JISIP (Jurnal Ilmu Sosial dan Pendidikan)
Vol. 10 No. 3 Juli 2026
e-ISSN : 2656-6753, p-ISSN: 2598-9944
DOI: *10.36312/jisip.v10i3.10985/http://ejournal.mandalanursa.org/index.php/JISIP/index*

Improving Students' Understanding of Mathematical Concepts Through *Problem-Based Learning* Held *Geoboard* on Plane Figures

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Article Info
Article history:
Received: 20 June 2026
Publish: 4 July 2026

Keywords:
Problem-Based Learning;
Geoboard;
Understanding Mathematical Concepts;
Two-dimensional figure.

Abstract
Students' understanding of mathematical concepts in the material on plane figures is still relatively low, so learning that actively involves students in constructing knowledge is needed. This study aims to improve students' understanding of mathematical concepts through the application of Problem-Based Learning(PBL) assisted by the Geoboard on the material of plane figures. This study is a Classroom Action Research (CAR) conducted in two cycles using the Kemmis and McTaggart model, which includes planning, action, observation, and reflection. The subjects were 34 seventh-grade students of SMP Islam Abu Abdillah Al Islami. Data were collected through conceptual understanding tests, observation, and documentation, then analyzed descriptively and quantitatively. The results of the study indicate that the application of Problem-Based Learning assisted by Geoboard can improve students' understanding of mathematical concepts. Classical mastery increased from 44% in cycle I to 93.93% in cycle II. Furthermore, all indicators of mathematical concept understanding improved in cycle II.

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1. INTRODUCTION

Mathematics is a discipline that plays a crucial role in developing students' logical, critical, systematic, and analytical thinking skills. Besides being a tool for developing problem-solving skills, mathematics also serves as a foundation for mastering science and technology. However, various assessment results indicate that Indonesian students' mathematical abilities still require attention. The *Programme for International Student Assessment* (PISA) 2022 showed that the mathematical literacy skills of Indonesian students were still below the average of member countries. *Organization for Economic Co-operation and Development* (OECD), especially in the aspect of understanding concepts and applying concepts in various contextual situations (OECD, 2023). These findings indicate that mathematics learning still faces challenges in building deep and meaningful conceptual understanding for students.

Understanding mathematical concepts is a fundamental skill that students must possess in learning mathematics. This ability is not only related to mastering definitions or formulas, but also includes the ability to re-explain a concept, classify objects based on certain characteristics, provide examples and non-examples, use various mathematical representations, and apply concepts in problem-solving. According to Edy and Nuraini (2021), conceptual understanding is the primary foundation for developing higher-order thinking skills and mathematical problem-solving. Therefore, students with a good

conceptual understanding will find it easier to connect various mathematical ideas and use them flexibly in a variety of situations.

One topic that requires a deep conceptual understanding is plane geometry. This material not only requires students to understand the properties and elements of geometric shapes, but also the ability to connect the concepts of area, perimeter, and the relationships between shapes in problem solving. The abstract nature of geometry often hinders students from fully grasping the concepts. Trimurtini et al. (2021), understanding of geometric concepts needs to be built gradually through concrete experiences towards symbolic representation so that students do not only memorize formulas, but are able to understand the meaning of the concepts being studied.

This problem was also found in seventh-grade students at Abu Abdillah Al Islami Islamic Middle School. Initial observations showed that students' mathematical conceptual understanding of plane geometry was still relatively low. Initial test results showed that the classical mastery level only reached 23.33%. Most students still had difficulty re-explaining previously learned concepts, identifying examples and non-examples, and applying concepts in contextual problem-solving. Furthermore, the learning process was still dominated by lecture methods, resulting in students receiving information passively and receiving fewer opportunities to build their understanding through meaningful learning activities.

One alternative that can be used to overcome this problem is the implementation *Problem Based Learning* (PBL). This learning model places contextual problems as the starting point of learning, encouraging students to investigate, discuss, think critically, and find solutions independently and collaboratively. Various studies have shown that PBL can increase student engagement in learning and help build a deeper understanding of concepts because students play an active role in constructing their own knowledge. (Ayari et al., 2025; Mashuri et al., 2025).

However, the application of PBL to plane geometry material needs to be supported by learning media that can help students visualize abstract geometric concepts. One relevant medium is the *Geoboard*, namely, a manipulative medium that allows students to form and explore various flat shapes directly. The use of a *Geoboard* can help students understand the relationships between building elements, compare shapes, and discover the concepts of area and perimeter through more concrete learning experiences. Previous research shows that *Geoboards are* effectively used to help visualize geometric concepts and improve students' understanding of flat geometry material(Ponte et al., 2023; Unaenah et al., 2023).

Research on Problem-Based Learning and its use, *Geoboard,* has been widely used and has shown positive results in mathematics learning. However, most research still examines the two approaches separately. Studies that integrate *Problem-Based Learning,* assisted *Geoboard* Research, specifically on improving understanding of mathematical concepts in plane geometry at the junior high school level, are still relatively limited. This situation indicates a need to examine the effectiveness of integrating these two components in mathematics learning. In addition to contributing to the development of mathematics learning, this research is expected to provide an alternative learning strategy that helps teachers create more meaningful and student-centered learning.

Based on this description, this research is focused on the application of *Problem-Based Learning*-assisted *Geoboard* to improve students' understanding of mathematical concepts in the material of plane figures. This study aims to describe the improvement in students' understanding of mathematical concepts after the application of *Problem-Based Learning*-assisted *Geoboard*. The results of this research are expected to provide benefits both theoretically, as a reinforcement of problem-based mathematics learning studies, and

practically, as a reference for teachers in improving the quality of geometry learning in schools.

2. RESEARCH METHODS

This research uses Classroom Action Research (CAR) with the Kemmis and McTaggart model, which includes four stages, namely planning (*planning*), implementation of actions (*action*), observation (*observation*), and reflection (*reflection*). CAR was chosen because it allows teachers to systematically improve learning based on real-world problems encountered in the classroom. The research was conducted in two cycles, each consisting of two meetings. The results of the reflections in each cycle were used as the basis for improving actions in the next cycle until the research success indicators were achieved.

The study was conducted in the even semester of the 2025/2026 academic year at Abu Abdillah Al Islami Islamic Junior High School, Medas, Gunungsari. The subjects were 34 seventh-grade students, consisting of 14 boys and 20 girls. Subject selection was based on initial observations showing students' low understanding of mathematical concepts in the topic of plane figures.

The action taken is in the form of implementation *Problem Based Learning* (PBL) assisted by a *Geoboard* on the material of plane figures. Learning is carried out according to PBL syntax, which includes orienting students to problems, organizing students for learning, guiding investigations, developing and presenting results, and analyzing and evaluating the problem-solving process. *The geoboard is* used as a concrete medium to help students visualize the concept of flat shapes and construct a more meaningful mathematical understanding.

Research data was collected through conceptual understanding tests, observation, and documentation. The conceptual understanding test was designed based on indicators of mathematical conceptual understanding, which include the ability to restate concepts, classify objects, provide examples and non-examples, present concepts in various representations, develop necessary and sufficient conditions, apply concepts, and relate various mathematical concepts. Observations were used to observe the implementation of learning and student activities during the intervention, while documentation served as supporting data for the research.

Data were analyzed quantitatively and descriptively. Concept comprehension test scores were calculated using a 0-4 scoring rubric, then converted into categories of excellent, good, moderate, low, and very low. Individual learning completion was determined based on the Minimum Completion Criteria (KKM) of 70, while the learning process was deemed successful if classical completion was reached by at least 80% of the total number of students participating in the learning. Observational data were analyzed using the percentage of learning implementation to support the interpretation of the research results in each cycle.

3. RESULTS AND DISCUSSION

3.1. Research result

Displaying research data. The results of the study show that the implementation of *Problem-Based Learning* (PBL) assisted in the study of plane geometry material, improved the understanding of mathematical concepts among seventh-grade students at Abu Abdillah Al Islami Islamic Middle School. This improvement was evident from the evaluation results conducted in each research cycle.

Table 1. Students' Mathematical Concept Understanding Completion

Cycle	Number of Students	Completed	Not Completed	Classical Completion
I	25	11	14	44%
II	33	31	2	93,93%

Based on Table 1, classical mastery increased from 44% in cycle I to 93.93% in cycle II. These results indicate that the research success indicator set at ≥80% was achieved in cycle II. To clarify the increase in students' understanding of mathematical concepts in each cycle, classical mastery data is presented in graphical form.

Graph 1. Improving Students' Understanding of Mathematical Concepts in Cycle I and Cycle II

Graph 1 shows a quite striking difference in mastery achievement between cycles I and II. The diagram shows a consistent upward trend after the implementation of learning improvement measures in cycle II. This visualization reinforces the finding that problem-based learning supported by the use of *Geoboard*able to help students understand the concept of flat shapes more effectively than the conditions in the previous cycle. In addition to classical completeness, improvements were also seen in each indicator of students' understanding of mathematical concepts as presented in Table 2.

Table 2. Percentage of Mathematical Concept Understanding Based on Indicators

Concept Understanding Indicators	Cycle I	Cycle II
Restating the concept	88%	95,45%
Classifying objects	52%	85%
Provide examples and non-examples	47%	74,24%
Presenting concepts in various representations	79%	85,57%
Develop necessary and sufficient conditions	50%	79,54%
Using or applying concepts	49%	85,60%
Linking various concepts	40%	81%

The data in Table 2 shows that all indicators of mathematical concept understanding increased in Cycle II. The largest increases occurred in the indicator linking various concepts, which increased from 40% to 81%, the indicator providing examples and non-examples, which increased from 47% to 74.24%, and the indicator using or applying concepts, which increased from 49% to 85.60%.

Figure 1. Student Activities in Problem-Based Learning Assisted by Geoboard

Learning documentation shows that students actively engaged in group discussions, developed problem-solving strategies, and utilized the Geoboard to concretely visualize geometric concepts. These activities were evident throughout the learning process in Cycle II.

3.2. Discussion

The increase in students' understanding of mathematical concepts in this study shows that the application of *Problem-Based Learning* (PBL) assisted by the *Geoboard* can create more meaningful learning. Through the PBL model, students not only receive information from the teacher but are actively involved in the process of discovering concepts through solving problems related to everyday life. This allows students to construct knowledge independently, making the concepts learned easier to understand and remember long-term.

The increase in classical mastery from 44% in cycle I to 93.93% in cycle II indicates that the application of PBL syntax has a positive impact on students' mathematical conceptual understanding. In the problem orientation stage, students are trained to understand the given problem. Next, in the investigation and group discussion stage, students gather information, analyze relationships between concepts, and develop problem-solving strategies. These activities help students build a deeper conceptual understanding compared to conventional teacher-centered learning.

The results of this study align with Sipahutar's (2022) opinion, which states that Problem-Based Learning can increase student engagement in learning and help develop critical thinking skills and understanding of mathematical concepts. Through problem-solving activities, students gain more active learning experiences, enabling them to understand mathematical concepts not only procedurally but also conceptually.

In addition to learning models, the use of the *Geoboard* also makes an important contribution to improving students' understanding of mathematical concepts. *Geoboard* functions as a manipulative medium that helps students visualize the shape, properties, area, and perimeter of plane figures concretely. Using rubber and a nailed board, students can form various plane figures and directly observe the relationships between geometric elements. This concrete learning experience helps students understand geometric concepts that were previously considered abstract.

Improvements in all indicators of understanding mathematical concepts strengthen the effectiveness of the use of the *Geoboard* in learning. The greatest improvement occurred in the indicator of linking various mathematical concepts, which shows that students are increasingly able to connect the concepts they have learned to solve problems. This finding indicates that the integration of PBL and *Geoboard* not only helps students understand concepts separately but also builds connections between

mathematical concepts as a whole. The findings of this study are also in line with research by Yoyana and Supriansyah (2025), which states that the use of media *Geoboard* can help students understand geometric concepts and improve mathematics learning outcomes. This success occurs because *Geoboard is* able to bridge students' thinking processes from the concrete to the abstract stage so that learning becomes easier to understand.

Overall, the research results prove that the implementation of *Problem Based Learning* assisted *Geoboard* effective in improving students' understanding of mathematical concepts in the material on plane figures. This success is demonstrated by the increase in classical mastery and all indicators of mathematical concept understanding. Thus, the combination of problem-based learning and the use of concrete media can be an effective learning alternative to improve the quality of mathematics learning in schools.

4. CONCLUSION

Based on the research results, it can be concluded that the implementation of *Problem-Based Learning* (PBL) assisted by *Geoboard* was able to improve students' understanding of mathematical concepts in the material on plane figures. This improvement was demonstrated by the classical completeness, which increased from 44% in cycle I to 93.93% in cycle II. Furthermore, all indicators of mathematical concept understanding increased after the implementation of the action. Thus, *Problem Based Learning* assisted by *Geoboard* effectively used as an alternative learning method to improve students' understanding of mathematical concepts in flat geometry material.

5. ACKNOWLEDGEMENTS

The author would like to express his deepest gratitude to the Principal and Mathematics Teacher of Abu Abdillah Al Islami Islamic Junior High School. Their support, research permits, and facilities were instrumental in ensuring the successful completion of this research.

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