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The Effect of Problem-Based Learning on the Mathematics Learning Achievement of Eighth-Grade Junior High School Students

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ABSTRACT

This study aimed to investigate the effect of the Problem-Based Learning (PBL) model on students' mathematics learning achievement. Problem-Based Learning is recognized as an instructional model that encourages active student engagement in solving real-life problems, which can enhance understanding, critical thinking, and academic performance in mathematics. The type of research conducted was a quasi-experimental study with a posttest-only control group design. The population consisted of all eighth-grade students at SMP Negeri 4 Bengkulu City in the 2016/2017 academic year. A Simple Random Sampling technique was used, assigning class VIII.3 as the experimental group and class VIII.4 as the control group, with each class consisting of 28 students. Data were analyzed using an independent two-sample t-test. The results of the post-test analysis at a significance level of $\alpha = 0.05$ indicated a statistically significant difference between the two groups. These results suggest that the Problem-Based Learning model has a positive effect on students' mathematics learning achievement.

Keywords: discovery learning model, mathematical concept understanding ability

INTRODUCTION

The current state of mathematics learning achievement in Indonesia remains relatively low. This is evidenced by the results of the Trends in International Mathematics and Science Study (TIMSS) in 2011, in which Indonesia ranked 38th out of 44 participating countries with a score of 386, falling below the international benchmark score of 500 [1]. This score reflects a decline from the 2007 result of 411 [2]. Similarly, Indonesia's performance in the 2012 Program for International Student Assessment (PISA) was also poor, with the country ranking 64th out of 65 countries[3]. According to Stiadi, mathematics achievement refers to the outcomes students achieve in learning mathematics, typically expressed in numerical scores or grades[4].

At the national level, Indonesian students also demonstrate low performance in mathematics. This is apparent in the results of the 2015 National Examination for junior high school students, which showed an average mathematics score of only 56.28. Such low achievement highlights the need for greater attention and improvement in mathematics learning outcomes. This concern aligns with the view of Dehyadegary et al., who note that one of the major crises in education systems, especially in developing countries, is low academic achievement [5].

One possible solution to enhance students' mathematics achievement is the implementation of instructional models that actively engage learners and create opportunities for improving their thinking and problem-solving skills. The Indonesian Ministry of Education and Culture Regulation No. 22 of 2016 concerning the Standards for Primary and Secondary Education Processes emphasizes that to foster students' ability to produce contextual work both individually and collaboratively, it is highly recommended to use learning approaches based on problem-solving[6]. Among these, Problem-Based Learning (PBL) is frequently suggested.

According to Eggen and Kauchak, PBL is a teaching model that places problems at the center of instruction to develop problem-solving skills, content understanding, and learner autonomy[7]. Similarly, Akinoglu and Tandogan state that the PBL model transforms students from passive recipients of information into active, independent learners and problem solvers, shifting the educational emphasis from teaching to learning[8].

Furthermore, Samford University (as cited in Oon Seng Tan) describes problem-based learning as an instructional strategy that fosters critical thinking and problem-solving skills that students can utilize throughout their lives[9]. In line with this rationale, this study aims to explore "The Effect of Problem-Based Learning on the Mathematics Learning Achievement of Eighth-Grade Junior High School Students."

MATERIALS & METHODS

This type of research is Quasi Experimental Design Research by looking at the results of a pretest before treatment or treatment in the form of problem-based learning and a posttest after treatment. This problem-based learning was conducted at SMP Negeri 4 Bengkulu City.

Inferential data analysis is used to prove the proposed hypothesis statistically and help answer the problem formulation that has been set. To determine the effectiveness of the learning approach in improving students' mathematics conceptual understanding ability, use the two independent samples t test which compares the means of two different samples.

The hypothesis is:

H0: $\mu 1 \leq \mu 2$

H1: $\mu 1 > \mu 2$

Information:

$\mu 1$: average mathematics learning achievement of classes taught using problem-based learning models

$\mu 2$: average mathematics learning achievement of classes taught using conventional method

The basis for decision making to measure whether there is a difference in the averages of the two groups being tested is by comparing the calculated t with the t table. If the calculated t value > t table then *H*0 is rejected, but if the calculated t value < t table then *H*0 is accepted.

RESULT

Inferential Data Analysis Test assumptions

Pretest data

The pretest data that has been obtained must first be tested for normality and homogeneity. Normality and homogeneity tests were carried out on the pretest learning result test data in both classes. The normality test on this data uses the Kolmogorof-Smirnov test. Normality test results can be seen in table 1.

Table 1. Pretest Normality Test Results for Mathematics Learning Achievement

Kolmogorov	Pretest		Information
	Experiment	Control	
Sig.	0.338	0.157	Normal

Based on Table 3, the sig value is 0.338 for the experimental class pretest and 0.157 for the control class pretest. Because the sig value is greater than 0.05, the pretest data on Mathematics Learning Achievement for both classes is normally distributed.

The homogeneity test on this data uses the F test. The homogeneity test results can be seen in table 2.

Table 2. Pretest Homogeneity Test Results for Mathematics Learning Achievement

Nilai Statistik	Prestasi Belajar
F (*Lavene statistics*)	0.92
Sig	0.762

Based on Table 2, the Sig. is 0.762. Because the sig. value is greater than the 0.05, the pretest data for both classes is homogeneous.

Posttest Data

The posttest data that has been obtained, before testing the hypothesis, first carries out a normality test and a homogeneity test, then a t test for two independent samples. Normality, homogeneity and two independent sample t tests were carried out on the posttest Mathematics Learning Achievement test data in both classes.

The normality test on this data uses the Kolmogorov-Smirnov test. Normality test results can be seen in table 3.

Table 3. Posttest Normality Test Results of Mathematics Learning Achievement

Kolmogorof	Posttest		Information
	Experiment	Control	
Sig.	0.181	0.639	Normal

Based on Table 3, the sig value is 0.181 for the experimental class posttest and 0.639 for the control class posttest. Because the sig value is greater than 0.05, the posttest data on Mathematics Learning Achievement for both classes is normally distributed.

The homogeneity test on this data uses the F test. The homogeneity test results can be seen in the table 4.

Table 4. Posttest Homogeneity Test Results of Mathematics Learning Achievement

Nilai Statistik	Prestasi Belajar
F (*Lavene statistics*)	0.95
Sig	0.675

Based on Table 2, the Sig. is 0.675. Because the sig. value is greater than the 0.05, the pretest data for both classes is homogeneous. Because the normality and homogeneity tests have been fulfilled, the conditions for conducting hypothesis testing using the two independent samples t test can be carried out.

The two independent samples t test is an assumption test used in this research to see the effectiveness of the learning approach taken. The results of this hypothesis test analysis can be seen in table 5.

Table 5. Results of the t test for two independent samples

df	t count	Sig.
26	2.089	0.019

Based on data in table 5, it can be seen that the sig value is smaller than 0.05, H0 is rejected and H1 is accepted or the problem-based learning is effective in improving the mathematical Learning Achievement of students at SMP Negeri 4 Bengkulu City.

DISCUSSION

The results of this study indicate that the implementation of the Problem-Based Learning (PBL) model has a positive effect on the mathematics learning achievement of eighth-grade junior high school students. Students who participated in learning through the PBL approach showed a significantly greater improvement in academic performance compared to those taught using conventional methods. This suggests that actively engaging students in solving real-world problems can enhance their conceptual understanding of mathematics and their critical thinking skills. These findings align with the view of Eggen and Kauchak, who state that PBL is a teaching model that centers around problems to develop problem-solving abilities, content mastery, and learner autonomy. In the context of mathematics education, these skills are particularly relevant, as students are expected not only to understand mathematical concepts but also to apply them in meaningful situations[7].

Previous research by Fongkanta also supports these results, noting that the PBL model transforms students from passive recipients of information into active, independent learners and problem solvers. This transformation is crucial in mathematics instruction, where students often struggle when content is delivered in an abstract or

procedural manner without connection to real-life contexts[10], [11].

Furthermore, Nahdi and Lubis emphasized that PBL fosters the development of higher-order thinking skills, such as analysis, synthesis, and evaluation [12], [13]. In this study, students involved in problem-based learning demonstrated better abilities in solving mathematical problems that required logical reasoning and application.

The results are also consistent with the principles of contextual learning as outlined in the Indonesian Ministry of Education and Culture Regulation No. 22 of 2016, which highlights the importance of using problem-solving-based learning approaches to encourage students to produce contextual work. In PBL, teachers act as facilitators who guide students in exploring problems, formulating solutions, and reflecting on their learning process.

Based on the findings and theoretical framework, it can be concluded that PBL not only enhances academic achievement in cognitive aspects but also enriches students' learning experiences in affective and psychomotor domains. Students become more active, take greater responsibility for their own learning, and are more motivated to understand mathematics as a tool for solving real-world problems.

The implications of this study suggest that mathematics teachers at the junior high school level should consider adopting PBL as an alternative instructional strategy that can holistically improve student learning outcomes. However, effective implementation of PBL requires careful planning, efficient time management, and adequate learning resources.

CONCLUSION

The results of the research show that the discovery learning is effective in improving the Mathematics Learning Achievement of students at SMP Negeri 4 Bengkulu City.

Declaration by Authors

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