The Effect of Implementing Problem-based Learning (PBL) Model with Teaching Aids for Ability Mathematical Problem-Solving

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Abstract. This research aims to determine the effect of the problem-based learning (PBL) model assisted by teaching aids on mathematical problem-solving abilities. This research is a quasi-experimental research using a pretest-posttest control group design. The population in this study was all grade 8 students at SMPN 4 Cibal, with a total of 44 people. The sampling technique used was saturated sampling. The research sample in the experimental class was grade 8A, totaling 22 students who applied the problem-based learning (PBL) model, which is assisted by teaching aids is applied to the experimental class. In contrast, the control class is class VIII B, which amounted to 22 students by applying conventional learning models. The instrument used in this research is a test instrument in the form of a description test. The analysis technique used is the t-test. From the data analysis, the comparison t-count = 3.41 while t-table = 1.72 at the 5% significance level. Based on the decision rule where t-count > t-table means $H0$ is rejected. Based on the research results, it can be concluded that the demonstration model supported by tools in the problem-based learning (PBL) approach positively influences students' ability to solve mathematical problems.

Keywords: PBL model; mathematical problem-solving abilities; teching aids

1 Introduction

At this time education is considered important in various areas of life, especially in the development of human resources. As time progresses, the demands of life also increase rapidly So to face all challenges, good education is needed whether formal or informal education. Education is a way or efforts to develop all potential in obtaining personality, skills, and intelligence required in everyday life. Education can also be interpreted as a process modifying attitudes (affective) through the learning process in class. Education must be able to produce output that can empower students become more active, intelligent, think creatively and be able to face things challenges of the times.

Mathematics education is one of the most important parts from national education. For every level of education, mathematics is required to be studied. Moreover, mathematics is also used in everyday activities. Each person will be involved with mathematics in their lives,

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starting from shapes simple to complex. Mathematics is an abstract science which has a symbolic language that is full of meaning [1], [2]. This causes many students to feel that mathematics is subjects that are difficult to understand. Mathematics learning is also a subject which is very important for students to learn. In connection with that matter, so students are required to master various mathematical skills. One of the goals of learning mathematics is to students can have the ability to solve problems. Students' ability to solve mathematical problems are abilities that students must have, meaning it is important for students to have and develop mathematical problem-solving abilities. This is in line with this opinion that solutions problems in mathematics are a cognitive ability fundamentals that can be trained and developed in students, so it is hoped that when students are able to solve mathematical problems well, students will also be quick in solving real problems after taking it formal education [3], [4]. Even though mathematics is a subject that it is very important in school and is often practiced in everyday life, but it is still considered a scary subject for students. Students sometimes feel anxious and have difficulty learning mathematics. Indonesia is a country with a high level of capability mathematics is still low compared to other countries. Program results for International Student Assessment (PISA) 2018 for abilities mathematics, Indonesian students scored 379 points compared with an international average of 489 and Indonesia is ranked 73rd out of 79 participating countries [5], [6]. These results shows that Indonesian students' are still not optimal. The problem is that problem-solving abilities are not yet optimal.

Students' mathematics, in line with the results of observations by researchers at SMPN 4 Cibal specifically in grade VIII in mathematics subjects, that in learning mathematics mathematical problem-solving abilities possessed by students are still not optimal. This is proven during learning mathematics, some students do not participate actively in learning and when students are given problems that are slightly different from the example, students will find it difficult to complete it, as well as when the teacher ask questions related to the problem that has been explained only one or two students who can answer. Apart from that, in implementation the teacher's learning process does not provide opportunities for students to solve examples of questions related to the problem mathematics, so it seems that students passive in mathematics class activities. Most teachers when delivering their teaching material monotonously, so that the students only become spectators learning, this can cause students to not be active in the process learn how to teach. There are even several math teachers, how to teach is by writing down the material until it's finished, then students understand the material that has been completed is recorded. Therefore, it can be concluded learning is still teacher-centered.

Furthermore, based on the description of the research results unstructured interviews with the mathematics teacher at SMPN 4 Cibal, he stated that students' mathematical problem-solving abilities at SMPN 4 Cibal are still categorized as not optimal. This is explained by the results obtained by students after taking the mid-semester exam in mathematics. Where students tend not to reach the minimum completeness criteria (Indonesian: KKM), out of a total of 44 students only 18 students achieved scores above the KKM with standard scores namely 72 and 26 students scored below the KKM. Not yet optimal students' mathematical problem-solving abilities are suspected because students are not optimal in learning mathematics in class, students are less able to understand the problem, there is a lack of student understanding towards problem-solving planning, learning is still centered in teachers,

the lack of using teaching aids to help learning process and limitations of using learning models used by teachers in the learning process. Learning model used by teachers is the conventional learning model with the explanation method, questioning method, discussion method and assignment.

This was also highlighted in previous research that "teachers have not developed optimal learning and learning approaches and models still centered on the teacher, causing a boredom effect on the self student" [7]–[9]. This sentence is almost the same as the description of the results of the research carried out [10] who stated "teachers are less innovative in choosing and using learning models that can trigger student activity in the class of learning process. One way for students to improve their abilities mathematical problem-solving is by applying problem models based learning assisted by teaching aids. It is thought that the use of a learning model that includes problems assisted by teaching aids can help improve students' mathematical problem-solving abilities. This is because of this model allows students to major benefit during learning activities. According to [11], the The problem-based learning model is a learning model that can support students to play an active role in the classroom in solving problems and using real world problems to learn. Apart from that, the model is problem-based learning can increase students' learning motivation [12]. Students' mathematical problem-solving abilities very important in learning activities because of its existence power in solving mathematical problem can equip students in resolve any issues or problems. One learning model which is able to improve mathematical problem-solving abilities is a problem-based learning model assisted by teaching aids.

The problem-based learning model that can train students to solve the problems they experience so that students can face every problem. The problem-based learning model is one of the internal models learning that uses problems as a first step in learning collect and integrate new knowledge [13]. Teaching aids or learning media are able to train students deeply complete the responsibilities given by the teacher. Students are given ease of receiving teaching using teaching aids because it will be easy for them to capture material. Props can be help students understand the material provided by the teacher, so that it can make students more interested in the material used [14], [15].

Mathematical teaching aids can be interpreted as a set of objects concrete that is designed, made, and arranged intentionally that is used to help add and understand concepts and theories in mathematics. By using learning aids as media mathematics becomes fun and easy for students to understand. By therefore, every teacher must be able to design and create use teaching aids in mathematics learning, so that students easy to understand mathematics. This opinion is supported by research results from [16] shows that there is an interaction between the Problem-based Learning model and teaching aids in encouraging students' mathematical problem-solving abilities [17].

2 Method

The research carried out was quasi-experimental research with a quantitative approach. The design in this research is Pretest Posttest Control Group Design. This research was conducted at SMPN 4 Cibal, Cibal District, Manggarai Regency 2023/2024 academic year in March 18-April 6 2024. The population used in this research was students grade 8 at

SMPN 4 Cibal, totaling 44 students, while the sample in the research consisted of 44 students in class 8A and 8B. The sampling technique uses saturated sampling. Based on the results of the analysis using the separated variance t test showed that all classes are declared equal. The data collection technique in research is the test technique. Test this tested for validity and reliability. Test validity using a formula Product Moment Correlation.

Table 1. Instrument Validity Test Display

Question Number	r count	r table	Results
1	0,67		
2	0,67		
3	0,60	0,42	All Valid
4	0,54		
5	0,62		

Based on the table above, the conclusion is that all questions are valid and can be used as research instruments. After the validity test was carried out, the two tests were tested its reliability. Reliability test uses the Cronbach's Alpha formula. The results of the instrument reliability test calculations obtained ri = 0,57. Based on the table obtained that the instrument has a degree moderate reliability.

3 Results and Discussion

Research was conducted at SMPN 4 CIBAL. In this research use two sample classes were used, namely class 8A as the experimental class which is taught by applying the problem-based learning model assisted by props and class 8B as the control class taught by applying direct learning models. The mathematics lesson taught in this research is wake flat side space. The following table is the result of descriptive statistical tests on problem-solving ability data.

Table 2. Description of Pretest Data for Experimental and Control Classes

Statistic	Experiment	Control
Mean	29,27	32,45
Variance	167,83	100,93
Std. Deviation	12,95	10,05
Modus	16	32
Median	26	32
Maximum	52	52
Minimum	16	16
Sum	644	714
Total of Students	22	22

Based on the calculations, it is known that the lowest pretest score was for the experimental class is 16 and the highest score is 52. Meanwhile, the pretest control class the lowest score was 16 and the highest score was 52. The average pretest score for the experimental class was 29,27 and class control 32,45. The following is the posttest result data.

Table 3. Description of Posttest Data

Statistic	Experiment	Control
Mean	57,36	49,82
Variance	61,86	46,44
Std. Deviation	7,87	6,81
Modus	52	42
Median	55	50
Maximum	74	60
Minimum	48	42
Sum	1262	1096
Total of Students	22	22

Table 3 shows in calculations descriptive statistics between the two groups. Highest student score is in the experimental group with a value of 74, while the value The lowest was in the control group with a value of 60. This means the students' highest mathematical problem-solving abilities are found in experimental group while problem-solving abilities. The lowest student mathematics was in the control group. Average value the experimental group was higher than the group average value control.

Based on data calculations on problem-solving abilities students' mathematics obtained the value x^2count for experimental class is 2,31, while the value of x^2count for the control class is 3,61, and x^2table for the experimental class is 9,49 at the significant level 5% with dk = 5-1= 4 and the control class is 7,81 at level significant 5% with dk = 4-1= 3. Based on the test criteria if x^2count < x^2table then the data is not normally distributed, because the results calculation of data normality test for problem-solving abilities students' mathematics for the two classes shows that x^2count < x^2table so it shows that the data is distributed normal.

Following is the result of the calculation of the homogeneity test of the solving ability data students' mathematical problems. Based on the data homogeneity test students' mathematical problem-solving obtained Fcount = 1,33 and value Ftable = 2,08 with a significance level of α = 0,05. Because the value of Fcount < Ftable then it means that both samples come from the same population (homogen).

The effectiveness of the learning model is carried out to see whether there is an influence on students' ability to solve mathematical problems between two classes after being treated with the application of models PBL assisted by teaching aids and conventional. Following are the results of the gain value test.

Table 4. Gain Value Result

Class	Pretest Average	Posttest Average	Post-Pret	N Gain	Category
Experiment	32,45	58,82	26,36	0,38	Medium
Control	29,27	49,82	20,55	0,28	Low

Based on the data in table, it is show that students who have the higher gain value is found in the experimental class, namely 0,38 in the medium category. Meanwhile, the control class gain value is 0,28 included in the low category. This means applying a PBL assisted by teaching aids on solving abilities students' mathematical problems are very effective compared

to application conventional learning model. Hypothesis testing aims to find out whether there is an influence ability to solve mathematical problems using the PBL model with different classes using a direct learning model. Here are the results calculation of hypothesis testing data on problem-solving abilities student mathematics.

Table 5. T-Test Results Posttest Data

Class	N	t count	t table	Results
Experiment	22	3,41	1,72	Reject H0, Accept H1
Control	22			

Based on the data, it is found that the results calculation of tcount = 3,41 and ttable = 1,72 at the significance level α = 0,05. Because tcount = 3,41 > ttable = 1,72, then H0 is rejected or H1 is accepted, means that the average value of mathematical problem-solving ability experimental class students are better than the average ability score solving mathematical problems for control class students so that they can it was concluded that students' ability to solve mathematical problems using PBL with the help of teaching aids is better than conventional learning.

Based on research results obtained from data processing statistically, it appeared that the average problem-solving ability mathematical students in the experimental class who apply the model PBL assisted by teaching aids is higher than the data mathematical problem-solving ability of students in the class controls that apply direct or conventional learning. In other words, the use of the PBL model assisted by teaching aids has an effect on students in working on students' mathematical problem-solving questions.

This is obtained from the results of descriptive statistical data students' pretest and posttest mathematical problem-solving abilities in the both classes. However, before researchers provide treatment to the experimental class by applying PBL model assisted by teaching aids and control classes by applying conventional learning models, first the researcher gave a pretest to both sample groups with questions description consisting of 5 points. The purpose of giving this pretest is to determine the initial abilities of students. The material taught for both classes are about building flat side spaces. Statistical results descriptive pretest of both classes for learning outcomes, obtained an value in the experimental class it was 32,45, and for the control class obtained an average value of 29,27. Judging from the average value pretest of both classes, we can find out that initial ability students before being given slightly different treatment.

After giving a pretest to both sample groups, the researcher provide different treatment. In the student's experimental class taught using a PBL model assisted by props while in the control class students are taught to use conventional learning models. After conduct learning, then both classes are given a posttest with 5 numbered description questions. Posttest results obtained for the grade 8A with an average value of 57,36, while for the grade 8B the average value was 46,44. From the results these calculations, application of the PBL model aided by teaching aids has an influence on students' ability to solve mathematical problems.

These results are in accordance with previous findings, namely research carried out by [14]–[17] that the average class that applies the model PBL assisted by teaching aids is

higher than the average class that applies conventional learning. Although Previous research analyzed the application of PBL models teaching aids on different targets, but they gives similar results. This shows the applicability of the model PBL assisted by teaching aids can fulfill every problem students' different learning needs. This is due to implementation this PBL model assisted by teaching aids can train students in understanding concepts through their own teaching-learning process in the classroom to meet each student's needs by level different abilities [3], [9], [18], [19].

4 Conclusion

Based on the previous explanation, shows that the application of the PBL model is assisted teaching aids influence problem-solving abilities student mathematics. This is supported by research data that the t value count = 3,41 > t table= 1,72. Apart from that, the average posttest score was obtained on the experimental class was 57.36 while the control class was 49,82. Furthermore, with the test results, the value of Gain is where students get the value the higher Gain was found in the experimental class, namely 0,38, whereas in the control class only got 0,28. Thus, you can it is concluded that H1 is accepted, meaning The application of the PBL model assisted by teaching aids has a significant impact on students' ability to solve mathematical problems at SMPN 4 CIBAL.

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