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Improving mathematical problem-solving ability through models of problem based learning

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Abstract: students who receive conventional learning One of the aims of learning mathematics at school is to develop students' mathematical problem-solving abilities. This is in accordance with the objectives of mathematics learning in the independent curriculum set by the Curriculum and Educational Assessment Standards Agency. In the learning process using the Problem Based Learning model, students will be faced with various mathematical problems which are also related to daily life, so diligent and persistent efforts are needed from students to solve these various problems. This research is experimental research because the researcher applies a treatment to the research sample and then wants to know the effect of this treatment, namely in the form of increasing mathematical problem-solving abilities. The treatment given is learning using the Problem Based Learning model in the experimental class and conventional learning in the control class. The statistical test used to analyze data on increasing mathematical problem-solving abilities is the t* test. Based on the results of the t test, it was found that the sig value was 0.000 < 0.05 so that H0 was rejected, it could be concluded that the average mathematical problem-solving ability of students who receive learning through the problem based learning model is better than.

Keywords: problem based learning, problem solving, t test, educational assessment.

1. Introduction

Mathematics is a scientific discipline that has a big influence in advancing thinking power. Mathematics is also very useful in everyday life to prepare and develop logical, flexible and precise thinking skills to solve problems [1]-[3]. Therefore, mathematics has become an existing subject and must be taught at all levels of education. One of the aims of learning mathematics at school is to develop students' mathematical problem-solving abilities. This is in accordance with the objectives of mathematics learning in the independent curriculum set by the Educational Curriculum and Assessment Standards Agency or BSKAP [4], namely (1) understanding mathematics learning material in the form of facts, concepts, principles, operations and mathematical relationships and applying them flexibly, accurately, efficient, and precise in solving mathematical problems (mathematical understanding and procedural skills); (2) using reasoning on patterns and properties, carrying out mathematical manipulations in making generalizations, compiling evidence, or explaining mathematical ideas and statements (mathematical reasoning and proof); (3) solving problems which includes the ability to understand problems, design mathematical models, complete models or interpret the solutions obtained (mathematical problem solving); (4) communicating ideas using symbols, tables, diagrams, or other media to clarify situations or problems, as well as presenting a situation in symbols or mathematical models (mathematical communication and representation); (5) linking mathematics learning material to a field of study, across fields of study, across fields of science, and with life (mathematical connections); and (6) have an attitude of appreciating the usefulness

of mathematics in life, namely having curiosity, attention and interest in studying mathematics, as well as a creative, patient, independent, diligent, open, tough, tenacious and confident attitude in solving problems.

Developing and improving students' abilities to solve problems both in mathematics, other fields and in everyday life is very important to pay attention to and must be a top priority. However, the reality on the ground is just the opposite. Students' mathematical problem-solving abilities, especially junior high school students, are still very low. This can be seen from the results of the TIMMS and PISA studies which show that the abilities of junior high school students, especially in mathematics, are still below international standards. The 2015 TIMSS results placed Indonesia in 44th place out of 49 participating countries with an average score of 397, while the average score international 500 [5]. Meanwhile, the results of the 2018 PISA study were not much different, where Indonesia was ranked 73rd out of 79 participating countries with an average mathematics score of 379 with an OECD average score of 487 [6]. The TIMSS and PISA results show that there are still many students who cannot solve international standard mathematics problems. This is because the test questions tested in both TIMSS and PISA are non-routine questions or mathematical problem-solving questions.

Mathematical problem solving is an ability that requires students to be able to solve mathematical problems, especially problems related to everyday life. Problem solving ability is the ability or potential of students to solve problems and apply them in everyday life [7][8]. Problem solving abilities are also students' efforts to analyze and find solutions to the problems they face. According to Flavell and McCormick [9] metacognition in problem solving involves the process of planning, monitoring and evaluating problems as well as choosing the right strategy. Meanwhile, problem solving process uses various knowledge which leads to decision making, students in solving problems must have a strategy, namely understanding the problem carefully, distinguishing between what is known and what is the problem that is being asked or must be solved, then looking for the relationship between what is asked and what is known [10][11].

Apart from problem solving abilities, another aspect that is also needed in learning mathematics is the attitude that students must have, including enjoying mathematics, appreciating the beauty of mathematics, having high curiosity and enjoying learning mathematics. With this attitude, students are expected to continue to develop their mathematical skills, using mathematics to solve the problems they face in their lives. This is in accordance with the objectives of learning mathematics in the sixth point of the Independent Curriculum, namely having an attitude of appreciating the usefulness of mathematics in life, namely having curiosity, attention and interest in studying mathematics, as well as a creative, patient, independent, diligent, open, tough, tenacious attitude and confident in problem solving. A similar thing is also found in the National Council of Teachers of Mathematics [12] in its seventh point regarding the objectives of learning mathematics, namely the formation of a positive attitude towards mathematics.

According to Polya, there are four steps that can be taken in solving mathematical problems, namely understanding the problem, planning a solution (devising a plan), implementing the solution plan (carrying out the plan), and checking the results again. completion (looking back) [13]. In line with Polya's opinion, indicators for solving mathematical problems were also expressed by Wardhani and Rumiati, namely: (1) Identifying elements that are known, asked about, and the adequacy of the elements needed; (2) Formulate everyday situation problems in mathematics or develop mathematical models; (3) Selecting a solution approach or strategy; (4) Applying strategies to solve various problems, both similar and new problems within or outside

mathematics; and (5) Explain or interpret the results according to the original problem or check the correctness of the answers [14].

The low ability of students to solve mathematical problems in learning mathematics needs serious attention from all groups, especially mathematics teachers. Many factors cause students' low mathematical problem-solving abilities in the mathematics learning process. One of them is that learning is still too dominated by teachers (teacher centered). Therefore, an appropriate learning model is needed so that it can change the learning process from a teacher teaching situation to a student learning situation. One innovation that is thought to be able to realize a learning process like this is mathematics learning with the Problem Based Learning (PBL) model or problem-based learning. Problem-based learning or PBL is effective learning for high order thinking processes. This learning helps students to process information that has already been created in their minds and construct their own knowledge about the social world and their surroundings [3][15]. Learning with the PBL model, which begins by exposing students to real everyday problems or simulated problems, is expected to improve problem solving abilities. In the learning process using the PBL model, students will be faced with various mathematical problems, so diligent and persistent efforts are needed from students to solve these various problems.

Based on the background and problem formulation described above, the aim of this research is to examine the increase in mathematical problem-solving abilities of students who receive learning using the Problem Based Learning model better than students who receive conventional learning.

2. Materials and Methods

This research is experimental research because the researcher gave treatment to the research sample and then wanted to know the effect of the treatment. The treatment given is learning using the Problem Based Learning (PBL) model in the experimental class and conventional learning in the control class. The experimental research used in the research is a quasi-experimental type with a quantitative approach. The design used in this research is the Pretest Post-test Control Group Design [16]. The research design used can be described as follows:

Experimental class	A:	O	X	O
Control class	A:	O		O

Description:
A: Random sample selection class
O: Pre-test and post-test
X: Mathematics learning with the Problem Based Learning (PBL) model

The data in this research were obtained from a set of instruments used, namely mathematical problem-solving ability test instruments. Mathematical problem-solving ability tests were given to experimental class and control class students before and after learning. The initial test was given to see the equality of the initial abilities of the two classes, while the final test was given to find out how much the students' mathematical reasoning abilities had improved after learning using the Problem Based Learning (PBL) model. The mathematical problem-solving ability test questionnaire was first validated by several validators and tested on students.

The data analyzed is quantitative data in the form of test results of students' mathematical problem-solving abilities. The statistical test used in this research is the average difference test with the following steps:

1. Determine the pretest and post-test scores for mathematical problem-solving abilities for the experimental class and control class
2. Determine the score for increasing mathematical problem-solving abilities using the normalized N-gain formula.
3. Normality test of pretest score data and N-gain using the Shapiro Wilk test.
4. Homogeneity test of the N-gain variance using the Levene Statistics Test.
5. After the data meets the normal and not homogeneous, then test it using the t* test.

a. Calculating Normalized Gain (N-Gain)

Normalized Gain is calculated after the pretest and post-test are carried out. According to Hake normalized gain formula (Normalized Gain) = g [17]:

$$g = \frac{posttest\ score - pretest\ score}{maximum\ possible\ score - pretest\ score} \quad (1)$$

The N-gain points obtained are then analyzed using the criteria in the following Table 1 [18]:

Table 1. N-Gain Interpretation

N-Gain Scores	Interpretation
$\boldsymbol{g \geq 0,7}$	High
$\boldsymbol{0,3 \leq g < 0,7}$	Medium
$\boldsymbol{g < 0,3}$	Low

Based on the gain score criteria, learning is said to be effective if the learning results students get an n-gain score > 0.3 with medium or high criteria.

b. Normality Test

The normality test is used to determine whether the research data to be analyzed is normally distributed or not. Normality test can calculate by using SPSS software.
The hypothesis used to normality test in this research are:
H0 : data is normally distributed
H1 : the data is not normally distributed

The hypothesis for testing normality is reject H0 if Sig value < 0,05. and H0 is accepted if the Sig value. $\geq 0{,}05$ with a significant level by 5% or $\alpha = 0.05$.

c. Homogeneity Test

The homogeneity test is used to determine whether the research population have the same variance (homogeneous) or not. Homogeneity test can calculate by using SPSS software. Homogeneity test of the N-gain variance using the Levene Statistics Test.
The hypothesis of homogeneity test in this research are:
H0: the variance of the two groups is homogeneous
H1: the variance of the two groups is not homogeneous

The hypothesis for testing homogeneity is reject H0 if Sig value < 0,05. and H0 is accepted if the Sig value. $\geq 0{,}05$ with a significant level by 5% or $\alpha = 0.05$.

d. t* test

The t* test aims to determine whether there are differences in students' mathematical problem-solving abilities in classes that use the problem based learning model and classes that use conventional learning. The hypothesis used to test the average difference in this research are:

H0 : the average mathematical problem-solving ability of students who receive learning using the problem based learning model is the same as students who receive conventional learning

H1 : the average mathematical problem-solving ability of students who receive learning using the problem based learning model is better than students who receive conventional learning

The hypothesis for testing homogeneity is reject H0 if Sig value < 0,05. and H0 is accepted if the Sig value. $\geq 0{,}05$ with a significant level by 5% or $\alpha = 0.05$.

3. Results and Discussion

This research was carried out on class VII junior high school students consisting of 26 students in the experimental class and 27 students in the control class. The data used is data from pretest and post-test results in both classes. Pre-test and post-test data were obtained by giving test instruments in the form of problem-solving ability questions to each student. The questions used are valid questions. The following are the results of the pretest, post-test and N-gain from each class shown in the Table 2:

Table 2. Mean of Pretest, Post Test and N-Gain

	Experimental		Control	
	N	$\bar{x}$	N	$\bar{x}$
Pretest	26	34,65	27	29,01
Post Test	26	78,92	27	65,70
N-Gain	26	0,68	27	0,52

Based on the table above, it can be seen that the average pre-test score for the experimental class is 34.65, which is slightly higher than the control class with an average score of 29.01. The average post test score for the experimental class increased by 44.27 compared to the average pretest score. Meanwhile, in the control class, the average post-test score increased by 36.69. At a glance, it appears that the mathematical problem-solving abilities of the experimental class are better than those of the control class. This also shows that the treatment given to the experimental class had a more significant impact on learning outcomes than the control class. In addition, the N-gain value for the experimental class is higher than the control class, which shows that the intervention or treatment applied to the experimental class is more effective in improving students' abilities compared to the control class which was not given special treatment. The average N-gain for the experimental class was 0.68 and the average N-gain for the control class was 0.52 and both were in the medium category.

Table 3. Normality Test Results

	Class	Shapiro Wilk		
		Statistic	df	Sig.
Pretest	Experimental	0,933	26	0,093
	Control	0,958	27	0,338
N-Gain	Experimental	0,958	26	0,357
	Control	0,975	27	0,728

Based on the table above, it can be seen that the results of the normality test using Shapiro Wilk for both classes, namely experimental and control, have a sig value > 0.05, so H0 is accepted, which means that the pretest scores for students' mathematical problem-solving abilities in both classes are normally distributed. Likewise, the N-gain value of students' mathematical problem-solving abilities for both classes has a sig value > 0.05, so H0 is accepted, which means the N-gain value for both classes is normally distributed.

Table 4. Results of the N-Gain Data Homogeneity Test

	Levene Statistic	N	Sig.
N-Gain	7,031	53	0,11

Based on the table above, it can be seen that the N-gain value appears to have a sig value of 0.11<0.05 so that H0 is rejected, which means that the N-gain variance for the two classes is not homogeneous. Because the N-Gain values for both classes are normally distributed but not homogeneous, hypothesis testing uses the t* test.

Table 5. t* Test Results for N-Gain Data

	Class	t* test	
		t*	Sig.
N-Gain	Experimental	20,041	0,000
	Control		

Based on the table above, it can be seen that the sig value is 0.000 < 0.05 so that H0 is rejected, it can be concluded that the average mathematical problem-solving ability of students who receive learning through the problem based learning model is better than students who receive conventional learning.

4. Conclusions

Based on the average pretest, post-test and N-gain scores, it can be seen that the average test score for mathematical problem- solving ability of experimental class students was higher than that of the control class and increased from pretest to post-test. At a glance, it appears that the mathematical problem-solving abilities in the experimental class are better than those in the control class. This also shows that the treatment given to the experimental class had a more significant impact on learning outcomes than the control class.

Based on the results of data analysis, a sig value of 0.000 < 0.05 is obtained so that H0 is rejected and it can be concluded that the average mathematical problem-solving ability of students who receive learning through the problem based learning model is better than students who receive conventional learning.

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