THE EFFECT OF 5E LEARNING CYCLE MODEL ON PROBLEM SOLVING ABILITY IN TERMS OF STUDENT NUMERICAL ABILITY

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ABSTRACT

Research objectives: 1) knowing differences in students' problem solving abilities based on learning model and numerical abilities; 2) knowing interactive influence between learning models and numerical abilities' on problem solving abilities. Learning model dimensions: 5E learning cycle and direct instruction. Type of research: quasi-experimental pretest posttest non-equivalent control group design. Research population: 287 students of SMAN 1 Kediri-Tabanan. Each experimental and control group gained two classes by simple random sampling technique. In terms of students' numerical abilities, 5E learning cycle applied in experimental group and direct instruction in control group. Data collected by problem solving ability tests. Data analyzed by descriptive analysis. Hypothesis tested by anacova technique. Descriptive analysis result: 1) physics problem solving abilitys' average score of experimental group higher than control group; 2) average score of physics problem solving abilities in high numerical abilitys' group higher than low numerical abilities' group; 3) physics problem solving abilitys' highest average score obtained by high numerical abilitys' experimental class group, and the lowest obtained by low numerical abilitys' control group. Hypothesis test result: 1) there are differences in students' problem solving abilities based on learning model and numerical abilities; 2) there is an interactive influence between learning models and numerical abilities on students' problem solving abilities.

Keywords*: 5E learning cycle model, direct instruction model, numerical ability, problem solving ability*

INTRODUCTION

Development of quality of human resources through education must be done. Various attempts have been made by the government to improve the quality of science education in general and the quality of physics education in particular. These efforts include (1) improving the quality of teaching staff through training, seminars and upgrading of physics teachers, (2) improvement and fulfillment of school facilities, and (3) conducting curriculum improvements (Jayanti & Hidayati, 2015).

Efforts to improve the quality of education, including curriculum changes that have been made so far, are still not satisfactory. There are indicators that show the low quality of education in Indonesia as follows. Based on the results of the TIMSS study (Trends in International Mathematics and Science Study) shows Indonesian students are ranked very low in the ability to (1) understand complex information, (2) theory, analysis and problem solving, (3) use of tools, procedures and solving problems and (4) conducting investigations (Winardi & Wardono, 2017).

The low quality of education such as the explanation above is caused by a lack of knowledge of how to implement the learning process. The learning process is still based on the understanding that knowledge can be transferred in full from the teacher's mind to the student's mind (Nisrina, et al., 2016). Learning that takes place in class is still teacher centered (Purwanto & Siregar, 2016). The learning process in class should take place student centered. Students must be able to construct knowledge in their own minds (Yuhasriati, 2012).

The low quality of education is also due to the physics learning that has been taking place so far more oriented to textbooks and curriculum achievement using the lecture method (Purwanto & Siregar, 2016) (Aprilia, et al., 2017). The learning process using the lecture method without linking it with natural phenomena causes students have no space to develop creativity, the ability to conduct experiments, hypothesize and the process skills that students should have become undeveloped. Physics learning feels dry because it is not associated with the context of students' daily lives (Muchsin, et al., 2015). In addition, learning with the lecture method also less stimulates students to be able to apply and practice their abilities in solving physics problems.

Problem solving ability is an important competency that must be possessed by students, especially in learning physics because according to Anderson (2009), problem solving ability is an important life skill that involves various processes including analyzing, interpreting, reasoning, predicting, evaluating and reflecting. Matlin (in Cahyani & Setyawati, 2016) also stated that problem solving is needed when we want to achieve certain goals but the way to solve them is still not clear, so in order to solve these problems, students are expected to understand the process of solving problems and become skilled in choosing and identifying conditions and relevant concepts, look for generalizations, formulate a plan for completion, and organize their previous owned skills.

Problem solving activities in learning physics, in addition to requiring mastery of physics concepts, it is also necessary to master mathematical concepts and skills as a result of applying a quantitative approach through the use of formulas. This is the reason why most students have difficulty solving physics problems because it is related to mathematical skills, which in learning physics at the high school level almost entirely using mathematical calculations. Therefore it can be said that numerical ability influence students' physics problem solving abilities. In relation to learn physics, the numerical ability possessed by students will help them understand and analyze every physics problem so that students will not have difficulty in learning physics. The ability possessed by students to solve physics problems itself will certainly be different if viewed from the level of numerical ability that they have, so that in order to be observed the difference, the numerical ability of students is classified into two categories, that was students with high numerical ability and students with low numerical ability.

In order to know the difference in students' problem solving abilities in terms of their numerical ability classification, so what is tested in this research was the learning model, which is the learning model that is 5E learning cycle model. The 5E Learning Cycle Model developed by Bybee et al. (2006) is a form of constructivism philosophy about learning which stated that knowledge is built in the minds of learners. This model is then elaborated into inquiry, thus indirectly the benefits of the inquiry approach in learning can be obtained through the application of the 5E Learning Cycle model. Sund & Trowbridge (in Tanti, 2012) stated that the benefits of inquiry approach in the 5E Learning Cycle model are as follows 1) Student centered learning process; 2) The learning process through inquiry forms and develops self-concepts; 3) The level of expectation increases; 4) Learning through inquiry process develops individual ability skills; 5) Prevent students from traditional learning methods that tend to memorize; 6) give time for students to assimilate and accommodate information. The 5E Learning Cycle model contains five learning phases which include the Engagement, Exploration, Explanation, Elaboration and Evaluation phases.

The research was conducted which is aimed at 1) Analyzing differences in problem solving abilities between groups of students whose learning by using the 5E learning cycle model and groups of students whose learning by using the direct instruction model; 2) Analyze differences in problem solving abilities between groups of students with high numerical ability and groups of students with low numerical ability; and 3) Analyzing the interactive effect between learning models (5E learning cycle models and direct instruction models) and students 'numerical abilities (high numerical abilities and low numerical abilities) on students' problem solving abilities.

METHODS

This is a quasi-experimental research with pretest posttest non-equivalent control group design. The full randomized process was not able to applied in this research. The population number on this research were 287 students of grade XI on second semester in SMA Negeri 1 Kediri-Tabanan in 2017/2018 academic year.

Simple random sampling was used to gained the samples, which was trough two stages. First stage was choosing four parallel classes from all parallel classes in the population by lottery. Second stage was taken randomly the four classes that have been selected by two classes receiving treatment of 5E learning cycle model (experimental group) and also two other sample classes receiving direct instruction model treatments (control groups).

Independent variables in this research were learning models and numerical abilities. The learning model variable has two dimensions, that were (a) 5E learning cycle model and (b) direct instruction model. The numerical ability variable also has two dimensions, that were (a) high numerical ability, and (b) low numerical ability. Covariate variables that was used as a statistical control were initial problem solving abilities. The dependent variable was the problem solving abilities. Problem solving ability tests were used to capture students' problem solving abilities about physical concepts before and after learning process. The problem solving ability test was in form of essay questions test which was given twice, that was before the learning process or as a pre-test and after the learning process or as a post-test.

Data collected in this research were problem solving ability and numerical ability. Problem-solving ability test was in form of essay questions consist of 5 items with an internal consistency index item (r) ranging from -0,771 to 0.968 with test reliability index of Alpha Cronbach 0.910 which is very highly qualified. The numerical ability test consists of 30 multiple choice questions with an internal consistency index item (r) ranging from -0,053 to. 0.714 with test reliability index of Alpha Cronbach 0.727 which highly qualified. Data were analyzed descriptively by using anacova. Descriptive analysis was used to describe the average score and standard deviation of students' physics problem solving abilities. Anacova was used on testing the research hypothesis. Before testing the hypotheses, prerequisite tests were performed which include data normality tests, homogeneity variance tests, linearity tests and simple linear regression tests. Kolmogorov-Smirnov and Shapiro-Wilk statistics was used to do the normality test of data distribution, while testing for homogeneity of variance between groups was using the Leven's Test of Equality of Error Variance, Linearity Test, and simple linear regression test. All hypothesis testing was carried out at a significance level of 0.05.

FINDINGS AND DISCUSSIONS

Data obtained from the results of the research were data on students' physics problem solving abilities. Based on the research, it was found that based on the learning model group, that were in the group of students whose learn with 5E learning cycle model there were 71.43% of score of the students' physics problem solving abilities that were very well qualified, and 28.57% were well qualified, while in the group of students whose learn with the direct instruction model there were 57.14% of score of students' physics problem solving abilities that were very well qualified, 35.71% were well qualified, and 7.14% were sufficiently qualified.

The data of students' physics problem solving abilities based on the numerical ability group found the results that in group of students with high numerical ability there were 74.29% of score of physics problem solving abilities that were very well qualified, 24.29% were well qualified, and 1.43% were sufficiently qualified, while in group of students with low numerical ability, it was found that there were 54.29% of scores of students' physics problem solving abilities that were very well qualified, 40.00% were well qualified, and 5.71% were sufficiently qualified.

Based on the average score of students' physics problem solving abilities found in learning model group that the score in the group of students whose learn with 5E learning cycle model that is equal to 52.37 with 5.76 of the standard deviation, which is greater than the average score in group of students whose learn with the direct instruction model which was 48.91 with 6.68 of the standard deviation. In the numerical ability group, the average score of physics problem solving ability for group of students with high numerical ability was 52.40 with 5.99 of the standard deviation, which is greater than the group of students with low numerical ability that the average score of physics problem solving ability was 48.89 with 6.45 of the standard deviation.

Data on average value of problem solving ability was also found based on stages of problem solving according to the type of polya, as presented in form of a percentage as shown in Table 1.

Table 1. Percentage of Students' Problem Solving Ability Average Score Based on Polya's Type Stage of Problem Solving Skills

GROUP	POLYA'S TYPE STAGE OF PROBLEM SOLVING SKILLS							
	I		II		III		IV	
	MEAN (%)	SD	MEAN (%)	SD	MEAN (%)	SD	MEAN (%)	SD
5E with High NA	85,71	1,42	95,57	1,43	89,14	2,26	54,48	2,31
5E with Low NA	82,86	1,32	89,43	2,72	85,00	2,24	52,57	1,78
DI with High NA	82,86	1,36	91,14	2,69	85,14	2,53	50,48	1,88
DI with Low NA	77,71	1,24	81,86	3,42	76,29	2,27	48,76	1,89
5E Model	**84,29**	**1,37**	**92,50**	**2,24**	**87,07**	**2,27**	**53,52**	**2,05**
DI Model	**80,29**	**1,32**	**86,50**	**3,20**	**80,71**	**2,54**	**49,62**	**1,88**
High NA	**84,29**	**1,39**	**93,36**	**2,19**	**87,14**	**2,41**	**52,48**	**2,11**
Low NA	**80,29**	**1,30**	**85,64**	**3,16**	**80,64**	**2,40**	**50,67**	**1,84**

Based on the table, it can be clearly seen that the percentage of average score of problem solving ability of the 5E learning cycle model group is always greater than the percentage of average score of problem solving ability of direct isntruction model group at each stage of Polya's problem solving type. Based on the numerical ability in accordance with the table above, it is clearly stated that the average score of problem solving ability of groups of students with high numerical ability is also always greater than the average score of problem solving abilities of groups of students with low numerical ability at each stage of Polya's problem solving type.

The result of the prerequisite tests were found that all data were normally distributed. Homogeneity test of variance which conducted both based on group of learning model and based on numerical ability group shows that the data is homogeneous. Linearity test wwhich conducted to determine the linearity of relationship between covariate variable data (initial problem solving ability) and the dependent variable data (problem solving ability) indicates there were a linear relationship. The simple linear regression test that was carried out produced a regression equation that were $\hat{Y} = 36{,}598 + 0{,}742\,\hat{X}$ which was used to predict the value of students' physics problem solving abilities.

Hypothesis testing was performed after the fulfillment of the requirements on all of the prerequisite tests. Hypothesis test results can be seen in Table 2.

Table 2. ANACOVA Result with Factorial 2 × 2

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	4277.967[a]	4	1069,492	95,606	0,000
Intercept	23448,248	1	23448,248	2096,122	0,000
*Initial PSA	3399,938	1	3399,938	303,933	0,000
**Learning Model (LM)	119,026	1	119,026	10,640	0,001
***Numerical Ability (NA)	84,472	1	84,472	7,551	0,007
LM * NA	54,423	1	54,423	4,865	0,029
Error	1510,176	135	11,186		
Total	364846,000	140			
Corrected Total	5788,143	139			

Based on the results of hypotheses testing from the table above it can be found that: 1) the covariate variable (initial problem solving ability) affects the dependent variable (problem solving ability) with an F value of 303.933 and a significance value of 0.000 ($p < 0.05$). 2) The learning model as an independent variable affects the dependent variable (problem solving ability) with an F value of 10.640 and a significance value of 0.001 ($p < 0.05$), which was then carried out the post hoc tests (LSD test) with the mean difference for the learning model group that was 1,868 which was greater compared to the LSD test rejection limit (1.12). 3) The numerical ability as an independent variable influences the dependent variable (problem solving ability) with an F value of 7,551 and a significance value of 0.007 ($p < 0.05$), which is then carried out the post hoc tests (LSD test) with the mean difference in numerical ability group were 1,583 which was greater than the LSD test rejection limit (1.12). 4) There is an interaction effect between the independent variable (learning model and numerical ability) towards the dependent variable (problem solving ability) with an F value of 4.865 and a significance value of 0.029 ($p < 0.05$).

Based on this explanation, the use of the 5E learning cycle model in an effort to obtain achievement and practice the ability to solve physics problems in students shows better results compared to the use of the direct instruction learning model. The 5E learning cycle model provides opportunities for students to learn new knowledge so that it is embedded in students as a concept. This model also increases student curiosity in every learning activity that is proven during the learning activities carried out, groups of students who are taught with the 5E learning cycle model are always actively involved. The 5E learning cycle model also has a target that is for students to be able to find and associate new knowledge with the knowledge that they already have. Positive relationship between the application of 5E learning cycle model with student activity, availability of opportunity to optimize learning and develop reasoning ability in students, availability of opportunity to build concepts to solve problems, creative and independent thinking skills, increasing in academic achievement, and creating a fun learning atmosphere causes the application of 5E learning cycle model were able to improve students' ability to solve problems.

The findings of the research show that the score of students' physics problem solving ability for the group of students with high numerical ability is better than the score of students' physics problem solving ability for the group of students with low numerical ability. Good problem solving skills require mental and intellectual process skills to find a problem and solve it based on accurate data and information, while numerical ability is an intelligence that enables to achieve or master the problem solving ability, because in numerical ability directs the individual in mastery good mental and intellectual process skills. Based on this, it can be stated that the better or higher the numerical ability possessed by students will also have an impact on the better or higher problem solving abilities possessed by individual students.

Learning activities using the 5E learning cycle model which consist of 5 (five) stages provide an opportunity for students to be able to practice their previous skills so the students will have a good mental and intellectual process skills in an effort to solve problems. The application of 5E learning cycle model is also supported by numerical abilities that possessed by students in an effort to solve problems. Students who have good numerical ability mean that these students have an organized way of thinking and are good at doing things and solving problems.

CONCLUSION

Based on the results of hypothesis testing and discussion, the following conclusions can be drawn.

Firstly, there are differences in problem solving abilities between groups of students who learn by using the 5E learning cycle model and groups of students who learn by using the direct instruction model, which is indicated by the meaning of post hoc test that the mean difference in learning model groups (1,868) is greater than the rejection limit of LSD test (1.12).

Secondly, there is a difference in problem solving abilities between groups of students with high numerical ability and groups of students with low numerical ability, which is also indicated by the meaning of post hoc test that the mean difference of numerical ability groups (1,583) is greater than the rejection limit of LSD test (1.12).

Finally, there is an interactive influence between the learning model (5E learning cycle model and direct instruction model) and the numerical ability of students (high numerical ability and low numerical ability) on students' problem solving abilities, as indicated by the results of hypothesis testing with an F value of 4.865 with significance value of 0.029 ($p < 0.05$).

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