaluation frameworks inconsistently complicates the measurement of the long-term efficacy of the digital learning programs.

Mitigation Strategies and Policy Recommendations for Promoting Digital Equity and Sustainability

The results provide a list of mitigation measures expected to potentially overcome the digital divide and the lack of equity in creating equal access to technology in the Secondary school system. Governments should also focus more on ways of integrating digital since it is one of the national education plans at the policy level. This will involve lowering the cost of the internet and streamlining access to the internet. It involves the provision of schools with adequate digital equipment, high-speed internet access, and adequate budget to benefit poor schools. It can be assisted by forming partnerships with the community through creating donation programmes of devices, providing more affordable internet packages, and establishing local learning locations, all of which will exert some positive impact. Teacher training is also another essential process. Teachers ought to have professional development programmes that assist in developing digital skills via continuous support and not one-time workshops, so that the use of technology is effective. Other teacher education programs must also incorporate digital pedagogy to equip future teachers. Less lucky students can be assisted specially with the help of lending equipment, offering offline classes, and implementing post-school online learning programmes.

Blended models of learning must be inclusive so as to handle different learners, such as the disabled or those with less support at home. The use of the principle of inclusive design will mean that digital platforms will be available to everyone, without any distinction of ability or background among the students.

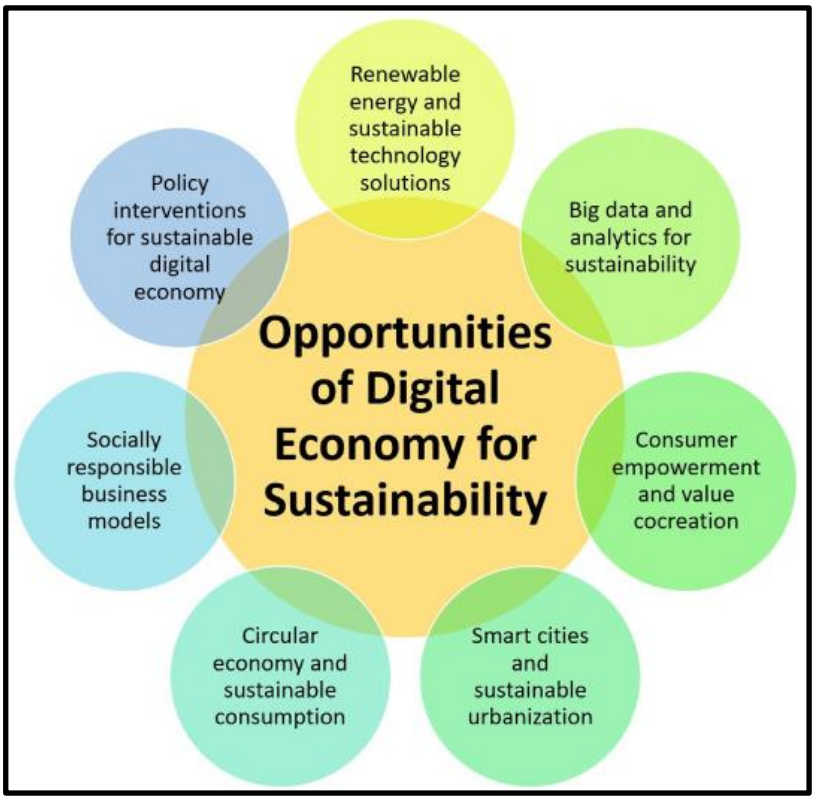


Figure 4. Mitigation Strategies and Policy Recommendations for Promoting Digital Equity and Sustainability
(Source: Topping et al., 2022)

At the pedagogical stage, the engagement discrepancies are alleviated by adhering to a learner-

centred approach. Engaging and interactive learning resources, including gamified, peer discussion, and project-based learning, add to the participation and motivation. Teachers should provide interventions to struggling students through regular monitoring and feedback systems that enable them to detect them in time. It is imperative to have a digital responsibility culture at schools to sustain the long term. The privacy and security of data, ethical use of technologies, and equitable management of digital resources should be reflected in the school administration. The policymakers are also expected to draw national benchmarks of quality assurance of digital education, which would be consistent in terms of schools and geographical settings. The discussion also shows that it is not a one-time process to mitigate and that mitigation is a continuous process that includes coordination among the policymakers, the teacher population, communities, and the major stakeholders (Mulenga, and Shilongo, 2025). Incremental surge on the aspect of investment, including combinations between the policies and social engagements, is required in a bid to create an inclusive digital education system. When these mitigation measures are installed successfully, they will not only help bridge the gaps in technology but they will also help build the roots on which a just, creative, and strong educational system can be formed and established.

CONCLUSION

Students with low economic status or living in disadvantaged rural areas have always had to overcome obstacles that impede their progress, and teachers have to be in a position to short-circuit them with bad, especially trained digital training, and need to alter teaching methods. As it seems, evidence shows that, despite the possibility of blended learning to breed innovative learner-centred settings, when implemented fairly, through technological availability, continuous professional growth, and making of inclusive designs, blended learning is only effective (Almarzuqi and Mat, 2024). The inequalities and evident inequalities and misbalances in policy execution and continual support to teachers/ educators remain to constrain its transformative capacity.

This work also contributes to the form) enhancement in the learning and teaching processes on the digital platform with the help of recognition and equity in education. It relies on the Technology Acceptance Model and Constructivist Learning Theory to understand how equitable exposure to technology can be potentially implemented to fuel student interest, motivation, as well as positive learning experiences (Arek Ciccobawa and Reddy, 2022). The research recommends better policies that would turn digital learning more into a level playing field. Such policies must have good and affordable internet connections, adequate investment in digital tools, and equal training opportunities for teachers. The study also urges governments to come up with long-term strategies that would incorporate social and economic disparities and the distance between urban and rural schools. In so doing, they will be able to make their education systems more balanced so that all students can enjoy the benefits of digital learning. The study on the whole contributes to theory and practice as well, by bringing about fairness, technology, and learning outcomes in unity .The research, in real-life application, provides practical solutions to teachers and organizations, focuses on lifelong learning, flexibility of teaching methods, and learner-centered design, which, in turn, would make blended learning environments accessible to everyone.

The weaknesses of this research narrow the scope of its findings. First, utilization of secondary data does not allow direct communication with the ongoing processes in the classroom and the realities that exist around both the teacher and students; the lack of primary data collection, including interviews or books, reduces the ability to record personal perception of the digital inequity and barriers to teaching. Second, when the authors have concentrated solely on secondary education, the entire research limits the generalisability of results to other levels of education, such as the primary and tertiary settings (Singh, Steele & Singh, 2021). In addition, the difference in infrastructure, socio-economic factors, and the level of technological preparation between the country and the region had not been explored to any depth. The study did not engage in an in-depth analysis of intersectional aspects like gender, disability, or cultural background, and so restricted the perspectives on subtle digital experiences of learning.

The major concern of future research must consist of primary empirical exploration, which includes teachers, students, and administrators, hence basing the analysis on the experiential inception of blended learning. Longitudinal research is necessary in order to identify permanent impacts of particular intervention phases and changes of policies on digital equity at numerous levels at a certain time. In addition, research ought to have anticipated the gender and disability factor in order to bring

forward the concealed impediments and strategies that are designed to be inclusive and formulated accordingly. The literature analysis on community and public-privacy partnerships may offer the practicality that involves addressing the problem of digital disparities (Joseph, Onwuzulike & Shitu, 2024). Overall, future research needs to deliver effective evidence that will transform policy and practice to ensure that digital learning will be fair, stable, and viable at the international scale. Such kind of research will be used as a baseline in promoting digital inclusivity and converting previous educational systems in most countries of the international arena.

Digital equity in education may be termed as a complex task that involves long-term collaboration between teachers, policymakers, society, and providers of technology. Scheduling of the blended learning process creates the potential available with changing the old education infrastructure only when it is done with purpose and intention, such a regarding human contact with emerging technologies. Through this, it comes about that with the emergence of the contemporary educational system, the scale of creating ethical, inclusive, and culturally responsive issues of digital practices has taken on a more salient theme in the contemporary world (Chen et al., 2024). Integration of a classroom should be guided by empathy, accessibility, as well as critical thinking, since technological abilities continue to evolve. In conclusion, fair blended instruction is not a new development on the pedagogical front; it is a social imperative that every learner, irrespective of background or capability, should be cast into the capability of a learning process and environment.

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Research on the Application of Multimedia in the Teaching of 'Electrical Machinery'

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ABSTRACT

This study aims to explore the specific application modes, practical effects, and existing challenges of multimedia technology in the teaching of Electrical Machinery, a core course in engineering disciplines. Guided by the Dual Coding Theory and Cognitive Load Theory, an analytical framework was constructed, and a sequential explanatory mixed-methods research design was adopted. A controlled experiment was conducted with two classes (n=92) of electrical engineering majors from a university, and both quantitative and qualitative data were collected through questionnaires, in-depth interviews, and classroom observations. The key findings are as follows: (1) The systematic application of multimedia resources such as 3D animations and simulation software significantly improved students' performance in understanding complex electromagnetic concepts and cognizing spatial structures ($p < .01$); (2) Multimedia effectively stimulated students' learning interest by creating contextualized scenarios, but improper design could increase extraneous cognitive load; (3) The in-depth integration of multimedia with traditional blackboard writing and physical models is the key to achieving effective teaching outcomes. Based on these findings, a "complementary integration" teaching framework was established, which provides theoretical references and practical pathways for optimizing the instructional design of engineering professional courses.

Keywords: Multimedia-assisted teaching; Electrical Machinery; Mixed-methods research; Cognitive load; Teaching optimization

INTRODUCTION

Electrical Machinery serves as an indispensable cornerstone in the curriculum system of Electrical Engineering and Automation. With electromagnetic field theory at its core, its knowledge system integrates physics, materials science, and dynamics, exhibiting high levels of abstraction, systematicness, and practicality (Li, Y., Wu, Y., & Liu, X., 2016). Specifically, this course covers complex internal structures of electrical machines, electromagnetic processes with temporal and spatial variations, and nonlinear energy conversion relationships—content that often proves difficult for students lacking engineering practical experience to grasp intuitively, thereby posing significant challenges to traditional teaching models (Yang, G., Xiao, Y., & Wang, Y., 2018). The teaching quality of Electrical Machinery directly impacts students' understanding and mastery of subsequent professional courses (e.g., Power System Analysis, Electrical Control Technology), making it a crucial link in cultivating qualified electrical engineers.

The in-depth development of educational informatization has provided an opportunity to address this teaching dilemma. Multimedia technology, by integrating multiple media forms such as text, graphics, animations, simulations, and videos, can visualize abstract principles, materialize dynamic processes, and three-dimensionally represent complex structures—aligning with the comprehensive requirements of engineering courses for intuitive cognition and logical thinking (Tayirova, 2023). For instance, 3D electrical machine models constructed using SolidWorks allow students to observe internal structures from any angle; animations developed via Flash or VB can clearly demonstrate the formation of rotating magnetic fields and the commutation process of DC motors; and virtual simulation experiments can overcome limitations of venues and equipment, providing students with a safe exploratory experimental environment. These applications have significantly enhanced the

intuitiveness and interest of teaching (More Valencia, Nizama Reyes, Lizana Puelles, & Sandoval Valdiviezo, 2023).

Nevertheless, there are notable divergences and misunderstandings in the current application of multimedia technology in teaching practice. On one hand, some applications merely remain at the level of simple "digitalization" of textbook content, failing to touch upon the educational essence of multimedia technology in supporting in-depth cognitive construction. On the other hand, some fall into the blindness of "technology supremacy," excessively pursuing the richness of media forms without deep integration with teaching objectives. This may lead to information overload, which instead distracts students' attention and increases their extraneous cognitive load (Sankaranarayanan, Yang, & Kwon, 2024). Therefore, research on the application of multimedia technology in the teaching of Electrical Machinery must not stop at generalized assertions of "effectiveness"; instead, it is essential to conduct an in-depth analysis of the internal mechanism regarding "why it is effective" and "how to optimize it."

Against this backdrop, this study aims to move beyond superficial verification of instructional effectiveness and focuses on addressing three core research questions: for typical learning difficulties in Electrical Machinery—such as motor structure, rotating magnetic fields, and characteristic curves—how can a systematic and refined multimedia teaching design and application scheme be constructed based on principles from the learning sciences? What specific effects does this scheme have on students' depth of knowledge construction, disciplinary interest and engagement, and cognitive load, and what cognitive mechanisms underlie these effects? And how can an optimized multimedia teaching framework be developed to maximize positive instructional outcomes while effectively avoiding potential risks, particularly by clarifying the complementary integration between multimedia approaches and traditional teaching tools such as blackboard writing and physical models?

Through a rigorous mixed-methods empirical study, this research will systematically explore the aforementioned questions. It aims to provide solutions with both theoretical depth and practical validity for the teaching innovation of Electrical Machinery and related engineering courses, thereby promoting the paradigm shift from "the application of technical tools" to "intelligent teaching design.

THEORETICAL FRAMEWORK

Multimedia-assisted teaching

In an academic context, this concept has two interpretations: broad and narrow. In the broad sense, multimedia-assisted teaching refers to "the combined application of multiple single-function teaching media"—for instance, the integrated use of blackboards, wall charts, slides, projectors, and other media in the teaching process (Ying, 2009). However, with the rapid development of information technology, the narrow interpretation is now widely accepted in both academic and practical fields: it specifically refers to the use of multimedia computers to comprehensively process and control various media information (including symbols, language, text, sound, graphics, images, and videos), organically integrate this information according to teaching requirements, present it via screens or projection equipment, and supplement it with audio and human-computer interaction to complete the teaching or training process (Peng, 2020). It is often regarded as synonymous with computer-assisted instruction.

Building on this, this study provides the following operational definition of multimedia-assisted teaching: it is a type of instructional system design that aims to promote learners' in-depth cognitive construction. Based on the principles of learning sciences (especially cognitive theories of multimedia learning), it systematically designs, develops, and applies digital media (such as animations, simulations, and interactive models), and organically integrates these media with traditional teaching methods (including teachers' lectures, blackboard-based deductions, and physical demonstrations) in a sequential manner. Its essence is not the simple accumulation of multiple media, but rather the emphasis on the alignment between media and teaching objectives, as well as the synergy of various teaching elements in the cognitive process; its ultimate goal is to optimize the teaching process (Scheiter et al., 2017).

It is particularly important to note that the key to successful multimedia-assisted teaching lies in "organic integration." It should play a "supporting" role, aiming to compensate for the limitations of traditional teaching in presenting abstract and dynamic knowledge—rather than replacing the leading role of teachers or the subjective status of students.

Review of Related Studies and Identification of Research Gaps

A review of existing domestic and international literature reveals that the educational value of

multimedia technology in science and engineering education has been widely acknowledged. However, the focus and depth of relevant studies have continued to evolve alongside technological advancements and developments in learning sciences. In the past five years, research has shifted significantly from merely validating the effectiveness of multimedia tools to exploring underlying cognitive mechanisms and constructing integrated learning ecologies (Mayer, 2020).

1. Deepening and Expansion of Recent Research Themes

Recent studies have moved beyond the simplistic comparison between multimedia instruction and traditional teaching methods, delving into more nuanced dimensions.First, in terms of research themes, scholars have begun to systematically investigate the influence of *emotional design* on learning outcomes. Studies have shown that incorporating emotionally positive design elements—such as warm colors and anthropomorphic characters—into multimedia learning materials can elicit learners' positive emotions, thereby enhancing their intrinsic motivation and sustained engagement. However, such effects are moderated by the complexity of learning materials and learners' prior knowledge (Plass & Kaplan, 2016; Schneider et al., 2022).

Second, *individual differences* have become another prominent research focus. Empirical findings consistently indicate that learners' characteristics—such as prior knowledge, working memory capacity, and cognitive style—significantly influence their receptivity to various forms of multimedia presentation and their corresponding learning outcomes (Kalyuga, 2021; Mayer, 2021). This challenges the "one-size-fits-all" design paradigm and underscores the necessity for *personalized adaptive instruction* (Sweller et al., 2019).

Furthermore, with the maturity of immersive technologies such as *Virtual Reality (VR)* and *Augmented Reality (AR)*, research has evolved from mere feasibility studies to exploring their unique advantages in creating high-fidelity learning contexts and fostering *embodied cognition*, as well as the potential cognitive load challenges they may introduce (Pellas et al., 2021; Radianti et al., 2020). For instance, the development and application of *virtual laboratories* have been shown to effectively address the scarcity of physical laboratory resources, providing safe, accessible, and efficient learning experiences in science education (Potkonjak et al., 2016).

2. Refinement and Diversification of Research Methods

In terms of methodology, recent empirical research exhibits an increasing level of *refinement and methodological pluralism*.On one hand, physiological measurement techniques—such as *eye-tracking*, *electroencephalography (EEG)*, and *galvanic skin response (GSR)*—are increasingly employed to objectively assess cognitive load and cognitive processes. These methods complement subjective measures, such as the NASA-TLX scale and self-reported cognitive load questionnaires (Antonietti et al., 2022; Brünken et al., 2020), thereby providing richer and more direct evidence for understanding the cognitive mechanisms underlying multimedia learning.

On the other hand, research designs have become more rigorous, with *mixed-method approaches* that combine true experiments, quasi-experiments, and qualitative investigations gaining prominence. Such designs enhance both internal validity and ecological validity, allowing for more meaningful interpretations within authentic educational contexts (Creswell & Plano Clark, 2017). For example, some studies have integrated eye-tracking data with retrospective interviews to uncover learners' cognitive strategies and difficulties when processing complex scientific animations (Liu et al., 2022).

3. Progress and Limitations of Domestic Research

In China, scholars have actively drawn upon leading international theories—such as *Cognitive Load Theory* and the *Cognitive Theory of Multimedia Learning*—while emphasizing localized practices and applied research (Jia et al., 2024; Wang et al., 2023). Many domestic studies focus on specific disciplinary challenges (e.g., physics, chemistry), developing multimedia resources tailored to these difficulties and evaluating their pedagogical effectiveness.

Nevertheless, several limitations remain in domestic research when viewed within the context of global academic discourse.First, *theoretical grounding* is sometimes insufficient, as some studies fail to situate their investigations firmly within well-established theoretical frameworks, thereby limiting the explanatory depth of observed phenomena.Second, research *timeframes* are often short, focusing primarily on immediate learning outcomes without tracking long-term retention or knowledge transfer.Third, the *exploration of cutting-edge technologies* remains limited—empirical studies on AI-driven adaptive learning systems and the application of *generative AI* in education are still in their nascent stages (Zhang et al., 2024).

4. Research Gaps Addressed by the Present Study

Based on a systematic review of recent literature, the present study aims to address the following research gaps that remain insufficiently explored:

a. From "Media Combination" to "Cognitive Sequencing":While many studies emphasize the importance of integrating multiple media types, few have systematically examined how to design the *optimal sequence and functional distribution* of media presentations according to different *knowledge types* (declarative, procedural, conceptual) and *cognitive goals*. This indicates a lack of empirically validated principles for constructing *cognitively optimal instructional sequences* (Mayer, 2020; Renkl & Scheiter, 2017). The proposed *"Complementary Integration Framework"* in this study seeks to fill this theoretical gap.

b. Fine-Grained Measurement of Cognitive Load:Although the significance of cognitive load is well recognized, many studies remain limited to assessing *overall cognitive load*. Insufficient attention has been paid to how multimedia instruction differentially affects the *intrinsic*, *extraneous*, and *germane* components of cognitive load and their dynamic interrelations (Leppink et al., 2020). This study employs a *multi-method measurement strategy* that integrates subjective ratings with performance-based indicators to reveal these mechanisms more precisely.

c. Long-Term Learning Outcomes and Affective Engagement:Existing studies predominantly focus on immediate learning achievements, paying limited attention to the long-term retention, knowledge transfer, and the development of *deep learning motivation* and *disciplinary emotions* (Bates et al., 2021; Plass & Kaplan, 2016). The present research addresses this gap by incorporating *delayed post-tests* and *in-depth interviews* to explore the sustained cognitive and affective impacts of multimedia learning.

d. Validation in Authentic and Complex Course Contexts:Many tightly controlled laboratory studies yield results that may lack applicability in authentic, dynamic classroom environments (Hattie & Zierer, 2019). This study conducts *empirical interventions within a full-scale engineering course*, aiming to provide evidence with high *external validity* for real-world educational settings.

In summary, this study does not seek to merely replicate previous validations of multimedia "effectiveness." Instead, grounded in prior research, it adopts a rigorous *mixed-method design* to explore *why* and *how* multimedia technologies function effectively in higher engineering education. By doing so, it aspires to construct a theoretically informed and practically meaningful framework that can guide the *deep integration of information technology and pedagogical practice* in contemporary education.

Theoretical Foundations

1. Mayer's Cognitive Theory of Multimedia Learning (CTML)

This is the core theory guiding multimedia instructional design. Mayer (2024) points out that effective multimedia learning occurs when learners can coordinate two types of representations: verbal (text or audio) and visual (images or animations). The theory is based on three core assumptions:

Dual channels: Humans possess separate processing channels for visual and auditory information;
Limited capacity: Each channel can only process a limited amount of information at one time;
Active processing: Learners actively construct knowledge models.

Based on these assumptions, Mayer proposed a series of multimedia instructional design principles, which directly guided the design of multimedia materials in this study:

a. **Coherence principle:** Remove interesting but irrelevant text, sounds, or images that do not align with core objectives to avoid distracting learners. In this study, all animations and simulations were strictly designed around the core principles of "three-phase asynchronous motors" to eliminate interference from irrelevant elements.

b. **Spatial and temporal contiguity principles:** Corresponding text explanations should be placed adjacent to their related graphics (spatial contiguity); narrations should be played simultaneously with corresponding animations (rather than sequentially) (temporal contiguity). Both principles aim to reduce the cognitive load on learners when integrating information. The courseware design in this study strictly adhered to these principles.

c. **Redundancy principle:** On-screen text should not fully duplicate the content of the teacher's narration, to prevent information redundancy and cognitive overload within the visual channel.

2. Cognitive Load Theory (CLT)

This theory provides a key framework for evaluating the effectiveness of multimedia-assisted teaching. Sweller (as cited in Kirschner, 2002) categorized cognitive load into three types: intrinsic,

extraneous, and germane. The advantage of multimedia-assisted teaching lies in its ability to effectively reduce intrinsic cognitive load (caused by the high interactivity of complex knowledge) by visualizing and dynamizing complex knowledge. However, improperly designed multimedia (e.g., cluttered interfaces or information overload) can generate significant extraneous cognitive load. An ideal design should, under the premise of controlling total cognitive load, maximize germane cognitive load— which contributes to schema construction and knowledge automation. In this study, a cognitive load scale included in the post-test was used to accurately assess the actual impact of the designed multimedia materials on the three types of cognitive load.

3. Dual Coding Theory (DCT) and Constructivism Learning Theory (CLT)

Dual Coding Theory (Clark & Paivio, 1991) explains why multimedia-assisted teaching can enhance memory and understanding: when the structure of an electrical machine (imagery) is presented simultaneously with its professional terminology and principle descriptions (verbal information), students are more likely to form stable memory connections.

From a macro perspective, Constructivism Learning Theory (Rosana & Handayaningrum, 2024) clarifies the role of multimedia-assisted teaching: it should not be a tool for one-way knowledge transmission, but rather a "cognitive tool" that enables students to actively explore and construct meaning. For example, the virtual simulation software used in this study allowed students to independently adjust parameters and observe changes in motor characteristics—creating a constructive environment where students could actively conduct "experiments" and make "discoveries."

METHOD

Research Design

A sequential explanatory mixed-methods design was employed in this study. In the first phase, quantitative research was conducted: data were collected via questionnaires and tests to understand the current status of multimedia application and its macro-level relationship with academic performance. In the second phase, qualitative research was carried out: in-depth interviews and classroom observations were used to further explain and supplement the quantitative results, and explore the underlying causes of the observed phenomena.

Research Participants and Data Sources

Participants

Two natural classes were randomly selected from second-year undergraduate students majoring in Electrical Engineering who took the Electrical Machinery course at a university, serving as the control class (n=45) and the experimental class (n=47), respectively. The two instructors had comparable teaching experience and competence. Additionally, 5 teachers from the course team were invited to participate in interviews.

Data Sources

The data for this study were collected from multiple sources to ensure comprehensive analysis and triangulation. These sources included students' pre-test and post-test transcripts to measure academic performance, questionnaires assessing students' learning interest and cognitive load, transcripts of audio-recorded interviews with both students and teachers, and systematic classroom observation records documenting teaching and learning processes.

Research Tools and Materials

Teaching Materials

For the core chapter on *three-phase asynchronous motors*, a set of multimedia teaching materials was developed and implemented in the experimental class, including a 3D interactive model of motor structure, animations illustrating the formation of rotating magnetic fields, simulation software for generating mechanical characteristic curves, and a database of virtual fault diagnosis cases. In contrast, the control class received instruction using conventional PPT-based courseware.

Measurement Tools

The research instruments included self-developed academic performance pre-test and post-test papers, whose content validity was verified by experts from the course team. Students' learning interest was measured using a five-point Likert-scale questionnaire, while cognitive load was assessed through a simplified version of the NASA-TLX scale to evaluate students' mental load under different teaching methods. In addition, semi-structured interview outlines were separately designed for students and teachers to obtain in-depth insights into their perceptions, experiences, and suggestions regarding

multimedia-assisted teaching.

Research Procedures

a. Preliminary Preparation (Weeks 1–2): The multimedia teaching material package was developed; a pilot experiment was conducted; and the measurement tools were revised.
b. Pre-test (Week 3): A basic knowledge test and a pre-test of learning interest were administered to students in both classes to ensure the homogeneity of the two groups.
c. Teaching Intervention (Weeks 4–9): The control class was taught using the traditional teaching model. For the experimental class, the developed multimedia materials were systematically integrated into the teaching process based on traditional lectures. Researchers conducted and recorded classroom observations.
d. Post-test and Data Collection (Week 10): A post-test of academic performance was conducted, and questionnaires on learning interest and cognitive load were distributed. Eight students with different academic performance levels were purposefully selected from the experimental class for semi-structured interviews; interviews with the 5 teachers were also conducted.
e. Data Analysis (Weeks 11–12): Quantitative data were statistically analyzed using SPSS (including independent samples t-test, analysis of covariance, etc.); qualitative interview data were coded and subjected to thematic analysis.

Data Analysis Methods

For quantitative data analysis, descriptive statistics and inferential statistics (t-test, ANOVA) were mainly used to compare differences between the two groups of students. For qualitative data, thematic analysis was adopted: core themes were extracted through open coding, axial coding, and selective coding. These themes were used to explain and supplement the quantitative results, collectively supporting the research conclusions.

FINDINGS AND DISCUSSION

Promoting Effect of Multimedia Application on the Deepening of Knowledge Construction

As shown in Table 1, the results of analysis of covariance (ANCOVA) indicated that after controlling for the influence of pre-test scores, the post-test academic performance of students in the experimental class (M=82.5, SD=6.8) was significantly higher than that in the control class (M=75.3, SD=8.1), with $F(1, 89) = 25.73$ and $p < .001$. The effect size ($\eta^2 = 0.224$) suggested that multimedia teaching intervention could explain 22.4% of the variance in academic performance, and this difference held important practical significance.

This finding aligns with the current development trend of educational informatization, which emphasizes using information technology to transform people's cognitive methods—shifting learning from being education-led to learner-led, and from passive reception to active exploration.

Table 1. Descriptive Statistics and ANCOVA Results of Pre-test and Post-test Scores Between Experimental Class and Control Class (N=92)

Group	Sample Size (n)	Pre-test Score (M±SD)	Post-test Score (M±SD)	Adjusted Post-test Mean (Madj)	Standard Error (SE)	F Value	Degrees of Freedom	p Value	Effect Size (η^2)
Experimental	47	72.15 ± 8.23	82.51 ± 6.78	82.45	0.92	25.73	(1, 89)	< .001	0.224
Control	45	71.89 ± 7.95	75.32 ± 8.12	75.38	0.94				

Dynamic visualization technology transforms abstract electromagnetic concepts into intuitive images, helping students establish accurate physical representations. For example, when describing the animation of rotating magnetic fields, one student commented: "The three-dimensional process of magnetic field synthesis, which originally required strong spatial imagination, becomes clear at a glance through animation demonstrations." This dual coding of visual representations and verbal symbols aligns with constructivist learning theory, which posits that learners acquire knowledge and skills through meaning construction in specific contexts.

The interactive exploration function allows students to independently adjust parameters and observe

continuous changes in motor characteristics. This experiential learning fosters in-depth cognition, making otherwise tedious knowledge vivid and understandable.

Notably, the appropriate application of multimedia technology can create diversified learning contexts, turning teaching activities into a process filled with intellectual enjoyment. This "education through entertainment" approach not only improves learning efficiency but also cultivates students' intrinsic interest in the discipline of electrical machinery. Meanwhile, this study also found that to achieve such effects, it is essential to ensure the close alignment between multimedia content and teaching objectives, avoiding the trap of formalistic application.

The Duality of Learning Motivation Stimulation and Cognitive Load

Data from the learning motivation scale, as presented in Table 2, showed that the increase in intrinsic motivation among students in the experimental class was significantly greater than that in the control class ($p < 0.01$). Students generally reported that interactive simulations and virtual cases "brought the joy of exploration"—this positive emotional experience is consistent with the "education through entertainment" concept supported by information technology. By providing a ubiquitous learning environment, modern information technology offers learners experiences that engage their intellect, senses, and emotions, thereby stimulating their intrinsic learning motivation.

Table 2. Comparison of Post-test Results of Learning Motivation (Intrinsic Motivation Dimension) Between Experimental Class and Control Class (N=92)

Group	Sample Size (n)	Posttest Intrinsic Motivation Scores (M)	Standard Deviation (SD)	Statistical Test Value (t)	p Value
Experimental	47	4.25	0.58	3.42	< 0.01
Control	45	3.71	0.62		

However, the measurement results of cognitive load showed complexity, as presented in Table 3. Although the average extraneous cognitive load of the experimental class was not significantly higher than that of the control class, the large within-group standard deviation indicated obvious individual differences. In-depth interviews revealed that when the presentation speed of animation information was too fast or the interface elements were overly complex, some students reported feeling "overloaded with information and unable to grasp the key points." This finding confirms the Cognitive Load Theory in multimedia teaching—improper instructional design will increase extraneous cognitive load, thereby affecting learning effects.

Table 3: Comparison of Post-test Results of Extraneous Cognitive Load Between Experimental Class and Control Class (N=92)

Group	Sample Size (n)	Post-test External Cognitive Load Score (M)	Standard Deviation (SD)	Statistical Test Value (t)	p Value
Experimental	47	5.10	2.45	0.35	0.73
Control	45	4.95	1.80		

Further analysis showed that the duality of cognitive load is reflected in two aspects: well-designed multimedia materials can increase germane cognitive load by integrating information and highlighting key points, thereby promoting schema construction; while poorly designed multimedia presentations will introduce a large amount of harmful extraneous cognitive load, interfering with learning. This duality suggests that teachers need to reasonably design multimedia teaching content based on students' cognitive characteristics, ensuring that it can not only stimulate learning interest but also avoid cognitive overload.

Key to Teaching Effectiveness: Sequential Integration of Multimedia and Traditional Methods

Results from classroom observations and teacher interviews indicated that the key to the success

of multimedia teaching lies in achieving sequential integration with traditional methods. A senior teacher emphasized: "The logical deduction process of blackboard writing is an irreplaceable thinking training, while the advantage of multimedia lies in the intuitive presentation of conclusions." This view is consistent with existing teaching practice research, suggesting that modern media and traditional media should complement each other rather than replace one another.

This study proposes a "complementary integration" framework, which emphasizes designing teaching sequences based on the characteristics of different knowledge types, as shown in Figure 1. For declarative knowledge, the sequence of "multimedia intuitive presentation → lecture on precise definitions" is adopted; for procedural knowledge, the path of "blackboard deduction → multimedia verification" is more appropriate; and for conceptual knowledge, the sequence of "problem context → thinking guidance → multimedia deepening" is applicable. This distinction is consistent with the concept of personalized learning supported by information technology, enabling teaching to adapt to the characteristics and needs of different learners.

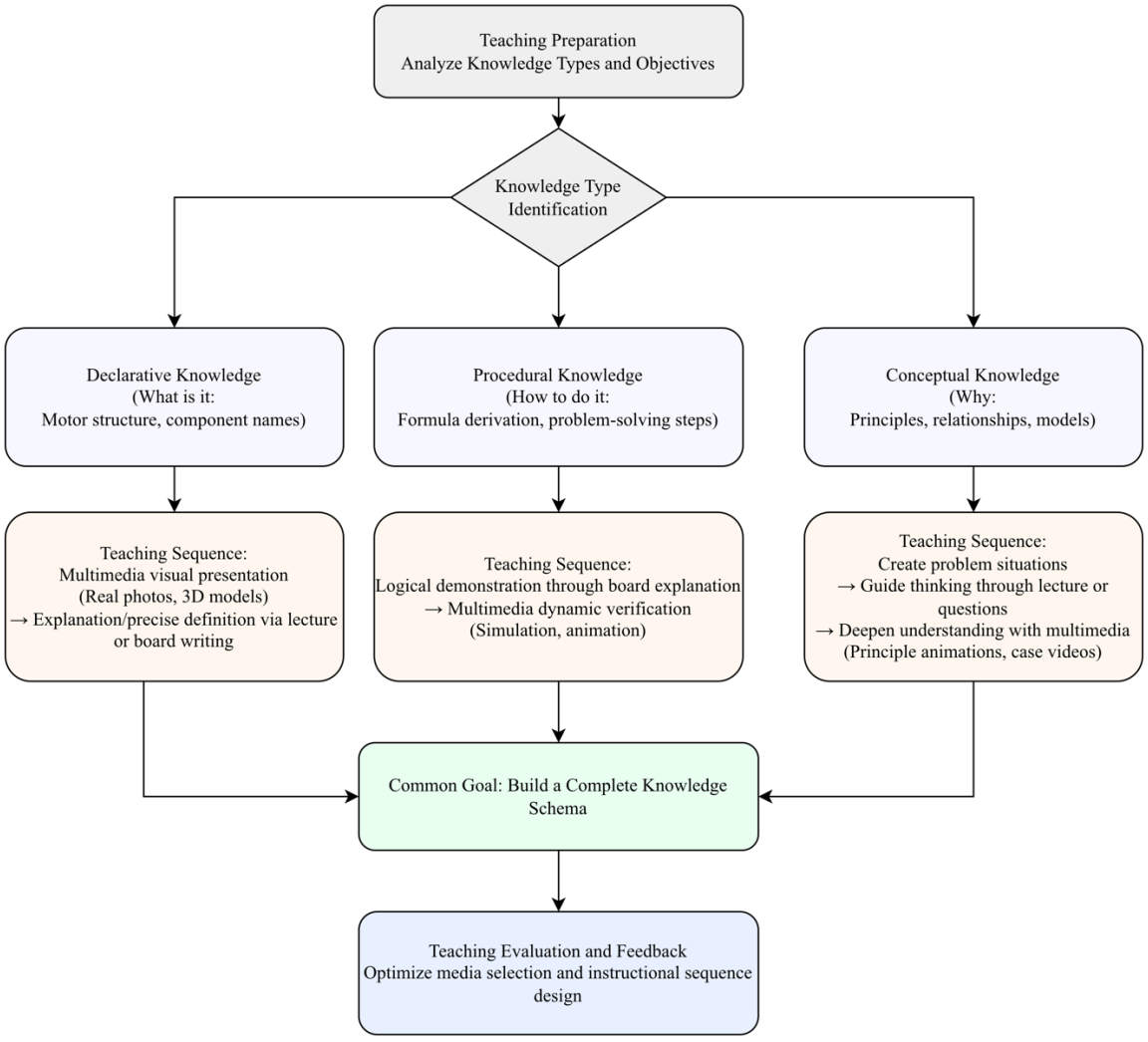


Figure 1. Teaching Framework Diagram for "Complementary Integration" in Electrical Machinery

It is worth noting that effective integration requires teachers to accurately grasp the characteristics of various teaching media. For example, in the teaching of motor structure, 3D models can intuitively display spatial relationships, but during principle deduction, step-by-step blackboard writing is more effective in guiding the development of thinking. This sequential integration embodies the "learner-centered" educational concept—by creating diversified learning contexts, it promotes students' active construction of knowledge. At the same time, teachers should avoid over-reliance on multimedia technology and ensure that their leading role in the teaching process is fully exerted.

CONCLUSION

Summarize the main points of your study. Consider writing down the key takeaways, the contribution of your chapter to theory, policy, or practice, the limitations of the study. You can also offer suggestions for future research or application.

Through empirical analysis using a mixed-methods approach, this study confirms that in the teaching of Electrical Machinery—a course characterized by high abstraction and systematic complexity—systematic multimedia applications designed based on cognitive theories can significantly enhance students' understanding of abstract electromagnetic concepts and deepen their knowledge construction. Quantitative data shows that the post-test scores of the experimental class were significantly higher than those of the reference class ($p<0.001$), and the effect size ($\eta^2=0.224$) indicates that the intervention has important practical significance.

Qualitative analysis further reveals that this facilitating effect is mainly achieved through dynamic visualization (e.g., animations of rotating magnetic field formation) and interactive exploration (e.g., parameter adjustment in simulation software). These methods effectively lower students' cognitive thresholds, confirming the supporting role of visual representations for verbal/symbolic representations as proposed in the Dual Coding Theory.

However, the study also found that the effectiveness of multimedia teaching is highly dependent on scientific instructional design. Cognitive load measurement results show that if multimedia information is presented too quickly or the interface is overly complex, it will cause extraneous cognitive load, which negatively impacts learning outcomes. Therefore, the core of successful teaching lies not in the technology itself, but in the in-depth integration and sequential arrangement of multimedia and traditional teaching methods (such as blackboard deduction and physical demonstrations). The "complementary integration" framework, derived from classroom observations and teacher interviews, emphasizes that the timing and function of different media should be carefully determined based on knowledge types (declarative, procedural, conceptual), rather than simply replacing one with another.
Based on the research findings, several teaching recommendations are proposed. In the development of multimedia resources, priority should be given to integrating scientific accuracy with educational value, ensuring that technological tools effectively serve instructional objectives rather than merely enhancing presentation. During classroom implementation, teachers are encouraged to flexibly select appropriate media combinations and presentation sequences according to different types of knowledge and students' learning characteristics. Furthermore, in terms of teacher professional development, greater emphasis should be placed on strengthening training in information-based teaching competencies so as to improve the overall quality of multimedia instructional design.

These recommendations provide important reference value for advancing the informatization reform of engineering education. In particular, for professional courses such as Electrical Machinery, which require a close integration of theoretical understanding and practical application, the scientific and rational use of multimedia technology can contribute to the cultivation of high-quality engineering talents with strong innovative awareness and practical abilities.

Nevertheless, this study has several limitations. First, the sample was drawn from a single institution; while this facilitated control of variables, the generalizability of the findings needs further verification through multi-center and large-sample comparative studies. Second, the research primarily focused on short-term instructional effects and did not include long-term follow-up data, making it difficult to determine whether multimedia teaching promotes long-term knowledge retention and transfer.

In conclusion, the application of multimedia technology in Electrical Machinery teaching is a systematic and comprehensive endeavor. Only by adhering to principles from the learning sciences, focusing on the enhancement of students' deep cognitive processing, and achieving creative integration between technology and pedagogy can the quality of higher engineering education be effectively improved.

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EMPOWERING TEACHERS FOR THE DIGITAL AGE: PROFESSIONAL DEVELOPMENT AND PEDAGOGICAL INNOVATION IN EDUCATION TRANSFORMATION

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ABSTRACT

The study observes the role of a teacher as empowered in the digital age with the help of professional development and pedagogical innovations. Furthermore, the teacher can empower mechanisms that will change the face of the education system. Utilizing secondary qualitative data taken from peer-review journals, academic articles and reports published between 2020 and 2025, this research examines how continuous professional development CPD improves teachers' digital competencies and confidence to integrate technology in the classroom. Another aspect of the study has analysed how pedagogical innovation helps improve teaching efficacy and student engagement learning outcome while also identifying the barriers to the adoption of digital devices and innovative pedagogical practice among the educators. The research finds that technology has made the educational path more creative and interactive. It helped the students to think and practice beyond the bookish knowledge. Teachers must be trained about the usage of technology. It must be used wisely so that it could not have a negative impact upon the thinning process of students. Educational leaders must be digitally empowered to foster the learning process. Pedogeological creativity has been suggested at the end of this study that helped the future students as well as teachers for enhancing the culture of learning.
Keywords: Teacher Empowerment, Digital Competence, Professional Development, Pedagogical Innovation, Education Transformation

INTRODUCTION

Due to the advancement of technology, the process of education has faced severe changes and the mode of education has gone through a huge transformation. Technology is used rapidly in the process of education in every institution. Today, students have a new way to learn in a class. This new way is not boring like traditional. Technology can perform numerous tasks. However, it requires technological experts who have been trained and educated in that respective field to think outside the box. Therefore, technology will always need a human presence. To improve education, the skills of teachers must be enhanced due to which it becomes necessary for them to continue with teaching. All around the world, everything is going digital. As a result, teachers need to develop competencies along with digital literacy in growing numbers. They also need to implement innovative methods to meet the learning requirements of students.

Competent teachers need to integrate technology not only in lesson planning but also in teaching. It is not the technology but the teacher who affects whether learning technology will enhance learning. Educational reforms and digital programs do not succeed at times because of technical issues, but because of teachers lacking sufficient preparation to change their ways of teaching. Thus, carrier programs should parliament states in inherited training models to introduce modern compos programs and common destinies involved. people need to teach teachers how to cook up a recipe so that others can have a positive impact with computers in education. Teacher development should become a lifelong process where teachers are always in need of new information and technologies because this would always be changing.

Changing how something is taught is as important as the development of tools. Traditional ways of teaching are not used as often anymore. Nowadays people focus on "you do it", learning through experience, not just sitting there. The use of digital tools, like artificial intelligence, computer learning, scoring, and blended learning models lets teachers reinvent the way they teach. Mostly, teachers do not

just teach any more. For instance, the use of digital training platforms causes a teacher to connect really to her students, to teach them in a way that fits. When a teacher learns something, they should teach and stays flexible, they inspire the student to succeed. Those problems happen because of inappropriate ideas or new tools. Also, just plain stupid and unfair rejection by corrupt policies. Job seekers and college students continuously desire educational change. Schools and governments need to invest in technology infrastructure to create a positive change in our education system. If the schools are connected to the tech companies, colleges, or research centres, teachers will be able to learn and evolve.

Overall, changes in the educational system in the digital era are reliant on the teacher as a learning facilitator, designer of digital experiences and agent of change. Teachers see them as technology gap enablers who will ultimately close ranks through their ability, confidence, and creativity to make the most of technology. As teachers are empowered through this methodology, their teaching quality improves. The education system is changing across the globe so professionals can prepare the students for an unpredictable future and a world that keeps changing.

The objectives of this study are to examine the role of professional development in enhancing teachers' digital competencies and effective use of technology, to evaluate the impact of pedagogical innovation on improving teachers' effectiveness in technology-enhanced classrooms, and to identify the challenges and barriers faced by both teachers and students in the use of digital tools in education. In addition, the study aims to propose effective strategies for promoting sustainable education and empowering teachers in the digital era.

THEORETICAL FRAMEWORK

As per **The Technological Pedagogical Content Knowledge (TPACK) framework** by Mishra and Koehler (2006), Teachers today do not just give students knowledge, but also show students how to learn the knowledge. They make learning easier and fun by using technology. This helps students understand their learning better. Teaching assistance initiatives are making all teachers more difficult. Teachers today benefit from CPD systems to get technology into the classroom as successfully as possible.

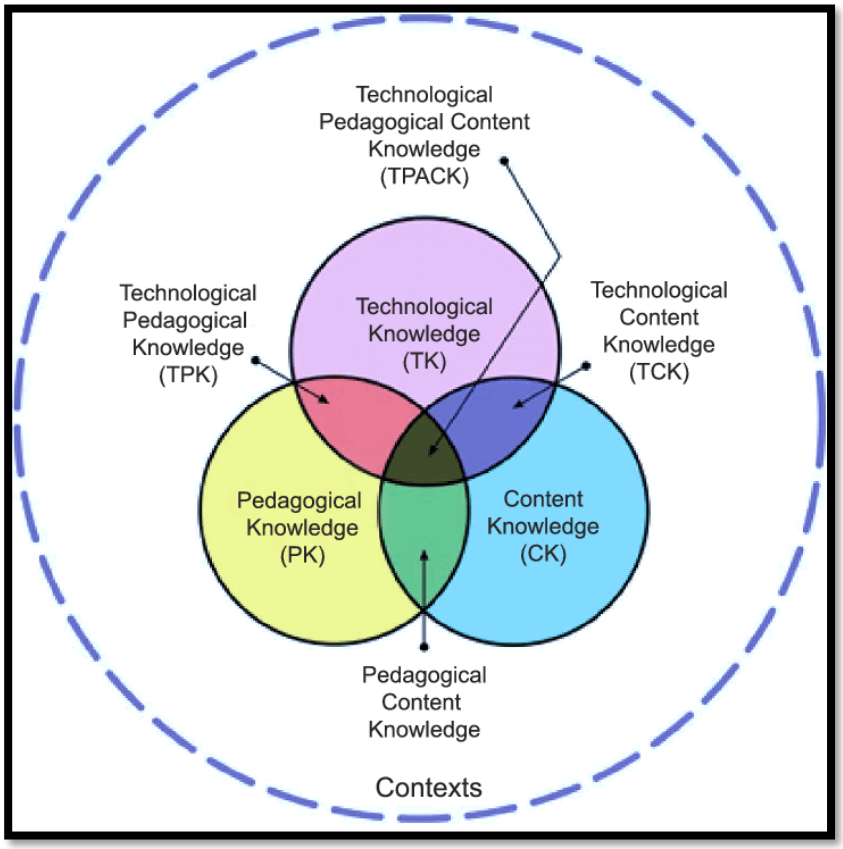


Figure 1. The Technological Pedagogical Content Knowledge (TPACK) framework
(Source: Aithal & Aithal, 2023)

As per Mushadi, Usman & Bahrun (2025), teachers need to have the mindset to use technology without being intimidated by it. CPD systems have to help generate that mindset. It is not a tech upgrade training but a learning cycle for life. Professional development is critical for the use of technology in learning contexts. Moreover, it enables teachers to develop the awareness, confidence and technical skills to use technology in transformational ways, rather than simply using it as an add-on.

A key impact of CPD on teachers is helping them become more confident in using technology for teaching purposes. Being familiar with a device or software does not really matter. According to Aithal & Aithal (2023), confidence is about having self-efficacy, that is the ability to control the performance using devices and software. Technology causes anxiety, fear or reluctance among many teachers, especially those from 'non-digital' generations and those from schools with less technological equipment. Well-designed professional development programs can help in overcoming psychological barriers.

As professionals apply their knowledge, skills and understanding, they are internally transformed and they see the world differently (Ovcharuk et al., 2020). The CPD team helps teachers convert innovative technologies and digital techniques into actions with hands-on practices, peer mentoring, and reflection. When teachers observe how digital tools enhance the learning experience of students, it inspires them to be confident to try new things and do things differently.

Schools need to train teachers, if they wish to use digital technology. The goal is to teach students online. Teachers should understand how to utilize digital tools to improve instruction, promote active learning and facilitate various types of learning. For example, with the help of multimedia, gamification, LMS, and data analytics, teachers can easily transform the traditional teaching process into an interactive process. For teachers to effectively integrate technology into their teaching, Continuous Professional Development (CPD) programs that use models like Technological Pedagogical Content Knowledge (TPACK) and the SAMR framework (Substitution, Augmentation, Modification and Redefinition) provide them with a useful framework (Fischer, Lundin & Lindberg, 2023). By using these frameworks, educators can evaluate whether their digital practices meet curriculum expectations, value the digital tools for specific contexts today and design a learning experience that promotes creativity, critical thinking and collaboration. Through continuing professional learning in the context of the frameworks, teachers learn how to scaffold technology and teach towards it. Learning quality is improved in the process of teaching.

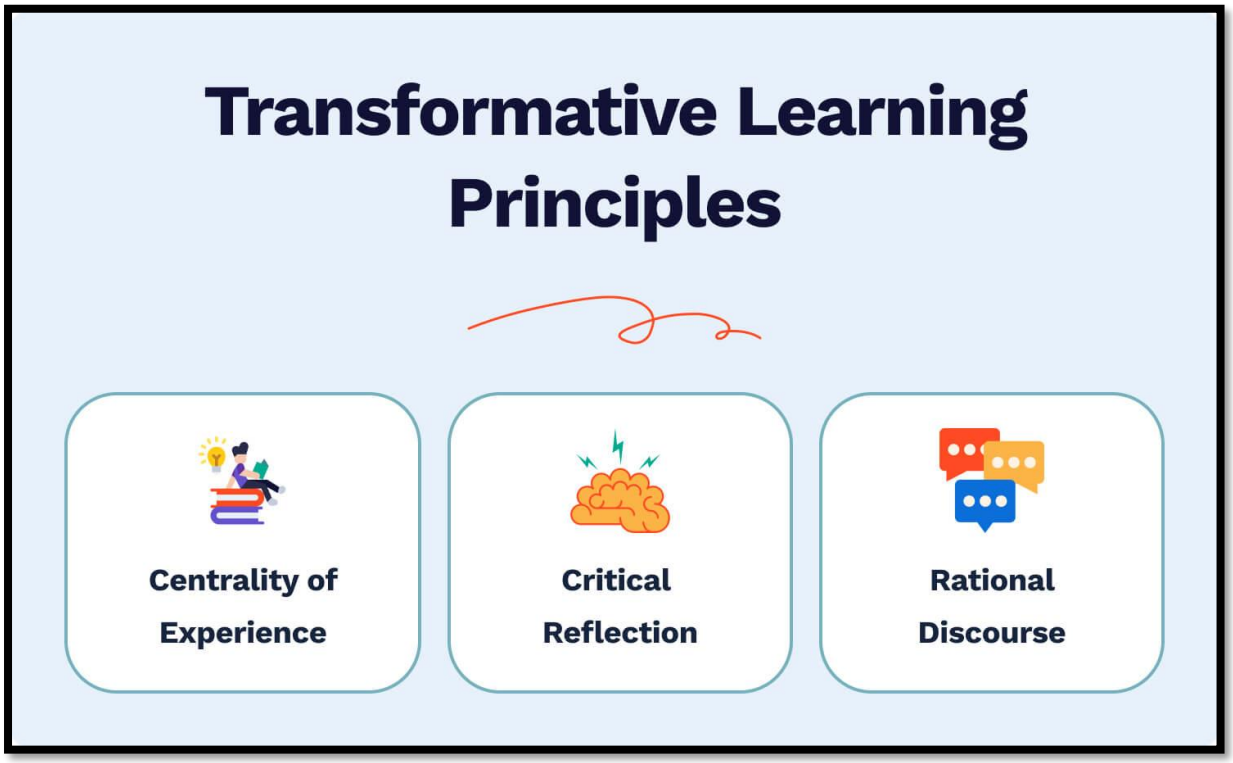


Figure 2. Transformative Learning principles
(Source: Gisbert Cervera & Caena, 2022)

Another important aspect of CPD is peer learning and collaboration. As per ***Transformative Learning Theory,*** Professional development programs that build communities of practice, mentoring relationships, and collective inquiry can help teachers discuss their experiences, struggle, and successes in the digital classroom. Helping professionals to learn more with the feeling of connectedness. It lessens the feeling of isolation that often occurs when using technology. Join Forces with Educators Around the Globe Through Digital Networking Professional learning networks, webinars, and online education communities can help to make connections far beyond the walls of educational institutions. It is becoming easier and easier to share ideas and innovations through these professional development opportunities. As per Gisbert Cervera & Caena (2022), when teachers or professionals share and collaborate with one another they learn and develop digital literacy. The digital skills of these professionals improve and they become more confident and practice new applications because they belong to a wider professional ecosystem for improvement.

Also, continuous training must have relevance to the teacher's and learning contexts' needs. What works for one class or school may not work for another, as different schools will have different levels of infrastructure. CPD programs are more meaningful when designed to keep in mind contextual realities such as device access, connectivity and institutional support. Teachers in rural or low-resource contexts are more likely to benefit from mobile learning methods and offline digital resources than AI (Sliwka et al., 2024). In other words, professional development must adapt to the teachers' experiences and the environments in which they work. Teachers will grow motivated and confident when they see a link between what they learn and what they do in the classroom.

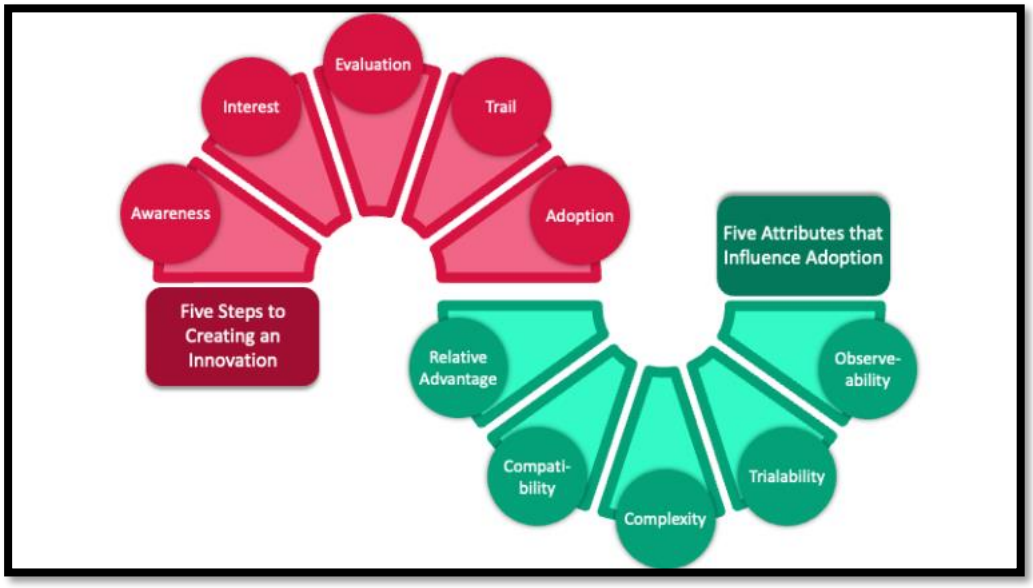


Figure 3: Diffusion of Innovation Theory
(Source: Kalyani, 2024)

Rogers' Diffusion of Innovation Theory (2003) explored institutional culture in an innovative way that can support digital innovation within the path of learning. The more a teacher understands how a new technique could benefit their classes, the more they become motivated. The head of the institution and the culture of the institution play a key role in enhancing a competence with digital. It is necessary to put more creativity and out-of-the-box thinking in our work. Strong leaders help educators take part in ongoing development activities to get access to time and resources (Kalyani, 2024). Due to feeling surplus and without meaning as their schools do not support them, those great teachers will leave their profession. For educators to achieve higher levels of success, educational leaders have to follow that collegiate professional development is added to already established and high impact strategies like a school improvement schedule that sets the standard in order for educational leaders to keep up with the high demands of being in a well demanded and high employee position.

As per Tan et al., (2021), the advancement of technology and information in today's time is certainly becoming more and more overpowering. This new force in education utilizes preconditioned traditional methods and transforms them to adapt to the ever-changing environment. It is necessary to deal with the many different, smaller parts of education to enhance it today. The use of computers at

school or the notebook of the student are new teaching methods that take the older methods back a notch. When taught in a new way and more, nobody forgets the rest quickly. The transition to online schools is more than just new technology. It's trying to be relevant to what people are using today. It's used to help in education.

Promoting teachers to be more effective, is a very start role effect at school. Traditional teachers measure their success by the amount of content they give out and how well the students have memorized the information in the classroom. Teaching is just a routine in our life, not many people understand effectively. Teachers are trying new ways to teach students, getting rid of what they once used to learn in classrooms (Ismail, Omar & Raman, 2021). These are approaches that encourage students to go down their own path and passively receive the correct answer. In an interactive model, students watch videos or activities at home, then go to class and help each other with a lesson that they completed beforehand together. This change in technology allows teachers to promote more practice to students while teaching the subject correctly, the way it is supposed to be taught in all major countries. Due to this, teachers become easier to learn from because they assist their students better.

Additionally modern teaching binds educational methods to technology for the benefit of both teacher and student. Nowadays, tools like interactive whiteboards, LMS, virtual worlds, and AI tend to make teachers' jobs a little easier when it comes to lesson plans. For example, teachers are able to use AI-powered analytics to detect students' progress in real time due to learning gaps, but to correct ones before it is too late that way it will help students better or faster by using the resources available (Al-Zyoud, 2020). Gamifying learning using elements that are part of games like a VW point system for riding public transportation increases motivation and retention by starting to take learning not as an academic subject but as a personal interest. Technology is helping teachers teach better by letting them pass on information more easily, help with classroom procedures, and look at data which is helping them improve (Kadaruddin, 2023).

Education is a vital key to students and their ability to grow and move on in life giving success and long term motivation. Traditional education is struggling to keep students involved, and it's still trying to use the same methods the old way. Teachers have to find a way to teach each student, and there's no one perfect way of doing things. Innovative teaching methods give students dynamic and participatory learning that captures their attention and keeps them curious (Rodés et al., 2021). Methods such as working together, working on solutions to problems (PBL), and hands-on learning are great ways for students to take more initiative. Through real-world issues, students are able to participate in something new, learn together, and actually use what they know. It lets students work on a project that does something good for the environment and challenges them to think more deeply.

This is true, because "The Technology of Technology" will bring the school to the present day. Through various types of digital technology students are now able to have hands on learning tables, a place to express their opinions and also a place to experiment freely. These online sites help us to communicate with others and have some other people's so called "perspectives" look at our works on the internet. Learning technologies can determine how quickly the learner solves a problem and respond appropriately, giving them interesting problems so they stay challenged. Students really enjoy learning when the stuff they learn is important to them, they get to participate, and it is relevant to their life. They get better grades, are motivated, and actually show up to class (Engeness, 2021).

The influence of pedagogical innovation on learning outcomes is the third dimension. A learning outcome tells how deeply the student has learned and understood and how much skill he has acquired and achieved. Through the innovative pedagogies provided by the best colleges in Mumbai, learners analyze, synthesize, evaluate and create ideas and knowledge. When educators stop focusing student’s attention on memorization and rote learning, the learning outcomes of students can become more inquiry based (Rawas, 2024). Another outcome is that students develop the ability to adapt and problem solve. As a result, the student can transfer their learning to different contexts. Research shows that students who get involved in active and experiential learning outdo their peers in tests that require them to know, do and transfer. Similarly, these days students also get a chance to evaluate their learning practices because of the continuous feedback mechanism which helps them to monitor, reflect, and act on the learning process. As per Mah & Groß (2024), when students learn and collaborate together, they can better understand one another’s presence, leading to an inclusive classroom. For a pedagogical innovation to be successful, people still need several facilitating factors such as teacher readiness, institutional support, and a culture of experimentation. All teachers are expected to have the flexibility

and digital literacy to implement innovative practices. If teachers do not undergo sufficient professional development to use technology in a confident manner, then every innovative approach and project can be put to waste. The school must have the infrastructure, resources, and policies to promote pedagogical innovation and risk-taking.

METHOD

As the method of data collection, the secondary method is used by the research from qualitative sources. The paper mainly made use of peer-reviewed journal articles, books, reports and policy documents published during the time period 2020-2025. It was appropriate to employ secondary qualitative data since it provided depth of information on current trends, challenges, and strategies in teacher digital empowerment. Furthermore, secondary qualitative data does not involve the time, cost, and accessibility constraints of primary data. The study has synthesized diverse perspectives of existing literature and provided trends to draw conclusions on the basis of existing literature and evidence on professional development and pedagogical innovation, educational transformation, etc.

Researcher collected the data through the use of highly developed sources like Google Scholar, Scopus, ResearchGate, ScienceDirect, and JSTOR which are all secondary data sources. Researcher has used specific keywords and phrases to identify potentially relevant studies, including teacher professional development in the digital age, pedagogical innovation, digital competencies in education, education technology, and education transformation. Only English publications from 2020–2025 were selected so that the findings reflect recent events or responses due to technological changes as affected by COVID-19. people eliminated any studies that were not relevant to our research aim and objective. people only focused on empirical studies, literature or literature reviews and theory-analytical studies related to digital pedagogy. Moreover, people also used studies related to teacher training and knowledge innovation.

The researcher got all the required books, and then people carefully took a look at them together through analysis. A numerous group of selected studies were examined closely and grouped by alike generation meaning. The conference had four various options in themes of interest and research about how to engage, understand, and develop teachers nowadays to survive in such a technological bind in the world. The analysis has been emphasized to understand what could be found in the literature. The researcher was able to capture teachers' experiences over different types of educational settings of digital transformation.

The study checked at only Academic relevant webinar sources to avoid false info from the web. In addition, this showed that some phrases possess a high definition One. Researchers reviewed many articles to check the truth and relevance of information each time. Whenever the CBC can determine a group of researchers conducted special studies examining similar topics with the goal of producing insights that are robust and repeatable. With proper cluttering and crediting to the right owner, each person's thoughts are safeguarded and made known. The study used all of the information sourced from the others' original works without utilizing any persons for test subject matter. The researcher assessed data relating to teacher empowerment in the contemporary digital age through data analysis. The provided input is not complete and appears to have missing information. Please provide complete information or context surrounding the given content to help me do a flawless paraphrasing.

FINDINGS AND DISCUSSION

Role of continuous professional development for developing teachers' digital competencies

Secondary qualitative data from various journals, reports, and publications was analysed. Between 2020 and 2025; research showed that empowering teachers has played a role through ideas in the digital age, proving helpful. The study found that consolidation of the current learning methodologies is crucial to enhance the impact of technology and to decrease the current vastly expanding disadvantaged gap occurring in lower family income communities. Teachers need better dissemination. The study stated that "Variário declares that it has grown owing to the divisions felt across the party and sociological factors". The study would further increase issues within. While the entire world is using the same digital tools, teachers are being expected to adapt and these are the ones being equipped by the educational system growing with this rapid transformation (Makinde, Ajani & Abdulrahman, 2024).
It was found that engaging in ongoing professional development was a main factor in teacher's ability to use more technology with their students because it helped them get better at doing things on the

computer and it gave them confidence in using technology in class. Studies almost always showed that when these plans were structured and stayed in place they made teachers better at using technology to teach students. Studies in scientific journals discovered that the minds of supposed "teacher's" of the "modern" world have opened to experience a new world and surpassed successfully the modern education method. The studies also demonstrate that incorporating teamwork into continuing professional programs has created much more confident teachers. The collegial work place let everyone learn from everyone and give out new ideas. Some teachers tried new things while learning the inner workings of a computer or something like that.

These teachers really knew how to use the computer and not just to click on buttons that have a neat picture on it. The result also showed how the creative ways of teaching affect the student teachers, students, and the student's learning. According to various research studies published in reputed journals like Educational Research Review and British Journal of Educational Technology, experimental classes like flipped classroom, blended learning, gamification, project-based learning make classrooms interesting for learners. When students work together to help one another learn (Junaedi et al., 2024). They learn more as time goes on. Using technology in interesting ways to help teachers teach can engage students more and help them learn better. For instance, by utilizing AI, teachers could analyze student progress and adjust their teaching techniques to offer assistance. Furthermore, teachers employ computer simulations to enhance the learning experience by making it more enjoyable. New technologies have enabled students to learn in whatever manner they need to keep up academically. Research shows that students who learn with technology are much more satisfied than those who attend typical classrooms. Students become more engaged and earn higher academic scores by taking online classes.
It was only at that point when they realized that teaching benefited them, the students, and themselves.

As per Cheng & Wang (2023), teachers improved their understanding of student academic progress and became more reflective through experimenting with new teaching methods and digital technology. New types of teaching encourage students to take more responsibility for their work. Consequently, there is greater cooperation between teachers and pupils than in years gone by. Their development was promoted by the teachers which led to increasing confidence, willingness to change and continual learning and teaching of new ideas. The effectiveness of pedagogical innovation is greatly influenced by favourable conditions at institutional, technological, and political levels.

Despite positive updates, the third major theme was that education is still a bit stuck on teaching techniques that were designed ages ago. Between the years of 2020 and 2025, a set of studies identified five major causes that happen almost every time. Studies from Education and Information Technologies and Teaching in Higher Education have concluded that many instructors in third worlds and financially frail communities lack enough technical education. The workload of teachers is accomplished by the admin officials of their school unpaid leaving the teacher sometimes overwhelmed any time for them needs to be taken out of their schedule.

Challenges and barriers teachers face in adopting digital tools and innovative teaching practices within educational institutions

The modern learning environment of the 21st century blends the use of technologies in education. Despite being increasingly recognized, many teachers still face various challenges or barriers to implementing any new technology in their schools. Roadblocks are not just technical or infrastructural in nature. Teachers' innovation is not only constrained by technical standards but also by educational, psychological, institutional and socio-cultural factors. Educational change depends on teachers willing and able to use digital tools and new ways of teaching (Wang et al., 2024)

Teachers lack sufficient training and digital literacy which is one of the topmost challenges. Today's technology is moving fast. Not all teachers have the knowledge or confidence to use it well. Older teachers are generally not able to understand software, online platforms and other tools for managing digital classrooms (Strielkowski et al., 2025). Poor training chances make the situation worse. A typical training would involve learning the key functions of the device rather than learning pedagogy or how to use the Technology for effective teaching-learning. Given that continuous, hands-on professional learning and mentoring may not be available to teachers, they may feel overwhelmed and uncertain about what innovative practices they should be adopting. When guidance is not provided, teachers all over the world – and especially in Hong Kong – make use of technology in a hit-and-miss manner. As teachers do not have the support they need, they just adapt technology to older ways of teaching rather than develop new pedagogies. In other words, teachers "substitute" old ways with new

technology rather than develop deeper pedagogical change (Pramesworo et al., 2023).

In poor schools, some technical innovation is bad, computers are rare to find, the internet should be okay, and whatnot. Lots of schools have everything they need except for technology to work with it. Students who do not have equal access to the internet and technology experience limitations and are at a disadvantage because of their socio-economic status. Therefore, educators might have some concern that technology usage in class could place a few students at a disadvantage, making problems controlling the class even worse too. Eden, Chisom & Adeniyi (2024) mentioned that institutional culture and resistance to change also play a key role in education. Schools tend to be structured tightly with layers of hierarchy and traditional curriculums instead of letting children use their imagination and create their own things. Instructors who attempt to introduce a new teaching method or digital program may find themselves with no help. Exposing teachers to new methods discourages when they cannot receive a reward for it. The people running the schools sometimes do not even know how using computers can help our learning. Collaborative and experimental teaching methods may be easily halted without supportive leadership.

Being overburdened and time constrained the whole day is another challenge for teachers. Future teachers need to adjust their timing due to the use of digital tools like new teaching methods. Teachers seldom get the chance to explore strategies like training on new technology as they may already be concerned about keeping up with workloads. Examining how technology and its integration impact the classroom and other lessons can be an intensive process. Teachers may view innovation as more stressful than something that would help them (Saborío-Taylor & Rojas-Ramírez, 2024). Teachers may make use of well-established methods to teach conceptual material due to the pressure of test scores and curriculum mandates. The focus on effective achievement of substantial and preplanned material can offer one solution to the curriculum problem.

Another challenge teachers encounter is that regarding personal technology and innovation. Many educators worry about losing their professional image because they think that technology could pose a threat to them. There is an ongoing debate as to if a computer or a pencil is a better learning tool. Resistance to technology in the classroom often has its roots in a student's past negative encounters with a poorly designed technology system or in a student's lack of understanding of how the technology used in class is supported by their curriculum. Teachers believe they can build a good future using technology in their everyday jobs. Teachers with low self-confidence have less of a chance of experimenting with new technology because they are afraid of computer problems, for instance.

Another issue that was added was that of morality. Teachers must help with different digital problems. Teachers are concerned about their students spending too much time on the computer and stopping the bullying there. In communities that are culturally strong, people may also refuse to use some technologies and/or Internet platforms because they fear losing their culture or seeing vile things on the Internet. UOP student. The teachers must develop teaching strategies that greatly respect local cultures while also developing the proper global citizen.

Impact of pedagogical innovation for increasing teaching effectiveness

Institutional and cultural challenges also emerged as significant barriers. Most of the schools were hierarchical in nature thus they resisted change. In addition, they had an immutable curriculum and assessments. As a result, they focused too much on standardized tests and did not use creative teaching ideas. As a result, educators with innovative ideas often faced pushback or lack of backing from the school leaders. According to the literature, psychological barriers such as low self-efficacy and fear of failure prevent technology adoption. Some teachers worried technical issues would stop them from being able to teach like experts. The results were consistent in different educational contexts suggesting that the need for stakeholder involvement in digital transformation does not only require financial investment but also a shift in mindset.

The inequity of access and services for professional development was also notable. Research revealed differences between students in rural and urban schools, public and private schools, and developed and developing countries (Rahmat, Syakhrani & Satria, 2021). Teachers in resource-limited environments often lacked the exposure to training and digital resources of their counterparts in well-resourced environments. The unequal access of school teachers to digital technologies caused a digital divide. This affected students' learning opportunities.

The findings highlighted the need for focused policies and equal training opportunities to narrow down the technology gap so every teacher can participate in the digital transformation. In this study, it

is shown that teachers must have an up-to-date education. Instructional methods were changed by teachers introducing new technology in class (Romano, Díaz & Aedo, 2023). They now must learn how to work technology onsite. Research showed that continuous training increases the skill set of teachers from tech to motivation, allowing students to participate in classes more due to better communication. Researchers like Trust and Whalen believe the best way to integrate tech is through sustainable and team work-based training for teachers so the tools can be used properly.

A key consequence of this conversation is the need for system ownership endowed backups. A teacher can only do their job if they have the tools and resources they need to do it, and for that to happen, practically the entire rest of the world has to be working with them instead of against them. The headmaster or other senior figure in the education system believes in the power of acceptance of one's strengths. As opined by Savelyeva & Park (2022), the collaborative team learning, use of programs for innovation and experimentation of new ideas through technology enhances people's motivation to generate new and innovative ideas. The conclusion of this study explains how access to digital tools and training opportunities differ by region and institution. Lasting changes in teaching demand principals be friendly. Teaching offers many advantages. This means teachers have the ability to complete their training as they like. The period after covid showed the world how education systems need to work differently and the teacher is leading.

CONCLUSION

To summarize, the results of this study show that although going to school is good, there might be a corpus of other things people can get so that people learn more out of life. The classroom is changing to help the teachers get better with technology. Getting education results in many advantages but these advantages can only happen when the people who are trying to get educated can get these advantages equally fairly in the world. Changing one's approach to education is important in a digital conversion. Old-fashioned teaching methods are not as popular anymore. People are often opting for new techniques that make people hands-on, actively involved, and personalized learning experiences. In addition to providing learners with an exchange that goes beyond mere learning, the academics who use such digital tools in their teaching. Barriers are different: computer turn off, cash and rule in a school to owing or having one or two devices to the relatives are against it. The government needs to look at all aspects to fix these problems. For better change to take place, it is important the teachers of the schools are able to learn new things, get access to technology and ensure everyone gets in on it and updates what is being reached. Intermediate teachers have the benefit of keeping up with how the technology works. The use of digital tools like artificial intelligence (AI), virtual learning environments, gamification and blended learning models offers opportunities to rethink pedagogy. Hence, teachers must be motivated to explore different strategies, redesign their curriculum, and adopt evidence-based practices integrating technology to enhance learner outcomes. Digital technology has great potential to increase the richness and quality of learning through an effective design to facilitate the experience for education.

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Mapping the Scope and Maturity of Digital Technology Applications in Education: A Systematic Review

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ABSTRACT

To comprehensively investigate the current state of digital education scenario applications in China, this study employs a Systematic Literature Review (SLR) approach to analyze the scope and maturity of digital technology applications in educational contexts between 2014 and 2024. By integrating educational scenarios with the "People-Process-Technology" (PPT) theory and the Capability Maturity Model Integration (CMMI), the study constructs a comprehensive "Educational Scenario–PPT Dimension–Maturity Model" framework to systematically analyze and reveal the developmental characteristics of digital transformation in education. The research selected literature from the CNKI and Scopus databases, incorporating both domestic and international perspectives, and identified and screened 1,601 eligible publications following the PRISMA guidelines for coding and analysis. The results indicate that: (1) The number of publications in the CNKI sample showed a fluctuating pattern from 2014 to 2021, with a resurgence after 2020 driven by policy initiatives and the COVID-19 pandemic; international research demonstrated a consistent growth trend, particularly accelerating after 2023 due to the influence of generative AI and large language models (LLMs); (2) Research focus predominantly centered on teaching and learning scenarios, while areas such as home-school interaction, educational services, and educational practice remained underexplored; (3) Higher education represented a research hotspot, whereas preschool and vocational education received relatively limited attention; (4) Most digital applications in educational scenarios were in the transition from "basic" to "mature" stages, with only a few achieving "optimized" or "leading" levels. This study provides a comprehensive analytical perspective for understanding digital transformation in education and offers insights for policy formulation, digital transformation practices, and future research directions.

Keywords: digital transformation; educational scenarios; application scope; maturity level

INTRODUCTION

Digital transformation in education has become a defining feature of global educational reform. As emerging technologies such as cloud computing, big data, artificial intelligence (AI), and more recently, large language models (LLMs), continue to reshape the educational ecosystem, digital technologies are being deeply integrated into various aspects of teaching, learning, and management. Governments worldwide have introduced strategic plans to accelerate the digitization of education, exemplified by UNESCO's "Futures of Education" report (2021) and the OECD's "Digital Education Outlook" (2023). In China, the launch of the "Digital Education Strategic Action" in 2022 signified the elevation of digital transformation in education to the level of national strategy.

However, this rapid development is accompanied by significant challenges (Rof et al., 2022). For instance, educational organizations and their members often lack a holistic understanding, failing to recognize digital transformation as a systemic change (Li et al., 2022). Efforts frequently focus on transforming a single aspect—such as educational products, services, models, or organization—or apply digital technologies only within specific scenarios like teaching, learning, management, or assessment. Many schools still heavily rely on outdated methods and legacy technologies, including old information systems, infrastructure, and technical architectures. Furthermore, key participants in educational activities often lack digital competencies and express confusion about the future direction of digital transformation (Lu et al., 2015). Addressing these issues first requires a comprehensive understanding of digital transformation. Thus, a critical question arises: To what extent and at what level of maturity

are digital technologies being applied across various educational scenarios?

Current research often concentrates on specific aspects of transformation or digital technology applications in particular contexts. For example, Bond et al. (2020) reviewed studies on using technology to enhance student engagement in specific disciplines within higher education. Butler-Henderson and Crawford (2020) focused on research related to online examinations, while Jian Feng Feng et al. (2022) explored the scope of teacher digital competence applications at an international level. A limited number of studies address the overall development of digital transformation. Farias-Gaytan et al. (2022) outlined digital transformation in higher education and discussed its scope within institutions. Benavides et al. (2020) summarized characteristics of digital transformation implementation in higher education institutions, identifying significant challenges and noting that digital transformation in education remains an emerging field lacking holistic development. Hu & Zhu (2022a & 2022b) proposed theoretical frameworks and practical logic for digital transformation. Overall, existing research tends to focus on specific applications rather than adopting a macro-level perspective; it emphasizes higher education while overlooking other academic domains; and it often prioritizes immediate action over positional reflection and strategic planning.

It is evident that previous studies have predominantly examined educational digitization from either a technological perspective (e.g., infrastructure, platforms, tools) or a pedagogical perspective (e.g., online learning, smart classrooms), with limited research adopting a holistic, systemic view to examine the "application scope" and "maturity" of digitalization in education.

Based on the above analysis, this study aims to address the following four research questions: What are the publication trends and primary research focus in studies on digital technology applications in education between 2014 and 2024? In which educational scenarios (e.g., teaching, learning, management, assessment) are digital technologies primarily applied? How are the three "People-Process-Technology" (PPT) dimensions manifested and functioning across different educational scenarios? What are the maturity levels and evolutionary trends of digital technology applications in various educational scenarios?

These questions form a logical sequence progressing from breadth to depth: starting with overall trends (RQ1), moving to scenario distribution (RQ2), then structural analysis (RQ3), and finally developmental stage assessment (RQ4). Together, they constitute a systematic research pathway for investigating digital transformation in education.

THEORETICAL FRAMEWORK

The digital transformation of education in China originated from the informatization construction phase in the late 20th century, initially driven primarily by infrastructure projects such as "School-to-School Connection," "Class-to-Class Connection," and "Person-to-Person Connection" (Ministry of Education, 2018). In recent years, guided by policies like the "Education Informatization 2.0 Action Plan" (2018) and the "Digital Education Strategic Action" (2022), the connotation of digital transformation has gradually expanded from hardware construction to encompass resources, applications, governance, and evaluation. However, overall, the digital transformation of basic education in China remains in the early stage of "deep integration" (Zhong, 2022). A comprehensive review of domestic and international research on educational digitization reveals that, despite relatively abundant outcomes, issues of singular and fragmented research themes persist. Existing studies predominantly focus on specific topics (e.g., intelligent teaching systems, blended learning, educational management systems), lacking a holistic perspective and a unified analytical framework covering the entire process and all elements of digital transformation in education. This limitation fundamentally hinders the efficient promotion of paradigm shifts in teaching, organizational structure, instructional processes, and evaluation methods within educational organizations (Hu et al., 2022).

This study addresses the application scope and maturity level of digital technologies in educational scenarios, establishing the necessary theoretical foundation, primarily including the clarification of educational business scenarios and the core theoretical basis for digital transformation.

Comprehensive Framework of Educational Business Scenarios

The core of the overall framework for educational business scenarios lies in the multi-stakeholder demands of the school, involving teachers, students, parents, and administrators. On one hand, the fundamental task of schools is to cultivate talent for the nation, fulfilling the role of teaching and educating. Their organizational space is relatively fixed and systematic. To serve the frontline of

teaching, schools require professional management personnel to provide support services and resource supply. On the other hand, schools possess an educational function, inevitably involving the evaluation, judgment, and assessment of the current state of learners based on value standards, followed by feedback and adjustment. Teachers, as the main actors in schools, need to promote educational development through teaching and research (Ma et al., 2019). Centered on the logical thread of "Demand-Function-Structure-Business Scenario" for digital transformation, and referencing the ten types of educational scenarios proposed by the Shanghai Education Commission (2021) in the "Shanghai Education Digital Transformation Implementation Plan (2021-2023)"—namely "Teaching, Learning, Management, Examination, Evaluation, Research, Service, Resources, Practical Activities, and Home-School Interaction"—this study logically synthesizes the demand-function-structure-business scenario of schools, abstracting six functional aspects: frontline teaching, school management, support services, teaching and research, evaluation and accreditation, and resource supply (Figure 1).

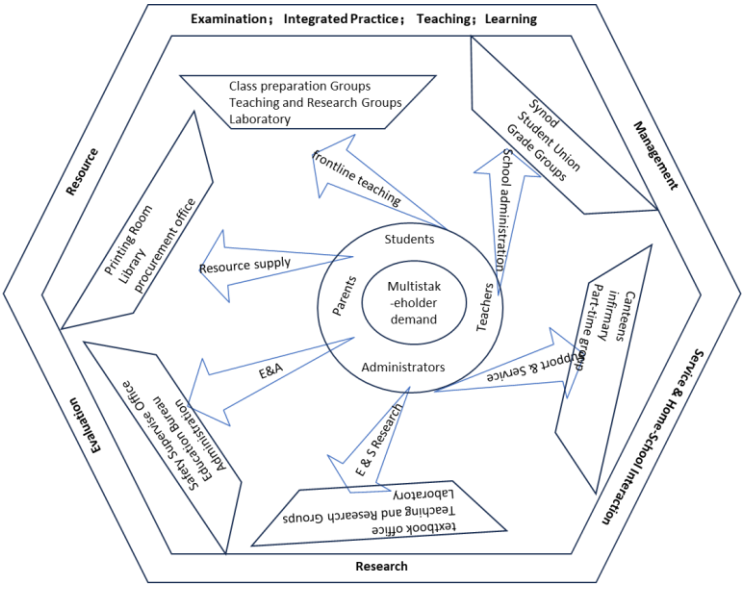


Figure 1. Comprehensive Framework of Educational Business Scenarios

In Figure 1, the functions and structures from the center to the periphery basically correspond to the ten business scenarios. Frontline teaching involves entities like lesson preparation groups and corresponds to examination, comprehensive practice, teaching, and learning scenarios. School management involves various departmental management bodies and corresponds to the management scenario. Support services involve entities like the clinic and canteen, corresponding to service and home-school interaction scenarios. Teaching and research involve groups like the teaching research office and correspond to the research scenario. Evaluation and accreditation involve committees like the school affairs supervision committee and correspond to the evaluation scenario. Resource supply involves entities like the library and corresponds to the resource scenario. The overall framework of educational business scenarios establishes the operational foundation for investigating the application scope of digital technologies in RQ1.

Dimension Framework for Digital Education Scenario Application

The People–Process–Technology (PPT) triangle framework proposed by Schneier (2008) is also applicable to research on digital transformation in education: the success of educational activities likewise depends on the synergy of the three elements: "People," "Process," and "Technology." Specifically, first, educational digitization is inseparable from the digital literacy and technical capabilities of teachers and students, i.e., the digital competence in the "People" dimension (Falloon, 2020). Second, educational digitization requires the digital reshaping of teaching models and processes, i.e., the digital services in the "Process" dimension (Korang & Atianashie, 2025). Finally, it also relies on digital infrastructure and specific technical tools, i.e., the digital environment in the "Technology" dimension (Zhu et al., 2022d). The application framework for digital education scenarios essentially maps the PPT framework from the corporate domain to the education domain; the three elements

constrain each other and are indispensable (see Figure 2). Therefore, based on the enterprise management PPT model, the dimension framework for digital education scenario application can be derived through mapping.

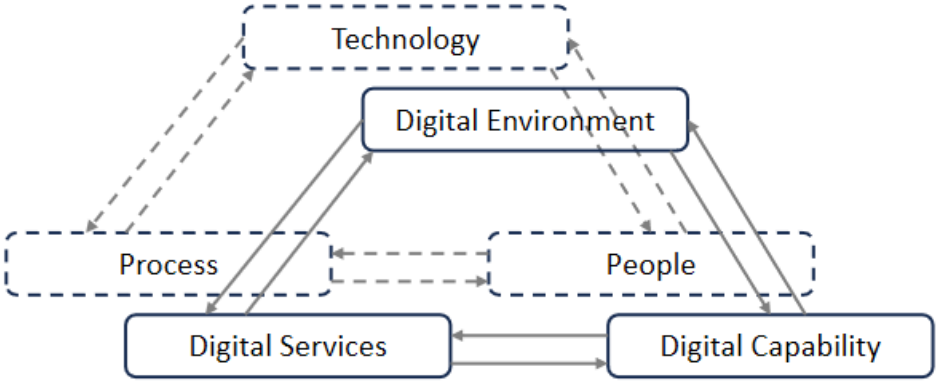


Figure 2. Dimension Framework for Digital Education Scenario Application

Maturity Model for Digital Education Scenario Application

The question of degree aims to clarify the stage and progress level of the transformation, i.e., the maturity level. Maturity assessment focuses on personnel, processes, technology, and achieved outcomes. Based on the applicability of existing models for assessing the maturity of digital education applications, this study draws on the Capability Maturity Model (Paulk et al., 1993) and its successor, the Capability Maturity Model Integration (CMMI Product Team, 2010), to propose five levels for the maturity model: Initial, Basic, Mature, Optimizing, and Leading (Table 1). Experts were invited to review and refine the maturity dimensions and their characterizations.

Table 1. Characterization of Digital Education Scenario Application Maturity

Maturity Level / Dimension	Digital Environment	Digital Services	Digital Capability
Initial Level(No Progress)	Digital technology infrastructure (e.g., smart campus, smart classroom, smart terminals) has not yet been constructed	Educational operational processes are not digitized (e.g., singular learning resources, complex school management processes)	No awareness of the need to develop digital capability among practitioners in various school domains
Basic Level(Spontaneous, Isolated)	Schools have built digital technology infrastructure for most domains, but issues like low equipment utilization exist.	A small number of practitioners use digital technology in learning, teaching, or management; school management shows a tendency towards digitization.	Schools gradually become aware of the need to improve practitioners' digital capability and explore corresponding measures, practicing on a small scale.
Mature Level(Organized, Scaled Application)	Smart campuses and classrooms are established; digital technology infrastructure achieves full coverage with high equipment utilization.	Digital technology is widely used in teaching, learning, management, research, examination, etc.,	Schools form a systematic digital capability training system; practitioners possess relatively high digital capability, achieving

		achieving quality resource sharing and systematic management.	basic full coverage of task digitization.
Optimizing Level(Deep Application, Integration)	Personalized digital technology infrastructure is refined based on practice (e.g., network upgrades, smart device updates).	School operational processes are fully digitized and, based on practice, become simpler and more convenient (e.g., easy-to-operate management processes).	Schools optimize and refine the training system; practitioners are proficient in handling digital teaching or management problems.
Leading Level(Deep Integration, Leading, Innovative)	Schools become demonstration sites for smart campuses/classrooms; digital technology infrastructure construction reaches leading levels in the region or even nationally.	School operational models reach leading levels in the region or even nationally, achieving quality resource sharing.	School high-quality training system is widely disseminated; practitioners' digital capability reaches leading levels in the region or even nationally.

In general, the Initial Level indicates that digitalisation has not yet commenced or is not yet underway. The Basic level means the school has provided digital technology infrastructure for most areas, showing signs of digital transformation. The Mature level indicates relatively high utilization rates and the acquisition of practical digital experience. The Optimizing level refers to the ability to optimize current teaching, research, management, etc., based on existing digital application experience, recognizing the advantages and competitiveness brought by digitization. The Leading level signifies a high degree of digital application, mature systems and operational levels, achieving leading status locally or in a broader region.

In summary, the educational scenario framework elaborates the map of educational business scenarios, the PPT model reveals the key dimensions of digital transformation in education, and the digital education scenario application maturity model clarifies the stage and progress level of digital transformation. These three models elaborate elements related to different aspects of digital transformation but cannot systematically reveal the internal relationships among the various elements of educational digitization. To address this deficiency, this study integrates the PPT model and the Capability Maturity Model Integration (CMMI) within the context of educational digitization, forming a comprehensive analytical framework of "Educational Scenario – PPT Dimension – Maturity Model" (Figure 3). This facilitates the investigation of the application scope and maturity level of educational digitization based on the ten educational scenarios (Teaching, Learning, Management, Examination, Evaluation, Service, Resources, Research, Practice, Home-School Interaction).

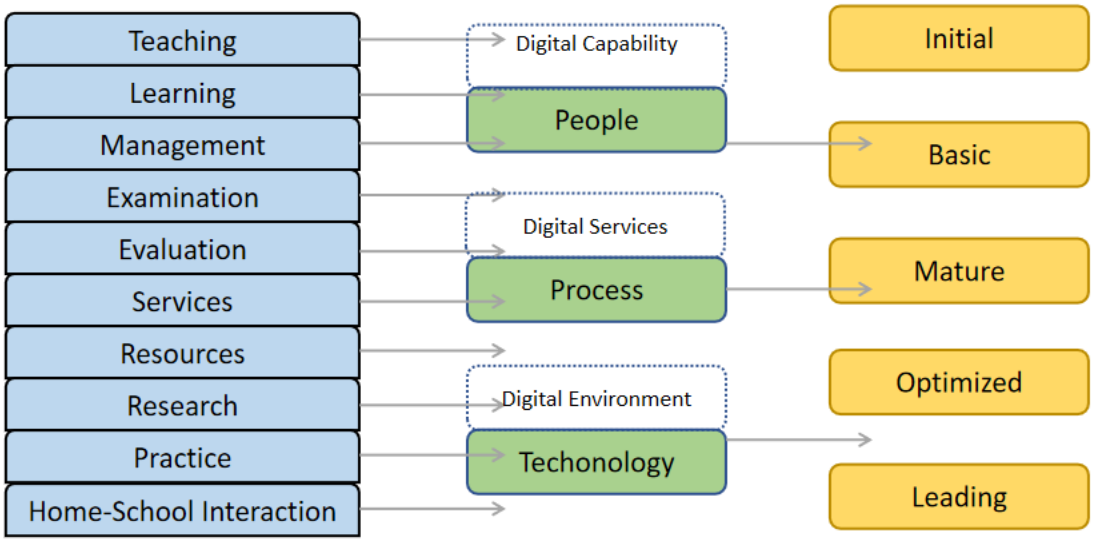


Figure 3. Comprehensive Framework of Digital Transformation in Education Scenarios & PPT Dimensions & Maturity Model

The core logic of Figure 3 encompasses three layers: Educational Scenarios, PPT Dimensions, and the Maturity Model. First, the educational scenarios cover ten aspects—Teaching, Learning, Management, Examination, Evaluation, Service, Resources, Research, Practice, and Home-School Interaction—comprehensively reflecting the operational links of the education system. Second, the PPT (People–Process–Technology) dimensions emphasize that educational digitization relies not only on technology but also involves the digital literacy of teachers and students (People), the reengineering of educational activities and management processes (Process), and the application of infrastructure and tools (Technology); these three elements interact and are indispensable. Finally, the Maturity Model is divided into five stages—Initial, Basic, Mature, Optimizing, and Leading—revealing the evolutionary path of digital transformation in education. The significance of this framework is twofold: on one hand, it provides researchers with a systematic, comparable analytical tool conducive to horizontal and vertical comparisons across different educational stages and scenarios; on the other hand, it offers a reference for policy formulation and educational practice, helping to identify短板场景 (scenarios needing improvement) and key links, thereby optimizing the strategic layout of digital transformation in education.

METHOD

Research Design

This study employs the Systematic Literature Review (SLR) method to analyze the scope and maturity of digital technology applications in educational scenarios in a systematic, transparent, and reproducible manner. The review process, guided by the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines (Page et al., 2020), includes identification, screening, and inclusion stages. This approach facilitates the integration of research findings from different educational levels and contexts, thereby mitigating the issues of subjectivity and selection bias often associated with traditional narrative reviews.

Data Sources

To ensure sample representativeness and international comparability, a dual-database strategy involving Chinese and English databases was adopted:

China National Knowledge Infrastructure (CNKI): Covers core Chinese educational journals, doctoral dissertations, and conference papers, reflecting the local practices and policy context of educational digitalization in China.

Scopus: A leading global abstract and citation database, indexing high-quality international research in educational technology, information science, and related fields, providing a global perspective.

The combination of these databases allows this study to reflect the characteristics of Chinese

educational digitalization research while also revealing overall international trends.

Search Strategy and Keywords

The literature search covers the period from 2014 to 2024, capturing the crucial decade marked by the integration of educational digitalization and AI development. To ensure comprehensiveness, the search strategy was constructed based on the multi-scenario nature of digital education research, utilizing a four-dimensional keyword system comprising the "Education Theme Group," "Digital Core Group," "Application and Maturity Group," and "Education Scenario Expansion Group" (Table 2). The Education Scenario Expansion Group includes ten types of scenarios: teaching, learning, management, evaluation, examination, service, resources, research, practice, and home-school interaction.

Table 2. Keyword Grouping Table

Group	English Keywords	Chinese Keywords	Description
Education Theme Group	education, school	教育、学校	Defining Research Domains
Digital Core Group	digitalization, educational technology, ICT, smart education, artificial intelligence, ChatGPT, large language model	数字化、教育技术、智慧教育、人工智能、大语言模型	Core Technological Themes
Application and Maturity Group	application, implementation, transformation, maturity, framework, readiness	应用、实施、转型、成熟度、框架、准备度	Research Focus
Education Scenario Expansion Group	teaching,classroom,instruction,pedagogy,learning,management,administration, school management,examination, testing,assessment, evaluation,practice,educational practice,teaching practice,pedagogical practice,service,educational services, student support , online support system, resources,digital resource",open educational resources,research,home-school interaction,home-school collaboration,family engagement,parental involvement,parent-school communication	教、学、管理、评估、考试、服务、资源、研究、实践与家校互动等十类场	Specific Educational Scenario Dimensions

Boolean operators (AND/OR) were used to combine keyword groups, ensuring coverage of the main activity scenarios within the education system and enabling the reflection of the application scope and maturity of digital technologies across different educational processes.

Scopus Search String:

(TITLE-ABS-KEY ("digital education" OR "educational digitalization" OR "smart education" OR "ict in education" OR "educational technology" OR "ai in education" OR "artificial intelligence in education" OR "large language model" OR "chatgpt") AND TITLE-ABS-KEY ("application" OR "implementation" OR "maturity" OR "framework" OR "transformation") AND TITLE-ABS-KEY ("teaching" OR "learning" OR "management" OR "assessment" OR "evaluation" OR "exam" OR "testing" OR "service" OR "resources" OR "research" OR "practice" OR "home-school interaction" OR "parental involvement" OR "family engagement") AND PUBYEAR > 2013 AND PUBYEAR < 2025)

CNKI Search Strategy:

SU=(教育 OR 学校 OR 教学 OR 学习 OR 管理 OR 考试 OR 评估 OR 服务 OR 资源 OR 研究

OR 实践 OR 家校互动) AND SU=(数字化 OR 信息化 OR 智慧教育 OR 教育技术 OR 人工智能 OR ChatGPT OR 大语言模型) AND SU=(应用 OR 实施 OR 成熟度 OR 框架 OR 转型) AND Year: 2014-2024

Inclusion and Exclusion Criteria

To ensure research quality, inclusion and exclusion criteria were established (Table 3), specifying conditions related to language, research topic, publication date, and document type, thereby guaranteeing the academic validity and relevance of the sample.

Table 3. Inclusion and Exclusion Criteria

No.	Inclusion Criteria	Exclusion Criteria
1	CSSCI-sourced journals and papers indexed in the Scopus database	Non-CSSCI and Scopus journal articles, theses, newspapers, books, conference papers, reports, etc.
2	Full text available	Full text unavailable
3	Published between 2014 and 2024	Other time periods
4	Title appearing only once	Duplicate titles
5	Focusing on China's digital education landscape	Digital education scenarios outside the education sector or in other countries
6	Focusing on ten categories of educational technology application scenarios (case-based articles)	Articles not addressing technology application across the ten educational scenarios (e.g., review articles)
7	Focusing on three sub-dimensions within ten scenarios: digital environments, digital services, and digital capabilities	Three sub-dimensions: digital environments, digital services, and digital capabilities for non-ten-scenario contexts

Data Screening Process

The literature screening followed the PRISMA 2020 flow diagram (Figure 4). The initial search identified 16,874 records (1,3624 from CNKI, 3,250 from Scopus). After removing duplicates, 15,021 records remained. Screening based on titles and abstracts excluded 11,853 records. Subsequent full-text assessment resulted in the final inclusion of 1,601 studies meeting all criteria.

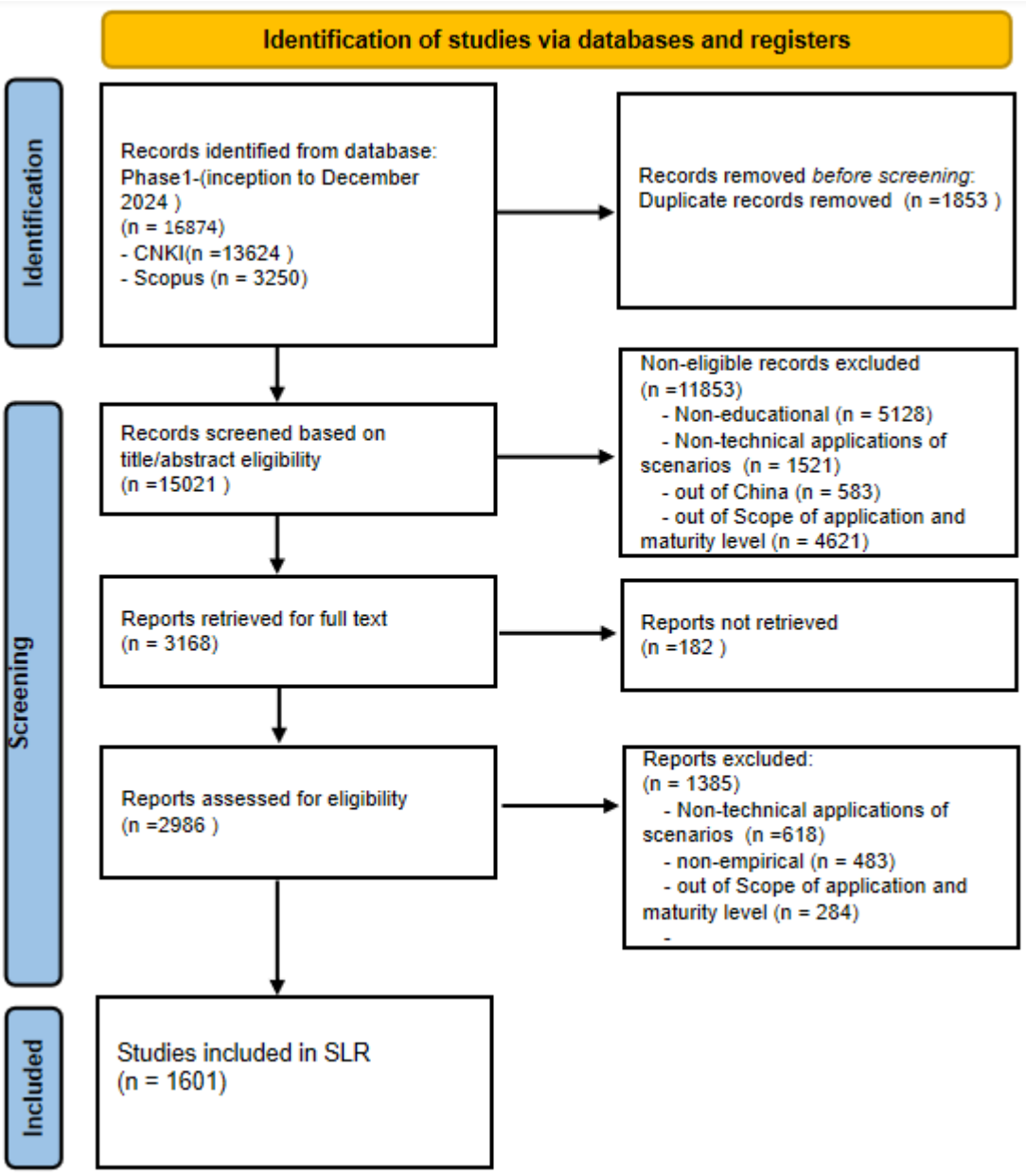


Figure 4. PRISMA Flow Diagram of the Literature Search and Selection Process

Data Analysis Methods

The included literature was coded across four dimensions: publication year, educational scenario type (10 categories), PPT dimension (People, Process, Technology), and maturity level (Initial, Basic, Mature, Optimizing, Leading). Coding was performed independently by two researchers, resulting in a Cohen's Kappa value of 0.86, indicating substantial inter-coder agreement.

A combination of descriptive statistics and thematic analysis was employed. Excel and VOSviewer software were used for visualizing annual trends and keyword co-occurrence networks, respectively.

FINDINGS AND DISCUSSION

Publication Trends in Digital Education Scenario Application Research

Analysis of the 1,601 sample publications indicates a dynamically fluctuating yet overall growing trend in educational digitalization research over the past decade (Figure 5).

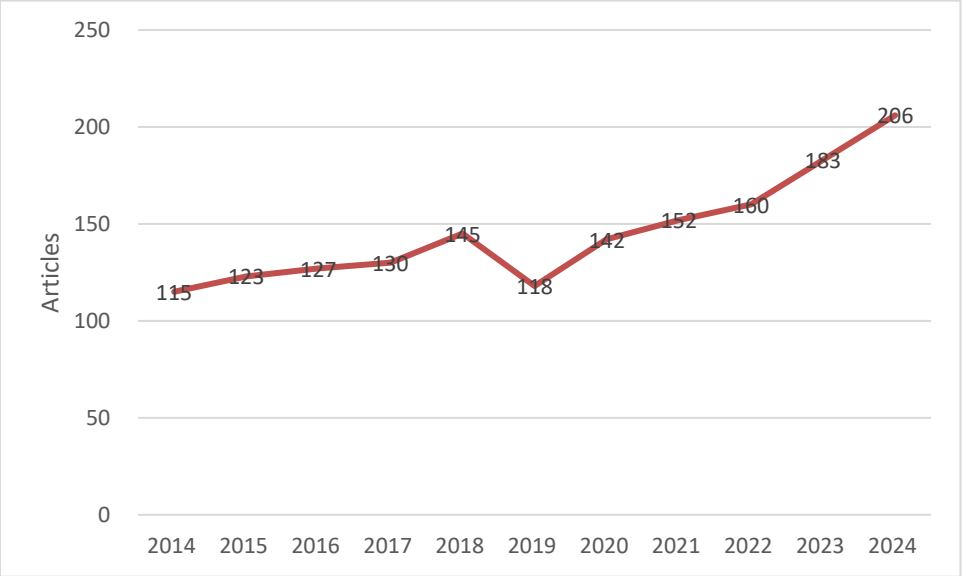


Figure 5. Annual Number of Publications on Digital Technology Application in Education (2014–2024)

Between 2014 and 2018, the number of studies increased steadily. Growth slowed between 2019 and 2021, with research on certain themes (e.g., online learning, blended learning) approaching saturation. Post-2020, publication numbers rebounded significantly. Since 2023, research integrating Artificial Intelligence (AI) and Large Language Models (LLMs) has exhibited exponential growth.

This publication trajectory clearly demonstrates distinct phases of evolution in digital transformation research, likely influenced by policy initiatives and the educational technology application environment. From 2014 to 2018, driven by policies like the "13th Five-Year Plan for Education Informatization," research focused on constructing smart education environments and exploring blended teaching models, leading to steady growth in publications. After 2019, research entered a plateau phase, marked by a surge in meta-analyses examining the effectiveness of online learning (e.g., Luo et al., 2017's review of blended learning outcomes), signaling a period of reflection and refinement within the field. The COVID-19 pandemic in 2020 served as a critical turning point, generating numerous empirical studies on "emergency remote teaching" and the digital divide (Zhao et al., 2020), which propelled the significant rebound in publications. Starting in 2023, generative AI, exemplified by ChatGPT, ignited a new wave of research, with scholars concentrating on frameworks for "AI literacy" (Ng et al., 2023) and the educational applications of intelligent tutoring systems (Bozkurt et al., 2023). This progression vividly illustrates a profound shift in research paradigm from "technology empowerment" to "ecosystem reshaping," marking education's transition towards a new ecology centered on human-machine collaboration.

Distribution Across Educational Scenarios

Research on digital education scenarios primarily encompasses ten categories, displaying a "tornado-shaped" distribution (Figure 6), decreasing from "Teaching" to "Home-School Interaction." "Teaching" is the most studied scenario, with both "Teaching" and "Learning" related publications exceeding 300 each, accounting for 24% and 21% respectively, indicating that research remains concentrated on instructional design and learning behaviors. "Management" (12%), "Evaluation" (10%), and "Examination" (9%) follow, reflecting increased awareness of digital governance and data-driven decision-making. "Service" (7%), "Resources" (6%), and "Research" (5%) are at a medium level. "Practice" (4%) and "Home-School Interaction" (1%) are noticeably under-researched.

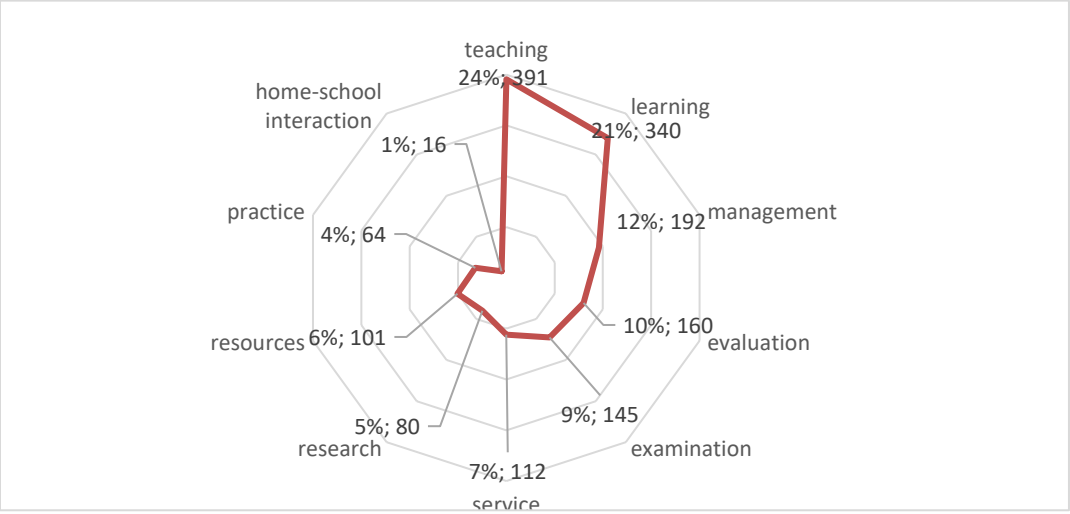


Figure 6. Distribution of Publications Across Digital Application Scenarios in Education

This distribution pattern aligns with expectations. Firstly, the frontline teaching module, as the core application scenario of the education system, logically possesses the most extensive research literature. The comprehensive practice application scenario refers to activity-based teaching; its relatively scarce research exists despite the current Chinese educational emphasis on core competencies and interdisciplinary teaching (Yuan, 2022). The examination scenario is crucial for assessing teaching effectiveness and guiding instructional adjustment; current research on digital examinations is scarce and often focuses on online exam platform development and foreign language disciplines, warranting greater attention. Secondly, the support services module aims to optimize the experience for teachers and students; as an auxiliary application scenario, it has a substantial body of literature. Within the home-school interaction scenario, daily communication needs might be met by instant messaging tools, resulting in relatively fewer dedicated studies; however, significant research potential exists in the context of home-school collaborative education. Thirdly, the teaching and research module is a driver for digital transformation in education, balanced regional educational development, and solving educational challenges (Fang et al., 2022), potentially leading educational advancement. Yet, its literature share is only 4.40%, seemingly insufficient. Fourthly, the school management module's application scenarios have a moderate volume of literature, covering both teaching and administrative management, with a relatively balanced presentation due to its broad scope. Fifthly, the resource supply module, as the supply side, has a relatively rich body of research literature. Finally, the evaluation and accreditation module scenario serves a guiding function; while relevant research exists, there remains room for expansion.

Research Status Across Educational Stages

A bibliometric analysis across educational stages reveals a pronounced "higher education centrality" phenomenon in digital transformation research. Specifically, the volume of literature focusing on higher education (1,053 publications) far exceeds that focusing on basic education (394 publications). This reflects deep-seated contradictions in resources and demands between the two sectors: the basic education system, despite its large scale, has limited resources allocated per school and faces challenges such as IT talent shortages and insufficient endogenous motivation for teaching model innovation (Ministry of Education, 2020b, 2021, 2022). Higher education, leveraging its resource and scenario advantages, naturally becomes a research hotspot.

Meanwhile, vocational and pre-school education have emerged as research “lowlands”. Whilst the former faces new developmental opportunities following the implementation of the new Vocational Education Law (2022), its current research foundation remains notably weak. The latter, due to the cognitive characteristics of pre-school children, has seen its digitalisation needs and informal learning scenarios insufficiently explored (Vilacheva et al., 2021). By contrast, lifelong education, as a policy focus, saw 238 research articles published. This volume reflects a shared understanding of building a learning society through digitalisation (Kim et al., 2019), signalling a significant future development direction.

Analysis of PPT Dimensions

Analysis according to the "People–Process–Technology" dimensions shows that the Technology dimension accounts for the highest proportion (48%), primarily focusing on platforms and AI systems. The People dimension (32%) concentrates on teacher competence and digital literacy. The Process dimension (20%), concerning instructional design and management processes, is less studied (see Figure 7).

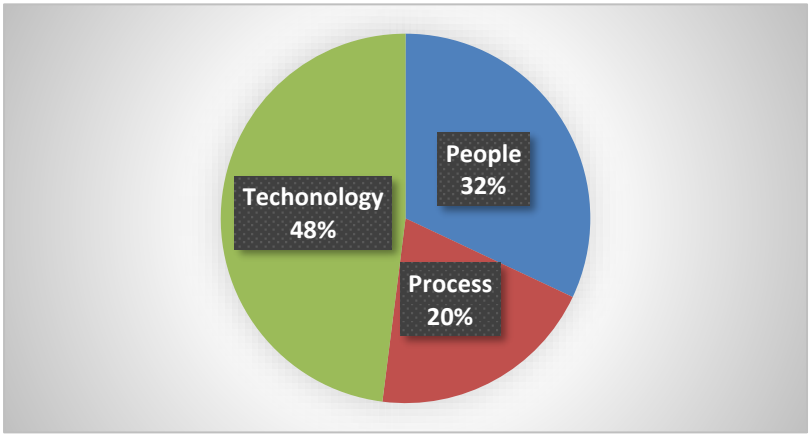


Figure 7. Number of Publications by PPT Dimensions in Educational Digitalization Research

Current research and practice exhibit a tendency to prioritise hardware over processes and capabilities. Following the establishment of numerous smart classrooms, utilisation rates remain low due to unaltered workflows and the failure to synchronously upgrade staff and student competencies. Consequently, technological investments struggle to translate into teaching performance. Future project proposals must incorporate budgets for process reform and training; otherwise, progress beyond basic application stages will prove challenging. There is an urgent call to prioritise process reengineering and capability enhancement to achieve the effective conversion of technological investments into tangible outcomes.

Maturity Degree of Digital Technology Applications in Education

The maturity distribution across different application scenarios is shown in Figure 8. Firstly, comparing the stages, the Initial stage has the highest number of publications (605). The average proportion of the Initial stage across all application scenarios is 38%, with no scenario having less than 30% or more than 50% of its studies at this level. Secondly, the proportion of the Basic stage ranges from 17% to 50%, with an average of 28%, significantly higher than the Mature, Optimizing, and Leading stages. The Mature stage averages 21%, followed by the Optimizing stage at 8%, and the Leading stage at 6%, indicating relatively low proportions at the higher maturity levels. This suggests that the overall level of digital transformation in Chinese education is beyond the Initial stage but remains predominantly at the Basic stage (Xing et al., 2022). China's "Smart Education 2.0" initiative promotes the maturation of infrastructure and governance systems; international research, meanwhile, shows diversity but converges towards development models emphasizing data intelligence and adaptive ecosystems.

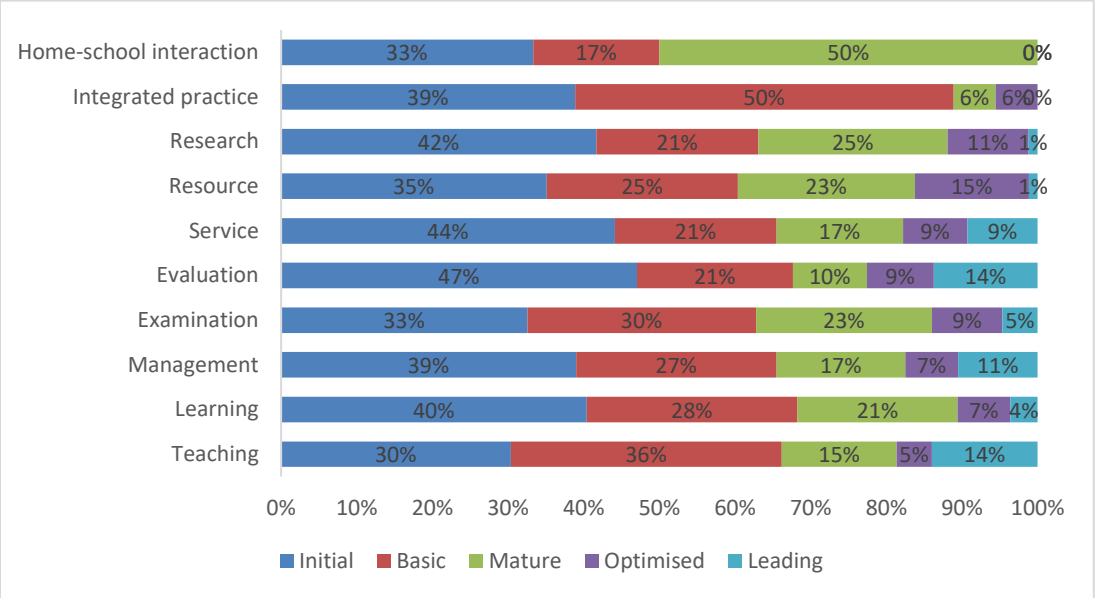


Figure 8. Maturity Level Percentages across Educational Technology Application Scenarios

Secondly, we analyze further based on the maturity findings for each application scenario. The Teaching scenario ranks first in digital education application research, with 34% of its applications reaching the Mature level or above, primarily distributed across the Digital Environment and Digital Services dimensions, with fewer studies in Digital Capability. The widespread educational application of technologies like big data, AI, and the metaverse further breaks spatiotemporal constraints and drives changes in the teaching environment. Teachers and educational administrators, as the core of teaching and decision-making subjects, have a decisive influence on digital teaching through their digital literacy, which is particularly crucial for enhancing students' digital competence (Qiu et al., 2021). However, research on Digital Capability is low in both absolute number and proportion, with only 26 publications (5.26%). To address the challenges of integrating digital technology into teaching, research in this area urgently needs strengthening. Furthermore, current research often focuses on isolated aspects like improving the competence of single subjects, highlighting the need to construct a systematic digital teaching ecology and strengthen research on digital strategy and systemic planning.

Research in the Learning scenario is widely distributed across the Digital Environment, Digital Services, and Digital Capability dimensions, with many studies at the Mature stage. However, research specifically on Digital Capability remains scarce and is mostly at the Basic stage. The root cause may lie in the domestic education system's tendency to prioritize improving students' academic performance, particularly in basic education, where insufficient attention is paid to the development of students' digital literacy, and a complete framework for student digital literacy development has not yet been formed (Wu et al., 2022). Yet students' application of digital technologies in learning constitutes a pivotal driver for educational digital transformation. Consequently, the state should establish a student digital literacy framework encompassing digital awareness, digital technology application, and digital social responsibility. This should be complemented by developing a digital literacy maturity assessment model to measure student capabilities and provide feedback guidance. Concurrently, emphasis must be placed on digital literacy foundational education, enhancing students' digital literacy through teaching.

Research in the Management, Service, and Resources scenarios is predominantly at the Mature stage, while research in Examination/Assessment, Research, Home-School Interaction, and Comprehensive Practice remains at the Basic stage, indicating that their digital transformation is still in early phases and may require policy guidance or funding support for deeper transformation. For scenarios at mature stages of digital transformation, efforts should focus on continuously summarizing experiences in digital technology application, progressing towards the Optimizing stage, and ultimately achieving comprehensive advancement across the three dimensions of Digital Environment, Digital Services, and Digital Capability.

Summary of Findings

Through this systematic literature review, this study has systematically梳理 (organized) and

clarified the overall trends in educational digital technology application, the current state of application scenarios, the important logical structure of the transformation, and the assessment of developmental stages. It integrated and established a theoretical foundation for systematic organization and analysis—the comprehensive "Scenario–Dimension–Maturity" framework—and revealed convergences and divergences between domestic and international research. This provides a comprehensive analytical perspective for industry practitioners and scholars to understand educational digital transformation and offers references for policy formulation, digital transformation practices, and future research directions.

However, all data in this study originated from existing research literature, and only two limited databases, CNKI and Scopus, were selected for data retrieval, potentially leading to insufficient data samples and limited authority of the analytical conclusions. Future research could conduct longitudinal tracking studies, combining quantitative and qualitative methods to analyze maturity evolution. Simultaneously, attention should be paid to the integrated application of educational AI and its associated ethical, equity, and data sovereignty issues. Exploring cross-scenario linkage mechanisms, such as the impact of management digitalization on teaching quality, is also recommended. Furthermore, combining machine learning methods to validate the effectiveness of the maturity model presents a promising avenue.

CONCLUSION

This study conducted a systematic review of the scope and maturity of digital technology applications in educational scenarios between 2014 and 2024, based on literature from the CNKI and Scopus databases. By constructing an analytical framework integrating "Educational Scenarios – PPT Dimensions – Maturity Model," the research revealed the evolving trajectory of digital transformation in education across various stages and contexts.

The results indicate a fluctuating yet overall growing trend in educational digitalization research over the past decade. A steady expansion occurred from 2014 to 2019, followed by a significant resurgence post-2020, driven by the pandemic and policy initiatives. The introduction of generative Artificial Intelligence (AI) and large language models (LLMs) marks a new, intelligent phase for education, centered on "human-machine collaborative learning systems."

Among the ten educational scenarios, research is most concentrated on Teaching and Learning, while areas such as Home-School Collaboration, Educational Services, and Educational Practice remain relatively understudied. From the PPT perspective, Technology still dominates, whereas the Process and People dimensions require further strengthening to achieve a balanced transformation. Maturity analysis reveals that most institutions are in a transition between the "Basic" and "Mature" stages, with only a few cases possessing policy and technological advantages reaching the "Optimizing" or "Leading" levels.

The main contributions of this study are threefold: (1) constructing a comprehensive analytical framework linking educational scenarios with digital maturity; (2) enabling a comparative synthesis of domestic and international educational digitalization research, revealing both convergences and divergences; and (3) incorporating AI-driven factors into maturity analysis, thereby expanding the depth and breadth of educational digitalization theory.

In conclusion, the sustainable advancement of educational digitalization should be grounded in the coordinated development of People, Processes, and Technology. It necessitates a focused effort on enhancing digital literacy, optimizing processes, and fostering innovative AI applications to build an equitable, flexible, and sustainable learning ecosystem.

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A Review of the Functions of the Cultural Heritage of the Mogao Caves at Dunhuang

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ABSTRACT

The Mogao Caves, also known as the "Caves of a Thousand Buddhas," were first constructed in the early 4th century and gradually expanded to more than 700 grottoes by the Yuan dynasty. Preserved within are extensive wall paintings, sculptures of Buddhas, bodhisattvas, and arhats, along with the invaluable Dunhuang manuscripts, encompassing Buddhist scriptures, Daoist texts, Confucian writings, and secular documents. This unique cultural complex is not only an unparalleled artistic and religious treasure but also a dynamic medium for cultural transmission and moral education. Historically, the Mogao Caves have functioned as a space for Buddhist devotion, while also carrying a didactic function that warns and instructs through visual narratives. In the modern context, their significance extends beyond religious and historical value to encompass heritage preservation, aesthetic appreciation, and even sustainable commercial development through tourism and digital dissemination. As such, the Mogao Caves represent a multidimensional cultural heritage site whose enduring relevance lies in the intersection of spiritual devotion, cultural memory, and contemporary socio-economic engagement.

Keywords: Mogao Caves; Moral and Didactic Function; Heritage Preservation; Aesthetic Value; Commercial Value

Introduction

The Mogao Caves, also known as the "Caves of a Thousand Buddhas," are located at the eastern foot of the Mingsha Mountains in Dunhuang, Gansu Province, China. The caves were first excavated in 366 CE during the Former Qin dynasty, when the monk Lè Zūn, inspired by a vision of golden rays and myriad Buddhas, vowed to carve a sanctuary into the cliff. Over the subsequent centuries, the Mogao complex underwent continuous expansion across multiple dynasties—including the Northern Liang, Northern Wei, Western Wei, Northern Zhou, Sui, Tang, Five Dynasties, Song, Western Xia, and Yuan—culminating in a monumental ensemble of 735 caves, more than 45,000 square meters of wall paintings, over 2,000 painted sculptures, and an extensive body of manuscript remains. Today, the Mogao Caves constitute the largest and best-preserved repository of Buddhist art in the world.

The artistic achievements of Mogao are exceptionally diverse. Its murals, often described as an "encyclopedia on the walls," represent the pinnacle of Dunhuang art and reflect over a millennium of religious, social, economic, and cultural developments. The paintings encompass a wide array of subjects, including Jātaka tales, avadāna narratives, depictions of the Buddha's life, sutra illustrations (jingbian), donor portraits, architectural landscapes, and scenes of everyday life. In addition to the murals and sculptures, the caves gained worldwide prominence with the discovery of the so-called "Library Cave" (Cave 17) in 1900, where more than 50,000 manuscripts were found. These texts include Buddhist scriptures, Daoist writings, Confucian documents, as well as treatises on astronomy, calendrics, medicine, literature, music, and dance—making Dunhuang an indispensable source for the emergence of "Dunhuang Studies."

Beyond their religious significance, the Mogao Caves function as a comprehensive repository of global art, history, and culture. Their murals and sculptures fulfilled critical roles in religious instruction and ritual devotion, while also transmitting historical memory, moral education, and didactic warnings. As a UNESCO World Cultural Heritage Site, the Mogao Caves embody the shared responsibility of humanity to safeguard and transmit cultural legacies. In recent decades, their aesthetic value has drawn

sustained attention from scholars and visitors worldwide, rendering them a focal point for art historical research and cross-cultural appreciation. Moreover, in the context of contemporary tourism and digital technologies, the caves' commercial and communicative potential has become increasingly prominent. A systematic review of the cultural functions of the Mogao Caves not only illuminates their historical significance but also provides critical insights for the future of cultural education and heritage preservation.

Moral and Educational Functions of Dunhuang's Digital Heritage: Warning Value in Contemporary Dissemination

The story of "The Deer and the Snitch", adapted from the wall paintings of Cave 257 at the Mogao Grottoes, has become one of the most vivid examples of how Dunhuang heritage can be mobilized for contemporary education. Recently released as an animated short film through the "Traveling in Dunhuang" WeChat mini-program, it brings the ancient tale to life for younger audiences in a culturally accessible medium (Du & Zhang, 2023; Du & Zhao, 2024). The narrative centers on the Nine-Colored Deer, a resplendent creature shimmering in nine hues, living along the Ganges River. When a man falls into the rushing waters, the deer leaps in to save him at the risk of its own life. In gratitude, the man bows and swears loyalty. The deer, however, issues a stern admonition: "Do not betray me; if you do, divine punishment will follow." Later, when the queen dreams of the deer's beauty, the king offers a reward to anyone who can reveal its whereabouts. Tempted by greed, the very man once saved betrays the deer's refuge. Yet, when the king and his soldiers surround it, their arrows disintegrate mid-air. The deer then recounts the betrayal, and the king, moved and angered, punishes the informer and orders eternal protection for the Nine-Colored Deer. The story thus becomes a timeless warning: never betray gratitude, and uphold honesty and loyalty. Through digital media, this tale now functions as a moral parable to guide adolescents, instilling values of integrity, fidelity, and the consequences of betrayal.

The educational power of Dunhuang art is not confined to narrative retellings. Within the Dunhuang VR Project, serious games are designed that merge entertainment with cultural learning. By transforming visual elements of murals into interactive, three-dimensional environments, students and general users can both "play" and "study." They may construct a virtual grotto, select correct roof types, identify decorative motifs, or virtually restore damaged architectural sections of murals. Such tasks, framed as puzzles and interactive missions, not only impart knowledge about Buddhist art and architectural styles but also strengthen problem-solving skills and foster appreciation for historical aesthetics (Liu, 2025). The playful immersion of VR environments thus reactivates heritage as a dynamic medium of cultural training, extending the murals' traditional 警世作用 ("warning and instructive function") into digital pedagogy.

At the institutional level, universities are increasingly integrating Dunhuang-inspired creative cultural products into curricula. These include textbooks enriched with mural details, panoramic images, digital museums, and multimedia teaching resources. Courses often feature high-resolution digital reproductions of wall paintings, lectures on painting techniques, and even dynamic presentations of mural replication processes. Exhibitions within universities highlight the stylistic development of mural art across dynasties, while special seminars explore themes such as the intersection of murals with music and dance, or their adaptation in modern design and visual arts (Chong, 2025). Such integration has expanded Dunhuang heritage from a preserved relic to an active cultural resource within higher education, enabling students to experience its history not only visually but also experientially.

The visual narrative function of the murals is particularly significant. They frequently employ serial, almost comic-like structures to depict Buddhist stories—whether the Jataka tales of the Buddha's previous lives, illustrations of Amitabha's Pure Land, or transformation tableaux of the Lotus Sutra. By reconstructing these murals in three-dimensional digital spaces, users can virtually roam within the caves, observing donors' portraits, ritual practices, and cosmic visions of the Pure Land. Zhao (2023) emphasizes that such immersive media convert murals from "static relics" into "dynamic educational media," allowing learners to establish emotional and cognitive connections by situating themselves within simulated Buddhist environments. This expands not only the intellectual grasp of religious philosophy but also strengthens moral reflection through embodied experience.

The public aesthetic perception derived from Digital Dunhuang further illustrates the pedagogical potential of immersive heritage. The project's high-definition images, 3D reconstructions, and interactive navigation allow viewers to zoom into mural details—the serene facial expressions of

Buddhas, the delicate gradations of pigments, or the elegance of brushstrokes. Unlike a passive museum visit, audiences engage in multimodal narratives through textual annotations, audio explanations, and guided interactions. In this process, the aesthetic experience of murals is fused with moral-philosophical learning, enabling reinterpretation of Buddhist concepts such as harmony, compassion, and cosmic order (Chen, 2025). Thus, Digital Dunhuang does not merely conserve; it actively reshapes public understanding of religion and art.

The musical dimension of Dunhuang culture adds another pedagogical layer. Dunhuang songs are characterized by both "rustic simplicity" and "refined delicacy." Their melodies, rhythms, and role-played performances embody regional traditions shaped by desert geography, Silk Road exchanges, and ethnic hybridity. The "Dunhuang Opera Spontaneous Music Class", introduced in schools, exemplifies how local tunes and operatic styles are taught as living traditions rather than antiquated curiosities. By incorporating these elements into classroom activities, educators link music to local identity and historical memory, affirming cultural continuity and safeguarding intangible heritage (Bai, 2023).

Heritage education also extends into hands-on workshops and intangible art training. "Mogao Cave mural copying courses" allow students to practice brush techniques, line drawings, and color mixing directly inspired by original frescoes. Dance and music classes adapt Dunhuang rhythms and movements, while crafts workshops, often led by heritage inheritors, teach mural construction, polychrome sculpture, and embroidery. These activities emphasize not only technical skills but also the ethos of craftsmanship, fostering cultural confidence and identity. As Lian (2024) notes, intangible cultural arts from Dunhuang serve as a "cultural calling card" in international dialogues, symbolizing both local rootedness and global relevance.

Beyond formal education, public engagement strategies ensure that Dunhuang heritage reaches broader audiences. Museums and heritage institutions organize exhibitions, lectures, and cultural exchange activities to disseminate knowledge of the Mogao Caves' history and artistic value. Digital exhibitions, virtual tours, and online platforms further democratize access, enabling audiences worldwide to participate in cultural appreciation. Xu et al. (2024) highlight that sustainable management requires not only technical preservation but also clear policies, cross-departmental collaboration, and resource planning. Public education thus becomes part of the heritage protection system itself, ensuring that audiences are not passive recipients but active interpreters and participants.

Taken together, these initiatives underscore how Dunhuang heritage continues to embody Moral and Didactic Function—a moral and warning function—through diverse contemporary media. From the parable of the Nine-Colored Deer to immersive VR experiences, from academic curricula to community-based music programs, the Mogao Caves transcend their original religious context to become multi-layered platforms for moral instruction, cultural identity, aesthetic education, and social engagement. The historical mandate of Dunhuang art—to guide, to warn, and to inspire—thus finds renewed vitality in the digital era, shaping not only cultural appreciation but also ethical consciousness for future generations.

Heritage Preservation Value of the Mogao Caves

The murals of the Mogao Caves are not merely works of art; they constitute a visual archive of religious doctrine, ritual performance, and cultural memory. One of the most remarkable artistic devices employed in these murals is the synoptic narrative. Within a single frame or adjacent registers, episodes from different points in time are juxtaposed to present an entire causal chain of events in condensed form. Repetition of figures within a single image allows the depiction of progression—such as the Buddha's life stories or episodes from sutras—while occupying minimal pictorial space. Many caves adopted compositional systems that corresponded directly to sutra passages or liturgical sequences, using horizontal registers or square compartments to separate narrative scenes. Distinct visual signifiers such as halos, lotus thrones, or the transmutation of weapons into ashes conveyed divine attributes, causal relationships, and moral lessons. As dynasties shifted and restoration projects were undertaken, the color schemes and stylistic nuances of these murals also evolved, providing an invaluable record of the aesthetic, doctrinal, and technical transformations across centuries (Kong, 2025).

However, this cultural treasure faces unprecedented challenges due to the fragility of its medium. The influx of large-scale tourism threatens to create irreversible damage to both the murals and the cave micro-environments. To mitigate this, the Dunhuang Academy has adopted a strategy of zoning, visitor flow control, and capacity limits. Access to the caves is strictly regulated: visitors must book in advance, and tours are scheduled according to the carrying capacity of each section. This policy

minimizes physical strain on the caves while balancing the demand for cultural access. Complementing these restrictions, digital initiatives such as Digital Dunhuang and Cloud Dunhuang provide virtual access through VR reconstructions, panoramic imaging, and 3D modeling. These platforms allow global audiences to explore the Mogao Caves online, reducing pressure on the physical site while amplifying educational and cultural outreach.

Preservation also relies on continuous environmental monitoring and scientific conservation techniques. Sensors track humidity, temperature, CO_2 concentration, and visitor density to ensure environmental conditions remain within safe thresholds. Preventive conservation is complemented by interventions such as structural reinforcement, consolidation of pigments, and restoration of faded colors. International collaborations, exhibition exchanges, and scholarly publications further extend the preservation mission by integrating advanced technologies with cultural communication. Artistic reinterpretations, educational projects, and contemporary creative practices bring Dunhuang's legacy into dialogue with modern life (Xu, Zhang, Du, & Seong, 2024).

A landmark achievement in digital preservation is the Mogao Caves Panorama Digital Library. Through high-resolution photography, 3D reconstruction, and panoramic stitching, this platform has created an immersive virtual archive of the caves. Users can freely navigate cave interiors, zoom into mural details, and engage with embedded annotations, audio guides, and scholarly commentary. Beyond replicating the physical experience of visiting the caves, the system provides layered interpretive content, enabling a deeper understanding of the murals' religious significance, historical context, and artistic techniques. By transcending geographical and temporal boundaries, the platform democratizes access to Dunhuang's heritage and fosters international cultural exchange. With multilingual support and open access, it marks a crucial transition from "physical protection" to "digital inheritance" (Hu, Ho, & Qiao, 2017).

The Dunhuang VR Museum extends this concept by combining high-fidelity 3D modeling, panoramic video, and multimodal interaction. Visitors equipped with VR headsets can not only visualize the restored hues and textures of murals but also experience the soundscapes of ancient Dunhuang through reconstructed music. Gesture recognition and handheld controllers allow users to "touch" murals, trigger interactive storylines, and follow virtual pilgrimage routes. By simulating the journey of a Silk Road traveler, visitors gradually unlock layers of Dunhuang's artistic and religious world. Such immersive experiences are particularly effective in education, as they inspire curiosity among younger generations while instilling a heightened awareness of heritage conservation. Crucially, VR provides a sustainable alternative to on-site visits, reducing human impact while broadening public engagement (Lu, 2019).

A notable example of this innovation is the reconstruction of Cave 61's Mount Wutai Pilgrimage Mural. Here, 2D mural fragments are combined with 3D-rendered architectural elements to create a hybrid immersive space. Buildings are modeled with authentic geometric depth, while painted figures retain their original flat aesthetic. The integration of concave cave walls, portals, and skyboxes generates a spatial sense of movement. This reconstruction allows viewers not only to observe the mural but to "walk into it," following pilgrims through reconstructed temples, landscapes, and divine encounters. Fragmented pictorial data is thus woven into a coherent narrative, transforming passive viewing into embodied storytelling (Mu, 2024).

High-precision scanning, modeling, and panoramic stitching further ensure the digital immortality of the Mogao Caves. Gigapixel photography preserves the finest pigment particles, cracks, and brushstrokes, while spherical panoramas allow users to rotate perspectives freely. Interactive "hotspots" embedded in the panoramas provide textual explanations, audio commentaries, or related historical materials, enhancing interpretive depth. When displayed on large screens, details such as mudras or miniature narrative scenes can be magnified, allowing both experts and lay audiences to study them in unprecedented detail (Hu, 2015; Hu, 2018).

The Getty Conservation Institute (GCI), in collaboration with the Dunhuang Academy, has developed a systematic conservation framework encompassing mural stabilization, environmental regulation, material analysis, and protective infrastructure. Measures include natural and assisted ventilation systems to reduce humidity fluctuations, filters to minimize dust, and controlled low-intensity lighting to prevent photo-oxidation of pigments. Non-invasive techniques such as X-ray fluorescence (XRF) and infrared spectroscopy are employed to analyze pigments and substrates, ensuring the scientific selection of conservation materials. In cases where micro-samples are extracted,

stability and chemical reactivity tests guide long-term preservation strategies. Structural monitoring of cave walls and pigment adhesion is conducted periodically to evaluate conservation efficacy and optimize future interventions.

Equally important is the integration of "hard energy" and "soft energy" in preservation. While structural reinforcements, chemical stabilizers, and environmental controls constitute the hard energy of conservation, public education, digital communication, and cultural dissemination embody the soft energy. Transparent protective barriers prevent direct human contact with murals, while multimedia installations inform visitors about preservation challenges and cultural values. Visitor routes are optimized to minimize environmental stress, ensuring sustainability of conservation work. This holistic approach reflects a high-dimensional model of heritage protection that unites scientific rigor with public participation and cultural consciousness (Getty Conservation Institute & Dunhuang Academy, 2023).

Through these multilayered strategies—spanning physical conservation, digital reproduction, immersive education, and public engagement—the Mogao Caves stand as a global exemplar of heritage protection. They illustrate how ancient cultural treasures can be safeguarded against environmental and human threats, while simultaneously being revitalized through innovative technologies. This dual focus ensures that Dunhuang's legacy continues to function not only as a religious and artistic treasure but also as a dynamic site of cross-cultural dialogue, technological innovation, and moral education for generations to come.

Appreciation Value of Dunhuang's Mogao Cave Murals

The Mogao Caves murals are not merely artistic decorations; they function as a visual text, narrating Buddhist scriptures, moral principles, and aspects of social life through highly developed pictorial storytelling. This visual text takes form in the so-called bianxiang (transformation tableaux), such as the Amitabha Sutra Transformation and the Lotus Sutra Transformation. These murals unfold the chapters and episodes of Buddhist sutras in sequential frames, much like illustrated storyboards. By arranging complex doctrines into comprehensible narrative scenes, the murals transformed the cave walls into a "visualized scripture." This was particularly powerful in a society where literacy was limited, as even the illiterate masses could grasp the essence of Buddhist teachings by viewing these pictorial renderings. The murals thus operated as a democratized medium of education and spiritual cultivation, bridging textual tradition and visual pedagogy (Kong, 2025).

The visual text of Dunhuang murals was further enriched by a sophisticated symbolic system that carried precise religious meanings. Hand gestures (mudrās) communicated different aspects of the Buddha's teaching and blessing; the lotus throne symbolized purity, enlightenment, and rebirth in the Pure Land; the halo radiating behind Buddhas or bodhisattvas signified divine illumination; while the celestial apsaras (flying deities) embodied joy, offering, and celebratory devotion. Through these symbols, viewers engaged in a process of "visual reading." Eye contact between figures, the positioning of hands, and the structuring of pictorial space guided the audience psychologically into the unfolding sacred narratives. In this sense, the murals functioned as an early form of immersive reading, not unlike today's concept of "immersive storytelling." In some caves, inscriptions or excerpts from scriptures were painted alongside the images, further clarifying the doctrinal points and enhancing the murals' didactic function. Importantly, the composition of the murals followed a religious hierarchy: the central wall often depicted the Buddha or major deities, while surrounding panels included disciples, devotees, or historical scenes, reinforcing both doctrinal centrality and social order.

One illustrative case is Cave 323, built during the early Tang dynasty. Though relatively small, with its front chamber constructed with a flat ceiling and the rear chamber capped with a dome, the cave encapsulates the full richness of Dunhuang mural tradition. High-resolution scanning, three-dimensional modeling, and detailed textual documentation have revealed its layers of meaning. The murals depict Buddhist scriptures and ritual scenes, including central Buddha images, guardian deities, disciples, and celestial beings. Through digital reconstruction, the cave has been transformed into a navigable entry in databases, allowing scholars and the general public to explore its artistic details. Beyond religious worship, the murals function visually as tools for education, imparting moral lessons, cosmological ideas, and cultural values.

With the advancement of digital technology, 3D virtual tours of Mogao Caves like Cave 323 have become central in scholarship, education, and public dissemination. Virtual navigation allows users to rotate perspectives freely, zoom into intricate details, and experience the cave's spatial arrangement. This provides not only aesthetic pleasure but also a deeper sense of proportion, scale, and composition

within the cave space. Scholars benefit by conducting detailed research remotely, while students and global audiences gain opportunities to experience Dunhuang heritage without being physically present. Such platforms demonstrate how virtual heritage effectively integrates research, teaching, and cultural outreach, greatly amplifying the appreciation value of the Mogao Caves (University of Washington Libraries, 2024).

A major innovation in the digital preservation and appreciation of Dunhuang art is the "AI for Dunhuang" project, one of the largest and most comprehensive mural datasets in the world. Containing over 10,000 mural images, it provides resources for training and evaluating restoration models. Through deep learning and computer vision, the project assists in digitally repairing murals damaged by environmental erosion, historical wear, or human interference. By reconstructing missing segments at the digital level, AI contributes to restoring the integrity of these artworks, enabling audiences to appreciate them closer to their original state (Yu et al., 2022).

The dataset also includes 3,455 images covering murals from different historical periods, thereby documenting stylistic evolutions from the Northern Wei through the Sui, Tang, Song, and Yuan dynasties. This provides art historians with a systematic basis for studying the transformation of iconography, techniques, and stylistic conventions across centuries. Furthermore, the dataset contains 6,147 tagged images annotated with attributes such as figures, Buddhist scenes, decorative elements, and color schemes. This allows researchers to quickly retrieve, for instance, all depictions of Avalokiteśvara (Guanyin) or specific transformation tableaux. Such rapid and precise access dramatically improves both the efficiency and the accuracy of Dunhuang studies, moving the field toward data-driven scholarship.

Beyond restoration and research, "AI for Dunhuang" also plays a pivotal role in digital dissemination and education. Its dataset supports the development of immersive experiences using virtual reality (VR) and augmented reality (AR). These technologies enable global audiences to engage interactively with Dunhuang art in museums, classrooms, or even personal devices. At the same time, the initiative fosters cross-disciplinary collaboration among computer scientists, art historians, archaeologists, and scholars of religion, illustrating how cultural heritage preservation increasingly relies on interdisciplinary innovation (Yu et al., 2022; Lian, 2024).

In parallel, the E-Dunhuang panoramic exhibition and virtual navigation platform exemplifies how digital heritage enhances appreciation. Based on 360-degree high-resolution panoramic images, it reproduces the interiors of caves, including murals, sculptures, and architectural layouts, with remarkable fidelity. Through intuitive controls, users can rotate, zoom, and shift their perspective, accessing every detail of the caves. Information layers are integrated into the interface: when clicking a specific area, supplementary annotations, high-definition images, or audio guides pop up. Its logical navigation system enables exploration by historical era, religious theme, or artistic style. The experience is enriched with scholarly commentaries, audio tours, and multimedia references, offering learners multi-sensory understanding.

For instance, while exploring the mural of the Western Pure Land Transformation, the system synchronizes sutra explanations with artistic analysis, helping users grasp both the doctrinal background and stylistic features. Interactive "learning prompts" embedded in the platform pose reflective questions to the viewer, encouraging critical engagement rather than passive observation. As Hu (2018) emphasizes, this platform is not merely a display of cultural heritage but an innovative pedagogical tool, significantly advancing global cross-cultural education in Dunhuang studies.

Together, these initiatives reveal the multifaceted appreciation value of Dunhuang murals. At the artistic level, they exemplify the pinnacle of ancient Chinese religious art, blending narrative clarity, symbolic sophistication, and aesthetic harmony. At the cultural level, they serve as visual scriptures, making Buddhist philosophy accessible to broader audiences across literacy levels and cultural backgrounds. At the technological level, they inspire innovations in digital heritage preservation, AI-based restoration, and immersive education. Finally, at the pedagogical level, they encourage interdisciplinary dialogue, cross-cultural appreciation, and ethical reflection.

Ultimately, the murals' appreciation value lies not only in their visual splendor but in their capacity to connect past and present, text and image, tradition and innovation. Whether viewed within the cave's dim interior, through a panoramic digital interface, or reconstructed via AI algorithms, Dunhuang murals continue to inspire awe, provoke moral thought, and foster cross-cultural understanding. In this sense, the Mogao murals are not only relics of the past but also living texts,

perpetually reinterpreted in the light of new technologies, new audiences, and new educational paradigms.

Commercial Value of the Mogao Caves

The commercial value of the Mogao Caves is not merely a question of economic benefit but rather a multidimensional concept that connects cultural heritage, tourism management, digital technologies, and global communication. In recent years, scholars and practitioners have increasingly examined how frameworks from psychology and consumer behavior can illuminate the mechanisms by which heritage sites generate sustainable cultural and economic returns. Among these frameworks, the Stimulus–Organism–Response (SOR) model has proven particularly relevant for understanding the visitor experience at the Mogao Caves.

The SOR model conceptualizes human behavior as a process in which external stimuli (S) affect an organism's internal states (O), which in turn generate behavioral responses (R). When applied to cultural tourism, this framework explains how visitors' exposure to heritage narratives influences their perceptions and behaviors.

In the case of the Mogao Caves, the stimulus (S) refers to the historical and narrative dimensions of the site: the murals and sculptures, the stories they represent, the evolution of artistic styles, accounts of cross-cultural exchanges along the Silk Road, and the biographies of historical figures associated with Dunhuang. These elements are communicated through exhibitions, guided tours, multimedia platforms, and storytelling techniques that bring the caves to life for contemporary audiences.

The organism (O) represents the visitors' internal cognitive and affective processes. After encountering these narratives, tourists construct mental images of the destination, form evaluations of its cultural and artistic significance, and assign personal value to the experience. This stage mediates between stimulus and response by shaping the overall impression and perceived value of the visit.

The response (R), finally, manifests as behavioral outcomes such as satisfaction, willingness to recommend the site, or the intention to revisit. Crucially, the decision to return—or to advocate for the site through word-of-mouth—depends on how strongly the stimuli (narratives, visual impressions, cultural depth) translate into perceived value and emotional attachment. Research suggests that by carefully curating historical storytelling and emphasizing cultural symbolism, heritage managers can enhance destination image and foster long-term visitor loyalty (Yuxin, 2024).

The SOR framework highlights the importance of stimuli, but in practice, heritage managers must also consider how these stimuli are framed and communicated. Here, the concept of impression management becomes crucial. Impression management refers to the deliberate control of information and imagery by institutions to shape public perception. For the Mogao Caves, impression management is both a branding strategy and a heritage preservation paradigm.

Digital media plays a central role in this process. High-resolution mural photography, before-and-after restoration comparisons, and detailed images of motifs such as apsaras or Buddha figures are disseminated via platforms such as Weibo, WeChat, Facebook, and Twitter. These visual materials are often accompanied by explanatory texts—short essays explaining the symbolic meaning of particular figures, online lectures on Buddhist art, or video documentaries of conservation work. Social media hashtags invite visitors to share their experiences, while livestreams and VR/AR virtual tours offer behind-the-scenes access to conservation laboratories or immersive explorations of cave interiors.

Through such strategies, the Mogao Caves are presented not only as a tourism destination but also as a transparent, living institution of cultural preservation. Visitors perceive conservation efforts as open and participatory, which strengthens trust and public engagement. Moreover, by highlighting restoration processes and academic research, impression management communicates that Dunhuang is not only a site of visual splendor but also a locus of scientific rigor and cultural responsibility.

The integration of impression management with social media has generated a new form of digital heritage marketplace. On platforms like Weibo and WeChat, the Dunhuang Academy and affiliated institutions continuously release updates about Digital Dunhuang, online exhibitions, and conservation results. Three distinct dimensions can be identified in this communication strategy:

1.Aesthetic orientation: By emphasizing mural colors, composition, and artistic beauty, digital content appeals to the public's sense of visual appreciation, reinforcing Dunhuang as an unparalleled art treasury.

2.Academic authority: Through online lectures, digital catalogues, and scholarly exhibitions, the site projects an image of intellectual seriousness, encouraging the public to recognize its heritage value

beyond mere tourism.

3.Narrative intimacy: Storytelling, user-generated content, and shared visitor experiences foster emotional closeness between the site and its audiences. By inviting participation and encouraging dialogue, Dunhuang establishes itself as part of personal and collective identity.

In international communication, managers emphasize the Mogao Caves as a "shared heritage of humanity" rather than overemphasizing national identity. This inclusive framing enables global audiences from diverse cultural backgrounds to establish emotional resonance with the site, thereby enhancing its international cultural capital (Jinsha, 2025).

The commercial success of heritage tourism inevitably brings challenges: overcrowding, environmental risks, and concerns about authenticity. Effective impression management must therefore include crisis communication. Proactive responses to visitor complaints, concerns about mural damage, or reports of environmental degradation are crucial for sustaining credibility. For example, when issues arise, official platforms often feature interviews with conservation experts or site managers, providing transparent explanations that reassure the public.

This strategy is reinforced by multilingual outreach. Tweets, posts, and videos in English, Japanese, and other languages highlight Dunhuang's role in Silk Road cultural exchange, positioning it as a bridge between civilizations. By monitoring metrics such as traffic volume, likes, shares, comment sentiment (positive vs. critical), and follower growth, managers can evaluate the effectiveness of impression management strategies and adjust communication policies accordingly.

Beyond descriptive communication, the commercial value of Dunhuang is increasingly linked to big data analytics. Scholars have begun to retrieve and clean social media data—for example, Weibo posts and comments containing the keyword "Digital Dunhuang." After removing noise and stopwords, high-frequency terms are analyzed to construct co-occurrence networks. Findings reveal that words such as "cultural art," "virtual experience," "technology," and "heritage protection" frequently appear alongside "Digital Dunhuang," indicating strong associations with innovation and cultural appreciation. In contrast, terms like "restoration," "environmental monitoring," or "conservation management" appear less frequently, suggesting that while the public values digital visualization, technical conservation is less visible in discourse (Liu, 2025).

Sentiment analysis further demonstrates that most online discussions are positive or neutral, with users praising the immersive experiences and cultural dissemination achieved through digital platforms. This indicates that digital heritage communication enhances not only visitor experience but also brand equity, which in turn strengthens the site's commercial sustainability.

Toward a Sustainable Commercial Strategy

The commercial value of the Mogao Caves thus lies in its capacity to integrate heritage preservation, tourism development, and digital communication into a coherent system. By combining the explanatory power of the SOR model with impression management strategies and data-driven insights, Dunhuang demonstrates how heritage sites can balance economic sustainability with cultural authenticity.

The final step in this process is adaptive policy-making. Feedback from media platforms—traffic flow, likes, shares, comment quality, and sentiment trends—enables managers to adjust commercial strategies in real time. For example, if user data indicates high interest in virtual exhibitions but concern about on-site overcrowding, the institution can prioritize investments in VR development while tightening physical visitor limits. Similarly, if international audiences respond more positively to narratives of cultural exchange than to nationalistic framing, managers can recalibrate their communication accordingly.

CONCLUSION

The Mogao Caves illustrate that commercial value in heritage contexts is not synonymous with commodification. Rather, it represents the sustainable circulation of cultural meaning, educational engagement, and economic return. Historical narratives function as stimuli that shape visitor impressions and perceived value; impression management strategies enhance the site's image and emotional connection; and digital analytics provide feedback loops for continuous adaptation.

In this sense, Dunhuang's commercial value emerges as an intersection of heritage, education, and commerce. By leveraging digital technologies, storytelling, and participatory communication, the site transforms itself into a global cultural brand while safeguarding its fragile treasures. As digital

platforms evolve and audiences diversify, the Mogao Caves will continue to stand as a model for how cultural heritage can be both preserved and reimagined for the future.

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RESEARCH ON THE PATH OF CULTURAL INHERITANCE AND EDUCATION OF CHINESE MEDICINE IN VOCATIONAL COLLEGE UNDER THE PERSPECTIVE OF "CRAFTSMANSHIP"

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ABSTRACT

Through investigation and research, a deep understanding of the contemporary connotation of traditional Chinese medicine culture of craftsmanship is gained. The current situation of the understanding of craftsmanship by teachers, students, and enterprises, which includes insufficient understanding, lack of professional integration, integration of industry and education in a formal manner, and lack of a craftsman-type teaching team, is also analyzed. In the end, it is concluded that the targeted countermeasures are to combine with the campus culture construction, hold and participate in traditional Chinese medicine skills competitions, set up more Chinese medicine special skills courses, carry out the reform of the curriculum and teaching mode, and adhere to and carry forward the "artisanal spirit" in the training of teachers, to provide practical guidance for the cultivation and inheritance of the craftsmanship spirit of the traditional culture of traditional Chinese medicine.
Keywords: Craftsmanship, Cultural inheritance, Traditional Chinese Medicine, Vocational college

INTRODUCTION

Higher vocational education, as the main place for cultivating China's future craftsmen, bears the heavy burden of cultivating and conveying qualified builders for the country, and to cultivate qualified craftsmen, higher vocational education cannot be separated from the proposition of cultivating the spirit of craftsmanship. Craftsmanship, as a spirit of dedication, excellence, concentration, innovation, and other rich connotations, whose core is the ultimate pursuit of quality, has great social value and educational significance, and is the spiritual benchmark of modern vocational education, as well as the characteristics and soul of vocational education, which is to "cultivate educated people with excellent morality ".

The traditional culture of Chinese medicine is characterized by the following features: firstly, diversity. In the long course of history, the exploration of countless practitioners of traditional Chinese medicine has left behind a rich culture of traditional Chinese medicine for future generations. Secondly, valuable. As a classic work of Chinese medicine, “Huang Di Nei Jing” is still a guide for modern health and wellness and a powerful tool for curing diseases and strengthening the body; “The Compendium of Materia Medica” is still regarded as a guiding principle by practitioners of Chinese medicine; The principle of "Great Physician Excellence and Sincerity" is still a professional guideline for doctors of TCM; and the fundamental basis for diagnosis and treatment of diseases by traditional Chinese medicine practitioners has remained to be the same as that for the present day. Thirdly, ethnicity. The traditional culture of Chinese medicine contains the philosophy of evidence-based treatment, the systematic thinking of the five elements theory, and the unique acupuncture technique, reflecting the unique wisdom of the Chinese nation.

The Chinese government attaches great importance to people's health, and the Healthy China Strategy clearly states that to meet the growing health needs of the people, the quality of services provided by the Chinese medicine industry should be further improved, and therefore it is necessary to cultivate high-quality Chinese medicine talents to meet this goal. The Outline of the Strategic Plan for the Development of Chinese Medicine (2016-2030) also sets out the objectives of cultivating talents for the inheritance of Chinese medicine and promoting the healthy development of Chinese medicine. In this regard, under the perspective of craftsmanship cultivation, higher vocational colleges should comply with the social demand for medical service talents, ensure that the talents not only have employment

knowledge and skills, but also pay attention to the improvement of students' comprehensive quality, and the core element is to inherit and carry forward the traditional culture of excellent traditional Chinese medicine, and organically integrated into the whole process of talent cultivation, to realize the double cultivation of their professionalism and humanistic qualities, and to better satisfy the social demand for talents of traditional Chinese Medicine.

The culture of TCM is a concentrated manifestation of the profound philosophical thinking, noble morals, and outstanding civilized wisdom of the Chinese nation in the process of development and accumulation of Chinese medicine. From the perspective of cultivating high-quality technical talents in the field of "craftsmanship", the cultural heritage of Chinese medicine is very rich in value. Fully exploring and applying the cultural resources of Chinese medicine can not only give full play to its function of educating people and promoting the overall development of students but also enrich the connotation of cultivating Chinese medicine professionals in higher vocational colleges and universities, further promoting the reform of the cultivation model, and enhance the cultivation work. It can also enrich the connotation of talent cultivation in higher vocational colleges further promote the reform of talent cultivation mode and enhance the pertinence and effectiveness of talent cultivation work.

This research firstly collected, collated, and analyzed the relevant domestic and international literature on craftsmanship, further refined and enriched the connotation of craftsmanship contained in the traditional culture of Chinese medicine, and achieved a high degree of compatibility between the two. Then a typical path of implanting Chinese medicine culture into professional talent training under the perspective of craftsmanship is designed. In the process of implantation, focusing on the integration of industrial elements, industry elements, and vocational elements, creating a campus atmosphere to promote the spirit of craftsmanship in Chinese medicine, and carrying out the cultivation of professionalism, dedication, and innovation qualities of students, to make the students have the basic qualities of the spirit of craftsmanship, comprehensively improve their professionalism, and enhance the effectiveness of cultural education.

THEORETICAL FRAMEWORK

Overview of research on the definition and connotation of craftsmanship in Traditional Chinese Medicine

Influenced by historical development, social division of labor, and industrial fields, the connotation of craftsmanship at the macro level is extremely rich. The craftsmanship of countries around the world stems from the long-term development and accumulation of their own national culture and character. Traditional Chinese Medicine (TCM), which has the longest history in China and has made great contributions to the continuity of the Chinese nation over the past thousand years, can be looked upon to be the industry that best represents this spirit.

According to **“**Shuo Wen Jie Zi**”**, an ancient Chinese book that explained the structure and meanings of Chinese script, listed that "doctors are healing craftsmen." "Craftsmen" in ancient times was originally a title for healers. The formation, inheritance, and promotion of craftsmanship in Chinese medicine are based on the supreme pursuit of skills and morality by medical workers and pharmacists, which is sublimated in practice and continuously internalized. (Wu, 2019) concluded records in “Zhou Li - Kaogong Ji" and mentioned that those who have great wisdom and create objects that are beneficial to human activities, and who record the process of making them and pass them on, can be called Craftsmen. Craftsmen are always people with great wisdom. From the perspective of the emerging society, (Du, 2021) illustrated that the educator Cai Yuanpei’s elaboration on the connotation of "technician": firstly, the spirit of diligence, secondly, proficient skills, and thirdly, the ability to produce value, raising the status of "technician" to an unprecedented level. He stated that “teachers' professional ethical responsibilities include both nurturing and establishing morality and in the process of education, both moral and intellectual education should be given equal importance, to cultivate students' good morals and help them form a correct outlook on life and values. Only students who have both moral and intellectual qualities can develop in an all-round way and become the talents demanded by modern society.” This statement emphasized that the criteria for teachers to implement moral education should also change at any time and in any place by different circumstances and that the moral education and indoctrination of students by teachers is not to make them into saintly personalities with high morals but to cultivate modern citizens who give equal importance to both public and private virtues. By future developing Sun Simiao’s judgement, (J. Xia & Cao, 2020) classified the level of professional

competence of medical workers according to the unique treatment concept of Chinese medicine, and proposed that "the upper worker treats the undiseased, the middle worker treats the desirous, and the lower worker treats the sick." In the classification of these levels of medical workers, the criteria are mainly twofold: the level of mastery of theory, and the level of diagnosis and treatment. Those who reached the highest level were regarded as "superior workers". Behind the principle of treating human beings rather than diseases is the medical concept of humanistic care and the pursuit of the highest level of medical skills. This concept and pursuit is the essence of craftsmanship (J. Xia & Cao, 2020). The highest level of Chinese medicine is "upper worker", which refers to those who have a wide range of knowledge, accurate diagnosis of diseases, and a high cure rate. Historically, those who could reach the realm of "upper worker" are all famous doctors who have excelled through the ages, such as Bian Que, Hua Tuo, Zhang Zhongjing, etc. They are all dedicated, persistent, and constantly pursuing excellence and perfection, they make every diagnosis and treatment process perfect, and every prescription can become a classic. Therefore, becoming an "upper worker" is also the goal of every TCM practitioner in his/her life. To become an" upper worker ", it is necessary to possess the craftsmanship of striving for excellence.

As Traditional Chinese Medicine is a unique culture and industry that originated in China, foreign research does not contain a clear definition of the connotation of craftsmanship and in-depth study. However, some foreign research has been implemented to stress the performance of craftsmen in professional activities with certain expositions. (Foege 2014) emphasized the importance of the spirit of innovation, referred to in his book on the essence of the artisan, which was a collection of modified technology available to solve problems, the realization of the creation of wealth. Moreover, Alec Foege also believed that the spirit of craftsmen can be expanded to the pursuit of innovation of the various sectors of the staff, if the staff treats their work to strive for excellence can be called “the spirit of craftsmanship”. Japanese scholar Kazushi Akutsu thinks that enterprises must cultivate the spirit of craftsmanship and believes that the pursuit of the spirit of craftsmanship is the basic quality for individuals to become craftsmen and pass on the spirit of craftsmanship. Japanese entrepreneur Toshihide Akiyama, on the other hand, analyzes the carpentry industry in which he works and speaks his view on the standard of talents cultivated by the spirit of craftsmanship, which is, the importance of personality is far more than that of technology. Asiyanbola stressed that a craftsman or artisan is a person who has acquired the basic skills in one or two trades. The person must be certified by the mentor or supervised trainer. The importance of vocational college in cultivating the spirits of craftsmen, (Decker, 2019) pointed out that the master craftsman passes along years of skill and wisdom to the younger apprentice while gaining the youthful, energetic infusion of labor from the burgeoning new learner. Highlighted the fundamental role of vocational colleges and universities in the training of craftsmen and emphasized the strategic significance of the integration of craftsmanship in education for the training of highly skilled personnel.

From foreign studies, it can be concluded that foreign scholars believe that the spirit of craftsmanship has a driving effect on the development of individuals and enterprises, which is a good guiding significance for us to further condense the research on the spirit of craftsmanship embedded in the traditional culture of traditional Chinese medicine. There are many domestic studies on craftsmanship, but the research is positioned in the field of Chinese medicine culture inheritance and education, especially on the combination of higher vocational colleges and universities in the cultivation of Chinese medicine-related professionals is relatively small, and there is an urgent need to improve the connotation of craftsmanship research on the Chinese Medicine industry.

Exploration of the Integration of Craftsmanship into Chinese Medicine Culture Inheritance and Education in Vocational Colleges

The foundation of "From Skill to the Way" is the combination of craftsmanship and character. In the Chinese craftsman tradition, merely striving for excellence is not enough to achieve transcendence in the realm of craftsmanship. The further pursuit of the craftsman is to "advance from skill to virtue", to realize the truths of the world in ordinary work, and finally to get rid of the spirit of the artisan and become an artist. The most direct embodiment of craftsmanship in the field of traditional Chinese medicine is "Great Medical Excellence and Sincerity". In this medical classic, which is known as the "Hippocratic Oath of the East". (Jian et al., 2022) concluded famous statements from Sun Simiao’s medical theory and pointed out that medical practitioners should possess two core elements - "Excellence" and "Sincerity". Only the combination of excellent medical skills and high moral integrity

can be called a "great doctor". It can be seen that "Great Physician and Sincerity" is highly compatible with the spirit of craftsmanship in the core and is a specific interpretation of the spirit of craftsmanship in the field of traditional Chinese medicine and the deepening of the industry.

Because of the combination of basic theory and practical skills, the combination of humanistic care and clinical practice, and the pursuit of value over economic benefits, the requirements for the construction of its human resources, and the connotation of craftsmanship in the field of traditional Chinese medicine are very suitable. Combined with the characteristics of the Chinese Medicine Industry, the excavation and interpretation of craftsmanship are more specific and subtle, which not only can make it fit the reality of Chinese medicine in higher vocational colleges but also is the enrichment and extension of the connotation of craftsmanship. (Zhao et al., 2021) believed that the use of craftsmanship can help students establish a correct labor attitude, form a good sense of labor identity and outstanding labor ability. Regarding the research on the importance of cultivating craftsmanship in the Chinese medicine industry, (Li et al., 2019) argued that the effect of Chinese medicine cultural education, which can inherit and innovate the value of Chinese medicine, needs to be led and reshaped by value rationality as a way to cultivate the craftsmanship of the students of Chinese medicine-related majors. (WU et al., 2018) and others believe that the ethnicity and value of traditional Chinese medicine culture and the spirit of dedication, innovation, integrity, and other spirits of craftsmanship have similarities and similarities, and expound that it is possible to create a good atmosphere for cultivating talents by culture, optimize the overall teaching mode of higher vocational colleges and universities by skills training, and innovate the teaching methods of Chinese medicine majors in higher vocational colleges and universities by emotionally touching the people, which can be used to improve the students' professional skills and strengthen the spirit of professionalism. According to (Li et al., 2019), when cultivating the craftsmanship of Chinese medicine students, it is necessary to follow the laws of psychology as a whole, and cultivate the benevolence, dedication, and refinement of medical students from the four paths of knowledge, emotion, will, and behavior. (Hang et al., 2023) insists that the cultivation of craftsmanship is a systematic project that requires the combined efforts of colleges, enterprises, the government and society. From the college level, the cultivation and inheritance of craftsmanship should be implemented into the curriculum; enterprises should create an enterprise culture that advocates "craftsmanship", establish incentive mechanisms, and integrate modern craftsmanship into production and apply it in practice by relying on the "dual system", modern apprenticeship and other forms of cultivation; The government should formulate and improve corresponding laws and regulations at the macro level to ensure the implementation of the cultivation of modern craftsmanship. At the same time, it is also necessary to bring into play the role of social forces and the correct value orientation of the craftsmanship spirit. Based on the research on the correlation between the inheritance of craftsmanship and the cultural inheritance of Chinese medicine, (Tian, 2018) pointed out that the essence of craftsmen's inheritance is that "all handicrafts are passed on orally and by heart", that is to say, craftsmen pass on their crafts and at the same time, they also pass on the spirit of striving for excellence and perseverance, which is a necessary quality for all craftsmen. This cultural trait, passed down from generation to generation, is similar to the teacher education of Chinese medicine. The "craftsmanship" in the teacher training of Chinese medicine culture is not simply a matter of The "craftsmanship" in TCM culture teacher education is not simply treating diseases and saving people as a tool to make a living and get rich, but also cultivating a kind of It is also necessary to cultivate a relentless pursuit of the cause, to establish a spirit of excellence, perseverance and refinement, and to develop a spirit of "craftsmanship" on behalf of the students. And to pass it on from generation to generation.

In terms of practical research, many Chinese Universities of TCM have actively explored and achieved certain results in the inheritance and innovative development of TCM culture. In the area of vocational education, which is characterized by the combination of knowledge and skills education, many people and institutions have carried out some research and practice in exploring the cultivation of students' awareness of Chinese medicine culture, and the inheritance and innovative development of traditional skills, and have gained some experience that can be referred to. (Li et al., 2019) proposed that students can recognize the importance of craftsmanship through the study of canonical books; perceive craftsmanship through the power of role models; cultivate craftsmanship through campus culture; and practice professionalism by using professional practice. (Zheng et al., 2019) put forward targeted countermeasures, such as the combination of craftsmanship education and campus culture construction, holding and participating in traditional Chinese medicine skills competitions, increasing the number of

courses on Chinese medicine special skills, reforming the teaching mode of the curriculum, and adhering to and promoting the "craftsmanship" in the training of teachers, to provide practical guidance for the cultivation and inheritance of the craftsmanship of the traditional culture of traditional Chinese medicine. A person's spiritual upbringing is composed of 4 psychological elements of knowledge, emotion, intention, and action, which refer to cognition, emotion, will, and behavior, respectively. From cognition to emotion, then from emotion to will, and finally from a will to behavior, it is a basic and inseparable assembly line of human self-control. (M. Xia, 2015) tried two aspects of improvement: Firstly, the knowledge of TCM cultural inheritance and innovation was incorporated in all teaching activities through teachers' words and teaching contents appropriately; secondly, students were allowed to feel the TCM culture of the TCM enterprises in the professional and vocational practices such as comprehensive practical training, graduation design, and top internship. This enables students to build up cultural self-confidence and professional pride and effectively stimulates students' ability to independent learning, self-management, and self-identification. (Chang et al., 2022) through their research, believed that the campus culture of TCM, as a kind of environmental education force, has a great influence on the formation of good ideological concepts and correct value orientation of students. By setting up a publicity area for the spirit of craftsmen of TCM in teaching buildings, canteens, libraries, and other iconic places on campus, and establishing online publicity channels through the official website of the school, new media, microblogging groups and other means of communication, students can be inspired by the power of role models at all times, and firmly hold on to their ideals and beliefs. Then, through rich extracurricular activities such as film and television dramas, drama rehearsals, social practice projects, knowledge competitions, etc., we create a campus atmosphere in which everyone respects the spirit of craftsmanship. (Xue et al., 2022) took "Humanities and Science +" of Chinese medicine culture as the core value leader, systematically designed a new type of second classroom curriculum system for the university, and through college students leading primary and middle school students to carry out cultural studies, classical recitation, Chinese medicine lectures, dialogues with famous doctors, and visits to non-hereditary people, etc., And finally formed an outstanding off-class curriculum system with distinctive disciplinary characteristics, prominent value leadership. (Hou, 2019) innovated teaching methods. He integrated Case study method and role-playing to activate the classroom and give a new look to the traditional Chinese medicine culture class. Taking the deeds of the medical sage Zhang Zhongjing as an example, students were organized to study the Treatise on Miscellaneous Diseases of Typhoid Fever to learn his innovative spirit and inspire them to devote themselves to the cause of medicine. By organizing students to role-play and rehearse the sitcom "Li Shizhen", they can understand the feelings of Li Shizhen as a medical saint and medicine fairy, and encourage students to continue to innovate and be "qualified pharmacists" in the new era. (Yingjie et al., 2020) has set the dual objectives of professional teaching and moral education in the teaching of the course of "Chinese Medicine Preparation Technology". Through the course learning of Chinese medicine concocting, students can master the basic theory, basic knowledge and basic skills of Chinese medicine concocting, and have the basic ability to engage in the production and research of Chinese medicine by using the relevant knowledge and skills of Chinese medicine concocting; at the same time, the traditional culture of Chinese medicine and craftsmanship are reasonably integrated into the knowledge in the process of teaching and learning, and students are guided to set up a correct outlook on life and values, and the goal of moral education is carried out in the whole teaching and learning process. The goal of moral education is carried out throughout the whole teaching process and serves the goal of training professional talents. (Yang et al., 2023) introduced a project management method. Under this method, the whole cultivation stage from the beginning of students' enrolment to their employment after graduation is regarded as a TCM cultural education project, and the education work is efficiently promoted in the five process groups of project initiation, planning, execution, control and completion, so as to change the phenomena of the marginalization, blindness, disorder and inefficiency of TCM cultural education with the guarantee of the system and mechanism. (Liu, 2019) designed an internship course, in which students and teachers go to the plant-rich field to carry out practical teaching. After collecting specimens of medicinal plants, students have to combine what they have learnt in class and judge the medicinal properties of the plants based on shape, color, smell and taste to deepen their understanding and memory. In the process of identifying medicinal plants, students must remain humble and low-key when they encounter plants they don't understand and look for information carefully with their classmates to learn together, or they can ask the teacher to give guidance and solve the problem

together. After completing the practical activities, each group will be assessed and evaluated to form a competitive mechanism, to continuously improve students' practical professional skills.

In summary, the concept and meaning of craftsmanship are different in each professional field, which leads to certain differences in the cultivation standards and methods of high-quality technical and skilled talents, and the cultural cultivation paths aiming at the cultivation of craftsmanship are also distinctive. In the existing research, the creation of Chinese medicine culture inheritance and nurturing mode in higher vocational colleges and universities based on the perspective of "craftsmanship" is left at the theoretical level, and its theory and practice have not yet been fruitful and worthwhile to promote the organic fusion, which has left a large research space to be explored.

METHOD

This research is designed to achieve three primary objectives. First, it seeks to conduct an in-depth investigation to delineate the core connotation and defining characteristics of craftsmanship within the traditional Chinese medicine (TCM) industry. Subsequently, it will critically analyze the significant role and implications of integrating cultural heritage and nurturing practices into TCM programs within the context of higher vocational education. Second, the study aims to explore and formulate strategic countermeasures for cultivating high-caliber TCM talent in vocational education systems. A key outcome of this exploration will be the construction of a specialized model for TCM cultural inheritance and nurturing, conceptualized and developed through the specific lens of the "craftsmanship" paradigm. Finally, the research will transition into the practical application phase, implementing the constructed model to identify and establish effective pathways and methodologies for promoting, perpetuating, and enhancing TCM cultural inheritance and nurturing within vocational educational settings.

The principal priority of this research lies in the systematic development and construction of a robust model for TCM cultural inheritance and education that is specifically tailored for vocational colleges and is grounded in the "craftsmanship" perspective. This endeavor is not merely theoretical; it necessitates the synchronous integration of theoretical principles with practical application. The ultimate goal is to create a coherent and well-defined model that is not only effective in its initial context but also possesses the qualities of being replicable, scalable for promotion, and suitable for academic and professional exchange. Conversely, the primary difficulty encountered in this study stems from a discernible scarcity of existing scholarly work that explicitly investigates the pathways and evaluates the efficacy of fostering TCM cultural inheritance specifically within the framework of "craftsmanship." This literature gap presents a significant challenge in the data collection phase of research, as it complicates the process of gathering comprehensive and representative information. Consequently, this limitation poses a potential constraint on ensuring the absolute authority and breadth of the data assembled for analysis.

To address these objectives and navigate the associated challenges, this study will employ a mixed-methods approach, primarily utilizing literature research and empirical research. The literature research method will be systematically employed to identify, collate, and synthesize exemplary research literature and established experiential knowledge pertinent to the research themes. The fundamental goal of this methodological component is to build a solid theoretical foundation and a comprehensive conceptual framework that will robustly inform and underpin the subsequent stages of the research process. Complementing this, the empirical research method will form the practical core of the study. During this phase, the "craftsmanship"-oriented model developed in the earlier part of the project will be actively deployed and applied. This application will focus on conducting a detailed study of the specialized model for cultural inheritance and nurturing as it is experienced by TCM students, allowing for the observation, analysis, and refinement of the model based on real-world educational practices and outcomes.

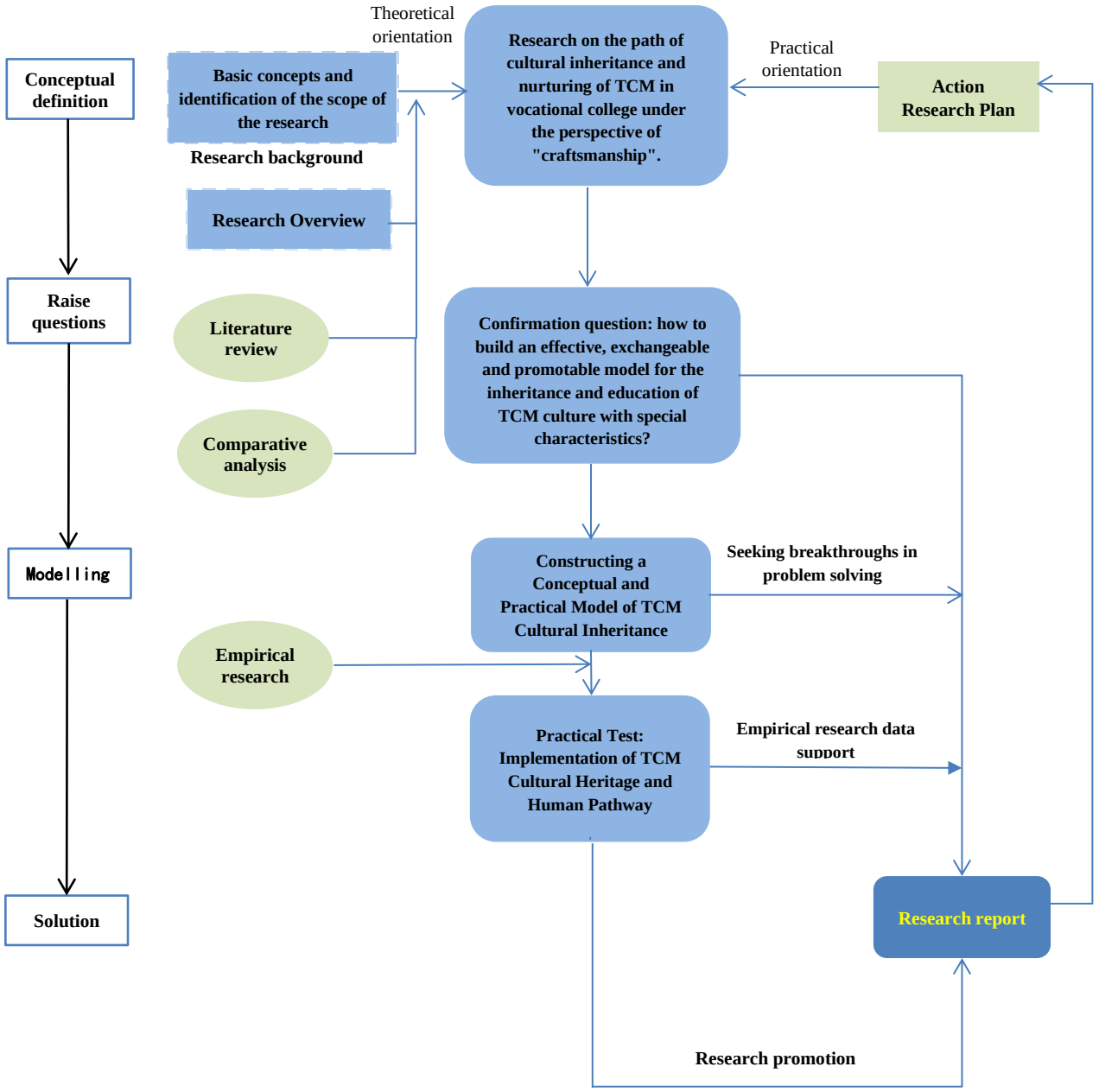


Figure 1. Research roadmap

FINDINGS AND DISCUSSION

The Connotation of Chinese Medicine Craftsmanship

In the long history of the development of TCM, there have been Bian Que, Hua Tuo, Sun Simiao, Li Shizhen and other medical craftsmen with noble medical ethics and exquisite art. From their stories, it is not difficult to draw the conclusion that to become a master craftsman, one must have extensive medical knowledge, exquisite medical skills and the spirit of striving for excellence. It is mentioned in "The Great Physician's Essence of Sincerity" that the way of healing is "a matter of the most exquisite and subtle nature", and that those who practice medicine should have a heart of "great kindness and compassion" and "see their sufferings as if they were their own", which is precisely the value orientation of the spirit of craftsmanship. This is precisely the value orientation of craftsmanship. This is consistent with the connotation of craftsmanship, which advocates striving for excellence, pursuing excellence, honesty and trustworthiness, love for one's work and dedication, dedication and rigor, and perseverance, and the essence of the spirit of craftsmanship in TCM lies in the spirit of "great kindness and

compassion" and "seeing one's suffering as if one were in it".

Higher vocational education of TCM is responsible for the inheritance and innovation of Chinese medicine and needs many highly skilled Chinese medicine talents with the spirit of craftsmanship. However, at present, higher vocational colleges pay more attention to the cultivation of "technology and skills", lack the continuity and environment of vocational ethics education, and neglect the education of students' values such as vocational quality, vocational connotation and vocational culture, and the education of craftsmanship has not been implemented well or thoroughly. Industry-teaching integration is an important form of cultivating craftsmanship. Through school-enterprise cooperation, higher vocational Chinese medicine colleges and universities guide students to enter hospitals and pharmaceutical enterprises to feel the culture and professionalism of Chinese medicine, and condense the realistic qualities of craftsmanship in the environment of industry-teaching integration: the professional ideal of striving for perfection and pursuing excellence in their careers, the professional spirit of honesty and trustworthy, and the professional attitude of focusing on rigorous and persevering in the work.

Path of Traditional Chinese Medicine Cultural Inheritance and Nurturing in the Context of Craftsmanship

The culture of Chinese medicine is the embodiment of the excellent traditional Chinese culture in the field of Chinese medicine, which contains a rich humanistic spirit, profound philosophical thoughts and scientific health concepts. Fully utilizing the philosophical wisdom, benevolence, harmony and way of thinking of Chinese medicine culture has a positive effect on the cultivation of qualified medical personnel. Medical vocational colleges should endeavor to explore positive and effective paths for the implementation of TCM culture inheritance and education strategy. Accelerating and upgrading the construction of Chinese medicine culture at the material level can provide a material basis for the implementation of Chinese medicine culture and educating people; standardizing and optimizing the construction of Chinese medicine culture at the institutional level can provide a systematic guarantee for the implementation of Chinese medicine culture and educating people; strengthening and highlighting the construction of Chinese medicine culture at the spiritual level can provide a spiritual guide for the implementation of Chinese medicine culture and educating people; attaching importance to and strengthening the construction of Chinese medicine culture at the behavioral level can provide a behavioral guide for the implementation of Chinese medicine culture and educating people. By strengthening and highlighting the construction of Chinese medicine culture at the spiritual level, it can provide spiritual guidance for the implementation of Chinese medicine cultural education strategy. To accomplish those goals, a model is designed and demonstrated as follows:

Create an environment for shaping craftsmanship

Characteristic campus culture and excellent enterprise culture is the best way to cultivate students' professionalism. As a traditional Chinese medicine university, the traditional Chinese medicine culture should be implanted into the whole process of professional talent cultivation in the field of industry-teaching integration, and in the process of implantation, industrial elements, industry elements and vocational elements should be integrated to create a campus atmosphere that promotes the spirit of craftsmanship of traditional Chinese medicine, and the professional, focused and innovative qualities should be cultivated in the students, so as to promote the internalization of the craftsmanship spirit into the pursuit of the students' spirit, and the externalization of it into the students' vocational behaviors, and to promote the basic qualities of the craftsmanship spirit and comprehensively enhance the vocational quality of students. The basic quality of the spirit of craftsmanship and the overall enhancement of professionalism is also promoted.

Building campus environment with Chinese medicine characteristics

Attaching importance to the cultivation of the environment on the quality of people, and actively create a campus landscape with rich Chinese medicine culture, focusing on the campus environment to enhance the cultural taste of the construction and details of the sculpture of the school in the campus greening, the formation of traditional Chinese medicine herbs as the main body of the "big medicine garden" pattern; in the campus landscape, the integration of elements of traditional Chinese medicine, give full play to campus culture In addition, the square can be used to set up bronze statues of famous doctors, sculptures, etc., in the teaching building, laboratory training buildings, office buildings, libraries and other walls of Chinese medicine portraits of famous doctors, etc., the establishment of an important platform for the inheritance and promotion of the culture of traditional Chinese medicine, to cultivate

students' noble morals, and to promote the excellent school spirit play a positive role in the school spirit, and so on.

Organizing Chinese medicine cultural activities

Focusing on the inheritance of Chinese medicine culture and promoting the integration of Chinese medicine culture into education and teaching, the university-enterprise co-operation carries out campus cultural activities of healthy and upward forms. Through school-enterprise co-operation, we carry out campus cultural activities in various forms, which are healthy and elegant, and endeavor to realize the cultural and practical education of Chinese medicine in a silent manner. Schools and enterprises to carry out "skilled craftsmen into the campus" theme activities and "alumni entrepreneurial success report", regularly invited enterprises skilled craftsmen, the National Traditional Chinese Medicine Skills Competition award-winning students, outstanding graduates, face-to-face exchanges with the students, guiding the students to establish the confidence of achievement This will guide students to build up confidence in achieving a wonderful life and strive to be great craftsmen, and further enhance the effectiveness of moral education. Holding the Chinese Medicine Culture Festival to promote the culture of Chinese medicine and inherit the spirit of craftsmanship. Through the culture of craftsmanship, the concepts of "benevolence and virtue" and "benevolence and skill" are used to guide the education of Chinese medicine, so that students can establish a professional attitude of excellence and the spirit of dedication.

Innovate talent cultivation mode and build a platform for cultivating craftsmanship.

According to the demand for talents in the regional Chinese medicine industry, we promote the exploration and practice of craftsman talent cultivation mode through the integration of industry and education, and build the talent cultivation mode of "school-enterprise cooperation and combination of engineering", in which the school carries out the order class cultivation with the relevant enterprises, and carries out the cultivation of teacher's training with the hospitals. Through school-enterprise cooperation and cooperation between schools and hospitals, a platform for Chinese medicine inheritance training is built, and the zero distance between teaching, experimental training, internship and specific posts is realized in the field of industry-teaching integration. Combined with the professional characteristics of Chinese medicine, the school-enterprise (hospital) cooperation revises the talent training program, integrates and penetrates the components of craftsmanship into the curriculum and practical teaching system, and runs through the whole process of education and teaching.

Deepen the teaching reform, explore the teaching modes of project teaching, case teaching, scene teaching, simulation teaching, and other teaching modes based on the actual jobs in the enterprises (industries), advocate the inspirational, exploratory, discursive, and participatory teaching, strengthen the integration of teaching, learning and doing, and promote the combination of knowledge and skills and the unity of theories and practices. Strengthen the construction of an on-campus productive practice teaching base, introduce real work scenarios, and carry out teaching according to the job tasks. Positions are the most direct and effective way to penetrate the spirit of craftsmanship. In the teaching reform, we tap the potential of students to strive for excellence, guide students to form the spirit of love and dedication and enable students to understand the connotation of the spirit of craftsmanship and internalize it into their professional qualities.

Create a team of full-time and part-time teachers to build a platform for TCM inheritance and training practice

The integration of industry and education to cultivate the spirit of craftsmanship should focus on the inspiring role of full-time and part-time teachers' role models. Cultivate the craftsmanship of teachers by carrying out teacher training, teacher teaching skills competitions and other activities, so that they can understand the infinite glory of craftsmen, firm beliefs, and consciously practice what they preach at all times; through the strengthening of exchanges and cooperation between teachers and hospitals and enterprises, teachers will be sent to hospitals and enterprises to strengthen the practical training and improve the level of skills, and to create a learning environment conducive to the cultivation of teachers' TCM heritage and cultivation of people and interpersonal relationships. Employing skilled craftsmen from enterprises to participate in students' experimental training and curriculum development, teaching and other links, cultivating the environment of inheritance and education, constantly improving the "dual teacher" teacher training system, truly realizing the "moral and artistic" of university teachers, and creating a team of specialists combined with craftsmen with the spirit of inheritance and education of Chinese medicine culture. The team of Chinese medicine culture inheritance educators with the spirit of

craftsmen will be created.

CONCLUSION

China is in the process of moving from a "big country of TCM" to a "strong country of TCM", which requires the participation of a large number of talents with the spirit of craftsmen in TCM. This requires that the main position of cultivating craftsmen in higher vocational colleges must follow the law of development of TCM, condense the connotation of the spirit of craftsmen in traditional Chinese medicine, keep the right and innovation, and play a greater role in the cultivation of the spirit of craftsmen and the inheritance of the culture of traditional Chinese medicine. Strengthening education on the cultural heritage of TCM and creating a good atmosphere for nurturing Chinese medicine culture will help stimulate students' interest in learning TCM, build up students' basic theories of TCM, cultivate their thinking ability in TCM, and enhance their determination and perseverance in the process of defending, passing on developing TCM.

Based on the study of the connotation of craftsmanship in the Chinese medicine industry, this study clarifies the historical inheritance and contemporary connotation of traditional Chinese medicine cultural craftsmanship, analyses the current situation of traditional Chinese medicine cultural nurturing in Chinese vocational education, and constructs a model and implementation path for Chinese medicine cultural inheritance and nurturing, which serves as theoretical guidance and model construction for the subsequent related studies. In future research, it is recommended to conduct empirical research on the talent cultivation model established by this study to demonstrate the effectiveness of the methodology proposed in this research.

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THE DOUBLE REDUCTION POLICY & IMPACT ON STUDENT ACHIEVEMENT AND PARENTAL REACTIONS IN COMPULSORY EDUCATION IN DONGCHENG DISTRICT, BEIJING, CHINA

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ABSTRACT

This paper examines the effects of China's Double Reduction Policy (DRP) on student academic achievement and parental reactions in compulsory education within Dongcheng District, Beijing. Drawing on a mixed-methods study that combines survey data (n=320) and semi-structured interviews (n=12) with stakeholders, the research investigates variations in outcomes across socioeconomic groups, teacher preparedness, and school-level implementation. Quantitative analyses (ANOVA, multiple regression) assess changes in achievement and perceived academic readiness, while thematic analysis of interviews explores parental anxiety, adaptation strategies, and informal tutoring markets. Findings indicate heterogeneous impacts: some students report improved well-being and engagement after reduced homework and tutoring, whereas others — particularly those previously reliant on intensive tutoring — express concerns about academic preparedness. Evidence also points to emergent informal markets and unequal capacity across schools to provide in-school remediation, which risks exacerbating socioeconomic disparities. The study concludes that the DRP's equity goals require targeted school support, teacher professional development, and mechanisms to monitor local implementation. The paper contributes district-level empirical evidence to debates on large-scale education reforms and offers policy recommendations to align wellbeing objectives with sustained academic outcomes.
Keywords: Double Reduction Policy, Educational equity, Parental reactions, Student achievement

INTRODUCTION

China's education system has historically emphasized high-stakes examinations, a strong exam-focused culture, and a robust market for private tutoring. In July 2021 the central government introduced the Double Reduction Policy (DRP) to reduce excessive homework and regulate off-campus tutoring for compulsory education, aiming to improve student wellbeing and promote educational equity. Dongcheng District in Beijing is a particularly revealing site for analysis due to its dense urban population, pronounced academic competition, and socioeconomic diversity. This paper uses district-level empirical data to assess how the DRP has reshaped student achievement and parental behaviour, asking: What is the impact of the DRP on student academic outcomes? How do parents react across socioeconomic strata? What implementation challenges and opportunities emerge at the school level?

THEORETICAL FRAMEWORK

Existing research frames the DRP discussion across several theoretical lenses. Cognitive Learning Theory highlights how changes to practice and scaffolding affect students' self-regulated learning. Parental Involvement Theory (Epstein, 2001) clarifies the shifting roles parents take in facilitating home learning and school–family partnerships under DRP. Social Reproduction Theory (Bourdieu) helps explain how differential access to compensatory resources (e.g., informal tutoring, extracurricular enrichment) may reproduce social stratification despite regulatory reforms. Policy implementation theory stresses that top-down reforms require local capacity and adaptive governance to avoid implementation gaps and unintended consequences.

METHOD

This mixed-methods study combines quantitative and qualitative techniques. The quantitative component employed structured surveys administered to 320 respondents (students and parents) across multiple schools in Dongcheng. Academic achievement indicators included internal school grades and standardized assessments where available. Statistical analyses included ANOVA to compare group means and multiple regression to investigate the relationship between policy implementation intensity and student outcomes. The qualitative component comprised 12 semi-structured interviews with parents and a small number of teachers to capture perceptions, adaptation behaviors, and emergent market responses. Thematic analysis followed Braun and Clarke's six-step procedure, and the study adhered to standard ethical safeguards.

FINDINGS AND DISCUSSION

Quantitative results showed heterogeneous effects. Aggregate test scores did not uniformly decline; instead, results varied by prior tutoring reliance, school type, and family socioeconomic status. Students from households that previously depended heavily on private tutoring reported larger perceived declines in exam readiness, while students from lower-income households often reported relief from reduced financial pressure and some gains in wellbeing indicators. Multivariate analyses suggest that school-level supports and teacher capacity significantly moderate academic outcomes: schools that rapidly instituted in-school remediation programs mitigated negative academic effects, whereas under-resourced schools struggled to fill the gap.

Qualitative interviews revealed that parental reactions ranged from relief to high anxiety. Many parents welcomed the reduced homework burden, noting better sleep and increased time for family activities and extracurricular pursuits. Conversely, parents oriented toward high-stakes outcomes sought informal alternatives, such as hiring private tutors under different job titles or purchasing overseas/online instruction, effectively creating a new shadow market that undermines the policy's equity aims. These findings underscore that regulation alone is insufficient to eliminate inequality: complementary investments in school capacity and clearer communication with parents are essential.

CONCLUSION

The Double Reduction Policy has produced mixed outcomes in Dongcheng District. While it successfully reduced certain forms of academic burden and supported student wellbeing for some, it also revealed and in some cases deepened inequities through informal markets and variable school readiness. Policy success therefore depends on pairing regulations with targeted investments in teacher training, school-based remediation, and monitoring systems that can identify local gaps in implementation. Future research should track longitudinal outcomes to assess the DRP's effect on high-stakes exam performance and social mobility over multiple cohorts.

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Artificial Intelligence and Business Education: Transformation, Challenges, and Future Prospects

ABSTRACT

The rapid advancement of Artificial Intelligence (AI) has triggered a paradigm shift across global industries, with business ecosystems undergoing unprecedented transformations in decision-making, operations, and talent demands. Against this backdrop, business education—tasked with nurturing future business leaders and professionals—faces both urgent imperatives and unprecedented opportunities. This paper systematically explores the integration of AI into business education, focusing on four core dimensions: the practical applications of AI in reshaping teaching models, the core value of AI-driven business education reform, the multifaceted challenges encountered in implementation, and actionable strategies for sustainable development. Drawing on case studies from leading business schools (e.g., MIT Sloan, Tsinghua SEM) and industry reports (McKinsey, World Economic Forum), the paper argues that AI is not merely a technical tool but a foundational driver for redefining the goals, content, and methods of business education. By addressing issues such as technological limitations, ethical risks, and educational inequities, business education can leverage AI to cultivate 复合型 (interdisciplinary) talents equipped with both business acumen and AI literacy, ultimately aligning with the needs of the intelligent era. The paper concludes with a vision for the future of AI-integrated business education, emphasizing the importance of collaboration among universities, enterprises, and policymakers to build an inclusive, innovative, and future-oriented educational ecosystem.
Keywords: Artificial Intelligence; Business Education; Educational Transformation; Talent Cultivation; Ethical Governance

INTRODUCTION

The 21st century has witnessed the rise of AI as a transformative force in global business. From predictive analytics optimizing supply chains (e.g., Amazon's AI-powered inventory management) to generative AI automating content creation (e.g., ChatGPT assisting in marketing copywriting), and from algorithmic trading reshaping finance to AI-driven customer relationship management (CRM) systems personalizing user experiences, AI has become embedded in every facet of business operations. According to the World Economic Forum's Future of Jobs Report 2023, by 2025, AI will automate 85 million jobs globally while creating 97 million new roles—most of which require proficiency in "AI-business synergy" (WEF, 2023). This shift demands a new breed of business talent: individuals who can not only master traditional business knowledge (e.g., finance, marketing, strategy) but also understand AI's capabilities, limitations, and ethical implications.

Traditional business education, rooted in lecture-based teaching, case studies from the pre-AI era, and siloed disciplinary curricula, is increasingly misaligned with the needs of the intelligent business world. Not only is there a lack of education on artificial intelligence skills, but there is also a lack of involvement of artificial intelligence in the curriculum. For instance, MBA programs designed a decade ago rarely include courses on AI ethics in algorithmic decision-making or AI-driven market analysis. Students often graduate with theoretical knowledge of business models but lack hands-on experience in leveraging AI tools to solve real-world problems—such as using machine learning to forecast market demand or using natural language processing (NLP) to analyze customer feedback. A 2022 survey by McKinsey found that 68% of corporate recruiters in the business sector cited a "skills gap" in new graduates, with 45% specifically highlighting deficiencies in AI literacy and data-driven decision-making (McKinsey, 2022).

This paper aims to address the question: How can AI be effectively integrated into business education to bridge the talent gap and prepare students for the AI-driven business landscape? To answer this, the paper is structured as follows: Section 2 examines the practical applications of AI in business education, including personalized learning, experiential teaching, and administrative optimization. Section 3 analyzes the core value of AI-driven reform from the perspectives of students, educational

institutions, and enterprises. Section 4 identifies key challenges, such as technological limitations, ethical risks, and educational inequities. Section 5 proposes actionable strategies to overcome these challenges. Section 6 outlines future prospects for AI-integrated business education. Finally, Section 7 concludes with a call for collaborative action.

AI's integration into business education is not a theoretical concept but a practical reality, with leading institutions already leveraging AI to transform how knowledge is delivered, absorbed, and applied. This section details four key application areas, supported by real-world case studies.

One of AI's greatest strengths in education is its ability to analyze large volumes of student data (e.g., learning progress, test scores, engagement patterns) to deliver personalized learning experiences—addressing the "one-size-fits-all" limitation of traditional lectures.The traditional teaching model is a mechanical process of teaching and learning. Due to the lack of real-time feedback systems and flexible matching mechanisms, it is difficult to provide enough students with the knowledge they want.

1. Adaptive Learning Platforms: Platforms like Coursera's AI-powered recommendation engine and Pearson's MyLab Business use machine learning algorithms to identify students' strengths and weaknesses. For example, if a student struggles with AI-driven financial forecasting, the platform will recommend targeted modules (e.g., tutorials on regression analysis in Python, case studies on AI in investment banking) and adjust the difficulty of practice exercises in real time. MIT Sloan School of Management's "AI for Business" course uses such a platform, resulting in a 23% improvement in student performance on AI-related assessments compared to traditional teaching methods (MIT Sloan, 2023).
2. Intelligent Tutoring Systems (ITS): AI-powered tutors, such as IBM's Watson and Carnegie Learning's MATHia, provide 24/7 personalized support to business students. For instance, a student working on a marketing project can use an ITS to ask questions like, "How can I use AI to segment customer groups?" The system will not only provide answers but also guide the student through step-by-step analyses (e.g., data collection, algorithm selection, result interpretation) and flag common mistakes (e.g., overreliance on biased datasets). A study by Stanford University found that business students using ITS for 10 hours per week showed a 17% higher retention rate of AI-related concepts than those relying solely on instructor support (Stanford GSB, 2022).

AI enables business education to move beyond passive case studies to immersive, interactive simulations that replicate the complexity of AI-driven business environments. These simulations allow students to apply theoretical knowledge to practical problems without the risks of real-world decision-making.

1. AI-Powered Business Simulations: Platforms like SAP's Business One and Harvard Business School's HBX CORe use AI to create dynamic business scenarios. For example, students may be tasked with managing a virtual e-commerce company, where AI generates real-time data on market trends, competitor actions, and customer behavior. Students must use AI tools to optimize pricing strategies (e.g., using demand forecasting algorithms), manage inventory (e.g., AI-driven stock replenishment), and resolve crises (e.g., a sudden drop in sales due to a competitor's AI-powered marketing campaign). Tsinghua University School of Economics and Management (SEM) integrated this simulation into its undergraduate business curriculum in 2021; post-course surveys showed that 82% of students reported feeling "more confident" in using AI to make business decisions (Tsinghua SEM, 2022).
2. Virtual Internships with AI Mentors: Companies like Deloitte and PwC have partnered with business schools to offer AI-driven virtual internships. Students work on simulated projects (e.g., auditing an AI-powered fintech firm, developing an AI marketing strategy for a retail brand) and receive feedback from AI mentors trained on industry best practices. The AI mentor tracks students' progress, identifies gaps in their approach (e.g., failing to consider AI ethics in a data-driven project), and provides personalized suggestions for improvement. A 2023 study by the Association to Advance Collegiate Schools of Business (AACSB) found that students who completed AI virtual internships were 34% more likely to receive job offers from top firms than those who did not (AACSB, 2023).

AI also streamlines administrative tasks for business school faculty and staff, freeing up time for teaching and research. Automated Grading and Feedback: AI tools like Gradescope and Turnitin's AI Feedback Studio can automatically grade objective assessments (e.g., multiple-choice questions on AI algorithms) and provide constructive feedback on subjective work (e.g., business plans incorporating AI). For example, a professor assigning a project on AI in supply chain management can use Gradescope to scan students' reports, check for adherence to business frameworks (e.g., Porter's Five Forces with AI integration), and highlight areas for improvement (e.g., "Your analysis of AI's impact on logistics lacks data support—consider adding case studies from Amazon or Walmart"). This reduces grading time by up to 50%, according to a survey of business school professors by the Chronicle of Higher Education (2022). Student Performance Analytics: AI dashboards, such as Blackboard's Predict and Canvas's Analytics, aggregate data on student attendance, assignment completion, and participation to identify at-risk students. For instance, if a student in an "AI and Marketing" course consistently misses deadlines for AI tool tutorials (e.g., Google Analytics 4's AI features), the system alerts the professor, who can intervene with additional support. The University of Pennsylvania's Wharton School implemented this tool in 2020, resulting in a 19% reduction in student dropout rates for AI-related business courses (Wharton, 2023).

AI is driving the integration of traditionally siloed business disciplines (e.g., finance, marketing, operations) with computer science and data science—creating interdisciplinary curricula that reflect the real-world synergy between AI and business. AI-Focused Electives and Specializations: Leading business schools now offer specialized tracks in "AI for Business," "Data-Driven Decision-Making," and "AI Ethics in Management." For example, INSEAD's MBA program includes a specialization in "AI and Digital Transformation," which covers courses like "Machine Learning for Marketing," "AI in Financial Risk Management," and "Algorithmic Fairness in Business." Students in this specialization complete a capstone project with partner companies (e.g., L'Oréal, Siemens) to solve real AI-related business problems—such as developing an AI tool to predict consumer trends for L'Oréal's skincare line (INSEAD, 2023). Embedded AI Modules in Core Courses: Even foundational business courses (e.g., "Introduction to Management," "Corporate Finance") now include AI-focused modules. For instance, a "Financial Accounting" course may teach students how AI automates bookkeeping (e.g., using QuickBooks' AI features) and how to interpret AI-generated financial reports. A "Strategic Management" course may explore how AI disrupts industry structures (e.g., Uber's AI-driven ride-hailing model disrupting taxi services) and how firms can develop AI-based competitive advantages. The London Business School (LBS) implemented this embedded approach in 2021; alumni surveys conducted in 2023 found that 76% of graduates used AI-related knowledge from core courses in their current roles (LBS, 2023).

The integration of artificial intelligence into the curriculum is a mutually beneficial move. Not only can it make the education model of universities closer to students, but it can also enable companies to recruit more useful graduates. At the same time, for the country, it will be conducive to promoting the development of an innovative society.The integration of AI into business education delivers multifaceted value, benefiting students, educational institutions, and the broader business community. This section explores these value propositions in detail.

AI-driven business education equips students with three critical skill sets needed for the intelligent era: AI Literacy and Technical Proficiency: Students learn to use AI tools (e.g., Python for data analysis, Tableau for data visualization, ChatGPT for content generation) and understand AI concepts (e.g., machine learning, neural networks, natural language processing) in a business context. This proficiency enables them to collaborate with data scientists and AI engineers—a key requirement for roles like "AI Marketing Specialist" or "Data-Driven Product Manager." Critical Thinking and Problem-Solving: AI simulations and projects force students to move beyond rote learning to analyze complex, dynamic business problems. For example, when using an AI business simulation to manage a virtual company, students must evaluate the trade-offs of AI adoption (e.g., cost vs. efficiency, automation vs. job displacement) and make data-driven decisions. This cultivates critical thinking skills that are irreplaceable by AI. Ethical Awareness and Social Responsibility: AI-driven curricula include modules on AI ethics—teaching students to identify and mitigate risks like algorithmic bias (e.g., a hiring AI tool that discriminates against female candidates) and data privacy violations (e.g., a retail AI system that misuses customer data). This prepares students to lead ethically in a world where AI's societal impact is increasingly scrutinized.

AI helps business schools improve educational quality, optimize resource allocation, and strengthen their reputation: Data-Driven Teaching Improvement: AI analytics provide professors with insights into which teaching methods (e.g., lectures, simulations, group projects) are most effective for AI-related content. For example, if data shows that students learn AI in finance better through simulations than lectures, professors can adjust their teaching approach. This leads to continuous improvement in course quality. Resource Efficiency: AI automates administrative tasks (e.g., grading, student advising) and optimizes resource allocation (e.g., scheduling AI labs, assigning faculty to high-demand courses). This allows schools to redirect resources toward high-value activities like hiring AI-savvy faculty or investing in state-of-the-art AI teaching tools. Global Competitiveness: Business schools that lead in AI integration attract top students and faculty from around the world. For example, MIT Sloan's "AI for Business" program consistently ranks among the top business courses globally, drawing students from over 50 countries (MIT Sloan, 2023). This enhances the school's global reputation and fosters international collaboration.

AI-driven business education directly addresses the talent needs of enterprises by: Supplying AI-Ready Graduates: Graduates from AI-integrated business programs require less on-the-job training, as they already possess the skills to use AI tools and solve AI-related business problems. This reduces hiring costs and accelerates the deployment of AI initiatives within firms. Facilitating Co-Innovation: Partnerships between business schools and enterprises (e.g., virtual internships, capstone projects) allow firms to tap into academic expertise to solve their AI challenges. For example, a manufacturing company struggling with AI-driven predictive maintenance can collaborate with a business school to develop a customized solution—while providing students with real-world experience. Driving Industry Transformation: By培养 (nurturing) graduates who understand both AI and business, AI-driven education accelerates the adoption of AI across industries. These graduates become change agents within firms, advocating for AI innovation and ensuring that AI is integrated strategically into business operations.Provide talents with more innovative thinking: Graduates who have received long-term education in artificial intelligence will have more diverse, leading, and inclusive work thinking. These graduates will be more suitable for intellectual work, which is beneficial for companies to innovate and develop within their business scope, and ensures the implementation of innovative policies, reducing conservative resistance to company development.

RESULTS AND DISCUSSION

The arrival of the era of artificial intelligence is no less than the collision of the steam age and the electrical age, so the process of integrating artificial intelligence into courses will not be very smooth.Despite its significant value, the integration of AI into business education faces several formidable challenges. These challenges span technological, ethical, pedagogical, and equity dimensions.

AI tools used in business education are not without flaws, which can undermine their effectiveness: Algorithmic Inaccuracy: AI adaptive learning platforms and simulations rely on algorithms that may produce incorrect or misleading results. For example, an AI tutor teaching AI in supply chain management may provide outdated information on predictive analytics models, or an AI simulation may generate unrealistic market data—leading students to develop flawed decision-making skills. Data Security and Privacy Concerns: AI tools collect and analyze large amounts of student data (e.g., learning patterns, personal information). This raises risks of data breaches or misuse. For instance, if a business school's AI student performance system is hacked, students' grades and personal data could be exposed. A 2023 survey by EDUCAUSE found that 42% of business schools had experienced at least one data breach related to AI education tools (EDUCAUSE, 2023). Dependence on Technical Infrastructure: AI integration requires robust technical infrastructure (e.g., high-speed internet, cloud computing, AI labs). Many institutions—especially those in developing countries or with limited budgets—lack the resources to build and maintain this infrastructure. For example, a business school in sub-Saharan Africa may struggle to access AI simulation platforms due to poor internet connectivity, putting its students at a disadvantage.

AI introduces complex ethical issues into business education that are not easily resolved: Algorithmic Bias in Teaching Tools: AI tools can inherit biases from their training data, leading to unfair treatment of students. For example, an AI grading system trained on essays by Western students may penalize students from non-Western backgrounds for using different writing styles—even if their

content is high-quality. Similarly, an AI recommendation engine may prioritize "traditional" business topics (e.g., finance, consulting) over AI-focused topics for female students, reinforcing gender stereotypes in the business world. Over-Reliance on AI and Erosion of Critical Thinking: If students become overly dependent on AI tools (e.g., using ChatGPT to write business reports, relying on AI tutors to solve problems), they may lose the ability to think critically and independently. A 2022 study by the University of California, Berkeley, found that 35% of business students admitted to using AI to complete assignments without understanding the underlying concepts—leading to poor performance on exams that required original thinking (UC Berkeley, 2022). Ethical Ambiguity in AI Business Scenarios: AI simulations often present students with ethical dilemmas that have no clear "right" answer—e.g., "Should a company use AI to lay off employees to cut costs?" or "Should a bank use AI to deny loans to high-risk customers, even if the algorithm is biased?" These scenarios can confuse students if not accompanied by structured ethical frameworks, leading to inconsistent or problematic decision-making.

The success of AI-driven business education depends heavily on the ability of faculty and institutions to adapt—but many face significant barriers: Faculty AI Literacy Gaps: Most business school faculty were trained in the pre-AI era and lack the knowledge and skills to teach AI-related content. A 2023 survey by the AACSB found that 61% of business professors reported feeling "unprepared" to teach courses on AI and business (AACSB, 2023). This gap is particularly acute for senior faculty, who may be resistant to learning new technologies or adapting their teaching methods. Curriculum Obsolescence: AI technology evolves at a rapid pace, making it difficult for business schools to keep their curricula up to date. For example, a course on "AI in Marketing" developed in 2020 may not include content on generative AI (e.g., Midjourney for visual marketing, ChatGPT for customer service)—tools that have become integral to marketing practice by 2023. This leads to a disconnect between what students learn and what employers demand. Balancing Technical and Business Skills: Integrating AI into business education requires striking a balance between technical skills (e.g., coding, data analysis) and business skills (e.g., strategy, leadership). If curricula focus too heavily on technical skills, students may become "AI technicians" rather than "business leaders who use AI." Conversely, if curricula neglect technical skills, students may lack the practical proficiency to apply AI in the workplace. Thinking error: Many business educators still believe that artificial intelligence and humans are competitors, while others only see it as a tool to promote efficiency. This kind of simple thinking ignores the beneficial effects of artificial intelligence.Graduates under this mindset education may not have a better understanding of the future development trends of artificial intelligence.

AI integration exacerbates existing inequalities in business education, creating a "digital divide" between institutions and students: Resource Disparities Between Institutions: Elite business schools (e.g., Harvard, Stanford, INSEAD) have the budgets to invest in AI tools, hire AI-savvy faculty, and partner with tech companies. In contrast, public universities and institutions in developing countries often cannot afford these resources. For example, a business school in India may not be able to access the same AI simulations as a school in the United States, putting its students at a competitive disadvantage in the global job market. Student Access to AI Tools: Not all students have access to AI tools outside of school (e.g., laptops with sufficient processing power, subscriptions to AI software like Tableau). This means that students from low-income backgrounds may struggle to complete homework or practice AI skills outside of class—widening the achievement gap. Cultural and Linguistic Barriers: Many AI education tools are developed in English and designed for Western business contexts. This can disadvantage students from non-English-speaking countries or non-Western cultures, who may struggle to understand the content or apply it to their local business environments. For example, an AI simulation focused on U.S. retail markets may not be relevant to a student planning to work in Chinese e-commerce. The unfairness of religion: Different religions have different requirements, and the gradual development of artificial intelligence may lead to incomplete compliance with religious doctrines. Some religious believers may not be able to learn and use artificial intelligence, leading to a huge productivity gap and exacerbating information and cultural conflicts between different religions.

Addressing the challenges of AI integration in business education requires coordinated action from multiple stakeholders—including business schools, enterprises, governments, and tech companies. This section proposes a set of actionable strategies. Develop AI Education Standards: Governments and educational bodies (e.g., AACSB, EQUIS) should establish global standards for AI tools used in business education—covering algorithm accuracy, data security, and privacy protection. Tools that meet these standards should be certified, helping schools make informed decisions about which tools to adopt.

Invest in Inclusive Technical Infrastructure: Governments and international organizations (e.g., UNESCO, World Bank) should provide funding to help developing countries and low-resource institutions build AI-ready infrastructure (e.g., high-speed internet, cloud computing access). Tech companies (e.g., Microsoft, Google) can contribute by offering free or low-cost access to AI tools (e.g., Microsoft Azure for education, Google Workspace for Education) to business schools in underserved regions. Conduct Regular Technical Audits: Business schools should regularly audit their AI tools to ensure they are accurate, secure, and up to date. This includes testing algorithms for errors, reviewing data security protocols, and updating software to reflect the latest AI advancements. Government led long-term fund entry: Some infrastructure and investments must be oriented towards long-term goals, and private enterprises cannot afford the costs incurred. Through the entry of long-term government funds, artificial intelligence construction will be carried out according to local conditions in different regions, and specialized education systems will be developed for different universities and colleges. At the same time, these high-quality graduates will return to the country.

Integrate AI Ethics into Curricula: Business schools should make AI ethics a mandatory component of all AI-related courses. This includes teaching students to identify algorithmic bias, apply ethical frameworks (e.g., utilitarianism, deontology) to AI business scenarios, and develop strategies for responsible AI adoption. For example, a course on “AI in Human Resources” could include a module on “Ethical AI Hiring Practices” that teaches students to audit AI hiring tools for bias. Establish AI Ethics Guidelines for Students: Schools should develop clear guidelines for students on the ethical use of AI tools (e.g., when it is appropriate to use ChatGPT, how to cite AI-generated content). This helps prevent academic misconduct and encourages students to use AI as a tool for learning rather than a replacement for critical thinking. Create AI Ethics Advisory Boards: Business schools should form advisory boards consisting of faculty, students,企业代表 (corporate representatives), and ethicists to oversee the ethical integration of AI into education. These boards can review AI tools for bias, develop ethical teaching materials, and address ethical dilemmas that arise in the classroom. Establishing a diversified punishment mechanism for violating ethics: With the advent of the era of artificial intelligence explosion, the ethical mechanism of artificial intelligence will gradually be deeply rooted in people's hearts. Set different punishment mechanisms based on the situation of different periods and different groups of people. In the early stage, simple punishment is mainly used to promote citizens' understanding of the boundaries of artificial intelligence use.

Provide Faculty AI Training Programs: Business schools should partner with tech companies (e.g., IBM, Amazon) and universities with strong AI programs (e.g., Stanford, MIT) to offer faculty training in AI and pedagogy. This training should include both technical skills (e.g., how to use AI teaching tools) and pedagogical skills (e.g., how to design AI-integrated courses). For example, INSEAD offers a “Faculty AI Bootcamp” that teaches professors to incorporate AI simulations into their courses (INSEAD, 2023). Adopt Agile Curriculum Design: Schools should move away from static curricula and adopt agile models that allow for rapid updates. This can include partnering with enterprises to co-design courses (ensuring content reflects current industry needs), using modular course structures (so new AI topics can be added quickly), and inviting industry experts to deliver guest lectures on emerging AI trends. Balance Technical and Business Skills: Curricula should be designed to integrate technical and business learning. For example, a course on “AI in Finance” could teach students to code a simple AI trading algorithm (technical skill) and then analyze the algorithm’s strategic impact on a firm’s financial performance (business skill). This ensures students develop both the “how” and “why” of AI in business. Enrich the teaching team: Vigorously introduce part-time teachers from the artificial intelligence industry or other industries to bring the freshest information and knowledge into the classroom. Full time teachers are inevitably unable to acquire the latest knowledge in the industry. By designing excellent personnel systems and introducing more talents into the classroom, it will promote the development of artificial intelligence knowledge.

Expand Access to AI Tools for Underserved Students: Business schools should provide free access to AI tools (e.g., laptops, software subscriptions) to students from low-income backgrounds. For example, the University of Michigan’s Ross School of Business offers a “AI Toolkit Grant” that covers the cost of AI software for students who cannot afford it (Ross, 2023). Develop Culturally and Linguistically Inclusive AI Tools: Tech companies and business schools should collaborate to develop AI education tools that are available in multiple languages and tailored to non-Western business contexts. For example, an AI simulation focused on Chinese e-commerce could be developed to help

students in Asia learn about AI-driven retail strategies. Foster International Collaboration: Elite business schools should partner with institutions in developing countries to share AI education resources (e.g., course materials, AI tools, faculty training programs). For example, Harvard Business School's "Global Initiative on AI and Business Education" provides free access to its AI course materials to 100+ business schools in Africa and Asia (HBS, 2023). Strengthen the promoting role of social teams: Balance the gap in the development of artificial intelligence through various associations, organizations, and federations. Encouraging more volunteers to join AI promotion and education projects will promote the diffusion of AI technology and tools to diverse populations.

As AI technology continues to evolve, its integration into business education will deepen—opening up new possibilities for teaching, learning, and talent cultivation. This section outlines three key future trends.

Generative AI tools such as ChatGPT, DALL·E, and GitHub Copilot are expected to become integral components of business education, not as substitutes for students' original work but as supportive tools that enhance creativity, analytical thinking, and problem-solving skills. For instance, students may use ChatGPT to draft business plans and subsequently critique, refine, and ethically evaluate the AI-generated content to improve strategic coherence. Marketing students can employ DALL·E to design AI-generated visual campaigns and assess their effectiveness through data-driven indicators such as customer engagement and brand awareness. In addition, business schools can leverage generative AI to develop personalized case studies aligned with students' interests, such as AI applications in sustainable fashion for learners focused on social entrepreneurship. Similarly, accounting students may utilize AI tools to identify accounting issues and explore improved financial management solutions, while hotel and tourism management students can apply AI to analyze online reviews, emerging tourism projects, and global development trends in order to design more innovative and attractive cultural tourism plans.

The integration of artificial intelligence and the metaverse has the potential to create highly immersive learning environments that closely simulate real-world business contexts. Through virtual "AI Business Conferences," students could interact with AI-generated avatars of industry leaders and participate in discussions on emerging AI trends. Global teams of students may collaborate within virtual "AI Startup Incubators," using AI tools to develop business ideas, pitch to virtual investors, and simulate the launch of AI-driven products. Furthermore, AI can be employed to simulate social and market feedback, enabling students to test marketing, human resource, and financial plans under various scenarios. These immersive environments enhance engagement and accessibility, allowing learners to practice business decision-making in a risk-free, global setting.

As AI-driven transformation accelerates across industries, business education is increasingly shifting toward a lifelong learning model. In collaboration with enterprises, business schools can use AI to design personalized continuous learning pathways by analyzing professionals' career goals and skill gaps and recommending targeted courses, such as generative AI applications in marketing or supply chain management. Micro-credentials and short-term certificate programs will become more prevalent, enabling professionals to upskill efficiently without pursuing full degree programs. Continuous education in artificial intelligence is particularly crucial, as rapid technological advancements render one-time academic training insufficient. Encouraging professionals to participate in AI-related continuing education and certification programs can support the integrated development of AI technologies, while organizations may adopt such certifications as recruitment criteria to attract up-to-date and highly skilled talent.

CONCLUSION

AI is not a passing trend in business education—it is a transformative force that is redefining how business knowledge is taught, learned, and applied. As this paper has shown, AI enables personalized learning, immersive experiential teaching, and administrative efficiency—delivering significant value to students, educational institutions, and enterprises. However, its integration also faces significant challenges, including technological limitations, ethical risks, pedagogical gaps, and equity concerns.

Overcoming these challenges requires collaboration: business schools must invest in faculty training and agile curricula; enterprises must partner with schools to co-design relevant content and provide real-world experience; governments must fund infrastructure and establish ethical standards;

and tech companies must develop inclusive, reliable AI tools.

The future of AI-integrated business education is bright. With generative AI, the metaverse, and lifelong learning programs, business schools will be able to培养 (nurture) a new generation of business leaders—individuals who are not only proficient in AI and business but also ethical, adaptable, and globally minded. These leaders will drive the responsible adoption of AI across industries, ensuring that AI serves as a force for good in the global economy.

The relationship between artificial intelligence and business education is not a zero sum game. It seems that if artificial intelligence gains the upper hand, human interests will be harmed. What we need to pay attention to is, with the assistance of better artificial intelligence, what new heights can the level of business education reach? The increase in the utilization rate of artificial intelligence will lead to an improvement in education level, an increase in employment opportunities, and an improvement in the quality of graduates. Artificial intelligence is beneficial for business education. Establishing a large-scale artificial intelligence model system for business education, combined with gain thinking, provides diversified educational models for diverse students. There is a Chinese proverb that teaches students according to their aptitude.

I propose that both business educators and students need to undergo a shift in their way of thinking, not only by adding artificial intelligence technology courses to their curriculum, but also by using large-scale artificial intelligence models as teaching quality tools. Educators should shift their thinking from using artificial intelligence as a tool to pursue automation to using AI as a tool to enhance the effect of gain, which will result in different effects and outcomes. This kind of transformation may seem like a simple change in wording, but it will have a profound impact on curriculum development, education quality, and employment levels. Knowledge workers view artificial intelligence as a partner and collaborator in solving creative problems together.

In the end, the goal of AI-driven business education is not to replace human intelligence with AI, but to empower humans with AI—to enhance our critical thinking, creativity, and problem-solving skills, and to prepare us to thrive in an increasingly intelligent world.

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The Urgency of Coding Education: Preparing the Future Generation with Digital Skills

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ABSTRACT

Coding education has become an urgent necessity in preparing the younger generation to face the challenges of the digital era. This article analyzes the urgency of coding education through a literature review focusing on its cognitive benefits, social impacts, and policy implications within the Indonesian education system. The findings indicate that early coding education not only develops technical skills but also enhances logical thinking, problem-solving, creativity, and collaboration abilities. The policy to integrate Coding and Artificial Intelligence (AI) subjects into the national curriculum, as part of the Indonesia Emas 2045 vision, faces major challenges such as infrastructural disparities and limited teacher competencies. Proposed solutions include strengthening digital infrastructure, providing continuous teacher training, and implementing project-based learning approaches. Comprehensive implementation requires synergy among the government, schools, industry, and society to create an inclusive and sustainable educational ecosystem. The article concludes that coding education is a strategic investment to develop high-quality human resources capable of competing in an increasingly digital global market.

Keywords: curriculum, coding education, digital skills, education policy

1. INTRODUCTION

In the rapidly evolving digital era, programming or coding skills have become one of the essential competencies that must be possessed by the younger generation, including early childhood learners. This is due to the increasing complexity of technological demands in everyday life and the significant influence of technology across various aspects of human activity, including education, economy, and employment (Firat, 2018). Coding education not only teaches technical skills but also involves critical thinking, problem-solving, and creativity, abilities that are highly needed in today's fast-changing world (Ng, 2017). Early introduction to coding education offers substantial long-term benefits. One of the most significant advantages is the development of higher cognitive skills, such as logical thinking, sequencing instructions, and structured problem-solving (Kanbul & Uzunboylu, 2017). Moreover, teaching coding to children introduces them to fundamental mathematical and scientific concepts in a fun and comprehensible way (Starkey & Popat, 2019). Studies have shown that early exposure to coding can enhance children's understanding of mathematical concepts and strengthen essential problem-solving skills applicable to daily life (Turan & Aydoğdu, 2020).

Beyond cognitive development, coding education also plays a role in improving children's social abilities, such as collaboration and communication. During the coding learning process, children often work in groups to complete projects or challenges, which teaches them teamwork and collective creativity (Başaran et al., 2025). Therefore, introducing coding to children not only focuses on technical competence but also supports the development of character and interpersonal skills that are valuable throughout their lives. The planned inclusion of Coding and Artificial Intelligence (AI) subjects in elementary school curricula represents the implementation of one of the eight missions (Asta Cita) set forth by President Prabowo Subianto and Vice President Gibran Rakabuming Raka. The fourth point of Asta Cita emphasizes strengthening human resource development, science, technology, education, health, sports achievement, gender equality, and the empowerment of women, youth, and people with disabilities (Dikdasmen, 2024). This initiative demonstrates the government's commitment to

preparing a technologically literate generation capable of adapting to the dynamics of the Fourth Industrial Revolution and the Society 5.0 era.

However, several challenges present a research gap in the implementation of coding education in Indonesia. First, most previous studies have primarily focused on developed countries with advanced digital infrastructure and highly prepared human resources (Bers, 2020; Kafai & Burke, 2022), while empirical research in developing contexts, particularly Indonesia, remains limited. Second, there is a discrepancy between national policy and practical implementation, as many elementary schools still lack adequate facilities such as computers, internet access, and qualified teachers with coding competencies (Putra et al., 2023). Third, existing studies tend to emphasize cognitive outcomes, while affective and social dimensions, such as learning motivation, digital confidence, and collaborative ability, have not been extensively explored (Rahman & Widodo, 2022).

Therefore, research on coding education for early childhood learners in Indonesia is both relevant and urgent. This study is expected to provide empirical contributions by bridging the gap between national policy and educational practice while enriching the understanding of how coding education can be effectively and sustainably integrated into Indonesia's elementary education system. Introducing coding to children not only equips them with technical abilities but also empowers them to explore creativity, think innovatively, and design solutions to future challenges. Thus, teaching coding from an early age represents a strategic investment in developing high-quality human resources capable of adapting to technological advancements and competing in an increasingly digital global landscape.

2. THEORETICAL FRAMEWORK

The theoretical framework of this study is constructed to explain how early coding education contributes to the development of children's cognitive, affective, and social abilities, as well as how contextual factors such as infrastructure readiness, teacher competence, and educational policy moderate these effects. This foundation integrates perspectives from learning theories (constructivism and social constructivism), computational thinking (CT) theory, the revised Bloom's taxonomy, innovation diffusion and policy implementation theories, and the ecological systems framework of child development. The integration of these theories provides a comprehensive understanding of the relationship between coding-based pedagogical interventions and multidimensional learning outcomes within Indonesia's transforming educational context toward the digital era.

In this study, coding education is defined as an instructional process that fosters the ability to write algorithmic instructions, understand programming logic, and design systematic solutions to problems. Meanwhile, computational thinking (CT) is conceptualized as a set of cognitive skills encompassing decomposition, pattern recognition, abstraction, and algorithmic design, core intellectual processes underlying problem-solving and computational reasoning (Wing, 2006). Furthermore, this study focuses on two main skill domains: cognitive skills (logical reasoning, problem solving, and information processing) and social-affective skills (collaboration, communication, learning motivation, and digital self-efficacy). These two domains are interrelated learning outcomes that jointly contribute to children's readiness for the challenges of the 21st century. Infrastructure readiness and teacher competence are defined as the availability of technological tools, network access, and pedagogical as well as technical capacity of teachers to effectively design and implement coding instruction.

Theoretically, coding education aligns closely with Piaget's constructivism, which emphasizes that children construct knowledge through active engagement, exploration, and manipulation of their learning environment. This is strengthened by Vygotsky's social constructivism, which underscores the importance of social interaction and scaffolding in knowledge formation. Coding activities involving group collaboration and reflective discussion thus provide opportunities for children to internalize logical and algorithmic concepts through

social experiences. Moreover, Computational Thinking theory (Wing, 2006) frames coding not merely as a technical skill but as a means to cultivate systematic, analytical, and creative thinking transferable across domains such as mathematics and science.

This framework is further supported by the Revised Bloom's Taxonomy, in which coding learning encourages learners to reach higher-order thinking levels, analyzing, evaluating, and creating. Activities such as algorithm design, simulation development, and debugging compel students to think critically and reflectively about their own learning processes. From an educational policy perspective, Rogers' Diffusion of Innovation Theory (2003) and Policy Implementation Theory (Sabatier & Mazmanian, 1980) explain that the successful implementation of coding and artificial intelligence (AI) curricula is strongly influenced by perceptions of adoption at the school level, resource readiness, and teachers' implementation capacity. These frameworks expand the analysis from pedagogical effectiveness to systemic and institutional dynamics. Similarly, Bronfenbrenner's Sociocultural-Ecological Systems Theory (1979) illustrates that the effectiveness of coding education cannot be separated from cross-level interactions, from macro-level contexts (national policy and curriculum), to meso-level (school and community), and micro-level (classroom and family).

Empirical evidence from developed countries demonstrates that early coding education significantly enhances computational thinking, problem-solving ability, and interest in STEM fields (Bers, 2020; Kafai & Burke, 2022). These studies highlight the effectiveness of project-based and game-based learning approaches that foster emotional engagement and curiosity among children. Findings from Starkey and Popat (2019) and Turan and Aydoğdu (2020) reveal a positive transfer effect between coding and mathematical skills when coding materials are conceptually integrated with logical and mathematical pattern operations. Moreover, Başaran et al. (2025) highlight the emergence of social-affective competencies such as collaboration and communication that naturally develop through group coding projects. However, in developing contexts such as Indonesia, empirical literature remains scarce and predominantly descriptive, focusing mainly on implementation challenges. Common barriers include gaps in digital infrastructure, limited teacher competence, and misalignment between curricular policies and actual school conditions (Putra et al., 2023).

Methodological limitations also persist in existing studies. Many employ pre-post designs without control groups, making it difficult to isolate the pure effects of coding education on learning outcomes. While qualitative studies provide rich insights into learning experiences, they lack empirical generalizability. Moreover, affective dimensions such as motivation, digital confidence, and collaboration are rarely measured quantitatively with culturally validated instruments. Thus, significant research gaps remain in contextual, affective, and methodological dimensions.

Based on this synthesis of theoretical and empirical evidence, the present study proposes a conceptual model that illustrates the relationship between coding education as the independent variable and children's learning outcomes as the dependent variable, covering three major domains: cognitive (computational thinking, problem solving, mathematical ability), affective (motivation and digital self-efficacy), and social (collaboration and communication). These relationships are mediated by pedagogical methods, particularly project-based and collaborative learning approaches, and moderated by infrastructure readiness, teacher competence, and school policy support. The model emphasizes that the success of coding education depends not solely on curricular content but on the synergistic interaction between pedagogical components and the broader educational ecosystem.

This study thus occupies a strategic position in filling the literature gap by providing contextual empirical evidence from Indonesia on the impact of early coding education on children's cognitive, affective, and social domains. It also contributes theoretically by integrating learning theories, computational thinking, and policy frameworks into a unified conceptual model that explores how and under what conditions coding education can be

implemented effectively, sustainably, and inclusively. Through a stronger methodological approach, such as a longitudinal quasi-experimental design, this research aims to advance scientific understanding of the role of coding education in shaping a digitally literate, critical, creative, and collaborative generation aligned with the vision of *Indonesia Emas 2045*.

3. METHOD

The method used in this study is a literature review, which serves as a systematic approach to collecting, analyzing, and interpreting written sources related to the research topic. This method not only focuses on understanding and analyzing the substantive content (such as theories and methodologies) from various references but also involves a critical assessment of the validity, relevance, and contribution of each source to the discussion. The sources reviewed include academic texts, scholarly articles, research reports, books, and policy documents, all of which were selectively chosen to ensure credibility and analytical depth (Ardiana et al., 2021), particularly in describing coding education policies. This method was chosen because it allows the researcher to explore, evaluate, and synthesize both theoretical and empirical sources comprehensively in relation to the research topic.

The process began with identifying the research question, namely: how can coding education equip young generations with the digital skills needed for the future? The focus was placed on its cognitive benefits, social impacts, and relevance to educational policy. The literature search was conducted systematically through reputable academic databases such as Google Scholar, ERIC, and ScienceDirect, using relevant keywords. The inclusion criteria required that publications be indexed and published within the last ten years to ensure the relevance and currency of the data.

Subsequently, the selected sources were analyzed qualitatively to identify key themes, including: (1) The Importance of Early Coding Education, (2) Educational Policy Implications and Future Digital Skills, and (3) Challenges and Solutions in Implementing Coding Education. The analysis employed a comparative narrative approach, enabling the researcher to compare findings across different contexts, such as variations in implementation between developed and developing countries.

FINDINGS AND DISCUSSION

The Importance of Early Coding Education

Based on the reviewed literature, coding education for children holds critical importance in a world increasingly dominated by technology. Teaching children about coding or programming from an early age does not merely equip them with technical skills; it also opens opportunities to develop critical thinking, problem-solving abilities, and creativity. Data suggest that children exposed to coding education at an early age experience improvements in several key competencies, such as:

Problem-Solving and Logical Thinking Skills

Coding education plays a vital role in fostering children's cognitive development, particularly in sharpening their problem-solving and logical reasoning capacities. Through the process of programming, children engage in analytical thinking—identifying problems, designing step-by-step solutions, testing them, and reflecting on errors to achieve optimal outcomes. This cyclical process mirrors the scientific method, allowing learners to cultivate persistence, accuracy, and metacognitive awareness. Moreover, coding inherently demands a structured way of thinking, since programming languages operate on precise rules and logical frameworks. As a result, children internalize mathematical reasoning patterns and systems thinking applicable beyond computer science (Stamatios Papadakis et al., 2022).

Research underscores that coding activities stimulate higher-order thinking skills, including critical analysis and deductive reasoning, as learners break down complex challenges into

manageable subproblems (Kanbul & Uzunboylu, 2017). This process aligns closely with the concept of computational logic, which underpins digital literacy and modern scientific inquiry. In this sense, coding is more than a technical competence—it is a fundamental cognitive skill that trains individuals to reason systematically and algorithmically (Demir, 2021). Furthermore, such training nurtures computational thinking, a mindset essential for navigating and solving technology-driven problems in contemporary life (Çiftci & Bildiren, 2020). Hence, early exposure to coding lays the foundation for rational thinking and systematic decision-making across multiple disciplines.

Enhancement of Computational Thinking

Computational thinking, as conceptualized by Wing (2006), refers to the mental process of formulating problems and their solutions in a form that can be effectively executed by a computer. It involves decomposition, abstraction, pattern recognition, and algorithmic design (Rosadi et al., 2020). Coding serves as a direct medium to cultivate this mode of thought because it requires students to translate abstract ideas into structured instructions. Beyond programming, computational thinking fosters a mindset that is transferable to other cognitive domains—enabling learners to analyze data, model real-world phenomena, and reason logically across diverse academic contexts.

Empirical studies reveal that children engaged in coding are more adept at applying mathematical and scientific concepts to practical problems, thereby bridging the gap between theory and practice (Starkey & Popat, 2019). For example, when coding simulations or digital experiments, students apply arithmetic logic, geometry, and causal reasoning to observe outcomes in real time. This pedagogical process enhances cognitive flexibility and encourages interdisciplinary learning, allowing students to perceive problem-solving as a holistic endeavor (Kocaman, 2023). Moreover, coding nurtures algorithmic literacy through iterative testing and debugging, reinforcing accuracy, patience, and reflective judgment (Kemendikdasmen, 2025). Thus, computational thinking cultivated through coding becomes a core literacy in the 21st century, parallel in importance to reading, writing, and numeracy (Turan & Aydoğdu, 2020).

Development of Creativity and Imagination

Beyond logical reasoning, coding education nurtures creativity and imagination by providing children with tools to construct digital artifacts such as games, animations, and interactive applications. This process transforms learning into an exploratory, design-oriented experience, where students combine logic and artistry to produce original work. Unlike rote learning, coding encourages creative experimentation, allowing learners to explore multiple solutions, test hypotheses, and innovate through trial and error. It also stimulates intrinsic motivation, as students experience the tangible outcomes of their ideas in real-time (Turan & Aydoğdu, 2020).

Stamatios Papadakis et al. (2022) emphasize that early exposure to coding and robotics not only enhances cognitive and linguistic development but also contributes to socio-emotional growth. By engaging in collaborative digital projects, children learn communication, empathy, and teamwork—skills essential in today's interconnected world. Furthermore, creativity in coding fosters divergent thinking, enabling learners to approach challenges from multiple perspectives and to envision novel solutions (Stamatis Papadakis, 2021). In this sense, coding education operates as a bridge between logic and imagination, cultivating well-rounded innovators who can navigate both technological and human-centered problem spaces.

Readiness for the Digital Era

The integration of coding and artificial intelligence (AI) education within Indonesia's national curriculum is a forward-looking policy designed to equip future generations with the competencies required for the digital age. This initiative aligns with the broader agenda of

developing a technologically literate society capable of adapting to and leading innovation in a globalized economy (Kemendikdasmen, 2025). Coding education thus functions as both a pedagogical strategy and a socio-economic imperative, linking education with workforce readiness and national competitiveness.

Children who acquire coding skills early gain a critical advantage in terms of digital adaptability, creativity, and resilience. These competencies are indispensable for navigating future job markets shaped by automation, data analytics, and AI integration (Fathurrohman et al., 2022). Research by Başaran et al. (2025) shows that exposure to coding from an early age enhances not only technical proficiency but also future-oriented learning dispositions, such as curiosity, collaboration, and innovation. Consequently, coding education serves as a cornerstone of digital citizenship, preparing students not just to use technology effectively but to shape its development ethically and sustainably. With sustained policy support, cross-sector collaboration, and equitable access, coding education in Indonesia can play a transformative role in realizing the national vision of "Indonesia Emas 2045."

Educational Policy Implications and Future Digital Skills

Coding education is not merely about learning to write computer code—it is a transformative pedagogical tool that fosters both logical and creative thinking, two of the most essential cognitive capacities in a world increasingly dependent on digital technology. It teaches not only syntax and logic but also persistence, abstraction, and problem decomposition—skills that form the foundation of computational thinking (Wing, 2006). In the Indonesian context, the government's initiative to include Coding and Artificial Intelligence (AI) as integral components of the basic education curriculum demonstrates a forward-looking vision to prepare the younger generation for an innovation-driven society. This policy aligns with the national long-term development framework, the Indonesia Emas 2045 Vision, which emphasizes digital transformation as a cornerstone of economic and human capital advancement (Prabowo Subianto & Gibran Rakabuming Raka).

This educational reform represents not only a curricular innovation but also a strategic response to global technological shifts. By embedding coding in formal education, Indonesia aims to cultivate a generation capable of critical innovation, digital creation, and ethical technology use, bridging the gap between technological literacy and national competitiveness. Coding education thus functions as an interdisciplinary connector that strengthens the quality of STEM (Science, Technology, Engineering, and Mathematics) learning, fostering integrative thinking and problem-solving across fields (Kemendikdasmen, 2025). When implemented effectively, it enhances both the nation's technological sovereignty and its capacity to compete in global markets increasingly shaped by artificial intelligence and automation.

Curriculum

The Coding and AI curriculum is designed as a dynamic and adaptive framework aligned with rapid technological developments and the diverse learning needs across educational levels. According to Law No. 20 of 2003 on the National Education System, a curriculum should encompass not only objectives and content but also pedagogical strategies and assessment mechanisms aimed at achieving holistic learning outcomes. In this regard, the Coding and AI curriculum is constructed on the principle of progressive competency development, where learning outcomes evolve from basic digital understanding in elementary schools to advanced computational problem-solving in secondary education.

Beyond technical knowledge, the curriculum integrates co-curricular and extracurricular dimensions, emphasizing computational thinking, ethical digital behavior, and social responsibility in technology use. This is particularly crucial in preparing students not only as competent coders but as digitally literate citizens who can evaluate and create technology responsibly. The teaching methodologies recommended—problem-based learning, project-

based learning, inquiry-based learning, and gamification—reflect constructivist and experiential learning theories, which position students as active participants in constructing knowledge rather than passive recipients (Kemendikdasmen, 2025).

Digital learning tools, online collaborative platforms, and authentic assessment models such as performance-based evaluation and competency certification ensure that learning remains both relevant and measurable. The integration of these elements underscores the curriculum's dual purpose: fostering creativity and ensuring technological adaptability as part of lifelong learning in the digital era.

Teacher Qualification and Competence

Teacher competence stands at the heart of successful Coding and AI education. Teachers act as facilitators of computational thinking, bridging abstract programming concepts with real-world problem-solving. In alignment with Ministerial Regulation No. 16/2007, educators are required to possess at least a D4/S1 qualification and demonstrate proficiency across four domains—pedagogical, personal, social, and professional competencies. However, in the context of coding education, additional expertise is demanded: mastery of digital literacy, algorithmic logic, and fundamental AI principles (Kemendikdasmen, 2025).

At the elementary level, teachers are expected to introduce coding concepts in an intuitive and playful manner, promoting curiosity and digital ethics. At the secondary level, the focus expands to algorithmic problem-solving, data-driven reasoning, and applied AI practices. The development of these competencies requires ongoing professional growth through structured capacity-building programs, including workshops, Bimbingan Teknis (Bimtek), peer mentoring, and partnerships with academic institutions or technology industries.

The pedagogical role of the teacher thus shifts from that of an information provider to a learning architect—a professional capable of designing engaging, student-centered learning ecosystems. Moreover, reflective teaching practices and collaborative communities of practice foster a culture of continuous innovation and adaptability, essential for sustaining relevance in a rapidly evolving digital landscape.

Implementation Strategy

The implementation of Coding and AI education in Indonesia adopts a phased and adaptive model to accommodate disparities in regional infrastructure, teacher readiness, and access to technological resources. In its initial phase, the program prioritizes schools with adequate digital facilities and trained teachers to serve as pilot institutions. This gradual rollout allows for iterative refinement of pedagogical strategies and resource distribution before nationwide expansion (Kemendikdasmen, 2025).

Key to the strategy's success are capacity-building initiatives and multi-stakeholder collaboration. Partnerships with global technology companies such as Google, Microsoft, and local tech ecosystems enhance resource sharing, professional development, and innovation transfer. Additionally, universities and teacher training institutions play a critical role in ensuring the academic rigor and sustainability of the initiative.

Continuous monitoring and evaluation mechanisms are integrated to measure both learning outcomes and policy effectiveness. These include assessments of student competency growth, teacher performance, and infrastructure utilization. Data-driven insights from these evaluations inform policy refinement, ensuring that implementation remains evidence-based and contextually responsive. Ultimately, this approach aims to create a self-sustaining educational ecosystem where technological literacy and innovation culture become integral to Indonesia's national education identity.

Challenges and Solutions in Implementing Coding Education

The implementation of coding education in Indonesia faces several challenges, primarily related to infrastructure and teacher capacity. Adequate infrastructure, such as computers, hardware, and stable internet connectivity, is still unevenly distributed across regions. Sarjito (2024) noted that infrastructure inequality in Papua has significantly affected educational access, while Ahmed et al. (2021) highlighted that limited investment in digital facilities has widened the educational gap. Similarly, Tambaip et al. (2025) emphasized the shortage of staff and resources in remote areas. Teacher competence in coding instruction remains another major challenge. Windiarti et al. (2023) found that low technological pedagogical competence hinders innovation in AI and coding-based education. To address these challenges, several comprehensive solutions are proposed:

Infrastructure Enhancement

One of the most pressing challenges lies in the unequal distribution of digital infrastructure—including access to computers, adequate hardware, electricity, and reliable internet connectivity. While urban schools in Java and major cities benefit from government-supported digitalization programs, many rural and remote regions still lack basic technological facilities. Sarjito (2024) reported that infrastructure disparities in Papua have significantly limited students' access to digital learning environments, creating a widening gap in educational equity. Similarly, Ahmed et al. (2021) observed that insufficient investment in digital infrastructure exacerbates existing socioeconomic inequalities, as technological access increasingly determines educational opportunities.

The digital divide also affects the consistency of learning outcomes and the scalability of coding initiatives. Tambaip et al. (2025) further emphasized that limited human resources and technical support staff in rural areas impede maintenance and sustainability of educational technology programs. To mitigate this, infrastructure development must be re-envisioned as part of a national digital inclusion strategy rather than isolated school-level initiatives.

Proposed solutions include public–private partnerships that leverage corporate social responsibility (CSR) funds for technology provision, the utilization of renewable energy sources to support power sustainability in off-grid areas (Amalia et al., 2024), and the adoption of cloud-based educational technologies to reduce dependence on local hardware (Arsal et al., n.d.). Programs such as the School Digitalization Initiative and BAKTI Internet Expansion for underserved regions are promising steps toward ensuring equitable access to digital learning infrastructure.

Teacher Training and Capacity Building

The success of coding education is profoundly dependent on teacher preparedness, particularly in terms of technological pedagogical content knowledge (TPACK). Windiarti et al. (2023) identified that the limited pedagogical integration of digital tools remains a major barrier to innovation in AI and coding instruction. Many teachers are proficient in general pedagogy but lack confidence in applying computational thinking principles and coding concepts in classroom settings.

This issue highlights a mismatch between curriculum expectations and teacher capability, which can undermine the quality and consistency of coding instruction. To address this, continuous professional development (CPD) must become a central pillar of implementation. National initiatives such as Bimbingan Teknis (Bimtek), certification programs, and partnerships with global technology companies (e.g., Google for Education, Microsoft Education) should be expanded to strengthen teachers' competence.

Capacity-building should also emphasize peer collaboration and reflective practice, allowing teachers to share best practices and co-develop instructional resources. Embedding coding and AI modules in teacher education programs (LPTK) can further institutionalize

competence from pre-service levels. In addition, incentives and career advancement pathways linked to digital teaching excellence could motivate teachers to engage in lifelong learning.

Integration of Innovative Learning Models

Beyond infrastructure and teacher competence, pedagogical adaptability determines how effectively coding education translates into meaningful learning outcomes. Traditional, theory-heavy instruction often fails to sustain students' engagement or stimulate creative problem-solving. Thus, integrative and experiential learning models are essential.

Combining STEAM (Science, Technology, Engineering, Arts, and Mathematics) with project-based learning (PBL) offers an interdisciplinary framework that connects coding with real-world contexts (Ningsih et al., 2023). Through this model, students learn to apply coding to design prototypes, animations, or data-based solutions that reflect both analytical and creative thinking. Such approaches also encourage collaboration, communication, and critical reflection, key components of 21st-century skills (Demir, 2021).

Moreover, gamification and design thinking pedagogy can further enhance motivation and foster innovation-oriented mindsets. Integrating coding activities with local culture and community-based projects (e.g., digital storytelling, environmental data mapping) can make learning more contextual, culturally relevant, and inclusive.

Policy Consistency and Systemic Integration

Despite strong policy direction, inconsistent implementation remains a challenge. Variations in regional governance capacity, budget allocation, and bureaucratic coordination often result in fragmented execution. Ensuring sustainability therefore requires policy coherence across national, provincial, and school levels. Clear standards for curriculum delivery, teacher training, and performance evaluation must be institutionalized.

Regular monitoring and evaluation mechanisms can provide evidence-based feedback to refine implementation strategies. This aligns with adaptive policy frameworks advocated by UNESCO (2023), which emphasize flexibility and iterative improvement in digital education reform.

Ultimately, addressing these challenges demands a multi-stakeholder, ecosystemic approach. The integration of government agencies, private industries, universities, and civil society organizations can foster synergy in resource mobilization and innovation diffusion. By aligning investments, training, and curriculum development under a shared national vision, Indonesia can bridge the digital divide and realize equitable access to quality coding education.

Through these strategies—enhancing infrastructure, strengthening teacher competence, innovating pedagogy, and ensuring policy coherence—Indonesia is positioned to transform coding education into a sustainable catalyst for human capital development. This comprehensive approach not only addresses technical and institutional barriers but also nurtures a generation of digitally literate, creative, and globally competitive learners ready to shape the future of Indonesia Emas 2045.

CONCLUSION

Coding education holds significant urgency in preparing younger generations to face the challenges of the digital era. Based on the literature review, early coding education not only teaches technical programming skills but also enhances cognitive abilities such as logical thinking, problem-solving, and creativity. Moreover, coding fosters social skills through collaboration in group projects while equipping students with essential digital literacy for the future.

The Indonesian government's policy of integrating Coding and Artificial Intelligence (AI) subjects into the primary and secondary education curriculum is a strategic step toward strengthening a competitive human resource base. The implementation of this policy

encompasses three main aspects: (1) developing a competency-based curriculum, (2) improving teacher qualifications through professional training, and (3) applying a gradual implementation strategy with a multi-stakeholder approach. However, challenges such as infrastructure inequality and limited teacher competence must still be addressed through technological investment, continuous training, and industry collaboration.

Therefore, coding education is not merely a technical subject but a long-term investment in creating an adaptive, creative, and globally competitive generation. For effective implementation, synergy between the government, schools, industry, and the community is essential to ensure equitable access and high-quality learning. Through these efforts, Indonesia can harness technological advancements to enhance global competitiveness and realize the vision of "Indonesia Emas 2045."

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