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APPLICATION OF PROBLEM-BASED LEARNING BASED ON ETHNOMATHEMATICS CANDI IJO TO IMPROVE MATHEMATICS LEARNING OUTCOMES ON FLAT BUILDINGS MATERIAL STUDENTS OF MTSN 9 BANTUL

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Abstract: The application of ethnomathematics-based problem-based learning model has been found to improve student engagement and mathematics learning outcomes. The study aims to improve students' mathematics learning outcomes through the application of problem-based learning model based on ethnomathematics of candi ijo in class VIII C MTsN 9 Bantul in the 2024/2025 academic year. This research is a class action research conducted in 2 cycles. Each cycle consists of planning, action, observation, and reflection. The research subjects were 30 students of class VIII C MTsN 9 Bantul in the 2024/2025 academic year. Research data were obtained through tests, interviews, and documentation. Data analysis used descriptive qualitative analysis techniques. Data validation using method triangulation techniques. The results showed that there was an increase in the learning outcomes of VIII C MTsN 9 Bantul students in the 2024/2025 academic year through the application of the problem-based learning model based on candi ijo ethnomathematics. The increase in learning outcomes is indicated by the increase in the average percentage achievement of math learning outcomes from 65.74% in the pre-cycle to 73.25% in cycle 1, further increasing to 80.15% in cycle 2. Based on these results, it can be concluded that there is an increase in student learning outcomes in mathematics, especially in flat building material through the application of the problem-based learning model based on candi ijo ethnomathematics.

Keywords: ethnomathematics, problem-based learning model, learning outcomes

Introduction

Mathematics education has developed significantly, adapting to the needs of society and technological advances. The development of education in Indonesia is closely related to curriculum changes, where it starts from a traditional approach to a more modern approach (Hidayat et al., 2025). Mathematics is essential for sustainable development, serving as a foundation for other sciences and playing an important role in Education for Sustainable Development (ESD) (Widiati & Juandi, 2019). In early childhood education, math is essential for cognitive development, with play practices enhancing learning (De Souza & Teixeira, 2021). The importance of math extends to developing countries, where it is key to driving innovation and technological progress (Pumwa & Mohamed, 2020). Mathematics performance is influenced by the training environment and the quality of teaching, which affect students' progress and their ability to acquire the skills necessary for problem solving and innovation (Pumwa & Mohamed, 2020). Integrating cultural elements and folklore into mathematics education is

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important for the development of students' learning process (Fouze & Amit, 2023). Overall, mathematics education is essential for personal, societal, and technological development at all levels of education including applying cultural elements in the mathematics learning process.

An integration of cultural and mathematical practices, ethnomathematics has shown significant results in teaching geometric shapes (Verner et al., 2019). Research has explored the application of ethnomathematics in various contexts, including culture in Jepara carvings (Aminah & Syamsuri, 2022), Islamic ornaments (Shahbari & Daher, 2020), local cultural practices (Mukwambo et al., 2023), and Kalimantan batik motifs (Sudrajat et al., 2023). The ethnomathematics approach has shown benefits such as improved understanding of geometric concepts, better proof processes, and deeper learning experiences (Harding, 2021). Ethnomathematics as an approach to learning by teachers to utilize students' prior knowledge and cultural context, making mathematics more relevant and meaningful (Mukwambo et al., 2023; Shahbari & Daher, 2020). Implementation strategies include exploration of cultural artifacts, analysis of geometric shapes in traditional designs, and use of local terminology to explain mathematical concepts (Aminah & Syamsuri, 2022; Sudrajat et al., 2023). By incorporating ethnomathematics into flat building learning, students can better understand and apply mathematical concepts in everyday life (Mania & Alam, 2021). This will potentially improve students' overall understanding and memory of geometric shapes. The ethnomathematics approach can also be applied with a problem-based learning model during the teaching and learning process (Purwanti et al., 2019). Thus, the ethnomathematics approach can be applied during the teaching and learning process with a problem-based learning model.

Several studies have shown that integrating ethnomathematics into the problem-based learning model can improve students' mathematical understanding and problem-solving skills. In line with research conducted by Perdana & Isrokatun (2019) and Maharani & Waluya (2024) which explains that the ethnomathematics-based problem-based learning model is more effective than conventional methods in improving mathematics understanding. The application of the ethnomathematics-based Problem Based Learning model has been found to increase student engagement and math learning outcomes (Widana & Diartiani, 2021). Developing open ethnomathematics-based teaching materials that are valid, practical, and effective can further improve learning activities and achievement (Suryawan, 2018). Integrating ethnomathematics, particularly Sundanese culture, into geometry and measurement learning can improve students' problem-solving skills and cultural awareness (Permana, 2023). The ethnomathematics approach provides a more contextual and culturally relevant learning experience, so it is appropriate to be applied in the learning process and of course the culture used is a local culture that is in accordance with the culture of students to facilitate learning.

Several previous studies have discussed ethnomathematics with the Problem Based Learning model in mathematics learning have shown that the introduction of culture-based mathematics concepts that can improve students' understanding ability with the material studied (Apriatni et al., 2022; Imam & Nugroho, 2020; Patmara et al., 2019; Syahnia et al., 2024). Some studies have raised ethnomathematics in cultural heritage such as batik, traditional houses, and traditional games (Sari et al., 2023). However, further exploration on the architecture of Candi Ijo as a learning resource is still very limited. In addition, there are still few studies that integrate ethnomathematics in the problem-based learning model as a contextual approach to increase student engagement in mathematics learning.

Research that combines the problem-based learning model with the ethnomathematics approach, especially those that utilize the architecture of Candi Ijo as a learning resource in flat building materials, is still very limited. In fact, the structure of Candi Ijo has many geometry elements that can be related to the concept of flat buildings, so it has the potential to improve students' understanding through a cultural context that is close to them. In addition, the application of the ethnomathematics-based Problem Based Learning combination in improving student learning outcomes in flat shapes at the Madrasah Tsanawiyah (MTs) level has not been widely studied. Students at this level often experience difficulties in understanding the concept of flat shapes due to the lack of connection with real experiences and limited contextual learning media (Wijaya et al., 2019).

Based on the research gap, this study aims to analyze the application of problem-based learning model based on Candi Ijo ethnomathematics in learning flat building materials to improve students' mathematics learning outcomes at MTsN 9 Bantul. This approach emphasizes the importance of innovative teaching methods, cultural integration, and effective leadership in improving mathematics learning outcomes. Thus, based on the problems that have been described, the author conducted a class action research entitled "Application of Problem-Based Learning Based on Ethnomathematics Candi Ijo to improve Mathematics Learning Outcomes on Flat Buildings Material Students of MTsN 9 Bantul". This research is expected to contribute to the innovation of culture-based learning and increase the effectiveness of problem-based learning models in learning mathematics.

Materials and Methods

This research is a Classroom Action Research (CAR) which aims to improve students' mathematics learning outcomes through the application of problem-based learning models on flat building materials. The PTK was carried out in two cycles by following the model developed by Kemmis and Mc. Taggart in Sugiyanti (2024) from the stages of planning, action, observation then reflection on the action. The

reflection of each cycle can produce data which is then described and qualitatively analyzed based on the facts and circumstances that occur in the classroom.

Planning activities include the preparation of the instruments used. The learning instruments prepared were teaching materials based on candi ijo ethnomathematics, student worksheets, and assessment sheets. The research instruments prepared include mathematics ability tests on flat building materials, observation sheets for the implementation of the learning process, student and teacher interview guidelines, and documentation equipment.

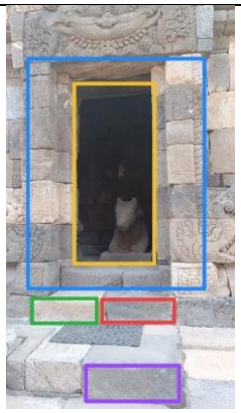
The implementation of action is in the form of applying the problem-based learning model based on ethnomathematics-based candi ijo ethnomathematics on flat building material to improve student learning outcomes. Observation is carried out on the implementation of the syntax of the problem-based learning model based on candi ijo ethnomathematics.

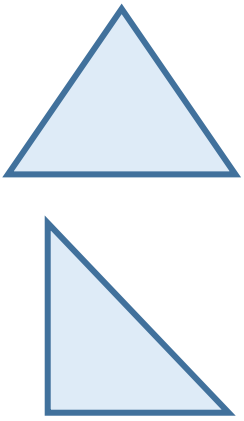
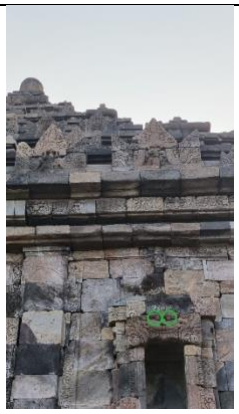
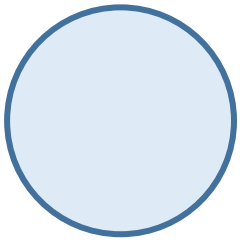
The reflection stage is a process analysis of the application of the problem-based learning model based on candi ijo ethnomathematics in flat building material in MTsN 9 Bantul. The results of the reflection stage analysis are used as the basis for action planning in the next cycle.

The research data is in the form of math ability test results on flat building materials. Data collection methods are different methods, namely tests, observations, interviews, and documentation, so that data validity uses method triangulation techniques (Moleong, 2010). The test of the ability of mathematics learning outcomes of flat building material uses description questions of flat building material. The target of the research achievement is an increase in the average test results of the mathematics ability of flat building material of MTsN 9 Bantul students from the pre-cycle. Data analysis of students' mathematics learning achievement if the average value of students' mathematics learning achievement test ≥ 70. While the research success criteria on learning observation, if the percentage value is in the "very good" category.

3. Results and Discussion

The research was conducted by applying ethnomathematics-based problem-based learning during the learning process of mathematics flat building material. Researchers utilize candi ijo as a medium to facilitate students' contextualization in learning flat building material. The following are the parts of candi ijo that are used to study flat building material:

Picture of Candi Ijo	**Pictures of Flat Buildings**	**Name of Flat Buildings**
 		Square
 		Rectangle
 		Trapezoid

 		Triangle
 		Circle

This classroom action research consisted of two cycles to determine the improvement of students' mathematics learning outcomes on flat building material. The average percentage of achievement of mathematics learning outcomes is presented in Figure 1:

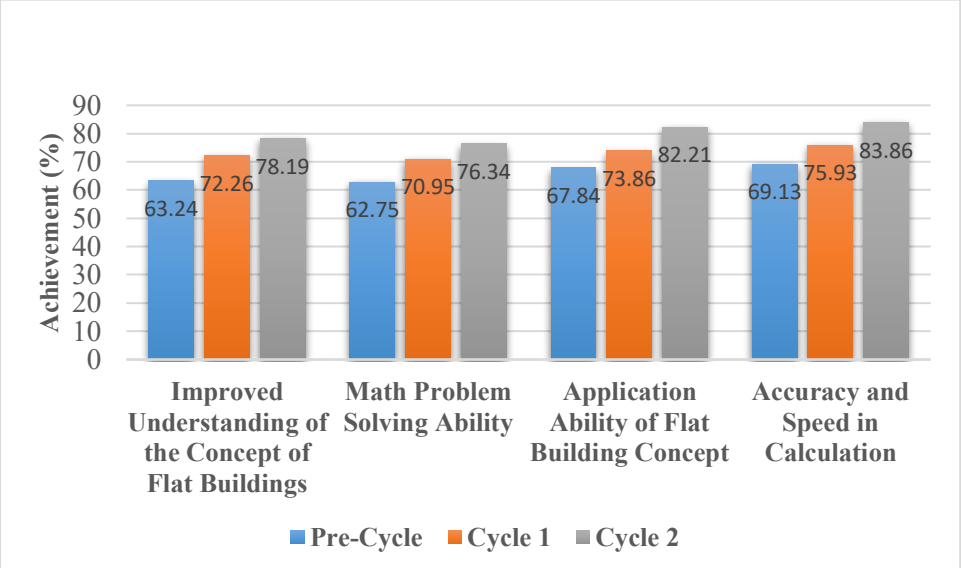


Figure 1. Average Percentage of Achievement of Each Aspect of Mathematics Learning Outcomes

Based on the data obtained, it is known that in general, students' mathematics learning outcomes on flat building material have increased from Pre-cycle to Cycle II. The increase in percentage achievement occurred in each aspect as well as the average percentage achievement of all aspects of mathematics learning outcomes. In the aspect of improved understanding of the concept of flat buildings, there was an increase in the average percentage achievement from 63.24% at the pre-cycle to 78.19% at the end of the cycle, the aspect of math problem solving ability increased from 62.75% to 76.34%, the aspect of application ability of flat building concept from 67.84% to 82.21%, and the aspect of accuracy and speed in calculation increased from 69.13% at the pre-cycle to 83.86% at the end of the cycle. Comparison of the average achievement score of all aspects of mathematics learning outcomes from Pre-Cycle, Cycle I, and Cycle II, can be seen in Figure 2. as follows:

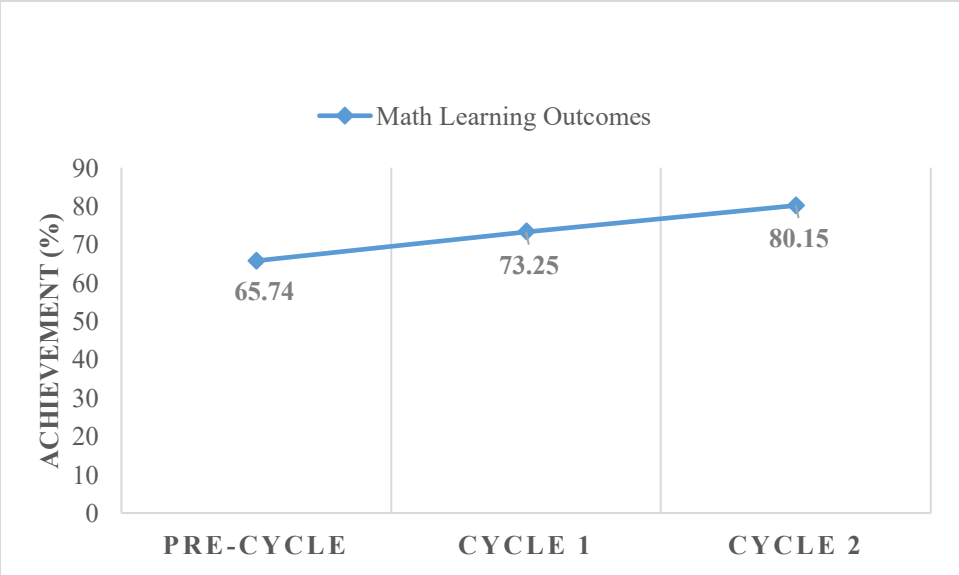


Figure 2. Comparison of Average Percentage of Achievement of Mathematics Learning Outcomes in Each Cycle

Based on the results and discussion of the research results in Cycle I, Cycle II, it is known that the application of the problem-based learning model based on candi ijo ethnomathematics can improve students' mathematics learning outcomes. The results of measuring mathematics learning outcomes at the end of the action showed that the average percentage of achievement of overall mathematics learning outcomes in class VIII C MTsN 9 Bantul at Pre-Cycle which amounted to 65.74% increased to 80.15% in Cycle II so that it was in accordance with the improvement target, namely an increase in the ability of mathematics learning outcomes in class VIII C MTsN 9 Bantul.

The results showed that with the application of problem based learning based on candi ijo ethnomathematics, there was an increase in students' mathematics learning outcomes in class VIII C MTsN 9 Bantul, this is because each syntax of problem based learning based on candi ijo ethnomathematics contains activities that train students' abilities in learning mathematics. Problem-based learning based on candi ijo ethnomathematics requires students to use experiences from themselves and others to gain the knowledge they want to learn, experiences from themselves can be obtained from practicum activities while other people's experiences can be obtained from reading books.

The scores of each student experienced different improvements. Most of them experienced an increase in score achievement, but some students' scores were not stable in certain cycles. Students who experienced continuous improvement were due to getting used to and being able to follow the learning model applied. Based on the results of interviews with students whose scores continued to increase, it was found that students stated that they were more enthusiastic about learning the problem-based learning model based on candi ijo ethnomathematics, because they felt more involved during the lesson, and they were interested in the problems in the reading presented in the implementation of candi ijo as a learning medium with an ethnomathematics approach, this is in accordance with the results of research by Agusdianita et al. (2023) which states that ethnomathematics-based Problem Based Learning model learning can improve student learning outcomes. Other research also supports that the ethnomathematics approach with the Problem Based Learning model can improve student maemathematics learning outcomes (Kurino & Herman, 2023). This is also in line with the research of Bintoro et al. (2024) which explains the Problem Based Learning model assisted by the ethnomathematics-laden ethlaf application can improve students' conceptual understanding abilities. Based on the results of interviews, students who continue to experience improvement admit that they feel happier with the Problem Based Learning learning model based on candi ijo ethnomathematics, because they are interested in the problems in the reading presented. According to interviews with students who experienced a decrease in the achievement score of mathematics learning outcomes, flat building material is more complex and extensive so that students have difficulty adapting to the new learning model.

Some students obtained unstable math learning outcomes scores, and some were fixed from the previous cycle. Based on observations, students whose scores fluctuate and those who remain show a less enthusiastic attitude during learning so that the achievement of scores in the observation sheet is not as high as students who experience continuous improvement, so that the results of the learning outcomes ability test do not increase linearly. This statement is in accordance with Chozaipah (2018), which states that students who lack participation usually get lower scores than students who actively participate. This

is in line with the research of Hikmah et al. (2024) that the application of ethnomathematics-oriented problem-based learning can improve the activities and learning outcomes of students who actively participate in the learning process. According to the results of interviews, some students whose scores were unstable admitted that students were sometimes confused when learning took place because the teacher did not explain directly and completely as is usually done. Other causes of student score instability include more complex learning materials that certain students find difficult, poor student conditions during the learning process, students concerned do not attend all class hours, some students are bored, and feel forced to read which results in not maximizing the student's participation in learning so that they do not read the readings seriously and do not participate in group discussion activities properly, and students have not been able to understand the material independently and wait for teacher explanations. Therefore, less than optimal student readiness can also affect student performance in class.

4. Conclusion

Based on the results of the study, it can be concluded that there is an increase in the ability of mathematics learning outcomes in general through the application of the problem-based learning model based on candi ijo ethnomathematics for students in class VIII C MTsN 9 Bantul in the 2024/2025 academic year. However, based on the results of observations and interviews, there are students whose scores go up and down or who are fixed because during the learning process they show a less enthusiastic attitude during learning so that the score in the observation sheet is not as high as students who experience continuous improvement, so that the results of the learning outcomes ability test do not increase linearly. Thus it is hoped that in the future all students can enthusiastically participate in class learning so that learning outcomes can improve significantly.

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