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The Effect of Problem-Based Learning Model on Students' Mathematical Problem-Solving Ability SMP Negeri 2 Bandar Petalangan

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Abstract

This study aims to determine the effect of the Problem-Based Learning model on the mathematical problem-solving ability. This study is a quantitative study with a quasi-experimental research type and a non-equivalent control group design. The population in this study was all students of class VIII of SMP Negeri 2 Bandar Petalangan, while the sample in this study amounted to 40 students, consisting of 2 classes, with a saturated sampling technique, meaning that all members of the population were used as samples. Data were collected using test sheets by conducting pretests and posttests, then analyzed using descriptive statistical analysis techniques and inferential statistical analysis with the SPSS program. The results showed that the Problem-Based Learning model had a significant effect on students' mathematical problem-solving abilities, with a Sig. value of 0,014 (0,014 <0,05). So it can be concluded that there is a significant influence of the Problem-Based Learning model on the Mathematical Problem-Solving Ability.

Keywords: Problem-Based Learning Model; Problem Solving Ability; Students' Mathematical.

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1. Introduction

The quality of human resources in a country is determined by several factors, one of the factors that plays an important role is education. Education is a process for us to improve, modify, and develop the skills and attitudes of an individual or group. Education is expected to enable people to grow with complete and integrated competencies, starting from competencies in attitudes, knowledge, and skills. Therefore, if the quality of education is low, it will result in the availability of high-quality human resources becoming very limited.

Education is a teaching and learning activity between students and teachers or educators. In this process, education is expected to be able to improve the quality of its students, one of which is in the field of mathematics. Latif & Akib (2016) stated that KTSP (2006) which was refined in the 2013 curriculum contains the objectives of learning mathematics, namely: (1) Understanding mathematical descriptions, explaining relationships between concepts, and applying concepts in a comprehensive, accurate, efficient, and precise to solve problems, (2) Apply reasoning about patterns and properties, perform mathematical operations, generalize, compile proofs or explanations of mathematical ideas and problems, (3) Problem solving, including the ability to understand problems, design mathematical models, solve models, and obtain results and interpret solutions, (4) Use symbols to communicate ideas, clarify problems using tables, diagrams, and other media, (5) Attitude of appreciating the benefits of mathematics in life, namely studying mathematics, curiosity, attention, interest, and perseverance as well as self-confidence in solving mathematical problems.

To achieve the objectives of learning mathematics, problem-solving skills are one of the skills that must be mastered by students. In the NCTM quoted by Zuhri & Purwosetiyono (2019), there are five process skills that must be mastered by students in learning mathematics, namely: (1) problem solving, (2) Reasoning and proof, (3) Communication, (4) Connection, and (5) Representation.

Mathematics is a subject that plays a very important role in the world of education. According to Siregar & Dahlya Narpila (2023), mathematics is also one of the basic sciences that is important to be taught to students because mathematics can train students to think logically and responsibly, have a good personality, and have problem-solving skills in everyday life. However, in the field, the reality is different; the level of students' problem-solving abilities is still relatively low.

Based on the results of PISA in 2022, Indonesia's average mathematics score was 366 points, lower than the OECD average of 472 points, and Indonesia was in 69th position out of 81 participating countries (OECD, 2024). In line with an interview conducted by the researcher on November 29, 2024, with a mathematics teacher at SMPN 2 Bandar Petalangan, students had difficulty working on story problems in the form of mathematical problem-solving skills. This is indicated by students who have difficulty applying the steps known, asked, and answered. In addition, on rather complicated questions, they have difficulty understanding the questions, they tend to jump straight to the answer without planning the steps to solve them, and feel confident with the answer, so they do not check further.

In line with the results of a study conducted by Rosfarianti et al (2021), it was found that the mathematical problem-solving ability of students at MTsN 2 North Aceh was still low; of all students who took the test, only 20% of students could solve it. While 80% of other students could not. Then, a study conducted by Sumarmo in Nurqolbiah et al (2016) stated that students think that there is only one correct way to solve problems, namely the one presented by the teacher in class, and the mathematics studied in school has little or no connection to the real world.

It is known that students' mathematical problem-solving abilities are still low. While this ability is an important competency in mathematics learning, the PISA results show that Indonesian students are still weak in this aspect, and this is an urgency in this study. This could happen, among other things, due to the use of conventional learning models. According to Syaiful in Ngaeni & Saefudin (2017), one of the factors that causes students' low mathematical problem-solving abilities is learning habits, students are accustomed to learning by memorizing, this does not train mathematical problem-solving abilities, this is due to conventional learning, teachers teach by applying mathematical concepts and number operations, providing examples of how to do it, then students are asked to work on similar problems that have been explained.

In line with Hadi and Nuranti (2018) stated that students tend to memorize formulas without understanding the concept and do mathematics carelessly, students prefer to use short methods without paying attention to the correct solution process. This learning focuses teaching and learning activities on the teacher so that students are less active and rarely get the opportunity to develop their mathematical problem-solving skills. To overcome this, we must choose and determine the learning model. Handayani et al (2018) stated that choosing the right learning model, in accordance with learning objectives, will greatly help and facilitate teachers in the learning process in the classroom. The learning model chosen must also be able to make students active, more motivated, improve their thinking skills, present tasks in the form of problems, so that students try to find solutions with various ideas. The Problem-Based Learning (PBL) model is a learning model that we can use as a solution to this problem.

By using the Problem-Based Learning model, students are required to actively present tasks in the form of problems and then find solutions in various ways. PBL is a complex constructivist teaching model and provides great opportunities for learning development (Darma et al., 2018). The Problem-Based Learning (PBL) model is a learning approach that is centered on students by providing problems from the real world at the beginning of learning (Rahmadani, 2019). In addition, Yanti (2017) stated that Problem-Based Learning is a learning model that makes learning conditions more active by guiding students to solve problems and use problems in the real world as learning materials.

Firdaus et al (2021) stated that PBL is a learning approach that uses everyday problems as a context to help students learn important thinking and problem-solving skills and acquire concepts from classroom learning materials. In addition, there is a significant influence of the Problem-Based Learning learning models on students' mathematical problem-solving abilities (Sipayung et al, 2022; Monica et al 2019; Putri

et al, 2019; Nisak & Istiana, 2017; Ulva et al 2020; Awalia, 2023; D. E. N. Putri et al 2024; Yusri et al, 2018; Yustinaningrum 2021; Sembiring & Siregar 2020). This is reinforced because the Problem-Based Learning model has advantages and objectives that can invite students to learn more effectively because they focus on problem solving, and students are able to develop themselves.

The mathematical problem-solving ability of the group of students whose learning uses a problem-based learning approach is better than the group of students whose learning uses conventional learning (Ubaidillah, 2017; Yuhani et al, 2018; Yerizon et al, 2021; Nst et al, 2023). Then, Krismayanti & Mansurdin (2020) concluded that there was an increase in the learning implementation plan, learning implementation, and the results of the implementation of integrated thematic learning using the Problem-Based Learning model.

Although PBL has been proven effective in mathematics learning, most studies still focus on conceptual understanding, not problem solving. Research at the junior high school level, especially in areas such as SMP Negeri 2 Bandar Petalangan, is also still limited. In fact, the PISA results show that Indonesian students' problem-solving abilities are still low. Therefore, this study applies the PBL model to the circle material and compares it with the lecture method to see its effect on students' mathematical problem-solving abilities. Based on the description above, the formulation of the problem in this study is whether there is an influence of the Problem-Based Learning model on the mathematical problem-solving ability of students of SMP Negeri 2 Bandar Petalangan? The purpose of this study is to determine whether there is an influence of the Problem-Based Learning model on the mathematical problem-solving ability of students of SMP Negeri 2 Bandar Petalangan.

2. Methods

This This study is a type of quasi-experimental research, one type of experimental research in which the researcher does not randomize the subjects of the research group, but the results achieved are quite significant, both in terms of internal and external validity (Yusuf, 2014), with a sample of all students in class VIII A and VIII B at SMP Negeri 2 Bandar Petalangan taken through saturated sampling techniques because the population is relatively small and because this study aims to make generalizations with a very small error rate Sugiyono in Lathifah & Yolanda (2024). Based on the data, class VIII A consists of 20 students and class VIII B consists of 20 students. The general characteristics of the sample include an age range of 13-14 years, consisting of male and female students. Class VIII A is designated as an experimental class that is given treatment using the Problem-Based Learning (PBL) model, while class VIII B is the control class with conventional learning methods.

Table 1 - Designated As an Experimental Class

Class	Pretest	Treatment	Postest
Experiment	O1E	X1	O2E
Control	O1K	X2	O2K

Information:
X_1 = Learning uses the Problem-Based Learning
X_2 = Learning using conventional models
O_1E = Pretest scores of mathematical problem-solving in the Experimental class O_1K = Pretest scores of mathematical problem-solving in the Control class
O_2E= Posttest scores of mathematical problem-solving in the Experimental class O_2K= Posttest scores of mathematical problem-solving in the Control class

The instrument in the form of a mathematical problem-solving ability essay test based on Sumarmo's indicators in Ulvah & Afriansyah 2016 developed by the researcher himself, was validated in terms of content through expert testing by two mathematics education lecturers and one mathematics subject teacher to assess the suitability of the questions with the indicators. The data collection technique in this study was a test technique, namely, by giving pretests and posttests to students to measure mathematical problem-solving abilities before and after the learning treatment. Data analysis used descriptive and inferential statistics with assumption tests in the form of normality tests using Shapiro-Wilk and homogeneity tests, followed by independent sample t-tests to test the significance of the differences between the experimental class and the control class with the help of SPSS *software*.

3. Results and Discussion

3.1. Results

Descriptive analysis based on the tests that have been conducted, namely pretest and posttest by researchers on students, it can be analyzed descriptively as follows:

Table 1- Descriptive Analysis

Descriptive Analysis	**Pretest**		**Posttest**	
	Eksperimen	**Kontrol**	**Eksperimen**	**Kontrol**
Number of samples ($\boldsymbol{n}$)	20	20	20	20
Average ($\bar{\boldsymbol{x}}$)	37,29	39,79	80,94	70,52
Standard deviation	4,478	4,161	10,629	14,595

From the table above, it can be seen that the experimental class and the control class are at almost the same initial/pretest ability. It can be seen from the average difference of the two classes that are within a range that is not too far apart, namely the experimental class obtained an average of 37.29 and the control class obtained an average of 39.79 before being given treatment in the second class. Then it can be seen that the average mathematical problem-solving ability of students from pretest to posttest has increased. When viewed from the posttest of the two classes, the average mathematical problem-solving ability of students in the experimental class, which was initially 37.29, became 80.94, and the control class, from 39.79 to 70.52. From the table above, it can be seen that there is an increase in students' mathematical problem-solving ability from pretest to posttest.

The data analysis technique used in this study was the two-sample difference test (t-test). The t-test was used to determine whether or not there was an effect before and after treatment. The pretest and posttest questions for the experimental and control classes were the same, consisting of 3 questions in the form of descriptions about the

Circle material. The pretest and posttest scores were analyzed statistically using the normality test, homogeneity test, and t-test.

A data normality test is conducted to determine whether the data in the experimental class and control class are normally distributed before being given treatment. The results of the Pretest that has been conducted on both classes are shown in the following table:

Table 2 - Test of Normality

	Class	Shapiro-Wilk Statistic	df	Sig.
Mathematical Problem-Solving Ability	Pretest kelas A (Experiment)	,926	20	,129
	Pretest kelas B (Control)	,931	20	,164

Based on the table above, the Shapiro-Wilk significance value for the experimental class Pretest data is > 0.05, namely (0.129), and the Shapiro-Wilk significance value for the control class Pretest data is > 0.05, namely (0.164). So it can be concluded that the data is normally distributed.

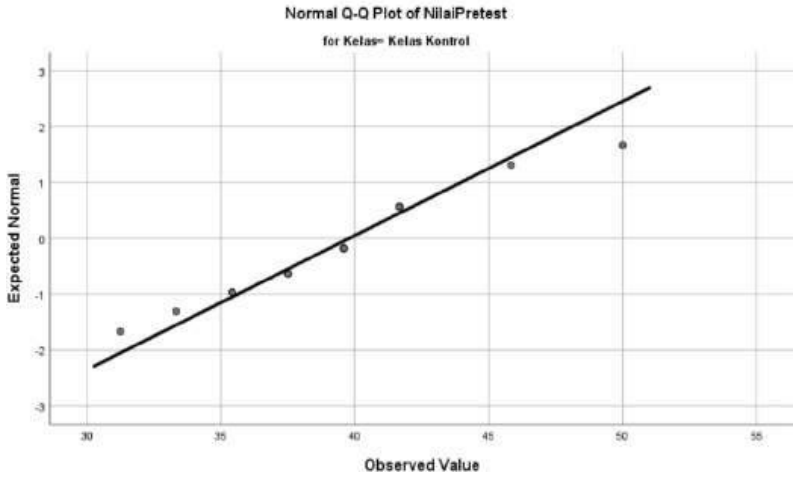

Figure 1 Results of the normality of the pretest scores for the Control class

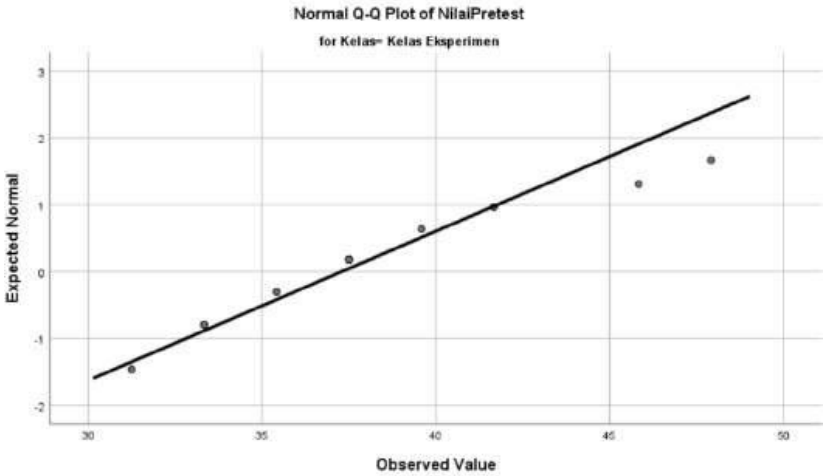

Figure 2 Results of the normality of the pretest scores for the experimental class

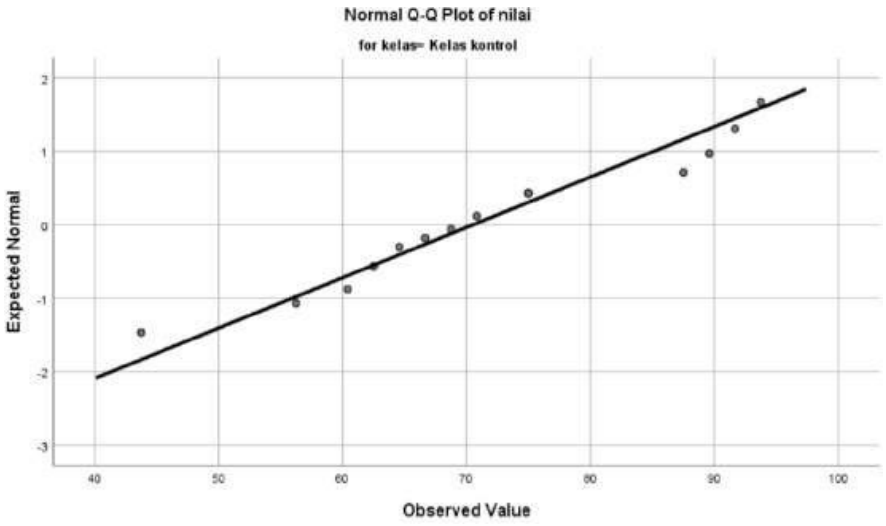

Figure 3 Results of normality of posttest scores for the control class

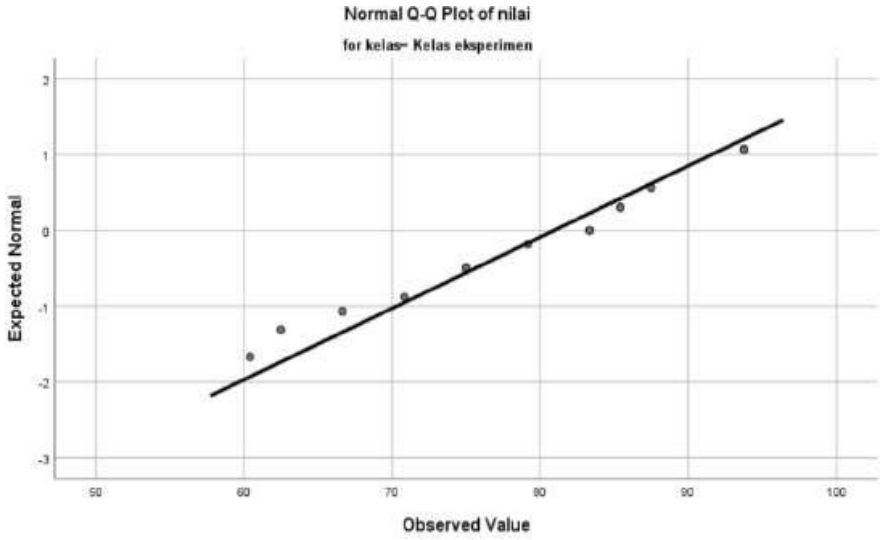

Figure 4 Results of the normality of the posttest scores for the experimental class

Based on the image above, it can be seen that the points are on a straight line, which means that the random error comes from a normal distribution, or in other words, the normality assumption is met.

The homogeneity test of the experimental class and control class can be seen in the following table:

Table 3 - Test of Homogeneity of Variance

	Levene Statistic	df1	df2	Sig.
Based on the Mean	,211	1	38	,649

The table above shows that the value of Based on Mean 0.649 > 0.05, so it can be concluded that *H*0 is accepted and *H*1 is rejected, which means that the variance of the pretest data of the experimental class and the control class is homogeneous.

The statistical test for calculating two averages of students' initial mathematical problem-solving abilities before being given different treatments is the t-test. The t-test of the experimental class and the control class can be seen in the following table:

Table 4 - Independent Samples Test

	F	Sig.	t	df	Sig. (2-tailed)
Equal Variances assumed	,211	,649	1,829	38	,075

The table above shows that the Sig. (2-tailed) value is 0.75 > 0.05, so it can be concluded that *H*0 is accepted and *H*1 is rejected, which means that there is no difference in the average before being given treatment (Pretest), meaning that students' mathematical problem solving abilities are balanced (the same) between the experimental class and the control class.

A data normality test is conducted to determine whether the data in the experimental class and control class are normally distributed after being given treatment. From the results of the Posttest that has been conducted on both classes can be seen in the following table:

Table 5 - Table Test of Normality

		Statistic	df	Sig.
Mathematical Problem-Solving Ability	Posttest kelas A (Experiment)	,920	20	,097
	Posttest kelas B (Control)	,943	20	,275

Based on the table above, the Shapiro-Wilk significance value for the control class Posttest data is > 0.05, namely (0.275), and the Shapiro-Wilk significance value for the experimental class Pretest data is > 0.05, namely (0.097). So it can be concluded that the data is normally distributed.

The homogeneity test of the experimental class and control class can be seen in the following table:

Table 6 - Homogeneity Test

	Levene Statistic	df1	df2	Sig.
Based on the Mean	1,137	1	38	,293

Based on the Mean 0.293 > 0.05, it can be concluded that *H*0 is accepted and *H*1 is rejected, which means that the variance of the posttest data of the experimental class and the control class is homogeneous.

The statistical test for calculating the two averages of students' mathematical problem-solving abilities after being given different treatments is the t-test. The t-test of the experimental class and the control class can be seen in the following table:

Table 6 - The t-test of the Experimental Class and the Control Class

	F	Sig.	t	df	Sig. (2-tailed)
Equal Variances assumed	1,137	,293	-2,580	38	,014

The table above shows that the significance value is 0.014 <0.05, then based on these criteria it is stated that *H*0 is rejected and *H*1 is accepted, which means that there is a difference in the average after being given treatment (Posttest), meaning that the experimental class has different mathematical problem solving abilities with the

mathematical problem solving abilities of the control class. It can be concluded that there is an influence of the Problem-Based Learning model on the Mathematical Problem-Solving Ability of Students of SMP Negeri 2 Bandar Petalangan.

Based on the results of the pretest and posttest data processing, it was obtained that the average pretest value of the experimental class was 37.29 and the posttest value was 80.94, while the average pretest value of the control class was 39.79 and the posttest value was 70.52. From the average posttest value between the experimental class and the control class, it can be concluded that the average value of the experimental class is higher than the control class. Based on the results of the analysis of the student posttest data, it can be seen that the significance value is 0.014 <0.05. So that *H*0 is rejected and *H*1 is accepted, which means that there is a difference in the average after being given treatment (Posttest), meaning that the experimental class has different mathematical problem-solving abilities from the mathematical problem-solving abilities of the control class. It can be concluded that there is an influence of the Problem-Based Learning model on the Mathematical Problem-Solving Ability of Students of SMP Negeri 2 Bandar Petalangan.

The Problem-Based Learning (PBL) model is more effective than conventional learning because it encourages students to actively build knowledge through solving real problems, in accordance with constructivism theory (Vygotsky, 1978). PBL trains students to think critically and collaboratively, in line with Vygotsky's concept of the zone of proximal development (ZPD), where interactions with teachers or peers help students' cognitive development. In addition, PBL supports problem-solving stages and increases learning motivation because students are directly involved in the learning process. Meanwhile, conventional teacher-centered learning tends to be passive and does not develop high-level thinking skills. Classes that are given treatment applying the problem-based learning model do not simply accept all the information conveyed by the teacher, but students actively participate in finding various information related to the material being studied (Setyaningsih & Rahman, 2022). These results are in line with Gultom et al (2022), who stated that the learning process using the Problem-Based Learning learning model, where students will actively think, communicate, search, process data, and finally conclude the knowledge they have to solve problems in the form of questions given by researchers. According to Elita et al (2019), the problem-based learning model is a learning model that is carried out through group discussions so that students can express their opinions to solve a problem and exchange information. In line with Girsang et al (2024), who stated that in the problem-based learning model, students are encouraged to think critically, analyze information, find creative solutions, and work in the same way as their classmates. According to Permatasari & Marlina (2023), the PBL learning model enables students to better understand problems, plan problems, solve problems according to plan, and recheck.

Based on the experience that researchers gained during the study of students who received learning with the Problem Based Learning model, where initially many students were less active in participating in learning, especially when solving problems in the LKPD, after some time students began to get used to and enjoy learning and became more active in the learning process. The last meeting, students were good at presenting the results of their groups, most importantly students no longer expect teachers as a whole in the learning process, they try to understand and find information themselves

to solve the problems given, so that students' mathematical problem-solving abilities in solving problems are more embedded in students in the experimental class. Students' habits of memorizing the steps of solving began to decrease; they began to learn to understand the flow and how to solve problems, so that if the problem is replaced, students are no longer confused in solving it.

From the theoretical study, data analysis, and observation results during the research, the research hypothesis can be accepted, which states that there is an influence of the Problem-Based Learning model on the mathematical problem-solving abilities of students at SMP Negeri 2 Bandar Petalangan. However, this study has several limitations, namely the small number of samples, short intervention duration, and only covering one material (circle). The focus of the study was only on the cognitive aspect without considering the affective aspects of students, such as motivation and learning attitudes. Therefore, it is recommended that further research use a larger sample, a wider range of materials, and a longer duration of intervention. In addition, it is important to measure students' non-cognitive aspects and consider a mixed methods approach to gain a more comprehensive understanding of the application of the Problem-Based Learning model.

4. Conclusions

Based on the results of the research and analysis of the data obtained, it can be concluded that there is a difference in students' mathematical problem solving abilities through the Problem Based Learning model and the conventional learning model of students at SMP Negeri 2 Bandar Petalangan, meaning that there is an influence of the Problem Based Learning model on the mathematical problem solving abilities of students at SMP Negeri 2 Bandar Petalangan.

Conflict of Interest

The authors declare no conflicts of interest.

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