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Learning Based Project as an Effective Strategy to Improve Student Understanding about Geometry Congested

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Abstract

Mathematics is often considered difficult because it requires deep conceptual and abstract understanding. Solid geometry is one of the most challenging topics for junior high school students. This study aims to determine the effectiveness of the Project Based Learning (PjBL) model in improving students' understanding of solid geometry. The study used Classroom Action Research (CAR) conducted in three cycles involving 21 seventh-grade students of SMP Melania II Jakarta during the 2024/2025 academic year. Data were collected through tests, observations, interviews, and documentation, and analyzed using descriptive quantitative methods. The results showed a continuous improvement in students' mathematical understanding across cycles. The average score increased from 46.33 in the pre-cycle to 59.72 in Cycle I, 82.50 in Cycle II, and 91.18 in Cycle III, while the percentage of students achieving the minimum mastery criteria (KKM = 75) increased from 14.29% to 87.25%. Students became more active, confident, and cooperative during the learning process. These findings indicate that Project Based Learning effectively enhances students' conceptual understanding and engagement in solid geometry.

Keywords: Classroom Action Research, Mathematical Understanding, Project-Based Learning, Solid Geometry.

1 INTRODUCTION

Mathematics is discipline Mathematics is a science that underpins the development of science, technology, and various aspects of modern life. The logical, critical, and creative thinking skills developed through mathematics play a vital role in developing 21st-century skills. However, mathematics remains a daunting subject for most students due to its abstract and symbolic nature.

International surveys such as the Trends in International Mathematics and Science Study (TIMSS) 2023 show that Indonesian students' mathematics abilities remain relatively low, with an average score of 379, ranking them 68th out of 80 countries (Mullis et al., 2023). This situation suggests that mathematics learning in Indonesia needs improvement, both in terms of approaches and teaching strategies.

Observations at Melania II Junior High School in Jakarta showed that seventh-grade students struggled to grasp the concept of geometric shapes, particularly in connecting formulas to geometric properties. The average score on the 2024 mathematics exam was 63, below the Minimum Completion Criteria (KKM) of 75. This indicates that students' conceptual understanding of geometric shapes still needs improvement.

The dominant learning approach used to date is lecture and practice, which tends to make students passive and dependent on the teacher. However, meaningful learning requires active student engagement in the knowledge-building process. One alternative that aligns with this principle is Project-Based Learning (PjBL), a learning model that

emphasizes student involvement in designing, implementing, and evaluating a project as a learning tool.

The Merdeka Curriculum, which has begun to be implemented in Indonesia, emphasizes the importance of project-based learning. According to Habibah (2024), project-based learning (PjBL) integrates knowledge with real-world experiences through collaborative and contextual activities. This model aligns with the constructivist theories of Piaget and Vygotsky, which emphasize that knowledge is constructed through active experience and social interaction.

By implementing PjBL, students not only understand formulas and concepts theoretically, but also experience and construct their own knowledge through contextual learning experiences. Through project activities, students can discover connections between mathematics and the real world, making learning more meaningful.

Therefore, the application of PjBL in spatial geometry learning is expected to improve students' thinking skills, creativity, and understanding of spatial geometry concepts, while changing the learning paradigm from teacher-centered to student-centered.

2 RESEARCH METHODS

2.1. Research Design

This study used a Classroom Action Research (CAR) design consisting of three cycles: planning, action, observation, and reflection. The goal was to improve students' understanding of solid geometry through repeated interventions using the PjBL model.

2.2. Participants and Arrangements

The study was conducted at Melania II Junior High School in Central Jakarta, Indonesia. Participants included 18 seventh-grade students during the even semester of the 2024/2025 academic year.

2.3. Procedure

Each cycle consists of:

1. Planning: Designing lesson plans, test instruments, and observation sheets.
2. Action: Implementing PjBL with group projects.
3. Observation: Monitoring student participation, engagement, and collaboration.
4. Reflection: Evaluate the results and plan improvements for the next cycle.

2.4. Data Collection

Data is collected through:

- Observation sheet: to assess student activity and cooperation.
- Written test: to measure mathematical understanding.
- Interviews: to collect student responses and reflections.
- Documentation: photos and notes from activity learning.

2.5. Data analysis

Quantitative data (exam scores) were analyzed descriptively to determine average scores and percentage mastery. Qualitative data (observations and interviews) were used to describe changes in student behavior and engagement.

3 RESULTS AND DISCUSSION

3.1. Pre-Cycle Results

Prior to the implementation of the PjBL model, students followed conventional learning methods in the form of lectures and practical exercises. The initial test results showed that

the average student score was only 46.33, with 14.29% achieving the Minimum Completion Criteria (KKM = 75). Observations revealed that most students did not yet understand basic geometric shape concepts, such as the relationship between edges, sides, and vertices. Furthermore, learning motivation was still low and student interaction in class tended to be passive.

3.2. Results of Cycle I

In the first cycle, learning focuses on creating simple projects, such as cube and cube models from recycled materials. The teacher acts as a facilitator, while students work in small groups to design and calculate the volume and surface area of their models.

Test results after cycle I showed an increase in the average score to 59.72, with 27.78% of students achieving the Minimum Competency (KKM). Students began to show enthusiasm for the project activities, although their involvement was uneven, with some still relying on teacher guidance. The reflection phase indicated the need for increased collaboration and a clearer division of tasks among group members.

3.3. Results of Cycle II

Improvements were made in cycle II by providing more structured project guidance and strengthening collaboration among group members. Students created prism and pyramid models and presented their project results to the class.

The average score increased to 82.50, and 61.90% of students successfully completed the learning. Students demonstrated significant improvements in conceptual understanding and ability to communicate mathematical ideas. They were more confident explaining their group work and were able to connect geometric shapes to real-life applications. These findings align with research by Santoso & Wulandari (2021), which found that PjBL improves students' higher-order thinking and collaboration skills.

3.4. Results of Cycle III

In the final cycle, project activities are developed into contextual applications. Students are given the freedom to design miniature buildings or 3D geometric designs for spaces using a variety of simple digital materials and media. This project encourages creativity while integrating mathematical concepts in a concrete way.

The average score increased to 91.18, with 87.25% of students achieving completion. Learning activities became more dynamic and collaborative. Students demonstrated independence, actively asked questions, and were able to summarize concepts through their project results. Observations also showed improvements in non-cognitive aspects such as self-confidence, responsibility, and group collaboration.

3.5. Data Analysis

Improvement results Study can be seen in the following table:

Table 1 Improvement results Study

Stage	Average value	Solution (%)	Development Description
Pre-Cycle	46.33	14.29	Students are passive and do not yet understand the basic concepts of spatial geometry.
Cycle I	59.72	14.29	Starting to be active in projects, but still needs intensive guidance.
Cycle II	82.50	61.90	Collaboration and conceptual understanding improved significantly.
Cycle III	91.18	87.25	Students are creative, independent, and able to apply concepts contextually.

4 Discussion

The three-cycle classroom action research (CAR) was completed following established research procedures. Overall, the classroom action proceeded smoothly without any obstacles. Prior to the action, a pre-cycle assessment was conducted, which indicated that only 14.29% of students successfully achieved the Qualification Standard (KKTP). This information was then used as the basis for the action.

The results of providing action in the form of implementing the Project Based Learning (PjBL) model in cycle I are shown by the results of the students' mathematical understanding ability test which did not reach the KKTP with a result of 27.78%. Then the researcher made improvements to the learning process in cycle II showing an increase in the results of the students' mathematical understanding ability test, namely students had not reached the KKTP with a result of 61.90%. Then the researcher made improvements to the learning process in cycle III showing an increase in the results of the students' mathematical understanding ability test, namely students had achieved the established success indicators with learning outcomes of 87.25%. Therefore, educators will not provide any more actions in the next cycle.

In general, the increase in students' creative mathematical thinking abilities from cycles 1 and 2 is presented in Figure 1.

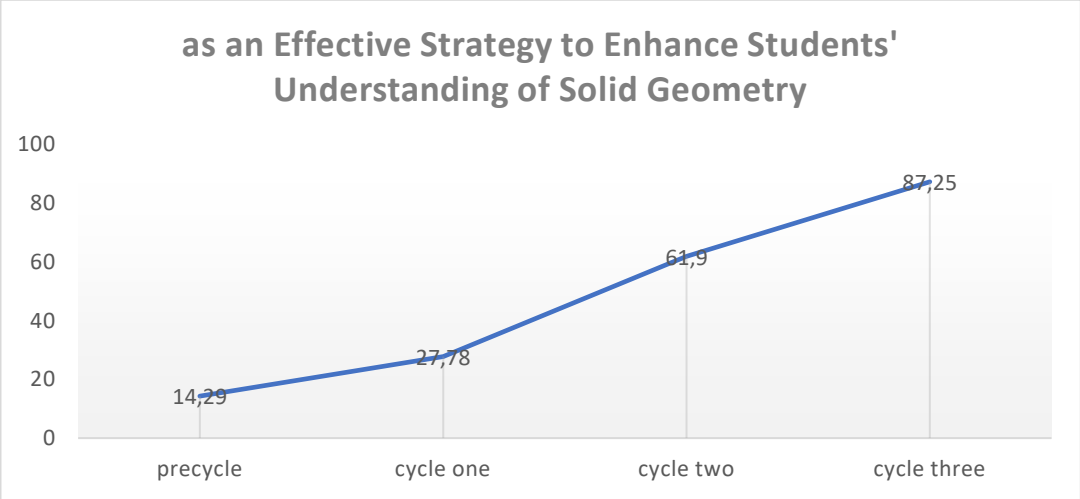

Figure 1. increase ability think creative

Figure 1 as an Effective Strategy For Increase ability Student about Geometry Congested in each cycle.

Based on Figure 1, researchers have been able to show an increase in students' mathematical understanding abilities in each cycle. In cycle 3, 87.25% of students' mathematical understanding abilities were possessed by all students, which indicates that the learning process carried out had achieved the established success indicators with learning outcomes of 87.25%. If calculated, the increase in students' mathematical understanding abilities from cycle 1, to 2, and to cycle 3 increased by 58.98%. Based on the description above, researchers can show that providing actions in class through the application of the Project Based Learning (PJBL) model can improve students' mathematical understanding abilities in the material of flat-sided solid shapes for grade VII.

5 CONCLUSION

Based on the results of classroom action research conducted over three cycles, it can be concluded that the implementation of the Project Based Learning (PjBL) model significantly improved students' mathematical understanding, particularly in spatial geometry. The learning process, which began with planning, action, observation, and reflection in each cycle, showed consistent improvements in cognitive, affective, and psychomotor aspects.

In the early stages (pre-cycle), students demonstrated a poor understanding of basic geometric concepts, such as the relationships between edges, sides, and vertices. The average score was 46.33, with a learning completion rate of only 14.29%. This situation illustrates that conventional one-way learning has not been able to foster conceptual understanding and student learning engagement.

After implementing the PjBL model in the first cycle, positive changes occurred in student learning activities. Through the cube and cuboid modeling project, students began to show enthusiasm, courage to ask questions, and a willingness to actively participate in group discussions. Although the average score only reached 59.72 with a completion rate of 27.78%, this already shows a promising initial increase in student engagement in the learning process.

Improvements in the second cycle, emphasizing collaboration and clearer role allocation within the group, resulted in even more significant improvements. The projects developed, including prism and pyramid models, helped students concretely understand the concepts of surface area and volume. The average score increased to 82.50, with 61.90% of students achieving completion. Students also demonstrated the ability to connect geometric concepts to everyday life situations, for example when explaining the shape of a roof, packaging, or simple building.

Finally, in the third cycle, project activities focused on the contextual application of spatial geometry through the creation of three-dimensional building miniatures and digital-based designs. Students were given the freedom to choose materials, tools, and presentation methods, which encouraged them to be more creative and independent. The results were very satisfying: the average score reached 91.18 with 87.25% of students completing the learning. The increase from pre-cycle to cycle III reached 44.85 points, indicating the real success of the PjBL implementation.

In addition to cognitive development, positive impacts are also seen in students' attitudes and character. Students become more confident, able to communicate well, work together productively, and demonstrate responsibility for the results of group work. Project-based learning experiences also strengthen 21st-century skills known as the 4Cs (Critical Thinking, Creativity, Collaboration, and Communication). Thus, PjBL learning not only improves mathematics learning outcomes but also develops students' social and emotional competencies, which are essential for modern life.

Theoretically, these findings reinforce Piaget and Vygotsky's views on constructivism theory, which emphasizes that knowledge is built through direct experience and social interaction. In the context of spatial geometry, PjBL allows students to construct understanding independently through exploration, experimentation, and reflection. The results of this study also align with previous findings by Habibah (2024), Suryani (2022), and Mustika & Nurfadilah (2023), which concluded that PjBL contributes to improving students' conceptual understanding, creativity, and learning motivation.

The research results show that the Project-Based Learning (PjBL) model is highly effective in teaching mathematics, particularly spatial geometry at the junior high school level. This model not only improves academic achievement but also fosters student engagement, responsibility, and collaboration. By integrating real-world experiences into learning, PjBL provides a strategic alternative for teachers in implementing the Independent Curriculum (Kurikulum Merdeka), while addressing the challenge of low higher-order thinking skills (HOTS) among Indonesian students in mathematics.

Therefore, it is recommended that mathematics teachers at the elementary and secondary levels consider implementing the Project-Based Learning (PjBL) model more

broadly and sustainably. Educational institutions also need to provide support in the form of facilities, teacher training, and curriculum policies that encourage the implementation of project-based learning. In this way, mathematics learning can be more meaningful, contextual, and optimally foster students' critical and creative thinking skills.

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