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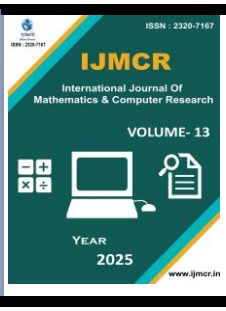

The Effect of the Problem-Based Learning Model on Students' Problem-Solving Skills in the Topic of Prims in Eight Grade Junior High School

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ABSTRACT

One of the objectives of mathematics learning in merdeka curriculum that is currently implemented is problem solving ability. Problem solving ability is an important ability and must be possessed by students, especially in learning mathematics. The learning process at school can be carried out using a learning model. One of the learning models that can be applied is the Problem Based Learning (PBL) learning model. This study aims to analyze the effect of using the Problem Based Learning (PBL) learning model in prism falt-sided space building material on the mathematical problem solving skills of 8th grade student. The research method used is an experiment with a one-group pretest-posttest design. The research subjects were students of class VIII A SMP Muhammadiyah 3 Yogyakarta. Data were obtained through problem solving ability tests before and after using the Problem Based Learning (PBL) learning model. The results showed that the n-gain core was in the high category of 0,83, while the results of hypothesis testing obtained $t_{calculated} = 40{,}396$ more than $t_{table} = 2{,}086$ which means H_0 is rejected and H_1 is accepted. So it can be concluded that there is an effect of problem-based learning (PBL) learning model on the mathematical problem solving ability of 8th grade students of SMP Muhammadiyah 3 Yogyakarta.

KEYWORDS: Problem-Based Learning, Problem-Solving Skill, and Experimental Research

INTRODUCTION

Education, whether acquired through formal or non-formal means, aims to assist and support children in their continuous learning journey. It serves as a deliberate effort to develop an individual's potential. Education is inherently linked to the acquisition of knowledge and stands as a fundamental pillar in shaping high-quality human resources. In an ever-evolving world, individuals are constantly required to enhance their knowledge in order to adapt to ongoing changes. Traditionally, learning was teacher-centered; however, the current educational paradigm emphasizes student-centered learning. In the era of globalization, students' abilities to think critically, analyze effectively, and solve problems have become increasingly vital. 21st-century learning focuses on empowering students as active participants in the learning process (Mardhiyah et al., 2021). Thus, students are expected to develop critical thinking, problem-solving, communication, collaboration, creativity, and innovation skills. These competencies are essential and must be cultivated within each student. The rapid pace of development requires students to actively participate by utilizing these skills. One of the disciplines taught from elementary to higher education is mathematics.

Mathematics plays a crucial role in sharpening students' skills. It is a fundamental discipline that supports students' academic success from basic education through to higher education (Sinambela et al., 2018). Mathematics is one of the disciplines that plays a vital role in developing students' logical and analytical thinking skills. Although it is often perceived as difficult by students, mathematics offers significant benefits for their academic and personal growth. The objectives of mathematics learning as outlined in the Merdeka curriculum include: (1) understanding facts, concepts, and their applications; (2) reasoning; (3) problem-solving; and (4) communicating ideas in mathematical form. Based on these objectives, it is essential for students to develop one of the core competencies—problem-solving ability. At the secondary school level, mathematics plays a key role in shaping students' capacity to address and solve a variety of real-world problems. Irfan et al. (2022) state that students must possess problem-

solving skills. Essentially, learning mathematics serves to enhance these skills, enabling students to solve various problems, including those encountered in everyday life.

Mathematical problem-solving ability refers to the effort made to resolve and find solutions to given mathematical problems (Ramadhani et al., 2019). Polya (1985) described problem-solving as a process aimed at tackling difficult steps and achieving goals that cannot be reached instantly. According to Polya (1985), the steps in problem-solving include understanding the problem, devising a plan for its solution, carrying out the plan, and reviewing the process. The Programme for International Student Assessment (PISA) reported that Indonesian students ranked 75th out of 81 participating countries in mathematical literacy. Mathematical literacy is crucial for students, as it is closely related to their thinking skills and their ability to solve various problems, including those encountered in everyday life. However, Indonesia is still categorized as low in this regard, indicating a strong need to improve mathematical literacy. Enhancing this competency will ultimately lead to better student problem-solving skills.

Students' problem-solving abilities vary, as shown by the study conducted by (Siagian et al., 2019), which found that 23.08% of students were at a high level of problem-solving ability, 26.92% were at a moderate level, and 50% were at a low level. Based on these findings, it can be concluded that students' problem-solving abilities are generally low and diverse. Several factors contribute to this low performance, including students' inability to understand the problem, difficulties in devising a plan, failure to identify relationships within the given problem, confusion in selecting appropriate problem-solving strategies, lack of confidence, feelings of boredom, and the use of inappropriate instructional models by teachers. Furthermore, a study by Yerizon et al. (2021) revealed that students often struggle to comprehend problems, fail to construct mathematical models based on the problems, and are unable to implement their planned strategies. The abundance of these contributing factors suggests that the ineffectiveness of learning models—particularly those that do not actively involve students in discovering and understanding concepts independently—is a major cause of students' low problem-solving abilities.

Instructional models assist teachers in shaping students so that learning objectives can be achieved optimally. Traditional mathematics instruction tends to focus on one-way information delivery from teacher to student, without providing sufficient opportunities for students to actively engage in exploration and problem-solving processes. This approach often results in passive learners who rely solely on the teacher's input, without developing the essential skills needed for effective problem-solving. There are various instructional models in mathematics that can be used to enhance active student engagement in learning, one of which is the Problem-Based Learning (PBL) model.

Problem-Based Learning (PBL) is a term used to describe learning that is centered around real-world problems. In this approach, students' learning is focused on addressing a given problem. The Problem-Based Learning (PBL) model presents students with real-life issues related to mathematical concepts, which they are then expected to solve through active learning experiences (Isrok'atun & Rosmala, 2018). This model requires students to take an active role throughout the learning process. Problem-Based Learning (PBL) has been shown to support the development of problem-solving skills (Ulger, 2018). Students are guided to collaborate with their peers within their respective groups. The problems given to students require them to engage in group discussions to find solutions. A study conducted by (Khoeriah et al., 2024) demonstrated that PBL-based student worksheets (LKS) assisted by GeoGebra were effective in enhancing students' problem-solving abilities. In addition, research by Oktaviana & Haryadi (2020) showed that the PBL model significantly improved students' problem-solving skills. Based on these studies, it can be concluded that the PBL model can effectively support the development of students' problem-solving abilities, making it a suitable alternative instructional approach for teachers to implement.

Three-dimensional geometric solids with flat surfaces, known as polyhedra, are part of the geometry component in mathematics taught to eighth-grade students. This topic includes prisms and pyramids, which require an understanding of three-dimensional concepts. Putro & Setyadi (2022) emphasize that it is important for students to learn about polyhedra because of their relevance to everyday life. The topic covers surface area and volume calculations of three-dimensional shapes. Learning this material requires strong visualization skills and a deep conceptual understanding to ensure that the problems presented can be solved accurately.

METHOD

This study is an experimental research employing a one-group pretest-posttest design. The research involved the implementation of the Problem-Based Learning (PBL) model as the treatment. The research design is presented in the Table 1 below.

Pretest	Score	Posttest
O_1	X	O_2

Description:

X: Treatment using the Problem-Based Learning (PBL) model

O_1: Pretest score (before the treatment)

O_2: Posttest score (after the treatment)

This research was conducted in Class VIII A of SMP Muhammadiyah 3 Yogyakarta during the even semester of the 2023/2024 academic year. A total of 21 students from Class VIII A served as the sample for this study. The sampling technique employed was cluster random sampling.

The instrument used in this research was a test designed to measure students' problem-solving abilities. The test consisted of three essay questions related to the topic of polyhedra, specifically prisms.

The normalized gain (n-gain) test is employed to assess the significance of the improvement between pretest and posttest scores. The formula utilized is as follows.

$$g = \frac{S_{Post} - S_{Pre}}{S_{Maks} - S_{Pre}}$$

Description:

g: gain score

S_{Post}: Posttest Score

S_{Pre}: Pretest Score

S_{Maks}: Maximum Score = 100

The criteria for interpreting the n-gain score can be seen in the Table 2.

N-Gain Score	Description
$g > 0{,}7$	High
$0{,}3 \leq g \leq 0{,}7$	Moderate
$g < 0{,}3$	Low

Normality was tested using the Kolmogorov-Smirnov method at a 5% significance level. If sig > 0.05, H_0 is accepted, indicating normal distribution, and the analysis proceeds with a paired sample t-test. In the t-test, if sig < 0.05, H_0 is rejected and H_1 is accepted.

Problem-solving skill indicators employed in this study were adapted from Polya (1985) and are shown in Table 3.

Problem-Solving Steps	Indicators
Understanding the problem	Able to identify what is given in the problem. Able to identify what is being asked in the problem.
Planning a solution strategy	Able to identify or determine the relationship between what is given and what is being asked in the problem Able to determine the strategy to be used to solve the problem Able to determine the formula to be used to solve the problem
Executing the solution strategy	Able to implement each method planned to solve the problem Able to apply each formula that has been planned to solve the problem Able to solve the problem completely
Looking back	Able to draw conclusions from the solution of the problem

RESULT AND DISCUSSION

Problem-solving skills are essential for students, particularly in mathematics learning. The problem-solving skills assessed in this study can be seen from the students' performance on the problems related to the prism material provided to them. Mathematical problem-solving skills are observed through four steps: understanding the problem, planning the solution strategy, executing the solution plan, and reviewing. This study applies the Problem-Based Learning (PBL) model. Problem-Based Learning (PBL) is a student-centered learning model in which students learn through the process of solving real-world problems. In PBL, students are presented with complex and challenging problems that require analysis and discussion to find the appropriate solution. This approach demands active student involvement, with the teacher acting primarily as a facilitator. The research was conducted over three meetings: the first meeting involved the administration of the pretest, the second meeting focused on the implementation of the problem-based learning model, and the third meeting involved the administration of the posttest. The researcher administered a test to 21 students, consisting of three essay-type questions on the topic of the flat-sided prism. The group discussion process to solve the problems in the Student Worksheet (LKPD) ran smoothly, and the majority of students actively participated in the discussion. The administration of the pretest and posttest to 21 students was conducted smoothly. During the pretest, it was evident that students were unable to solve the problems given, as they had not yet received the material on flat-sided prisms. However, during the posttest, the majority of students were able to solve the problems presented. The data, including the pretest and posttest scores, are presented in Table 4.

Statistic	Pretest	Posttest
Large sample	21	21
Minimum value	2	75
Maximum value	15	95
Mean value	7,7143	84,3333
Median	7	83
Variance	9,514	58,433
Standard deviation	3,08452	7,64417

Based on the data presented in Table 4, the students' average pretest score was higher than the median. This indicates that no student obtained a score that was significantly lower or far from the median. Similarly, the calculation of the posttest scores shows that the mean score was higher than the median, indicating that no student scored significantly below or far from the median.

The results of the n-gain score analysis were utilized to identify the level of improvement in students' mathematical problem-solving abilities following the implementation of the problem-based learning model, as presented in Table 5.

N-Gain Score	Categories	Number of students	Relative frequency
$g > 0{,}7$	High	21	100%
$0{,}3 \leq g \leq 0{,}7$	Moderate	0	0%
$g < 0{,}3$	Low	0	0%

As presented in Table 5, all 21 students were classified in the high category. This indicates a statistically significant difference in students' mathematical problem-solving abilities between the pretest and posttest. To fulfill the assumptions for further statistical analysis, a normality test was conducted to examine whether the data followed a normal distribution. In this study, the Kolmogorov-Smirnov test was employed using SPSS version 26. The results of the normality test are summarized in Table 6.

Data type	Number of students	Asym. Sig	Interpretation
Pretest	21	0,200	Normally distributed
Posttest	21	0,084	Normally ditributed

The table above shows that the Asymp.Sig value>0.05, indicating that H_0 is accepted. Therefore, it can be concluded that the data are normally distributed. Subsequently, a t-test was conducted, and the results are presented in Table 7.

Statistic	Results
df	20
α	0,05
$t_{calculated}$	40,396
t_{table}	2,086

Based on the t-test results, it is shown that $t_{calculated} > t_{table}$, which indicates that H_0 is rejected and H_1 is accepted. This suggests that students' mathematical problem-solving abilities after the implementation of the problem-based learning (PBL) model are better than before its implementation. Thus, the researcher confirms that the problem-based learning (PBL) model has a significant effect on students' mathematical problem-solving abilities. The problem-based learning (PBL) model has been proven to have a significant effect, as it involves learning activities that encourage students to actively engage in the learning process. The problem-based learning (PBL) model positively influences students by promoting critical thinking, collaboration, motivation, and independent learning. It also helps students connect concepts to real-life situations and encourages creative thinking in solving complex problems. Therefore, implementing the PBL model can effectively enhance students' mathematical problem-solving skills.

The PBL model implemented in the classroom has a significant impact on the stages of students' problem-solving abilities. Problem-solving ability refers to the capacity of students to apply appropriate strategies to solve problems (Bradshaw & Hazell, 2017). This aligns with Wong & Yip (2023), who stated that mathematical problem-solving ability is essential for students, as it helps them address real-life problems. Thus, mathematical problem-solving ability can be defined as an individual's capacity to find appropriate solutions to mathematical problems that cannot be solved directly.

Problem-solving ability is not only useful in mathematics but also in daily life. In mathematics, this ability can be developed through both routine and non-routine problems. Teachers should present problems related to real-life situations, making it easier for students to understand and apply their knowledge. Mathematical problems often require a process to find solutions, rather than an immediate answer. The stages involved in problem-solving in this study were adapted from Polya (1985), which include understanding the problem, planning the solution, executing the plan, and reviewing the solution. In the understanding stage, the majority of students were able to clearly write down what was known and what was being asked in the problem. In the planning stage, most students were able to determine the formulas needed to solve the problem. In the execution stage, most students were able to carry out each step of the planned solution and apply the formulas as intended. However, some students were unable to complete the solution correctly. In the reviewing stage, not all students wrote down the conclusion of the problem-solving process.

The results of the test conducted after the implementation of the PBL model show that students' problem-solving abilities improved, indicating that the PBL model influences students' mathematical problem-solving skills. This study is supported by previous research conducted by Anam et al. (2020), which found that the average problem-solving scores with the use of the problem-based learning model were higher than those using the conventional model, suggesting that the PBL model can enhance problem-solving skills in mathematics education. Furthermore, a study by Putri et al. (2019) found that problem-solving ability was influenced by the implementation of the PBL model, leading to improved mathematical problem-solving skills. Additionally, research by Nasution et al. (2018) showed that students' mathematical problem-solving abilities were better when the PBL model was applied compared to conventional teaching methods. Based on these previous studies, the findings of this research are supported, confirming that the problem-based learning (PBL) model implemented in mathematics education can enhance students' mathematical problem-solving skills.

CONCLUSION

Based on the results and discussion presented previously, it can be concluded that the problem-based learning (PBL) model has a significant effect on students' mathematical problem-solving abilities. The findings of this study provide a recommendation for the implementation of the PBL model as a reference for teachers in enhancing students' mathematical problem-solving skills.

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