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The Effect of the Polya Model Problem Solving Method on Improving Student Learning Outcomes in Solving Math Word Problems

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abstract

The application of learning methods that train their thinking skills and solve mathematical problems, especially in math word problems, needs to be done because students' ability to solve math problems tends to be below. Therefore, this study aims to determine and measure the improvement of learning outcomes on the application of the problem-solving method of the Polya model. This research method uses experimental research with quantitative research type and one group pretest-posttest design, with descriptive data analysis techniques and one-sample t-test. The population in this study were seventh-grade students of SMP Negeri 11 Maros Baru for the 2018/2019 academic year. Based on the results of data analysis, the average normalized gain score reached 0,71 including the high category and the value-ρ = 0,000 < ½α = 0,025 on the t-test, which means there is a significant increase. The results of this study indicate that there is a significant increase in students' mathematics learning outcomes after being taught the Polya model problem-solving method.

Keywords:
Problem Solving Methods, Polya Models, Learning Outcomes, Math Word problems.

INTRODUCTION

Mathematics learning aims to direct students to be able to understand and master concepts, propositions, theorems, generalizations, and mathematics as a whole. Furthermore, students are also expected to be able to think logically, critically, systematically. The problems studied in learning mathematics are generally presented in the form of problems in the form of problem-solving. Therefore, it is necessary to have the ability to solve mathematical problems (Setiyowati et al., 2018).

Based on information from the seventh-grade mathematics teacher at SMP Negeri 11 Maros Baru, students' ability to solve mathematical problems is still low, so that it affects student-learning outcomes. Although in the application of mathematics learning, teachers have used various methods, including lectures, exercises, and discussions. However, this method has not been developed optimally so that student-learning outcomes have not been maximized. This is indicated by the learning method used to make the teacher's role more dominant so that not all students are seen as active in the learning process. The teacher delivered more material with the lecture method, and then students were given practice questions. This causes the learning process has not to be maximized in providing opportunities for students to think critically and act creatively. This kind of learning causes students to work procedurally without understanding the actual concept. In addition, learning is still fixated on textbooks and less related to everyday life so that students to solve mathematical problems realistically, especially in the form of story questions cannot interpret learning.

According to Nasution (2018) "Learning methods are needed in schools, especially for learning in the classroom". This is in line with the definition of learning methods in the book of Uno & Mohammad (2014) that learning methods are defined as the methods used by teachers in carrying out their functions and are tools to achieve learning objectives. Based on the problems above, teachers must be able to design learning methods that make students active, train their thinking skills, and solve mathematical problems, especially in math word problems. Many methods can be used in the learning process, one of which is the Problem Solving Model Polya method.

Problem Solving Model Polya is a very good problem-solving model used to train students' ability to solve problems (Komariah, 2011). The problem-solving method is learning that involves students to be active, creative, and able to think logically, critically, and able to think at a high level in conveying their ideas to solve a problem they face (Samura, 2019). According to Polya, there are four steps that students must go through to solve problems. The four steps understand the problem, planning a settlement strategy, implementing the planned settlement strategy, and re-checking the answers that have been found (Tim MKPBM, 2001).

Research conducted by Setiyowati et al. (2018) states that applying the Polya model problem-solving method can make students more active in the learning process, especially in problem-solving skills, and produce significant data when viewed from posttest results that exceed the minimum completeness criteria so that it can be concluded that the Polya model problem-solving method can help students in improving students' mathematical problem-solving competence. In this study, the research subjects were third-grade elementary school students, so this study applied the Polya model of problem-solving

learning at a higher level, namely seventh-grade junior high school students in terms of story-forming math problems. The application of the Polya model problem-solving learning model is expected to be able to improve students' ability to solve story-shaped math problems because through this learning students are trained to find the essence of the problem, then simplify story sentences by writing known and asked data.

METHODS

This type of research is a Pre-Experimental study with a design in the form of One Group Pretest-Posttest Design by using a treatment on the research object by involving only one class as the experimental class without control variables. The population in this study was class VII students of SMP Negeri 11 Maros Baru for the 2018/2019 academic year, totaling 160 students. The sample is class VII.B students, totaling 32 students with 18 female students and 14 male students. The sampling technique is Simple Random Sampling. The data collection instrument used a test of student learning outcomes in the form of five math story questions that had been validated by experts. The data analysis technique in this study, namely the student learning outcomes obtained will be analyzed descriptively and inferentially as follows:

Descriptive analysis

Descriptive statistical analysis was used to describe the characteristics of the distribution of student learning outcomes. This analysis includes the highest value, lowest value, average, and standard deviation. In addition to describing student learning outcomes, this study describes how the differences that occur after students are given treatment. The difference is reviewed based on the calculation of the normalized gain value. The normalized gain value in this study was obtained by dividing the gain score (posttest and pretest difference) by the difference between the maximum score and the pretest score.

Inferential analysis

Inferential statistics are used to test the research hypotheses. This study used statistical analysis One Sample T-test to test the research hypothesis. However, before testing the hypothesis, a prerequisite test is first carried out. The prerequisite test conducted before testing this hypothesis is the normalized gain score test for the data on mathematics learning outcomes. This study for normality test used the SPSS application program.

RESULT AND DISCUSSION

Description of Research Results

The description of the results of this study describes the learning outcomes of students before and after being given treatment in the form of applying the Polya model Problem-Solving method in the experimental class. Data on student learning outcomes, both pretest and posttest of students taught by applying the Polya model Problem-Solving method on quadrilaterals in mathematics learning in full can be seen in the appendix, while the results of the descriptive analysis can be seen in the appendix. More details are presented in the following table 1:

Table 1. Recapitulation of Students' Mathematics Learning Outcomes Tests

	Pre Test	Post-test
Number of Samples	32	32
Min	30	69
Max	58	97
Mean	44,66	83,22
Standard Deviation	8,190	7,056
Variance	67.072	49,789

In table 1, it can be seen that the score of student learning outcomes after being taught by the Problem Solving method of the Polya model experienced a positive change. This can be seen from the change in the score that occurs at the lowest value that is close to the minimum completeness criterion value, which is 75 and the highest value is close to 100. The standard deviation value shows a decrease in value which indicates that students' scores are getting closer to the average where the average value is also showed a positive change because at the time of the pretest the average value based on the learning outcomes criteria was in a low category and increased to the high category. A positive change in value is also shown in research conducted by Setiyowati et al. (2018), with the lowest value increasing from 30 to 50, the highest value increasing from 81 to 90, and the average also increasing from 62,32 to 73,11.

Based on the description of student learning outcomes above, the learning outcomes of students after being taught by applying the Polya model Problem-Solving method in the experimental class in this study can be said to increase. In other words, the learning outcomes of students after being treated are different from the learning outcomes of students before being treated. These differences indicate an increase in students' mathematics learning outcomes. After the students were taught using the Problem Solving Polya model, the researchers analyzed the normalized gain scores that are shown in the following table 2:

Table 2. Normalized Gain of Student Learning Outcomes

	Min	Max	Mean	Variance	Std. Deviation
Normalized Gain Score	0,52	0,93	0,71	0,010	0,09853

Table 2 shows that the average normalized gain of student learning outcomes is 0,71 where this value is in the high category. That is, classically, the learning outcomes of students on the material of quadrilaterals after being taught by applying the Polya model Problem-Solving method experienced a high increase.

Inferential Analysis

Prerequisite test results analysis of research results

The prerequisite test used in analyzing the results of this study is the normality test, where the normality test is used to determine the data used comes from a population that is normally or not normally distributed. The normality test of the data used in this study was carried out with the help of the SPSS 24 application program. The data were normally distributed if the value in the Shapiro-Wilk test was more than alpha (α).

Hypothesis:

Ho: Data comes from a normally distributed population.

H_1: Data comes from a population that is not normally distributed.

Test rule:

Ho is accepted, if score-p $(sig) > 0.05$

H_1 is accepted, if score-$\rho(sig) < 0.05$

The computational results of data normality testing can be seen in table 3 below:

Table 3. Normality Test Results

Source	Score-$\boldsymbol{\rho}$	$\boldsymbol{\alpha}$	Decision	Conclusion
Normalized Gain	0,689	0,05	Score-$\rho > \alpha$	Normal

Based on the results of the normality test above, the Score-ρ (sig) value in the Shapiro-Wilk test is more than 0,05 so it can be concluded that the data in this study came from a normally distributed population.

Hypothesis testing results

Hypothesis testing in this study used a one-sample t-test on normalized gain data. The t-test in this study was used to determine the increase in students' mathematics learning outcomes after the Polya model Problem-Solving method was applied to the rectangular flat-shaped material.

Hypothesis:

Ho : There is no significant increase in student learning outcomes after being taught by applying the Polya model problem-solving method in solving math word problems.

H_1 : There is a significant increase in student learning outcomes after being taught by applying the Polya model problem-solving method in solving math word problems.

The statistical hypothesis:

$$H_0 = \mu_{\bar{g}} \leq 0{,}30 \text{ versus } H_1 = \mu_{\bar{g}} \geq 0{,}30$$

Test rule:

Ho is accepted, if score-p $(sig) \geq 0{,}05$

Ho is rejected, if score-$\rho(sig) < 0{,}05$

The computational results of this test carried out with the help of SPSS 24 can be seen in the appendix. The summary of the results is presented in the following table:

Table 4. One-Sample t-Test

Source	t	Score-$\boldsymbol{\rho}$	Decision
Normalized Gain of Mathematics Learning Outcomes	23,383	0,000	Ho rejected

Based on the summary of the results of data analysis in table 4, it is obtained that $t = 23{,}383$ with score-$\rho = 0{,}000 < \frac{1}{2}\alpha = 0{,}025$, then according to the decision-making criteria for hypothesis testing, it can be concluded that Ho is rejected. That is, there is a significant increase in students' mathematics learning outcomes after being taught by applying the Polya model Problem-Solving method in solving math word problems. In table 2 it can be seen that the parameters of the average gain are normalized for the pre-test and post-test scores of students' mathematics learning outcomes with $\mu_{\bar{g}} = 0{,}71$ is at high criteria.

Discussion

The application of the model Polya Problem Solving method in solving mathematical word problems can improve the learning outcomes of students. This effect can be explained by the average value of the student learning outcomes test which is measured through the initial test before the students are given treatment (pre-test) and the final test after the students are given treatment (post-test), where the average value of the students is in the pre-test was 44,66 then the average value increased to 83,22 in the post-test. It is also seen in the Post-test also shows that 30 out of 32 students or in other words 93,75% of students have achieved the Minimum Completeness Criteria in mathematics at SMP Negeri 11 Maros Baru, which is 75. In addition, a significant increase in students' mathematics learning outcomes can also be seen through the parameters of the normalized gain average value of students' mathematics learning outcomes that reached 0,71 with high criteria.

Learning by using the Problem Solving Polya model in solving math word problems on rectangular flat-shaped material aims to help students' difficulties in solving math problems in the form of stories, especially in analyzing and understanding word problems in determining the steps for solving problems. This is because, in this learning, students are guided to find the essence of the problem, and then summarize it in known and asked data. Writing known and asked data can bridge students in understanding the problem because the sentence of the question becomes simpler. With that, students will easily find out the right arithmetic operation to solve the problem. What is more positive is that students show good learning outcomes. This can be seen when students actively respond and can answer the practice questions given by the steps in solving word problems.

This is by the opinion of Setiyowati et al. (2018) in their research on the application of the Polya model Problem-Solving Method to the ability to solve problems, which showed a significant difference, namely the average value of the pretest or before treatment was 62,32 and after given treatment or posttest using the Problem-Solving Polya model of 73,11, based on the t-test, it was obtained that $t = 5{,}543 > t_{table} = 2{,}09$.

In addition, based on research by Komariah (2011) entitled the application of the Polya model problem-solving learning method to improve problem-solving skills for class IX J students at SMPN 3 Cimahi, the results showed that the problem-solving method using the Polya model could improve students' ability to solve mathematical problems. The problem-solving steps of the Polya model can guide students' creativity in solving problems scientifically. This motivates students to be able to learn independently and trains students to think logically and carefully so that students' mistakes in the process of solving problems are controlled by looking back on the steps that have been taken. Based on the description above, it can be concluded that learning with the problem-solving method of

the Polya model in solving math word problems in class VII SMP Negeri 11 Maros Baru can improve students' mathematics learning outcomes.

CONCLUSION AND IMPLICATION

Based on the results of the calculation of the normalized average gain of student learning outcomes is 0,71 which is in the high category. The ρ-value of the results of the one-sample t-test analysis is less than which indicates that there is a significant increase in students' mathematics learning outcomes after being taught by applying the Polya model problem-solving method in solving math word problems. During the implementation of the learning process in the classroom, there are still some obstacles experienced, including there are still students who have low basic knowledge of mathematics (such as multiplication and division) so that students need to be reminded again and make the learning process less efficient.

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