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).

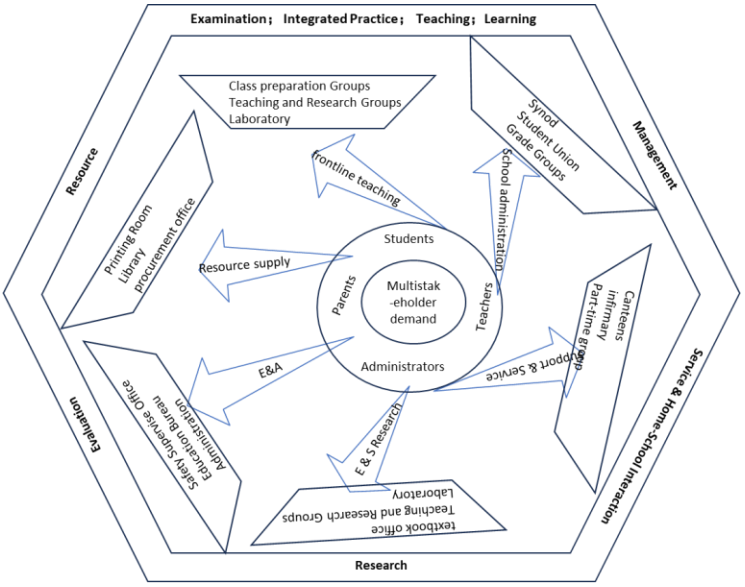

Figure 1. Comprehensive Framework of Educational Business Scenarios

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.

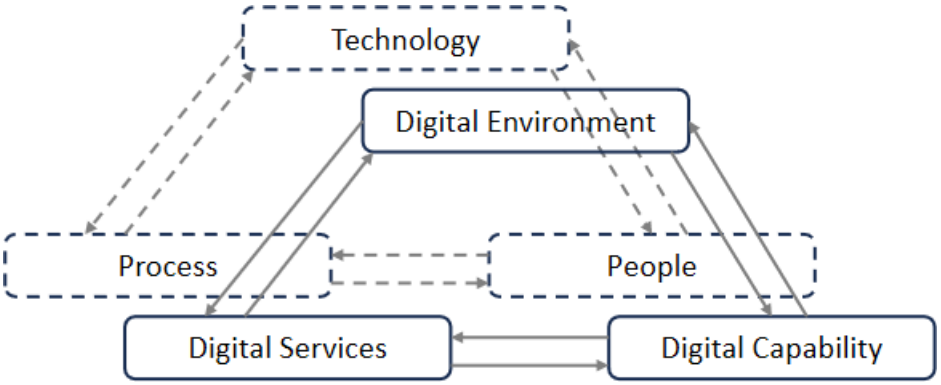

Figure 2. Dimension Framework for Digital Education Scenario Application

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).

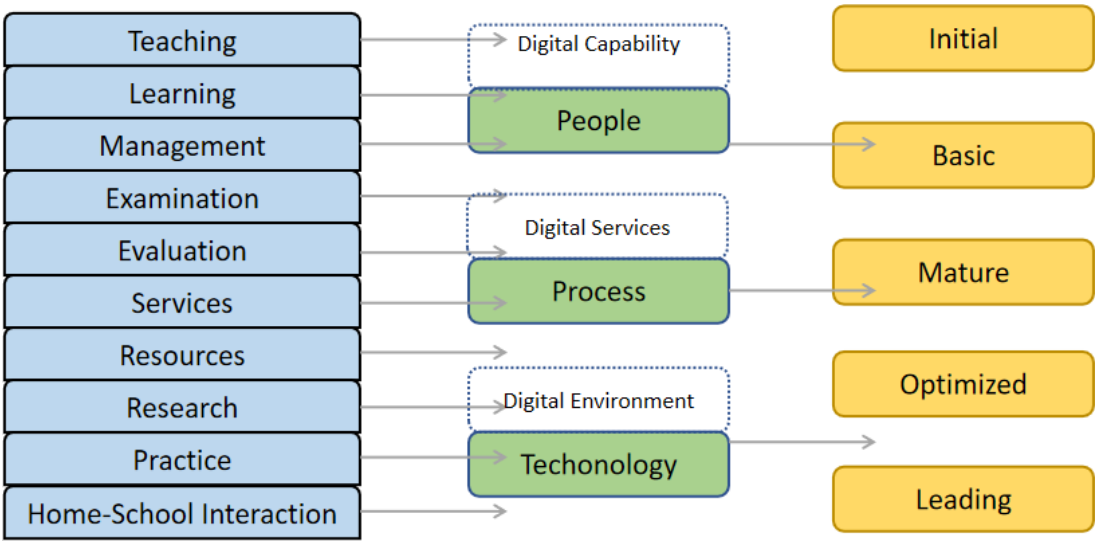

Figure 3. Comprehensive Framework of Digital Transformation in Education Scenarios & PPT Dimensions & Maturity Model

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.

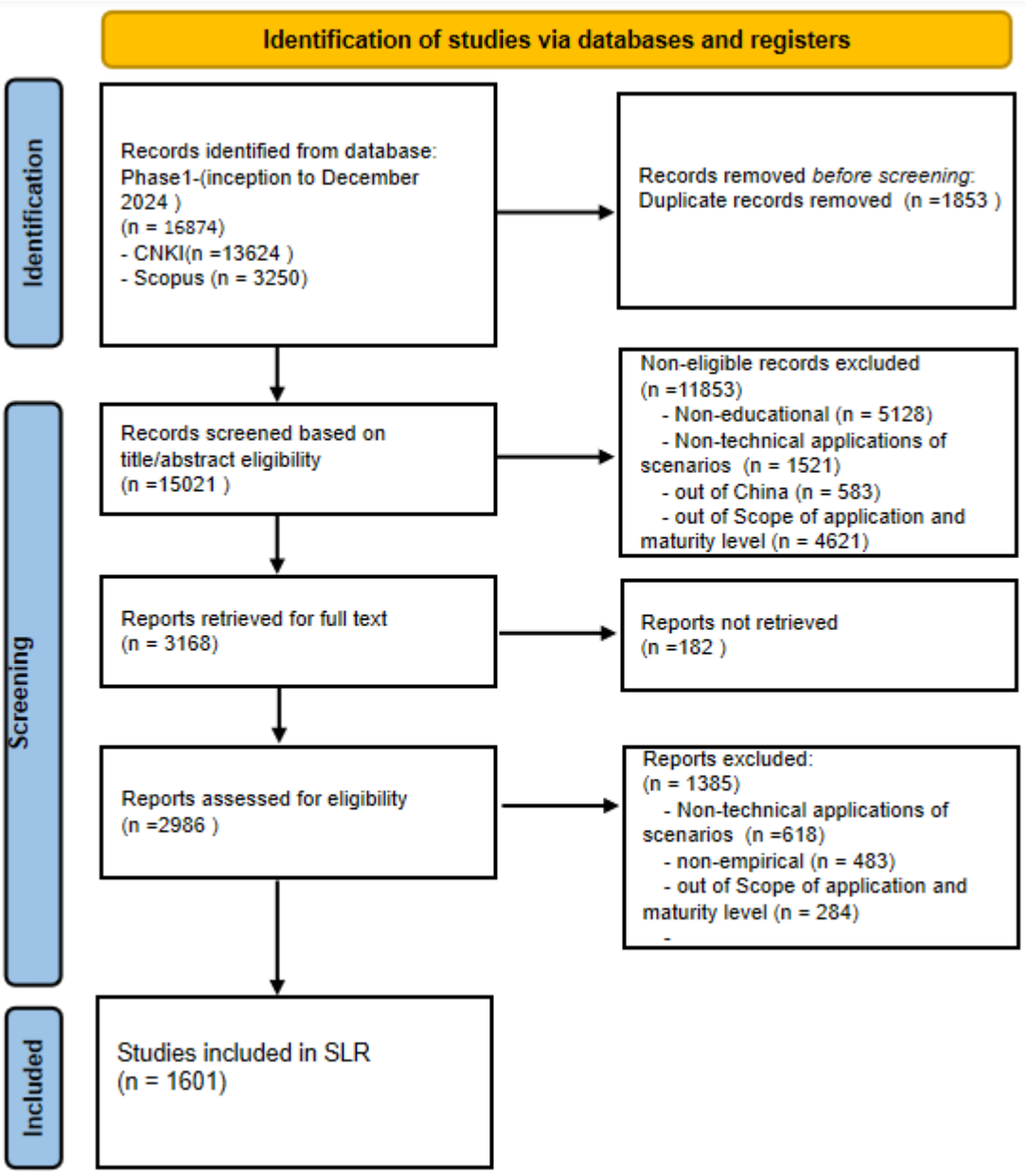

Figure 4. PRISMA Flow Diagram of the Literature Search and Selection Process

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).

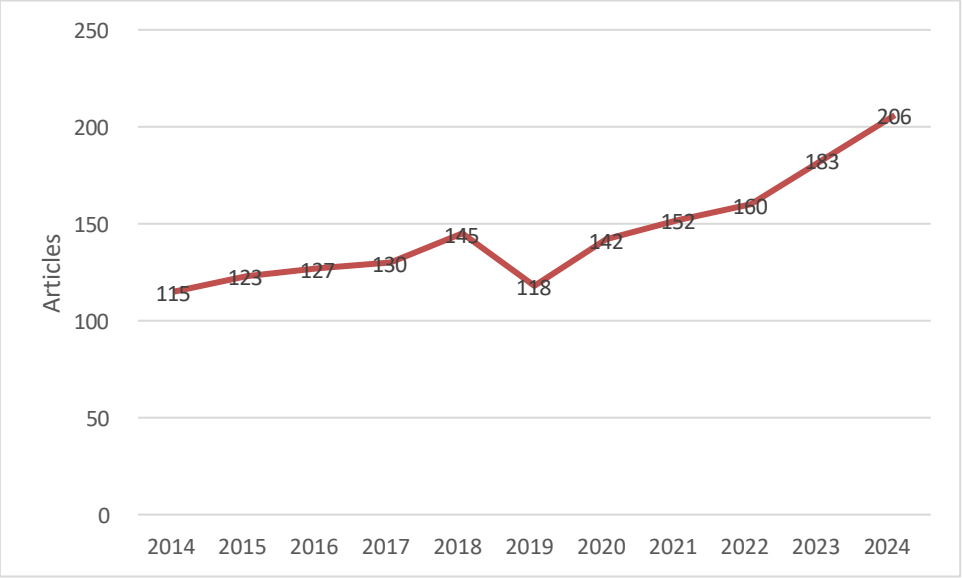

Figure 5. Annual Number of Publications on Digital Technology Application in Education (2014–2024)

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.

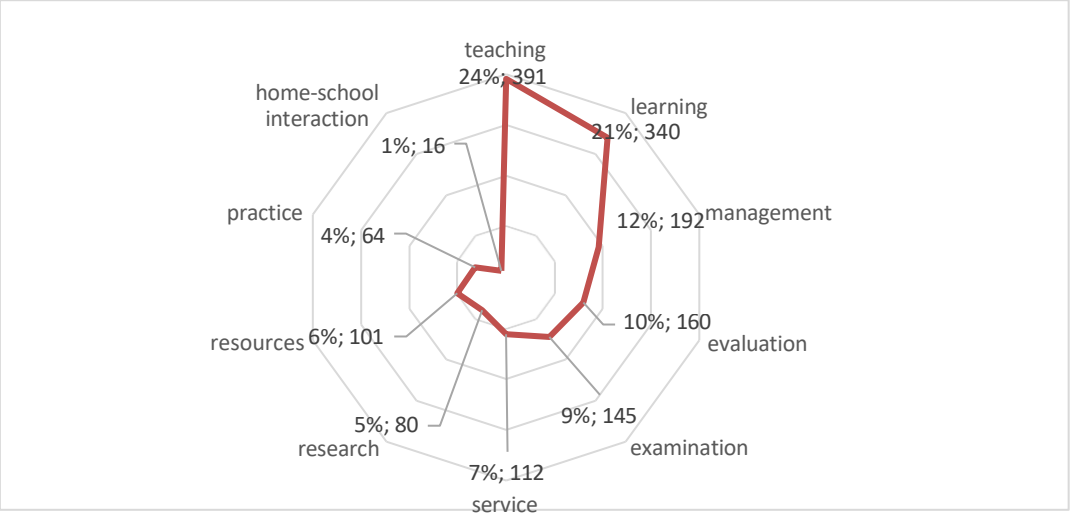

Figure 6. Distribution of Publications Across Digital Application Scenarios in Education

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).

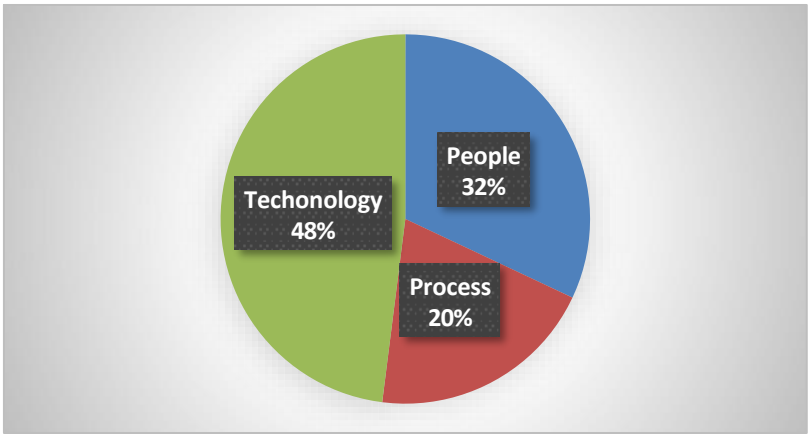

Figure 7. Number of Publications by PPT Dimensions in Educational Digitalization Research

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.

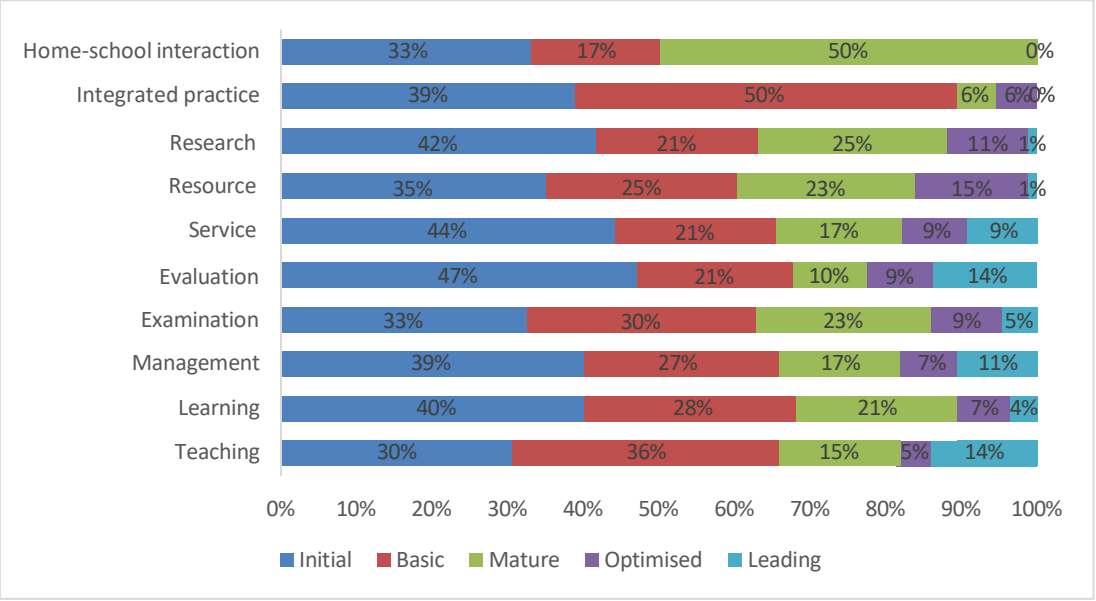

Figure 8. Maturity Level Percentages across Educational Technology Application Scenarios

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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