

The Problem-Based Learning Model in Enhancing Students' Conceptual Understanding of Algebra

Mita Angiriani^{1*}, Nurina Kurniasari², Nisa Permatasari³
¹²³Mathematics Education Study Program, STKIP Kusuma Negara, Jakarta Indonesia
*mitaangiriani@stkipkusumanegara.ac.id

Abstract

This study aims to analyze the effect of the Problem-Based Learning (PBL) model on students' conceptual understanding. The research was conducted in two classes: an experimental class implementing the PBL model and a control class applying conventional learning methods. Prior to hypothesis testing, prerequisite tests were conducted, including a normality test using the Lilliefors test, which showed that $L < L_{table}$, indicating that the samples were drawn from a *Count Table* normally distributed population. The results of the homogeneity test using the F-test revealed that $F = 1.682$, while $L = 1.704$ at a significance level of 0.05, showing that both samples *Count Table* were homogeneous. These findings indicate that the implementation of the Problem-Based Learning (PBL) model has a significant effect on students' conceptual understanding compared to conventional learning models.

Keywords: Problem-Based Learning (PBL), Conceptual Understanding, Algebra

1 INTRODUCTION

Education is an essential aspect of life. Quality education will lead to a better quality of future generations. Innovation in the field of education continues to develop, thereby improving its quality. Currently, the quality of education needs serious attention, as rapid technological and social developments demand that all aspects related to education—teachers, students, parents, and the government—think more broadly to create better education and learning processes. The educational situation should be designed in accordance with the present developments. Education in schools is a structured and directed process so that everything done by teachers and students can achieve the intended learning goals. Education is designed to create an enjoyable and conducive learning environment that enables students to develop their potential (Saefulloh et al., 2021).

Mathematics plays an important role in improving the quality of education. It is one of the disciplines taught in formal educational institutions. According to Zamnah et al. (2021), mathematics is a fundamental science that plays a crucial role in the development of other sciences, which in turn directly influence technological advancement. Mathematics teaches an organized structure in which concepts are arranged systematically from the simplest to the most complex.

Therefore, to learn mathematics effectively, students must thoroughly understand the previous concepts, which serve as prerequisites for understanding subsequent ones (Anggraeni et al., 2021).

Most students find mathematics difficult to learn. According to Bloom (as cited in Dimiyati & Mudjiono, 2013), learning is a process of behavioral change consisting of cognitive, affective, and psychomotor aspects. Bloom identifies six cognitive abilities: knowledge, comprehension, application, analysis, synthesis, and evaluation. The affective

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domain includes five abilities: receiving, responding, valuing, organizing, and characterizing by a value system (Dimiyati & Mudjiono, 2013). Meanwhile, the psychomotor domain comprises seven abilities: perception, set, guided response, mechanism, complex overt response, adaptation, and origination (Dimiyati & Mudjiono, 2013). Students tend to forget easily after learning mathematics because they merely memorize without understanding the material.

Students can achieve learning objectives when they are able to understand concepts well. According to Lase (2020), conceptual understanding is the most important part of the learning process and problem-solving, both in academic and real-life contexts. In conceptual understanding, students are expected to discover, construct, and apply concepts to solve existing problems. By mastering concepts effectively, students will find it easier to solve problems and apply their knowledge in real-life situations.

This aligns with Rosmawati and Sritresna's (2021) definition that conceptual understanding refers to students' ability to master material, comprehend, and apply it in mathematics learning.

Jusniani (as cited in Septian, Agustina, & Maghfirah, 2020) states that students can be said to understand a concept when they can explain it in their own words, distinguish and classify objects into examples and non-examples, as well as identify relationships between concepts that have been learned. Furthermore, Pranata (2016) explains that mathematical conceptual understanding is the process and way of comprehending ideas within learning materials, where students are not only familiar with or aware of concepts but can also restate them in simpler terms and apply them appropriately.

Conceptual understanding in mathematics affects students' learning quality and, consequently, their academic achievement (Yanti et al., 2019). Based on these views, students' conceptual understanding is a crucial element in learning mathematics. Mastery of numerous concepts allows individuals to solve problems more effectively since problem-solving requires rules that are grounded in conceptual knowledge. Concepts are abstract ideas that allow individuals to classify objects or events and determine whether they represent examples or non-examples of those ideas.

According to O'Connell (as cited in Mulyani, 2018), students will find it easier to solve mathematical problems when they possess strong conceptual understanding, as it enables them to connect and resolve problems based on previously understood concepts. The achievement of conceptual understanding can be identified through several indicators. Shadiq (2009) outlines the indicators of conceptual understanding as follows:

(1) restating a concept; (2) classifying objects according to specific properties (in line with the concept); (3) providing examples and non-examples; (4) representing the concept in mathematical form; (5) developing necessary or sufficient conditions of a concept; and (6) applying concepts or algorithms to problem-solving.

However, based on observations conducted at SMP Negeri 10 Kota Bekasi, many students face challenges in understanding concepts, especially in abstract topics such as algebra. These difficulties often arise because the learning approach emphasizes procedural mechanics rather than conceptual understanding. As a result, students may be able to solve problems by following certain steps without truly understanding the reasoning behind them, which hinders their ability to apply these concepts to new or more complex situations.

One learning model believed to address these issues is *Problem-Based Learning (PBL)*. PBL is a student-centered learning model that uses real-world problems as a means to encourage critical thinking and collaborative problem-solving. According to Savery and Duffy (1995), *Problem-Based Learning* is a constructivist instructional approach that emphasizes active inquiry and meaning-making from information obtained through investigation.

PBL uses problems as the main focus and has an active teaching strategy for students, assisting them in developing skills for thinking and solving problems collaboratively (Kauchak & Eggen, 2012; Rusmono 2017; Silva, 2018). Problems encourage students to share knowledge, negotiate alternative ideas, search for

information, and build arguments to support solutions that have been established (Sawyer, 2014). PBL can improve critical thinking skills (Marzuki & Basariah, 2017; Silva et al., 2018). Students are more motivated to be involved in the learning process using the PBL model, which improves their critical thinking skills (Setyosari & Sumarmi, 2017)

During the learning process using the PBL model, students are not expected to merely listen, take notes, and memorize the material. Instead, through PBL, students are encouraged to think critically, communicate, discuss, search for and process data, and draw conclusions. Using conceptual problems as the foundation of learning is crucial, as learning will not occur if there is no problem to explore. Conceptual understanding is a competency demonstrated by students in comprehending and selecting appropriate strategies to solve problems. Conceptual understanding is vital for students; however, many still consider it difficult to achieve. This is also evident at SMP Negeri 10 Kota Bekasi, where most students struggle when faced with conceptual understanding questions. Students tend to be passive, and teachers often provide information directly—meaning students only receive and apply formulas without knowing their origins or understanding why a particular formula is used.

2 RESEARCH METHODS

The research method used in this study is a quasi-experimental design with a post-test only design. In this design, two classes were selected randomly. The research was conducted over a period of two months, specifically from May to June 2025. The population of this study consisted of all seventh-grade students divided into eight classes. To determine which classes would serve as the research samples, the cluster random sampling technique was employed.

The conceptual understanding test served as the research instrument, presented in the form of essay questions. Students' conceptual understanding was assessed through the results of these essay tests administered to both the experimental and control classes. The instrument met the required criteria for validity, reliability, discrimination power (very good), and moderate difficulty index.

The prerequisite tests in this study included the normality test using the Lilliefors test and the homogeneity test using the F-test. The hypothesis testing was conducted using the t-test.

3 RESULT AND DISCUSSION

3.1 Result

The data analysis in this study was conducted with the assistance of **Microsoft Excel**. The following table presents the **descriptive statistical analysis** results of the **post-test scores** from the experimental and control classes.

1. Descriptive Statistical Results of Post-Test Data

Table 1. Measures of Central Tendency and Dispersion of Post-Test Data for Experimental and Control Classes

Measures of Central Tendency and Dispersion	Experimental Class	Control Class
Highest Score	96,00	92,00
Lowest Score	52,00	28,00
Mean	83,30	63,70
Standard Deviation (SD)	10,20	16,86

Based on the post-test results conducted in both sample classes—the experimental and control groups—the following findings were obtained. In the experimental class, consisting of 40 students, the post-test scores ranged from a highest score of 96.00 to a lowest score of 52.00. The mean score was 83.30, with a standard deviation (SD) of 10.20.

Meanwhile, in the control class, which also consisted of 40 students, the post-test scores ranged from a highest score of 92.00 to a lowest score of 28.00. The mean score obtained was 63.70, with a standard deviation (SD) of 16.86.

To determine whether the difference in post-test scores between the experimental and control classes was statistically significant, an inferential statistical test was conducted. The normality test used was the Lilliefors test with a 5% significance level.

2. Normality Test Result

Table 3.2. Calculation of the Normality Test for Post-Test Results

N	L_{sub}		L_{table}		Conclusion
	Experimental	control	Experimental	control	
40	0,107	0,137	0,147		Normal

The obtained values are $L_{sub\ Experimental} = 0,107$ and $L_{table\ Control} = 0,137$, while

$L_{Table\ Experimental}$ dan $L_{Table\ Control} = 0,147$ dengan $n = 40$. Karena $L_{sub} < L_{table}$ is accepted,

which means that the population is normally distributed.

3. Homogeneity Test Results

Table 3.3. Calculation of the Homogeneity Test for Post-Test Results

Class	N	F_{Sub}	F_{Table}	Conclusion
Experimental & Contro	40	1,682	1,704	Homogeneous

The obtained value of $F_{Sub} = 1,682$, while $F_{Table} = 1,704$ at a 5% significance level, with 39 degrees of freedom for both the numerator and the denominator. Since $F_{Sub} < F_{Table}$, H_0 is accepted, which means that the post-test results of the experimental and control classes are homogeneous.

4. Independent Sample t-Test Results

Table 3.4. Calculation of the Independent Sample t-Test for Post-Test Results

T_{Sub}	T_{table}	Conclusion
6,29	1,99	Rejected

Based on the calculation results $T_{Sub} = 6,29$ while $T_{Table} = 1,99$ $T_{Sub} > T_{Table}$ since H_0

rejected. This means that the experimental class achieved better learning outcomes, and the use of the *Problem-Based Learning* (PBL) model was more effective in improving students' learning achievement compared to the conventional learning model. Implementing the *Problem-Based Learning* (PBL) model also enabled students to meet the Minimum Mastery Criteria (KKM).

3.2 Discussion

During the research process, several findings were obtained from the two classes that were given different treatments. In the class that applied the Problem-Based Learning (PBL) model, students were actively involved in the learning process, exploring and constructing knowledge related to the given problems. In contrast, the class that used the conventional learning model was still dominated by the teacher, with students being less engaged in the learning process.

Encouraging students' interest and active participation in understanding the concepts taught is not an easy task. Teachers are required to create an engaging and dynamic learning atmosphere. The selection of an appropriate learning model helps students develop activeness and interest, which in turn enhances their motivation to learn, awareness, and thinking abilities.

Learning using the Problem-Based Learning (PBL) model and the conventional learning model was implemented in teaching algebra to seventh-grade students at SMPN 10 Kota Bekasi. Based on the effectiveness indicators—specifically, the average score of conceptual understanding—it was found that students taught using the Problem-Based Learning (PBL) model achieved higher average scores than those taught using the conventional learning model. Therefore, it can be concluded that the Problem-Based Learning (PBL) model is more effective than the conventional learning model in teaching algebra to seventh-grade students at SMPN 10 Kota Bekasi.

This finding is supported by previous research conducted by Marfuqotul Hidayah, titled "*The Implementation of Problem Based Learning in Mathematics Learning to Improve Conceptual Understanding Skills of Eighth-Grade Students in the Second Semester of SMPN 1 Teras, Academic Year 2014/2015.*" The results of that study indicated that the implementation of the Problem-Based Learning strategy successfully improved students' conceptual understanding skills.

4 CONCLUSION

The Problem Based Learning (PBL) model has been proven effective in enhancing students' conceptual understanding. Through PBL, students actively engage in discovering knowledge and connecting the material to real-life contexts. Consequently, the implementation of PBL leads to better learning outcomes compared to the conventional learning model.

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