The Effectiveness of the Problem-Based Learning Model Assisted by Flat-Sided Solid Shape Board on Students' Mathematical Problem-Solving Ability

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Abstract

This study was motivated by the low mathematical problem-solving ability of students, particularly in solving problems related to cube and cuboid topics, especially those involving surface area and volume calculations. The objectives of this research are: (1) to determine the mastery of students' mathematical problem-solving ability, and (2) to determine the improvement of students' mathematical problem-solving ability after being taught using the Problem-Based Learning model assisted by the flat-sided solid shape board media in the cube and cuboid material for Grade VIII students at SMP N 3 Brebes. This research is an experimental study with a One-Group Pretest-Posttest Design. The research sample was class VIII F of SMP Negeri 3 Brebes in the 2025/2026 academic year. Data collection techniques used were tests and documentation. The test instruments in this study included a pre-test and a post-test, which had been tested for validity, reliability, difficulty level, and discrimination index. Data were analyzed using prerequisite tests, namely normality and homogeneity tests, and hypothesis testing, which included a one-sided right proportion test, paired sample t-test, and N-gain score analysis. The results showed that the implementation of the Problem-Based Learning model assisted by the BRUKUBA board was effective in improving students' mathematical problem-solving ability. This was evident from the increase in test scores before and after the treatment, as well as statistical test results that supported the effectiveness of the model and media. Therefore, this learning model and media can serve as an alternative in mathematics learning, particularly in flat-sided solid shape topics.

Keywords: solid geometry, mathematics learning, mathematical problem-solving, problem-based learning, BRUKUBA board

1 INTRODUCTION

Mathematics plays an important role in developing the ability to think and solve problems systematically and logically in everyday life. According to Sasih, Soepriyanto, and Prayitno (2022), mathematics helps individuals understand patterns and structures to solve problems. However, students' ability to understand mathematical concepts varies greatly, which affects their skills in solving problems, particularly those related to problem-solving.

Rahmayanti & Maryati (2021) state that problem-solving is a process of reaching a goal by organizing concepts and skills into new patterns. This skill is essential to help students face real-life problems. However, in practice, many students still struggle to solve mathematics problems.

Observations at SMP Negeri 3 Brebes show that students have difficulty solving mathematics problems, especially in flat-sided solid geometry topics such as cubes and cuboids. This is due to the lack of concrete learning media that can help visualize the concepts. Teachers also acknowledge that teaching is still dominated by lecture methods, which make students less active.

To address this issue, a learning model is needed that can encourage active participation and enhance students' thinking skills. One suitable model is Problem-Based Learning, which is student-centered and emphasizes solving real-world problems. Problem-Based Learning encourages active engagement, collaboration, and problem-solving. To support the success of Problem-Based Learning, the flat-sided solid shape board (BRUKUBA) is used, enabling students to manipulate the nets of solid shapes to concretely understand surface area and volume.

Based on this background, this study aims to: (1) determine the mastery of mathematical problem-solving ability of Grade VIII students at SMP Negeri 3 Brebes after the implementation of the Problem-Based Learning model assisted by the flat-sided solid shape board, and (2) determine whether there is an improvement in students' mathematical problem-solving ability after the implementation of the Problem-Based Learning model assisted by the flat-sided solid shape board.

2 METHODOLOGY

This research is an experimental study with a quantitative approach. The research design used was a one-group pretest-posttest design, in which students received treatment in the form of the Problem-Based Learning model assisted by the flat-sided solid shape board (cube and cuboid).

The population in this study included all eighth-grade students of SMP Negeri 3 Brebes in the 2025/2026 academic year. The research sample was selected using purposive sampling, namely class VIII F as the experimental class. Data collection techniques were carried out through documentation and essay tests related to mathematical problem-solving ability.

The test instruments used had undergone validation using the Product Moment correlation formula and reliability testing with the Cronbach's Alpha coefficient, both calculated with the aid of Microsoft Excel. The analysis also included item difficulty level, discrimination index, and prerequisite tests in the form of normality and homogeneity tests.

Data were analyzed using a one-sided right proportion test to determine the mastery of students' mathematical problem-solving ability, as well as a paired sample t-test to determine the improvement after the implementation of the Problem-Based Learning model assisted by the flat-sided solid shape board. The N-Gain Score calculation was used to determine the average score after the implementation of the Problem-Based Learning model assisted by the flat-sided solid shape board.

3 RESULTS

3.1 Research Data Description

The study was conducted in class VIII F of SMP Negeri 3 Brebes in the 2025/2026 academic year as the experimental class. Learning was carried out using the Problem-Based Learning model assisted by the flat-sided solid shape board, applied to the cube and cuboid material. The pre-test results showed the lowest score was 26, the highest score was 92, the average score was 56.83, and the median was 53. After the treatment, the post-test scores increased to a minimum of 60, a maximum of 98, an average of 84.22, and a median of 84. The Liliefors normality test showed that the pre-test data (L_calculated = 0.141 < L_table = 0.159) and post-test data (L_calculated = 0.107 < L_table = 0.154) were normally distributed. The homogeneity test (F_calculated = 0.919 < F_table = 1.840) indicated that the data had homogeneous variance.

3.1.1 HYPOTHESIS TESTING RESULTS

After the data met the assumptions of normality and homogeneity, a one-sided right proportion test, a paired sample t-test, and an N-Gain Score analysis were conducted to address the research objectives.

a. One-Sided Right Proportion Test

Binomial Test

		Category	N	Observed Prop.	Test Prop.	Exact Sig. (1-tailed)
Posttest	Group 1	<= 75	4	,1	,7	,000[a]
	Group 2	> 75	27	,9		
	Total		31	1,0		

a. Alternative hypothesis states that the proportion of cases in the first group < ,7.

Figure 1. Output of the Right-Tailed Proportion Test

Based on the analysis results, mastery in mathematical problem-solving skills reached 87%, exceeding the predetermined classical mastery criterion of 70%. This indicates that the application of the Problem-Based Learning model assisted by the *Bangun Ruang Sisi Datar* board (BRUKUBA) can

support the achievement of mastery in mathematical problem-solving skills.

b. Paired Sample t-Test

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	Posttest - Pretest	27,548	14,212	2,553	22,335	32,761	10,792	30	,000

Figure 2. Output of the paired t-test between pre-test and post-test scores

The analysis results based on Figure 2 show that the calculated t value (t-count) is 10.792 with a Sig. (2-tailed) value of 0.000 < 0.05. Therefore, H_0 is rejected, and it can be concluded that there is a significant improvement between pre-test and post-test scores. This t-count value indicates an increase in students' mathematical problem-solving skills after being taught using the Problem-Based Learning model assisted by the Bangun Ruang Sisi Datar board. Thus, the application of the Problem-Based Learning model with the aid of the Bangun Ruang Sisi Datar board contributes to improving students' mathematical problem-solving abilities.

c. N-Gain Score

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
N_Gain_Score	31	,25	,91	,6273	,17145
N_Gain_Percent	31	25,00	90,57	62,7324	17,14522
Valid N (listwise)	31				

Figure 3. Output of descriptive statistics for N-Gain Score and N-Gain Percent

Based on descriptive analysis results, the average N-Gain Score obtained was 0.627 or equivalent to 62.73%. Referring to Hake's interpretation criteria (in Pratiwi et al., 2021:275), this score falls into the medium category (0.30 ≤ N-Gain < 0.70). This finding shows that the application of the Problem-Based Learning model with the aid of the Bangun Ruang Sisi Datar board can improve students' mathematical problem-solving skills in the medium category. Therefore, the applied learning approach can be considered quite effective in helping students understand the cube and cuboid material.

3.1.2 DISCUSSION

The research results show that applying the Problem-Based Learning (PBL) model assisted by the *Bangun Ruang Sisi Datar* (BRUKUBA) board in cube and cuboid material for Grade VIII students at SMP Negeri 3 Brebes successfully improved students' mathematical problem-solving abilities. Based on the proportion test, learning mastery reached 87% with a minimum mastery criterion (KKTP) of 75, exceeding the minimum target of 70%. The paired sample t-test and N-Gain Score also showed significant improvements in problem-solving ability after the learning implementation.

This improvement occurred because the Problem-Based Learning syntax from problem orientation, group organization, guidance, development and presentation of results, to evaluation provided students with opportunities to understand problems, plan strategies, execute solutions, and recheck answers according to Polya's stages (Polya, 1973). In addition to the PBL syntax that supports problem-solving stages and indicators, learning media also play an important role (Sutomo & Turmudi, 2024). Qiftiyani (2020) stated that the use of learning media such as the *Bangun Ruang Sisi Datar* board has a significant role in enhancing these skills.

Through the activity of pulling strings on cube and cuboid nets, students can visually and concretely understand the structure of three-dimensional shapes (Fharhah, 2025; Musiyati, 2024). This aligns with Bruner's theory regarding the enactive and iconic stages, which facilitate the transition to the symbolic

stage (Ahmad Hatip et al., 2021). This medium makes it easier for students to understand difficult concepts through real learning experiences (Candra Wahida & Ifada Novikasari, 2022).

4 CONCLUSIONS

Based on the research conducted at SMP Negeri 3 Brebes in the even semester of the 2024/2025 academic year on cube and cuboid material, it can be concluded that:

1. There is mastery of students' mathematical problem-solving skills after being taught using the Problem-Based Learning model assisted by the *Bangun Ruang Sisi Datar* (BRUKUBA) board, with a mastery percentage exceeding 70% according to the set criteria.
2. There is an improvement in students' mathematical problem-solving skills after applying the Problem-Based Learning model assisted by the *Bangun Ruang Sisi Datar* board, as indicated by statistical test results and N-Gain values in the medium category.

From these conclusions, the Problem-Based Learning model assisted by the *Bangun Ruang Sisi Datar* board can be considered one of the alternative learning models in mathematics learning, particularly for improving students' mathematical problem-solving skills in three-dimensional shape material.

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