

Research Article

# The Effect of the Problem-Based Learning Model Based on Ethnomathematics on Students' Learning Outcomes as Seen in the Face of Learning Styles

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## ABSTRACT

This study aims to analyze the effect of the ethnomathematics-based Problem Based Learning (PBL) learning model on students' mathematics learning outcomes in terms of learning styles. The study used a quantitative approach with a quasi-experimental design. The subjects were 60 seventh-grade students of MTs Negeri 10 Jember who were divided into two groups, namely the experimental class and the control class. The experimental class received learning using the ethnomathematics-based PBL model, while the control class received conventional learning. The research instruments included a learning outcome test and a learning style questionnaire. Data analysis was carried out using a t-test (independent sample t-test) to determine differences in learning outcomes between the two groups. The results of the normality test showed that the data were normally distributed ( $p > 0.05$ ), and the homogeneity test showed that the data variance was homogeneous ( $p > 0.05$ ). The results of the t-test showed that there was a significant difference between the experimental class and the control class ( $p = 0.000 < 0.05$ ). The average learning outcomes of students in the experimental class were higher. It can be concluded that the ethnomathematics-based PBL model is effective in improving mathematics learning outcomes, especially for students with a visual learning style.

**Keywords:** Ethnomathematics; Learning Styles; Learning Outcomes; Problem-Based Learning

## 1. INTRODUCTION

Education is a key aspect determining a person's success in life, and it is provided with the goal of preparing students to compete and adapt to the modern world. Education is a strategic aspect of national development that requires serious attention and management because it will improve the quality of human resources, which are the foundation for development (Djononiarjo, 2018). Education not only equips individuals with academic knowledge but also develops essential skills such as critical thinking, creativity, and problem-solving (Changwong et al., 2018; Nisa et al., 2024). In the era of globalization, education plays a pivotal role in ensuring that individuals can compete on an international scale (Berkat et al., 2025). Quality education fosters innovation, which is essential for economic growth and societal progress. Moreover, education promotes social awareness and responsibility, enabling individuals to contribute positively to their communities. Therefore, continuous improvement in educational systems is crucial to meet the evolving demands of the modern world.

One area that plays a crucial role in improving and developing the quality of human resources in education is mathematics. Mathematics is a branch of science whose learning process includes various formulas, numbers, and mathematical symbols (Hasanah et al., 2023). Mathematics is a subject often considered difficult by many. Learning mathematics requires a high level of creative thinking, and learning management is crucial for successful learning. Educators, especially mathematics teachers, must be able to deliver learning effectively and efficiently so that students can ultimately connect what they learn with new things in their environment and become creative and innovative problem-solving individuals (Indrawati, 2023).

In the process of learning mathematics, a person's success can be observed from their ability to solve various problems that arise during the learning process (Sachdeva & Eggen, 2021). The effectiveness of mathematics teaching and learning activities can be measured through student learning outcomes. These learning outcomes reflect students' academic achievement, which is achieved through various forms of evaluation, such as exams, assignments, and active participation in question-and-answer sessions that support the achievement of learning objectives (Butar et al., 2022). If students' mathematics learning outcomes show a positive trend, this can be an indicator that the learning process has been effective

(Fitriah et al., 2023; Sinaga, 2022). Conversely, if student learning outcomes are low, this indicates that the learning activities have not achieved the expected level of success.

Furthermore, in active learning, each student has a different learning style. Learning style is one of the abilities each person possesses to absorb, organize, and manage the information they receive (Nuralan et al., 2022). According to Nurnaifah et al., 2022, learning style is a method for obtaining, mastering, and managing information during learning activities. Learning style plays a crucial role in supporting the educational process because it is directly related to how students understand the learning material presented. This includes its relationship to the curriculum, the teaching methods applied, and the assessment system used as a benchmark for learning success (Azzahrah Putri et al., 2021). Student learning styles are a crucial factor in improving the quality of learning. Every student naturally learns differently. By understanding these various learning styles, teachers can be more effective in delivering material, thus optimizing student learning outcomes (Jean Imaniar Djara et al., 2023). Lessons will be easier to understand if teachers present material in a learning style that suits their students. When students approach learning through their own learning styles, we see rapid changes in attitudes and higher levels of achievement. In schools, many teachers teach monotonously and fail to understand students' learning styles, which impacts student academic achievement. (Supit et al., 2023). Therefore, it is important for educators to develop teaching approaches that not only encourage active student participation but also consider their learning styles.

One learning model considered effective in addressing this problem is Problem-Based Learning (PBL) (Almulla, 2020; Soamole et al., 2023). Problem-Based Learning (PBL) is a problem-solving-oriented learning approach in which educators act as facilitators, providing students with real-world problems to solve. This model encourages students to develop critical thinking skills. Furthermore, PBL encourages active student involvement in the learning process through inquiry, discussion, and exploration, making the student's role more dominant than the teacher's (Anwar & Jurotun, 2019). This learning model presents real-life situations as learning objects. This makes learning more engaging because these situations create student interest and a desire to learn (Maulana et al., 2023).

Research results show that the PBL model can improve student learning outcomes. This is because the model's multi-stage steps can be implemented (Nurbaeti, 2019). With this approach, students are expected to be more active in critical thinking during the learning process (Ati et al., 2020). It can be concluded that problem-based learning is a learning process that starts with real-world problems and encourages students to explore problems based on their prior knowledge and experience (Butar et al., 2022). Although PBL has been proven successful in improving student learning outcomes, it faces numerous challenges when used in mathematics learning. One major challenge is the lack of connection between the mathematical material and students' daily lives. Therefore, an approach is needed that can bridge existing problems and the learning process. In the context of mathematics learning, there is a concept known as ethnomathematics, an approach that integrates mathematical material with local cultural elements found in students' daily lives (Hartanti & Ramlah, 2021). By using ethnomathematics as a teaching method, the subject matter can be directly connected to the students' culture, making it easier for them to understand the material because it directly relates to everyday life (Masruroh et al., 2022).

According to Ajmain et al. (2020), ethnomathematics is the study of a society's culture, including historical relics related to mathematics and its use in mathematics learning. Applying ethnomathematics to mathematics learning allows students to gain a deeper understanding, not only of mathematical concepts but also of the cultural values underlying them. For teachers, this approach facilitates the instilling of cultural values in students through relevant learning contexts. Thus, the culture that underlies the birth of mathematical concepts can be more easily understood by students. These values are part of the national character that has been ingrained in our lives since an early age (Kusumawati et al., 2022).

The incorporation of ethnomathematics-based PBL can improve students' mathematical understanding. Education that incorporates ethnomathematics actually allows material from that culture to spark a desire to learn and also enhances students' understanding of the material because it is directly related to their culture, thus influencing their daily activities in society, making it easier to understand. This method makes mathematics learning more engaging and meaningful for students (Kencanawaty et al., 2020). The application of the Problem-Based Learning (PBL) model, combined with a scientific approach and integrated with the local cultural context, aims to increase student interest in learning and create a more active and participatory learning environment. Through this approach, it is hoped that student learning outcomes will improve, while also fostering their enthusiasm and perseverance in participating in the learning process to optimally achieve learning objectives (Noor Safitri et al., 2020). The findings in this study are related to the results of previous research conducted by other researchers (Jean et al., 2023). The results show that the ethnomathematics-based PBL model significantly contributes to improving students' mathematics learning achievement. Based on the explanation above, it can be concluded that although ethnomathematics-based PBL has significant potential to improve mathematics learning outcomes, when designing and implementing this model, it is important to consider differences in student learning styles. Therefore, this research aims to examine the effect of ethnomathematics-based problem-based learning on students' mathematics learning outcomes and to examine how student learning styles can influence the effectiveness of this teaching model.

## 2. RESEARCH METHOD

This research is a quantitative study with a quasi-experimental approach using a post-test-only control group design. In this research design, there were two non-randomly selected groups: an experimental group that received treatment through the ethnomathematics-based Problem-Based Learning (PBL) model and a control group that followed conventional learning methods. Both groups were given a post-test only after the treatment to evaluate the effect of the learning model on learning outcomes. Furthermore, this study also considered differences in student learning outcomes based on various learning styles, namely visual, auditory, and kinesthetic, allowing for comparisons based on individual student characteristics. The study population was 60 seventh-grade students at MTs NEGERI 10 JEMBER. In this study, data was collected through two main instruments: a post-test to measure student learning outcomes after the treatment and a learning style questionnaire to identify each student's dominant learning style. After data collection, the next step was data analysis. Data analysis was conducted in several stages prior to hypothesis testing. The initial step in data analysis was to conduct a normality test using the Shapiro-Wilk method and a homogeneity test using Levene's Test to ensure that the data met the assumptions of parametric statistical analysis. Once these assumptions were met, the analysis continued with an independent sample t-test to determine whether there were significant differences in learning outcomes between the experimental and control groups.

## 3. RESULTS AND DISCUSSION

This study aims to examine the effect of implementing an ethnomathematics-based Problem-Based Learning (PBL) model on the mathematics learning outcomes of seventh-grade students, based on their learning styles. The subjects in this study consisted of two classes: an experimental class that received the ethnomathematics-based PBL model, and a control class that used conventional learning methods. After the treatment, both groups were given a post-test to measure student learning outcomes on the surface area and volume of cubes and cuboids. Before administering the post-test, students were given a questionnaire to identify their frequently used learning styles. The questionnaire consisted of 20 statements with answer options A (Visual), B (Auditory), and C (Kinesthetic). The summary results from 30 students in the control class and 30 students in the experimental class are presented in the following **Table 1**.

**Table 1.** Student Learning Styles

Control Class					Experimental Class				
Name	Visual	Auditory	Kinesthetic	Total	Name	Visual	Auditory	Kinesthetic	Total
Student 1	14	4	2	20	Student 1	13	4	3	20
Student 2	13	5	2	20	Student 2	14	4	2	20
Student 3	14	4	2	20	Student 3	13	5	2	20
Student 4	14	4	2	20	Student 4	13	5	2	20
Student 5	14	4	2	20	Student 5	14	4	2	20
Student 6	14	3	3	20	Student 6	14	5	1	20
Student 7	14	3	3	20	Student 7	14	4	2	20
Student 8	14	4	2	20	Student 8	14	4	2	20
Student 9	14	4	2	20	Student 9	14	4	2	20
Student 10	14	4	2	20	Student 10	14	4	2	20
Student 11	13	4	3	20	Student 11	14	5	1	20
Student 12	13	4	3	20	Student 12	14	4	2	20
Student 13	14	3	3	20	Student 13	15	4	1	20
Student 14	13	4	3	20	Student 14	14	4	2	20
Student 15	13	4	3	20	Student 15	15	3	2	20
Student 16	11	6	3	20	Student 16	14	5	1	20
Student 17	11	5	4	20	Student 17	15	3	2	20
Student 18	9	6	5	20	Student 18	14	4	2	20
Student 19	10	6	4	20	Student 19	15	4	1	20
Student 20	10	5	5	20	Student 20	14	4	2	20
Student 21	10	10	0	20	Student 21	15	4	1	20
Student 22	10	6	4	20	Student 22	14	4	2	20
Student 23	10	5	5	20	Student 23	15	3	2	20
Student 24	20	0	0	20	Student 24	16	3	1	20
Student 25	10	5	5	20	Student 25	15	3	2	20
Student 26	10	6	4	20	Student 26	15	3	2	20
Student 27	9	6	5	20	Student 27	15	4	1	20
Student 28	14	0	6	20	Student 28	14	4	2	20
Student 29	10	4	6	20	Student 29	15	4	1	20
Student 30	9	6	5	20	Student 30	15	3	2	20

The data (in **Table 1**) shown that the visual learning style was the most dominant among the students in this study. This dominance aligns with the characteristics of the material being studied, namely flat-sided geometric shapes (cubes and cuboids), which require a visual understanding of shape, structure, and spatial representation. Students with a visual learning style generally understand material more easily when presented through media containing visual elements, such as pictures, diagrams, colors, and other visual representations. In the context of the ethnomathematics-based problem-based learning model, students are encouraged to observe cultural objects that contain mathematical elements, such as the shapes of traditional foods, which are generally visual. This approach helps students with a visual learning style connect mathematical concepts with cultural realities in a concrete way.

### 3.1. Statistical test

#### 3.1.1 Normality Test

To determine whether the student learning outcome data is normally distributed, a normality test was conducted using the Shapiro-Wilk method. This method was chosen based on the sample size of less than 50 participants in each group. The results of the normality test analysis are presented in the following table:

**Table 2.** Normality Test

Class	Kolmogorov-Smirnov <sup>a</sup>			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	Df	Sig.
1.00	.144	30	.113	.955	30	.229
2.00	.119	30	.200*	.933	30	.060

\*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

Based on the results in the **Table 2**, the significance value for both groups is greater than (Sig. > 0.05). This indicates that the student learning outcome data in the experimental and control classes are normally distributed.

#### 3.1.2 Homogeneity Test

After the normality test is conducted and the data is declared normally distributed, the next step is to conduct a homogeneity test to determine whether the variance between the experimental and control groups is homogeneous. This homogeneity test for variance is conducted using Levene's Test for Equality of Variances.

**Table 3.** Test of Homogeneity of Variances

		Levene Statistic	df1	df2	Sig.
Model	Based on Mean	2.071	1	58	.155
	Based on Median	1.900	1	58	.173
	Based on Median and with adjusted df	1.900	1	49.217	.174
	Based on trimmed mean	1.916	1	58	.172

Based on the results in the table above, a significance value of 0.155 was obtained, meaning that the sig value is > 0.05. This indicates that the data has homogeneous variance between the experimental and control classes.

#### 3.1.3 Independent T-Test

The independent sample t-test was used to determine whether there was a significant difference between student learning outcomes in the experimental and control classes. This test was conducted after the data met the basic assumptions of parametric analysis, namely normality and homogeneity. Based on the analysis results presented in the previous table, a significance value of 0.000 was obtained, meaning the value is <0.05. This finding indicates a statistically significant difference between student learning outcomes in the experimental and control classes. The average student learning outcome score in the experimental class reached 79.6000, while in the control class it was only 65.3667. Thus, students in the experimental class demonstrated better learning outcomes than those in the control class. This indicates that the implementation of the Problem-Based Learning (PBL) model focusing on ethnomathematics was effective in improving students' understanding of the concepts of surface area and volume of cubes and cuboids. After the implementation of the Problem-Based Learning (PBL) model with a focus on ethnomathematics, there was a significant improvement in students' understanding of the concepts of surface area and the volume of cubes and cuboids (Maharani & Waluya, 2024; Syahnia et al., 2024). Students became more capable of linking the lesson content with cultural contexts and real-life experiences. The learning process turned more active, collaborative, and engaging, which encouraged students to participate more fully. This, in turn, had a positive impact on their learning outcomes and boosted their confidence in applying mathematical concepts.

**Table 4.** Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	T	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper	
Model	Equal variances assumed	2.071	.155	4.628	58	.000	14.23333	3.07533	8.07739	20.38928
	Equal variances not assumed			4.628	52.989	.000	14.23333	3.07533	8.06497	20.40170

By integrating local cultural elements (ethnomathematics) into the context of everyday problems, students can more easily grasp the material in a concrete way. For example, students were asked to calculate the surface area and volume of cubes and cuboids using traditional food shapes. This approach has proven to be more suitable for students with visual learning styles, as they are more supported by images, concrete shapes, and exploratory activities. On the other hand, control classes that implemented conventional methods often struggled to connect the subject matter to everyday life. One-way learning resulted in low student engagement. Therefore, the ethnomathematics-based PBL model not only contributes to improved learning outcomes but also creates contextual, meaningful learning experiences that align with students' visual learning styles.

#### 4. CONCLUSION

The research results show that the implementation of the ethnomathematics-based Problem-Based Learning (PBL) model had a significant positive impact on improving the learning outcomes of seventh-grade students, particularly those with a predisposition for visual learning styles. Students who participated in the ethnomathematics-based PBL model achieved higher learning outcomes compared to students who participated in conventional learning methods. The integration of the Problem-Based Learning (PBL) model with local cultural elements through an ethnomathematics approach has proven effective in improving understanding of mathematical concepts, particularly in the surface area and volume of cubes and cuboids. This approach provides a more contextual and meaningful learning experience, especially for students with a predisposition for visual learning styles. The effectiveness of this approach is reflected in the significant difference in average learning outcomes between the experimental and control classes. Therefore, problem-based learning with local cultural content is highly appropriate for students with a predominantly visual learning style because it stimulates critical thinking, strengthens visual understanding, and increases active student participation in the mathematics learning process.

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