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Problem Based Learning Learning Model for Improving The Mathematical Problem Solving Ability of Grade VIII Students of SMPN 1 Damar

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ABSTRACT

Problem-solving ability is one of the higher-order thinking skills (HOTs) that students need in facing the 21st century. The reality on the ground shows that students' problem-solving abilities are still below the KKM. In efforts to overcome this problem, researchers apply Problem Based Learning (PBL) learning to improve students' problem-solving abilities. The research conducted aims to investigate whether the magnitude of the increase in the problem-solving ability of students who learn using the PBL model is higher than that of students who learn using conventional learning. This research is a quantitative study with a non-equivalent pretest-posttest control group design. The population in this study were all students of class VIII SMP Negeri 1 Damar, East Belitung Regency, while the research sample was class VIIIA class VIIIB. The research sample was selected by a simple random sampling technique. The instrument used in this study was a test. The results of the data analysis show that the magnitude of the increase in the mathematical problem-solving ability of students who learn using the PBL model is higher than that of students who learn using conventional learning.
Keywords : Mathematical problem Solving Ability, PBL Models, HOTs , Nonequivalent Pretest-Posttest Control Group Design.

ABSTRAK

Kemampuan pemecahan masalah merupakan salah satu kemampuan berpikir tingkat tinggi (HOTs) yang di butuhkan siswa dalam menghadapi abad 21. Kenyataan di lapangan menunjukkan bahwa kemampuan pemecahan masalah siswa masih dibawah KKM. Upaya untuk mengatasi hal tersebut peneliti menerapkan pembelajaran Problem Based Learning (PBL) untuk meningkatkan kemampuan pemecahan masalah siswa. Penelitian yang dilakukan bertujuan untuk menyelidiki apakah besarnya peningkatan kemampuan pemecahan masalah siswa yang belajar menggunakan model PBL lebih tinggi dibandingkan dengan siswa yang belajar menggunakan pembelajaran konvensional. Penelitian ini merupakan penelitian kuantitatif dengan rancangan non-equivalent pretest-posttest control group design. Populasi dalam penelitian ini seluruh siswa kelas VIII SMP Negeri 1 Damar Kabupaten Belitung Timur, sedangkan sampel penelitian adalah kelas VIIIA kelas VIIIB. Sampel penelitian ini dipilih dengan teknik simple random sampling. Intrumen yang digunakan dalam penelitian ini berupa tes. Hasil analisis data menunjukkan bahwa besarnya peningkatan kemampuan pemecahan masalah matematis siswa yang belajar menggunakan model

PBL lebih tinggi dibandingkan dengan siswa yang belajar menggunakan pembelajaran konvensional.
Kata kunci: Kemampuan Pemecahan Masalah Matematis, Model PBL, HOTs, Nonequivalent Pretest-Posttest Control Group Design.

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PRELIMINARY

Problem solving ability is one of the five abilities that students must have in learning mathematics (NCTM, 2000; Rahman et al., 2018; Suwarno & Murnaka, 2021). In addition, Kemendiknas (2006) and Kemendikbud (2014) place students' ability to solve problems as one of the objectives of learning mathematics in Indonesia. Thus, the ability to solve problems is one of the abilities that students in learning mathematics must master. The essence of problem-solving skills is knowing what to do when faced with unusual or non-routine problems (Arifin et al., 2022; NCTM, 2000). Non-routine problems are new problems that students have never encountered, and solving them requires prior knowledge. Therefore, for students to gain the ability to solve problems, a person must have a lot of experience in solving various problems (Suherman & Turmudi, 2001). From the results of observations and initial studies conducted at SMP Negeri 1 Damar, East Belitung Regency, students experienced difficulties when faced with questions that contained non-routine problems. One of them is the following problem.

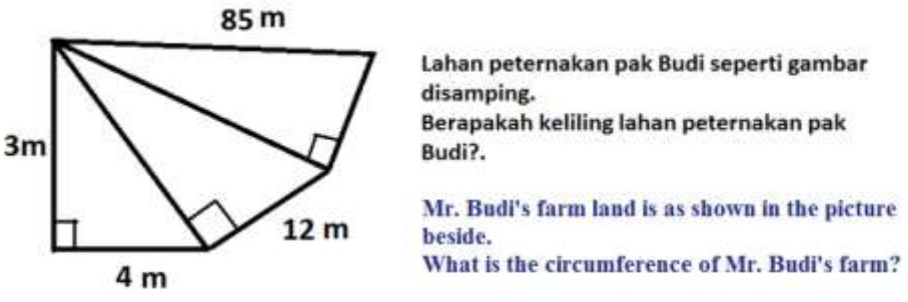

Figure 1. Sample Questions for Preliminary Studies and Observations

The questions above refer to one of the indicators of problem-solving ability, namely students are able to apply and adapt various approaches and strategies to solve problems. From the test results, only one out of 27 students in class VIIIA of SMP Negeri

1 Damar could solve the problem correctly. From the results of an interview with one of the mathematics teachers at the school, it was revealed that students did not repeat the lessons they had learned and rarely got non-routine questions. In addition, teachers at school still use the lecture method, commonly used to convey material in daily learning activities.

Suherman & Turmudi (2001) stated that one weakness of the lecture method is that knowledge gained through lectures is forgotten more quickly and causes students to learn to memorize. Therefore, a learning model is needed that can improve problem-solving skills at SMP Negeri 1 Damar, East Belitung Regency. One learning model that can improve problem solving skills is Problem Based Learning (PBL) or Problem Based Learning (Suwarno & Pranuta, 2019; Tan, 2004). The PBL model uses problems as a first step to gaining new knowledge (Kemendikbud, 2014). The benefits of this PBL model include helping students to develop thinking skills and problem solving skills (Arends, 2013). Therefore, the PBL model can be used as an effort to improve problem solving abilities. This PBL model has been applied in research (Fatimah, 2012), the results of this study indicate that the PBL model is more suitable for improving problem solving abilities. Research conducted by Gunantara et al., (2014) also shows that the application of PBL learning can improve students' problem solving abilities. Therefore, researchers are interested in conducting research that is different from the research above. The purpose of this study was to investigate whether the magnitude of the increase in the problem-solving ability of students who studied using the PBL model was higher than that of students who studied using conventional learning

METHODS

This research is a quantitative study with a nonequivalent pretest-posttest control group design. In this design, there is a pretest, treatment, and posttest. The research design can be described as follows (Sugiyono, 2010).

O	X	O
O	X	O

Information:

X : Treatment with Problem Based Learning (PBL) learning model

O: Experimental class pretest

O: Posttest experimental class

O: Control class pretest

O: Posttest control class

This research was conducted at SMP Negeri 1 Damar, East Belitung Regency. The population in this study were all students of class VIII SMP Negeri 1 Damar, East Belitung Regency, which consisted of 4 classes. The sample used in this study was students of class VIIIA and VIIIB at SMP Negeri 1 Damar. The sampling technique used in this study was simple random sampling. The instrument used in this study was a test instrument, namely a description test, to measure students' problem-solving abilities. the problem-solving ability indicators used in this study refer to problem-solving indicators according to National Council of Teachers of Mathematics (NCTM), namely: 1) students can build new mathematical knowledge through problem solving; 2) solve problems that arise in mathematics or in other contexts involving mathematics; 3) apply and adapt various approaches and strategies to solve problems; 4) monitor and reflect on the problem solving process. The four indicators will be used in this study.

RESULTS AND DISCUSSION

1. Research Results

1.1 Pretest and Posttest Class Experiment and Control

The data obtained in this study are pretest and posttest data. The pretest data shows students' problem-solving abilities on the material surface area and volume of cubes and blocks before the learning process is carried out. The posttest data shows students' problem solving abilities on the material surface area and volume of cubes and blocks after the learning process is carried out. Pretest and posttest data were processed using descriptive statistics. Data processing using descriptive statistics for the experimental and control classes was carried out to obtain the minimum, maximum, average, and standard deviation values of the two classes. The results of the descriptive analysis of the pretest and posttest values are shown in Table 1.

Table 1. Descriptive Data Analysis Results

	Experiment Class			Control Class		
	Pretest	Posttest	Normalized Change	Pretest	Posttest	Normalized Change
Number of data (n)	26	26	26	21	21	21
Highest Value (Xmax)	37.50	87.50	0.87	37.50	87.50	0.87
Lowest Value (Xmin)	0	12.50	0	0	6.25	0
Average ($\bar{X}$)	8.17	34.38	0.28	7.14	17.55	0.11
Standard Deviation (S)	10.74	17.52	0.17	7.73	11.80	0.11

Ideal Value = 100

Based on Table 2, the highest pretest score for the experimental class and the highest pretest for the control class is the same, namely 37.5. The highest posttest score for the experimental class is also the same as the highest score for the control class. Meanwhile, the pretest means the difference between the control and experimental classes was only 1.03. In contrast, the posttest average of the control and experimental classes had a more significant difference, namely 16.83. In addition, the standard deviation value for the pretest data, the control class is smaller than the experimental class, meaning that the distribution of student scores in the control class is smaller, or it can be said that the student scores in the control class tend to be homogeneous or more spread out than the student scores in the experimental class. On the other hand, the standard deviation of the posttest scores in the control class is smaller than that in the experimental class. It can be said that the values of students in the control class tend to be homogeneous or more spread out.

1.2 Normalized Change

The data obtained from the pretest and posttest are then processed to look for normalized change values to find out the magnitude of the increase in the increase in students' solving abilities that occur before and after learning. To find out the amount of normalized change is calculated using the following formula (Marx & Cummings, 2007).

$$c = \begin{cases} \dfrac{\text{post} - \text{pre}}{100 - \text{pre}} & \text{post} \geq \text{pre} \\ \text{dihapus} & \text{Post} = \text{pre} = 100 \text{ atau } 0 \\ 0 & \text{post} = \text{pre} \\ \dfrac{\text{post} - \text{pre}}{\text{pre}} & \text{post} < \text{pre} \end{cases}$$

Note: :
C = Normalized change

In addition to pretest and posttest data, normalized change data is also shown. Normalized change is an increase in problem solving skills obtained by each student on the material surface area and volume of cubes and blocks from pretest to posttest. The normalized change data is shown in table 1.

Normalized change is tested to see the magnitude of the increase in the experimental class compared to the control class. The hypothesis tested is as follows. SPSS data normalized change output is shown in table 2.

Table 2. Results of Normalized Change Data Analysis

	Normalized Change
Mann-Whitney U	111.500
Wilcoxon W	342.500
Z	-3.475
Asymp.Sig. (2-tailed)	.003

The Mann Whitney test results show the significance of Asymp.Sig. (2-tailed) namely 0.003 < 0.05. Therefore, it can be concluded that the magnitude of the increase in problem solving abilities of students who learn using the PBL model is higher than that of students who learn using conventional learning.

2. Discussion

In the experimental class, before the teacher applies problem-based learning, the teacher first divides students into five groups consisting of six to seven people in one group. The first step of the learning process in the experimental class begins with conveying the learning objectives, motivating students to solve the problems presented. Followed by the teacher distributing Student Worksheets (LKS) to each student then asking students to understand the problems that exist in the LKS. LKS is one of the teaching materials that plays a very important role in providing assignments that are relevant to the material being taught (Murnaka et al., 2018; Wahyuni et al., 2021; Widiyanti & Nisa, 2021). The worksheets that are distributed become student guides that can be used to carry out investigative or problem-solving activities, so as to be able to train students to be better able to analyze questions in the form of non-routine problems so that students will develop their ideas (Anastasya et al., 2021; Septina et al., 2018).

Teaching materials in the form of worksheets will support students' problem-solving abilities. The right teaching materials in the learning process are no less important. Namely, the suitable learning model is also very influential on students' problem-solving abilities. Then, the teacher distributes cardboard and LKK to each group. In the second step, the teacher conveys the time students can use to understand problems, work on problems individually, work on problems in groups, and present in front of the class, as well as time used to evaluate the problem solving process. The third step is for students to work on LKS which is distributed by the teacher individually and in groups. Figure 1 shows student activities when understanding and working on LKS individually.

Figure 2. Student Activities When Understanding and Working on Worksheets Individual

Figure 3. Activities when Students are in Groups

After the time for working on the LKS individually is up, the teacher asks students to collect the LKS answers, and then students solve the problems found in the LKK in groups. Figure 3 above shows the activities when students are in groups. After students complete the problem in groups, the solution is written on cardboard. The cardboard will be used for presentations in front of the class, which is done in the third step.

The third step is the teacher asking two groups whose solutions are not the same or the result is not the same to present the results of the group discussion in front of the class. Other groups are welcome to provide feedback and objections. The fourth step is the teacher provides responses and straightens out the answers given by each group, and then the teacher gives conclusions from the material that has been studied. Student activities during presentations in front of the class are shown in Figure 4.

Figure 4. Student Activities During Presentations in Front of the Class

The problem-based learning model in the experimental class was applied by researchers by providing worksheets, both individual and group worksheets. The worksheet contains problems that are arranged according to indicators of mathematical problem-solving ability, then followed by students presenting the results of their group discussions. The application of problem-based learning encourages students to be active during the learning process so that they can solve problems and better understand the learning that has been done. The teacher only acts as a facilitator and guides students during the learning process. It is like the final step in this model is the analysis and reflection of the problem solving process.

At this stage the teacher explains how the answers between the groups can be different when the answers between groups are different. Steps that can improve problem-solving skills in the PBL model are from solving problems in groups to analyzing and evaluating the problem-solving process. This is in line with (Tan, 2004) which states that PBL is an innovation in learning because in problem-based learning students' thinking abilities are really optimized through a systematic group or team work process, so that students can empower, hone, test, and develop abilities. think continuously. However, to determine the solution to a given problem, students must use prior knowledge in order to find their own solution. This is in line with (Arends, 2013) which says that the emphasis of the PBL model lies in the problems given by the teacher to students, then students are asked to investigate and find their own solutions.

Mathematical problem solving ability is the ability of students to solve non-routine problems. The non-routine problems are arranged based on indicators of problem solving abilities according to NCTM (2000), namely: 1) students can build new mathematical knowledge through problem solving; 2) students can solve problems that arise in mathematics or in other contexts involving mathematics; 3) students are able to apply and adapt various approaches and strategies to solve problems; 4) students are able to monitor and reflect on the process of solving problems.

In this study, students' problem solving abilities were trained by giving worksheets. Problems in the given LKS are arranged based on problem solving indicators. After being trained by giving LKS students' problem solving abilities increased. This is in line with (Rosmawati et al., 2012) which states that one way that can be done to improve problem solving abilities is through the use of problem solving based Student Activity Sheets (LKS) in learning mathematics. Experimental class students who do not yet have the ability to solve mathematical problems are trained with problems in worksheets and use the PBL model so that students can solve these problems. Nevertheless, of the 4 questions given to students during the posttest in the experimental class, the question that was answered correctly by most students was question number 6. As many as 13 experimental class students answered question number 6 correctly. The indicator for question number 6 was applying and adapt different approaches and strategies to solve problems. The answers of students who answered correctly are as shown in Figure 4. below.

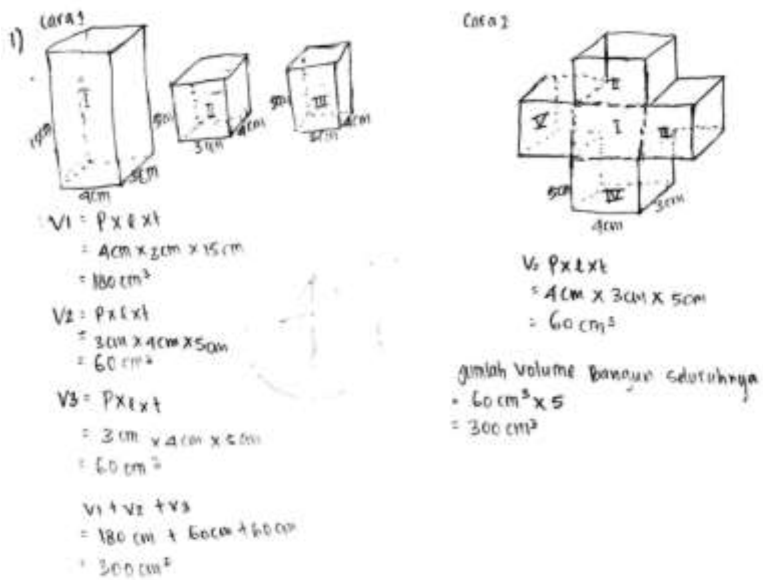

Figure 5. Posttest Results of Experimental Class Students

This shows that in the experimental class, there were students who could answer the indicators, and apply and adapt various approaches and strategies to solve problems. Therefore, a small proportion of experimental class students have problem solving skills after being given treatment. This is in line with research conducted by Angkotasan (2014), the Problem Based Learning model is effective in terms of students' mathematical problem solving abilities.

The results of an inferential analysis also show that the average experimental class students who receive PBL learning are higher than the average student who receives conventional learning. This shows that experimental class students' problem-solving abilities are better than control class students after being given treatment. Furthermore, PBL can be used as a reference in the learning process to improve the quality of learning following the objectives of learning mathematics and is expected to provide a pleasant experience for students during the learning process because learning begins with problems. Arends (2013) that problem-based learning (PBL) is a learning approach in which students work on authentic problems with the intention of constructing their own knowledge, developing inquiry and thinking skills, developing independence, and self-confidence. This is in line with the opinion (Karatas & Baki, 2013) which states that students who receive problem-solving-based learning complete the problem-solving questions given. (Padmavathy & Mareesh, 2013) also revealed that the effectiveness of the PBL model in learning mathematics can increase students' knowledge and the ability to use mathematical concepts in everyday problems.

CONCLUSION

Based on the data analysis that has been done, it can be concluded that the magnitude of the increase in the problem-solving ability of students who learn using the PBL model is higher than students who learn using conventional learning.

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