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Problem-Based Learning vs Student Teams Achievement Divisions Assessed from Student's Mathematics Problem Solving Ability

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Abstract. This research aims: (1) to find out the effect of the PBL (2) to find out the effect of the STAD (3) and to find out the effectiveness between the PBL and STAD Models to mathematical problem-solving skills of third-grade students at SD N Mejing 2. This type of research is a Quasi Experiment with a research design Pretest-Posttest Only Control Design. The instruments used in this research are problem-solving skills test and observation of learning activities. Data analysis in this research used t-test with a significant level of 5%. The final results of this research show that: (1) There is an influence between students' problem-solving skills before and after the PBL model applied. The results of the analysis are $t \text{ count} = -10,081 \leq t \text{ table} = -1,703$; (2) There is an influence between students' problem-solving skills before and after the STAD learning model applied. The results of the analysis are $t \text{ count} = -5,403 \leq t \text{ table} = -1,703$; (3) Learning with PBL more effective than STAD against students' mathematical problem-solving skills, analyzed by t-test of two samples. The results of the analysis are $t \text{ count} = 2,970 \geq t \text{ table} = 1,674$, the significance level of 5%.

1. Introduction

Mathematics is one of the essential subjects at the Elementary School (SD) level [1]. This mathematics subject is one of the subjects which will eventually be included in the National Examination (UN) material. Mathematics is one of the basic sciences in developing science and technology to other educational levels. Mathematics can also be applied to everyday life. Also, to achieve the objectives of learning mathematics, students must have the ability to solve mathematical problems. Problem-solving as a learning strategy where the problem is used can help students to understand the subject matter they are learning. In solving this problem, students are faced with various problems which are used as direct learning materials so that students become sensitive and responsive to all the problems faced by students in their daily life.

The provision of learning material by the teacher mostly uses the lecture method, which indirectly has an impact, namely that students become less active in learning. The learning process in the classroom is only directed at students' ability to memorize information so that students do not understand the real concept. Students never have group activities in the class. Students also have difficulty solving the

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questions if they find a slight difference from the sample questions, even though the questions measure the same ability. The impact of this problem makes students' mathematical problem-solving abilities not developed and is classified as low.

Problem-solving as a learning strategy where the problem is used can help students to understand the subject matter they are learning [2], [3]. In solving this problem, students are faced with various problems which are used as direct learning materials so that students become sensitive and responsive to all the problems faced by students in their daily life. According to Reys [4] suggests that three things must be considered in learning through problem-solving so that students are interested in the problems they are facing, namely: (1) Providing direct, active experience and continuous in solving various problems; (2) Creating a positive relationship between student interest and success; (3) Creating a close relationship between students, problems, problem-solving behaviour, and classroom atmosphere.

Students are not accustomed to being independent in learning material, and there is less variety in the learning methods used by the teacher. Also, the learning process in the classroom is only directed at students' ability to memorize information. Students listen and write more. Students never have group activities in the class. Students also never try to understand and find the true meaning of the objectives of learning mathematics and cause the content of the lesson to be memorized so that students do not understand the real concept. This causes students to have difficulty solving the questions if they find a slight difference from the sample questions, even though the questions measure the same ability. Besides, students also have difficulty solving problems in the form of stories because students do not understand the concept of the material. The impact of this problem makes students' mathematical problem-solving abilities not developed and is classified as low.

The learning model that has been used by teachers is teacher-centred. The teacher uses the learning model to make the problem-solving abilities of grade III students of SD N Mejing 2 not developed and is classified as low. The solution to improve the math problem solving of grade III students of SD N Mejing 2 is that another model is needed to improve students' mathematical problem-solving abilities.

Effectiveness comes from the word "effective" which means there is an effect (effect, affect, impression), effective or productive, can bring results. Effectiveness is the conformity between the person carrying out the task and the intended target [5]. According to Isjoni and Arif, the learning model is a strategy used by teachers to increase learning motivation, learning attitudes among students, being able to think critically, have social skills, and achieve more optimal learning outcomes [6].

Bern and Erison [7] emphasized that Problem Based Learning (PBL) is a learning model that involves students in solving problems by integrating various concepts and skills. This learning model includes gathering, collating information, and presenting. Student Teams Achievement Divisions (STAD) are one of the cooperative learning models [8] with the syntax: briefings, create heterogeneous groups (4-5 people), discuss learning materials-worksheets-modules collaboratively, group presentations so that class discussion, individual quizzes and give rewards [9][10].

According to Greeno [11], problem-solving in mathematics learning means a series of mental operations performed by a person to achieve specific goals. Mathematical solving involves both solving math problems at school and outside of school.

According to Polya, the steps for solving the problem [12] are: Understanding the problem, planning for the solution, through calculations, and re-checking the process and results. According to [13], learning is a two-way interaction between a teacher and a student, was between the two their communication (transfers intense and directed) towards a predetermined target. Mathematics is the knowledge of quantity and space, one of the many systematic and orderly branches of science. Mathematics are numbers and calculations that are part of human life [14].

The results of previous relevant research, Adi Setiawan (2015/2016) conducted a study entitled "The Effectiveness of models in terms of Problem Based Learning Problem Solving Ability and Mathematical Creativity". This study aims to determine whether the model is Problem Based Learning more effective than conventional learning models in terms of problem-solving abilities and mathematical creativity in mathematics learning. This type of research is quasi-experimental (Quasi

Experiment) with pretest-posttest control group design. The study population was all students of class VIII SMP N 1 Ngaglik Sleman in the 2015/2016 academic year. Based on the test results of students' mathematical problem-solving data. It can be seen that $t \text{ count} = 2.333 > t \text{ table} = 2.004$, then H_0 is rejected, meaning that the students' mathematical problem-solving ability after participating in Problem Based Learning is higher than before following Problem Based Learning.

Research results Arsep Sahputra (2012/2013) conducted a study entitled "The Effect of the Application of cooperative Learning Model Student Teams Achievement Divisions (STAD) with an approach on the Open-Ended Mathematical Problem Solving Ability of Class VIII Students of SMP Negeri 20 Pekanbaru". The purpose of this study was to find out whether there were differences in the mathematics problem-solving abilities of students of class VIII SMP Negeri 20 Pekanbaru. Between students who applied the learning model Student Teams Achievement Divisions (STAD) with the approach Open-Ended and students who applied conventional learning. This type of research is quasi-experimental (Quasi Experiment) with pretest-posttest control group design. The study population was all students of class VIII SMP Negeri 20 Pekanbaru in the 2012/2013 academic year. Based on the results of data testing of students' mathematical problem-solving abilities. It can be seen that $t \text{ count} = 3.27 > t \text{ table} = 1.99$ then H_0 is rejected, meaning that the students' mathematical problem-solving ability after participating in the Student Teams Achievement Divisions is higher than before following Student Teams Achievement. Divisions.

Based on relevant previous research results, it strengthens the basis of this research. Furthermore, the learning model will be tested Problem Based Learning (PBL) and Student Teams Achievement Divisions (STAD) on third-grade students of SD Negeri Mejing 2. Experiments of the two learning models are more specific in terms of mathematical problem-solving abilities.

1 Methodology

This research is a "Quasi Experiment" research design with pretest-posttest only control design, which is conducted to determine whether there is an effect of a treatment imposed on the subject by the researcher. The sample of this study was grouped into two groups, namely the first group treated with the PBL learning model and the second group treated with the STAD learning model. This research design can be described as follows:

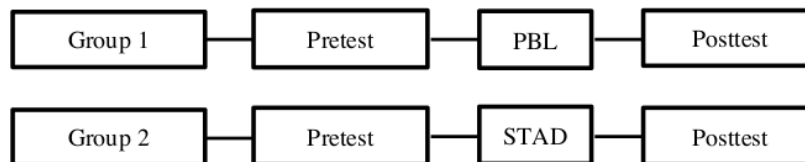


Figure 1. Research design

The design of activities in research to test the effectiveness of the Problem Based Learning model and Student Teams Achievement Divisions model is as follows.

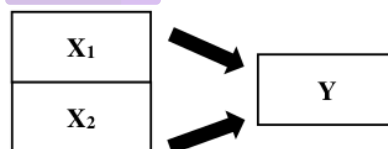


Figure 2. Research variable

with:

X_1 = PBL model

X_2 = STAD model

Y = math problem-solving skills

In this study, there are two variables, namely the independent variable PBL and STAD models and one dependent variable, namely the ability to solve mathematical problems. This research was conducted at SD N Mejing 2 which has an address at Patukan Ambarketawang Gamping Sleman with a total of 86 students as subjects, 30 students were used as trials so that the remaining 56 students will be studied.

Data collection techniques used were tests to determine students' mathematical problem-solving abilities and observations to determine teacher and student activities during the learning process. The research instruments used in this study were the test questions and observation sheets.

The data analysis techniques in this study were data analysis of test instrument trials, data analysis of observations, problem-solving ability test analysis, data pretest, and data posttest. The test data analysis of the test instrument was in the form of validity testing using the correlation formula Product Moment and SPSS version 21. In contrast, the reliability test used the Alpha and SPSS formulas version 21. The data analysis pretest used the normality and homogeneity test with the help of SPSS version 21. Posttest data analysis used the test. Normality with the help of SPSS version 21 and hypothesis testing using the formula Paired Sample and the Independent Sample T-Test.

3. Results

Test the validity of the items in this study using software SPSS version 21. For validity testing criteria, the results of the calculation of r_{xy} are compared with the product-moment in the table with a significance level of $\alpha = 5\%$; if $r_{xy} > r_{table}$, then the item is said to be valid. The trial analysis calculation can be seen in the following table.

Table 1. Test of Analysis of the Validity of the Pretest Questions

No Item	r_{count}	r_{table}	Information
1	0,818**		Valid
2	0,861**		Valid
3	0,877**	0,3610	Valid
4	0,809**		Valid
5	0,780**		Valid

Table 2. Test of Analysis of the Validity of the Posttest Questions

No Item	r_{count}	r_{table}	Information
1	0,824**		Valid
2	0,854**		Valid
3	0,854**		Valid
4	0,766**		Valid
5	0,835**		Valid
6	0,857**	0,3610	Valid
7	0,799**		Valid
8	0,777**		Valid
9	0,775**		Valid
10	0,696**		Valid

The results of the calculation of reliability testing using the Alpha formula. If the value is ≥ 0.05 , the instrument is declared reliable. The calculations can be seen in the following table:

Table 3. Pretest Reliability Test

Cronbach's Alpha	N of Items
,883	5

It is known that the reliability index is 0.883, so the instrument is declared high reliability because it is located in the range of $0.70 \leq r_{11} \leq 0.90$. After all, this instrument is declared valid and reliable, so instrument pretest this can be used in research.

Table 4. Posttest Reliability Test

Cronbach's Alpha	Sp. N of Items
,935	10

It is known that the reliability index is 0.935, so the instrument is declared very high reliability because it is located in the range of $0.90 \leq r_{11} \leq 1.00$. After all, this instrument is declared valid and reliable, so instrument posttest this can be used in research.

Based on the results of the pretest students' mathematical problem-solving abilities in the PBL class obtained results with the average achievement of pretest 61.19. STAD class obtained results with the average achievement of pretest 64.47. based on these data, it can be concluded as follows:

Table 5. Average Per-Aspect pretest of Students' Mathematical Problem Solving Ability

Problem Solving	Average			
	PBL	Category	STAD	Category
A	65	well	90,72	Very well
B	61,12	well	50	Enough
C	77,54	well	67,14	well
D	41,11	Enough	50	Enough

Based on the results, posttest the students' mathematics problem-solving ability in the PBL class obtained results with the average achievement of *posttest*82.41. Meanwhile, the STAD class obtained results with an average achievement of *posttest*72.95. More details can be seen in table 6.

Table 6. Average Per-Aspect posttest of Students' Mathematical Problem Solving Ability

Problem Solving	Average			
	PBL	Category	STAD	Category
A	84,65	Very well	80	Very well
B	86,79	Very well	69,64	Enough
C	82,14	Very well	77,50	well
D	72,86	well	63,43	Enough

The comparison of the average pretest and posttest values is presented in Figure 3 below:

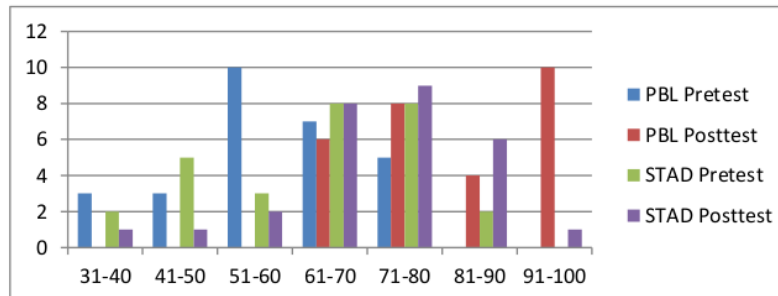


Figure 3. Diagram of the Pretest and Posttest Values for the PBL and STAD Classes

Hypothesis 1 Test, Hypothesis: There is an influence between students' problem-solving abilities before and after the learning model is applied Problem Based Learning.

H_1 : There is an influence between students' problem-solving abilities before and after the implementation of the learning model Problem-Based Learning

H_0 : There is no influence between students' problem-solving abilities before and after the implementation of the learning model. Problem Based Learning

Statistical test value $t = -10.081$, the significance level is 5%. Determining the criteria for rejection H_0 , H_0 is rejected if $t_{\text{count}} < t_{\text{table}}(0.05)(27) = -1.703$. The decision $t_{\text{count}} = -10.081 < t_{\text{table}} = -1.703$ then H_0 is rejected. The decision above can be concluded that there is an influence between students' problem-solving abilities before and after the application of the learning model Problem-Based Learning.

Hypothesis 2 Test, Hypothesis: There is an influence between students' problem-solving abilities before and after the learning model is applied to Student Teams Achievement Divisions.

H_1 : There is an influence between students' problem-solving abilities before and after the application of the Student Teams Achievement Divisions

H_0 : There is no influence between students' problem-solving abilities before and after the application of the learning model. Student Teams Achievement Divisions

Statistical test value $t = -5.403$, the significance level is 5%. Determining the criteria for rejection H_0 , H_0 is rejected if $t_{\text{count}} < t_{\text{table}}(0.05)(27) = -1.703$. The decision $t_{\text{count}} = -5.403 < t_{\text{table}} = -1.703$ then H_0 is rejected. The above decision can be concluded that there is an influence between students' problem-solving abilities before and after the learning model is applied Student Teams Achievement Divisions.

Research Hypothesis Test, After the assumption test is fulfilled, the hypothesis is tested. The research hypothesis is using t-test. This test was conducted to determine whether the model was Problem Based Learning more effective than the Student Teams Achievement Divisions for the mathematics problem-solving ability of grade III students at SD N Mejing 2. Test the research hypothesis as follows:

$H_0: \mu_1 = \mu_2$ (average value mathematical problem-solving skills with the same PBL and STAD learning models)

$H_0: \mu_1 > \mu_2$ (the average value of mathematics problem-solving ability with PBL learning model is higher than STAD)

Significance level: $\alpha = 0.05$, Test statistic, $t = 2.970$ Based on the value in the table $t = 1.674$.

Based on the final calculation that has been obtained from the t-test, namely $t_{\text{count}} = 2.970$ and $t_{\text{table}} = 1.674$. Thus H_1 is accepted because of $t_{\text{count}} > t_{\text{table}}$. The average value of the mathematics problem-solving ability of class III A students of SD N Mejing 2 with the Model Problem-Based Learning (PBL) is higher than the average value of the mathematics problem-solving abilities of grade III B students of SD N Mejing 2 with the Model Student Teams Achievement Divisions.

Based on the decision of the hypothesized results above. It can be concluded that the model is Problem Based Learning (PBL) more effective than the Student Teams Achievement Divisions in

1 mathematics learning on the mathematics problem-solving abilities of grade III students of SD N Mejing 2.

Based on the results of teacher observations in learning activities to show that learning activities using the model *Problem Based Learning* at the first meeting amounted to 84.21% and the second meeting 94.74. The results of student observations in learning activities indicate that learning activities using the model *Problem Based Learning* at the first and second meetings are in the high category. The average value of *pretest* the PBL class was 60.71, and the average score was *posttest* 82.41. They are testing the research hypothesis using the test *Paired Sample*. This can be seen from statistical calculations. Wherefrom the results of these calculations $t_{\text{count}} = -10.081$ and $t_{\text{table}} = -1.703$ so that H_0 is rejected, it can be concluded that there is an influence between students' problem-solving abilities before and after the learning model is applied *Problem Based Learning*.

Based on the results of teacher observations in learning activities that learning activities using the model *Student Teams Achievement Divisions* at the first meeting were 83.33% and the second meeting was 88.89%. The results of student observations in learning activities show that learning activities using the model *Student Teams Achievement Divisions* at the first and second meetings are in the high category. The average score for *pretest* the STAD class was 64.46, and the average score was *posttest* 72.95. They were testing the research hypothesis using the test *Paired Sample*. This can be seen from statistical calculations. Wherefrom the results of these calculations $t_{\text{count}} = -5.403$ and $t_{\text{table}} = -1.703$ so that H_0 is rejected, it can be concluded that there is an influence between students' problem-solving abilities before and after the application of the learning model *Student Teams Achievement Divisions*.

The average score for *posttest* the PBL class was 82.41, and the average score for *posttest* the STAD class was 72.95. Testing the research hypothesis used the one-sample t-test. This can be seen from the statistical calculations using the two-sample proportion test. Wherefrom the results of these calculations $t_{\text{count}} = 2.970$ and $t_{\text{table}} = 1.674$ so that H_1 is accepted. It can be concluded that the model is *Problem Based Learning* more effective than the model *Student Teams Achievement Divisions* in mathematics learning on the problem-solving abilities of grade III students of SD N Mejing 2.

4. Conclusions

The results of the *analysis* of the research hypothesis using the test, *Paired Sample* namely $t_{\text{count}} = -10.081$ and $t_{\text{table}} = -1.703$ with a significant level of 5%. It was found that there was an influence between students' problem-solving abilities before and after the implementation of the learning model *Problem-Based Learning*. The results of the analysis of the second research hypothesis, using the test, *Paired Sample*, namely $t_{\text{count}} = -5.403$ and $t_{\text{table}} = -1.703$ and a significant test with a significant level of 5%. There is also an influence between students' problem-solving abilities before and after the learning model is applied to *Student Teams Achievement Divisions*. The results of the analysis of the third research hypothesis, using the t-test, namely $t_{\text{count}} = 2.970$ and $t_{\text{table}} = 1.674$ and a significant test with a significant level of 5%. It shows that the average value of mathematical problem-solving abilities with the model *Problem-Based Learning* is higher than the average value of math problem-solving abilities using the model *Student Teams Achievement Divisions*. So, the model is *Problem Based Learning* more effective than the model *Student Teams Achievement Divisions* in students' mathematical problem-solving abilities. This further strengthens the research findings [3][15]–[17].

The suggestions put forward by researchers from the results of the research carried out are those mathematics learning with the model *Problem-Based Learning* and *Student Teams Achievement Divisions* should continue to be developed in teaching and learning activities and be used as a choice of teachers. Because with the model *Problem-Based Learning*, students are more active in the learning process and develop their abilities to adapt to new knowledge. For further researchers, it is hoped that they can carry out research or develop research models of *Problem Based Learning* on problem-solving abilities. With the same material and other materials and not only for learning mathematics but also for other subjects.

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Missing "," You may need to place a comma after this word.



Possessive You may need to use an apostrophe to show possession.



Wrong Article You may have used the wrong article or pronoun. Proofread the sentence to make sure that the article or pronoun agrees with the word it describes.



Article Error You may need to use an article before this word. Consider using the article **the**.



Wrong Article You may have used the wrong article or pronoun. Proofread the sentence to make sure that the article or pronoun agrees with the word it describes.



Sp. This word is misspelled. Use a dictionary or spellchecker when you proofread your work.



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Article Error You may need to remove this article.



Missing "," You may need to place a comma after this word.

