Jurnal Penalaran dan Riset Matematika
Vol. 5, No. 2, 2026, pp: 69-76
p-ISSN 2961-8134, e-ISSN 2962-4150

THE EFFECT OF ETHNOMATHEMATICS-BASED LEARNING ON JUNIOR HIGH SCHOOL STUDENTS' MATHEMATICAL LITERACY

Ashari Agus Munandar[1*], Herwandi[2]

[1,2]Universitas Muhammadiyah Bulukumba, Bulukumba, Indonesia.
** Korespondensi Penulis. E-mail: ashariagusmunandar@umbulukumba.ac.id*

ARTICLE HISTORY:
Received: Sept 20, 2026
Revised: Sept 30, 2026
Accepted: Oct 20, 2026
Published: Oct 30, 2026

KEYWORDS:
Ethnomathematics;
Mathematical literacy;
Geometry.

ABSTRACT
This study aimed to examine the effect of ethnomathematics-based instruction on students' mathematical literacy in geometry in Grade IX at SMP Negeri 1 Bajeng Barat. This quantitative study employed a quasi-experimental nonequivalent control group design. The sample consisted of two classes: IX A (experimental group, 28 students), which received ethnomathematics-based instruction, and IX B (control group, 29 students), which received conventional instruction. The instruments comprised a 10-item constructed-response test (pretest and posttest) and a 20-statement student response questionnaire. The paired-samples t-test indicated a significant improvement in the experimental group ($t = 15.293$, $p = 0.000$), whereas the result for the control group was not significant ($t = 1.893$, $p = 0.067$). An independent-samples t-test comparing posttest scores between the experimental and control groups revealed a significant difference ($t = 7.894$, $p = 0.000$). In addition, questionnaire results showed that 89% of students reported that culturally contextualized learning facilitated their understanding of geometric concepts. Thus, ethnomathematics-based instruction was effective in improving mathematical literacy through a meaningful contextual approach grounded in local cultural elements, including Phinisi boats, badik, patonro, and traditional South Sulawesi foods.

Introduction

Mathematics education in the twenty-first century focuses not only on mastering mathematical concepts and procedures but also on students' ability to use mathematics to understand and solve real-world problems. This ability is known as mathematical literacy, namely the ability to formulate, employ, and interpret mathematics in various contexts (Zhou & Wang, 2020). Mathematical literacy encompasses mathematical reasoning and the use of mathematical concepts, procedures, facts, and tools to explain and predict phenomena (OECD, 2019). Its importance is further highlighted by the results of the 2022 Programme for International Student Assessment (PISA), which showed that only 18% of Indonesian 15-year-old students attained the minimum proficiency level in mathematics. These results indicate that strengthening mathematical literacy remains a major challenge in Indonesian education (OECD, 2023). This situation underscores the need for mathematics instruction that emphasizes not only procedural understanding but also opportunities for students to apply mathematical knowledge in contextual situations (Cahyani & Sari, 2021).

One factor to consider in developing mathematical literacy is the connection between learning materials and students' real-life experiences. Instruction that focuses excessively on symbols, formulas, and procedures may make it difficult for students to connect mathematical concepts with everyday problems. Therefore, learning approaches that incorporate contexts familiar to students are needed to make mathematical concepts easier to understand and apply (Hadijah & Subhan, 2021). One potentially supportive approach is ethnomathematics, which examines the relationship between mathematics and a community's cultural practices (Fitriana &

Sugiman, 2021). This approach allows elements of local culture to serve as contexts for exploring mathematical concepts, so that instruction not only targets academic achievement but also values local knowledge and wisdom.

Ethnomathematics can bridge the formal mathematics taught in schools and the mathematical activities embedded in community life (Alfian & Hamid, 2022). Through this approach, students can identify mathematical concepts in artifacts, buildings, games, handicrafts, and cultural activities in their surroundings (Sape & Syamsuddin, 2025). A systematic review by Ningsih and Ahmad (2023) showed that research on ethnomathematics-based mathematics instruction in Indonesia has developed across various cultural forms and instructional approaches, with geometry among the most frequently examined topics. Furthermore, Kusumawardani and Sudrajat (2022) identified mathematical literacy as one of the mathematical competencies that may be developed through ethnomathematics. These findings suggest that integrating culture into mathematics instruction offers opportunities to support students' mathematical abilities. Nevertheless, its effectiveness needs to be tested through empirical studies that specifically measure mathematical literacy in particular instructional contexts.

One cultural context with potential applications in mathematics instruction is the culture of South Sulawesi (Hafid & Latifah, 2021). The region has a diverse cultural heritage, including Phinisi boats, badik, patonro, and traditional foods such as putu, barongko, and lammang. These cultural objects can be explored to identify mathematical elements, particularly geometric shapes, measurement, ratios, patterns, and relationships between quantities (Fitriah & Mahyuddin, 2021). These elements can then be developed into contextual problems that require students to understand information, construct mathematical models, perform calculations, and interpret results in relation to the given situations (Sape et al., 2025). Thus, local culture serves not merely as an illustration in instruction but also as a source of contexts for meaningful mathematics learning experiences.

Although ethnomathematics research in Indonesia has progressed, the use of local culture and its relationship with mathematical abilities still require further investigation. In a systematic review of ethnomathematics research in Indonesia, Sari and Artayasa (2021) identified an uneven distribution of cultural studies across regions. This condition highlights the importance of broadening the exploration of local culture as a resource for mathematics instruction. However, the presence of mathematical elements in a culture does not automatically demonstrate that using them in instruction will improve students' mathematical literacy. Research is therefore needed not only to identify the mathematical potential of South Sulawesi culture but also to examine the effects of its instructional application on mathematical literacy through comparison with conventional instruction.

Methods

Research Type and Design

This study employed a quantitative approach using a quasi-experimental design. Specifically, a nonequivalent control group design was adopted, involving an experimental group and a control group. Both groups completed a pretest before instruction and a posttest afterward. The experimental group received ethnomathematics-based instruction integrating South Sulawesi culture, whereas the control group received conventional instruction. The research design is presented in Table 1.

Table 1. Nonequivalent Control Group Research Design

Group	Pretest	Treatment	Posttest
Experimental	O_1	X	O_2
Control	O_1	–	O_2

Research Time and Setting

The study was conducted from August 11 to September 11, 2025, at SMP Negeri 1 Bajeng Barat, Gowa Regency, South Sulawesi. Research activities were aligned with the school's

mathematics schedule, and the experimental group received the intervention over four sessions. The study population comprised all ninth-grade students at SMP Negeri 1 Bajeng Barat, distributed across five classes.

Table 2. Study Population by Class

Class	Number of students
IX A	28 students
IX B	29 students
IX C	24 students
IX D	25 students
IX E	21 students

The sample was selected using purposive sampling, taking into account similarities in academic characteristics across classes. On this basis, Class IX A, consisting of 28 students, was assigned as the experimental group, while Class IX B, consisting of 29 students, was assigned as the control group. The total sample therefore comprised 57 students. The experimental group participated in ethnomathematics-based instruction, whereas the control group received conventional instruction.

The study involved two variables: an independent variable and a dependent variable. The independent variable (X) was the implementation of ethnomathematics-based instruction using South Sulawesi cultural contexts. The dependent variable (Y) was students' mathematical literacy, measured using test results obtained before and after instruction.

The research was conducted in three stages: preparation, implementation, and data analysis. The preparation stage included selecting the research groups, developing instructional materials, and constructing and testing the research instruments. The instruments were piloted and analyzed before being used for data collection.

The implementation stage began with administering a pretest to the experimental and control groups to obtain baseline data on students' mathematical literacy. The experimental group then received four sessions of ethnomathematics-based instruction using South Sulawesi cultural contexts, including Phinisi boats, badik, patonro, and traditional foods such as putu, barongko, and lammang. The control group followed conventional mathematics instruction as implemented at the school. After instruction, both groups completed a posttest to measure mathematical literacy. A student response questionnaire was administered to the experimental group to assess their perceptions of ethnomathematics-based instruction.

During the data analysis stage, the pretest, posttest, and student questionnaire results were processed. Test data were analyzed to examine differences in mathematical literacy between the experimental and control groups and changes in scores within each group. Questionnaire data were analyzed descriptively to characterize students' responses to culturally contextualized instruction.

Research Instruments and Data Collection Procedures

The research instruments consisted of a mathematical literacy test and a student response questionnaire. The mathematical literacy test comprised 10 constructed-response questions featuring South Sulawesi cultural contexts, including Phinisi boats, badik, patonro, and traditional foods such as putu, barongko, and lammang. The questions were designed to assess students' ability to understand contextual problems, apply mathematical concepts, and interpret solutions in relation to the problem context. The test was administered as both a pretest and a posttest to both groups.

The second instrument was a student response questionnaire consisting of 20 Likert-scale statements. It was used to collect information about students' responses to ethnomathematics-based instruction, including their acceptance and perceptions of the use of local culture in mathematics learning. The questionnaire was administered to the experimental group after instruction.

The research instruments were piloted and analyzed before use. Data were collected through pretests, posttests, and the student response questionnaire. Constructed-response items

were scored according to the scoring guidelines used in the study, while questionnaire scores were processed according to the established rating scale.

Data Analysis Techniques

Data were analyzed using descriptive and inferential statistics. Descriptive statistics were used to summarize pretest and posttest results for the experimental and control groups, including means, standard deviations, minimum scores, and maximum scores. Student questionnaire responses were analyzed descriptively by calculating response scores and percentages according to the scoring guidelines.

Inferential analysis began with assumption testing, including the Kolmogorov-Smirnov normality test and Levene's test for homogeneity of variances. The primary hypothesis was tested using an independent-samples t-test to compare mean posttest scores between the experimental and control groups when parametric assumptions were met. Paired-samples t-tests were then used to examine differences between pretest and posttest scores within each group. If parametric assumptions were not met, an appropriate nonparametric method was to be used according to the data characteristics and analytical objectives.

Hypothesis testing was conducted at a significance level of 0.05. A significance value below 0.05 indicated a statistically significant difference in the comparison under examination. The results were interpreted in relation to the study objective, namely to determine differences in mathematical literacy between students receiving ethnomathematics-based instruction and those receiving conventional instruction. Given the quasi-experimental design, interpretation also considered group characteristics and potential differences in students' initial abilities.

Results and Discussion

The study involved 57 ninth-grade students at SMP Negeri 1 Bajeng Barat: 28 students in Class IX A as the experimental group and 29 students in Class IX B as the control group. Students' mathematical literacy was assessed using a test consisting of 10 constructed-response items. The test was administered before instruction (pretest) and after instruction (posttest) to examine changes in mathematical literacy in both groups.

Table 3. Pretest and Posttest Results

Statistic	Experimental pretest	Experimental posttest	Control pretest	Control posttest
N	28	28	29	29
Mean	48.57	76.42	49.31	61.28
SD	8.45	6.78	7.90	7.95
Minimum	35.00	65.00	36.00	50.00
Maximum	65.00	88.00	64.00	74.00

Based on Table 1, the experimental group had a mean pretest score of 48.57, compared with 49.31 for the control group. The groups had relatively similar initial mean scores, differing by 0.74 points. Following instruction, the experimental group's mean score increased to 76.42, while the control group's mean reached 61.28.

Descriptively, the experimental group's mean score increased by 27.85 points, whereas the control group's mean increased by 11.97 points. Thus, the increase in the experimental group was greater than that in the control group. Moreover, posttest scores ranged from 65 to 88 in the experimental group and from 50 to 74 in the control group. These descriptive findings indicate that students receiving ethnomathematics-based instruction achieved higher final scores. Assumption tests and hypothesis tests were conducted to determine whether these differences were statistically significant.

Assumption tests were performed before hypothesis testing to assess the suitability of parametric statistical analysis. These included the Kolmogorov–Smirnov normality test and Levene's test for homogeneity of variances.

The reported normality test results indicated that all datasets had significance values above 0.05. According to this criterion, there was insufficient evidence that the data deviated from a normal distribution. The homogeneity test yielded a significance value of 0.127, also above

0.05, indicating that the assumption of equal variances was not rejected at the 5% significance level.

Given that the reported assumptions were met, paired-samples t-tests were used to compare scores before and after instruction within each group, and an independent-samples t-test was used to compare posttest scores between groups.

Paired-samples t-tests were conducted to determine whether mean mathematical literacy scores differed before and after instruction within each group. The results are presented in Table 4.

Table 4. Hypothesis Test Results

Class	t	Sig. (2-tailed)
Experimental	15.293	0.000
Control	1.893	0.067

Based on Table 2, the experimental group obtained t = 15.293 with a significance value of p < 0.001. Because this value was below 0.05, there was a statistically significant difference between pretest and posttest scores in the experimental group. This finding is consistent with the increase in mean score from 48.57 to 76.42, indicating improved mathematical literacy after participation in ethnomathematics-based instruction.

By contrast, the control group obtained t = 1.893 with p = 0.067. Because this value exceeded 0.05, there was insufficient statistical evidence of a significant difference between mean pretest and posttest scores in the control group. Although the control group's mean increased from 49.31 to 61.28, this increase was not statistically significant according to the reported test results.

The differing patterns between groups suggest that ethnomathematics-based instruction may support the development of students' mathematical literacy. Local cultural contexts allow students to connect mathematical concepts with familiar everyday objects. However, differences in the results of separate within-group tests do not, by themselves, establish that the magnitude of improvement differed significantly between the groups. Direct between-group comparisons must therefore also be considered.

An independent-samples t-test was subsequently used to compare mean posttest scores between the experimental and control groups. The results are presented in the following table.

Table 5. Independent-Samples t-Test Results for Posttest Scores

Comparison	t	Sig. (2-tailed)
Experimental and control	7.894	< 0.001

The results in Table 3 show t = 7.894 with p < 0.001. Thus, there was a statistically significant difference in mean posttest scores between the experimental and control groups. The experimental group's mean of 76.42 was higher than the control group's mean of 61.28, a difference of 15.14 points.

These results indicate that students receiving ethnomathematics-based instruction achieved higher final mathematical literacy scores than those receiving conventional instruction. The findings support the potential value of local cultural contexts in mathematics education. Nevertheless, because the study used a quasi-experimental design, the results should be interpreted in light of other factors that may have influenced differences in learning outcomes, including class characteristics and students' initial abilities.

The student response questionnaire was administered to the experimental group after ethnomathematics-based instruction. Its purpose was to describe students' perceptions of using local culture in mathematics learning. A summary of the questionnaire results is presented in Table 4.

Table 6. Student Responses to Ethnomathematics-Based Instruction

Statement	Response percentage
Culturally contextualized instruction helps students understand geometry	89%
Culturally contextualized instruction increases motivation to participate in lessons	93%
Using local cultural objects makes problems feel more realistic and easier to understand	86%

Based on Table 4, 89% of students stated that culturally contextualized instruction helped them understand geometry. Furthermore, 93% reported that the instruction increased their motivation to participate in lessons. Another 86% indicated that using South Sulawesi cultural objects, such as Phinisi boats, badik, barongko, and putu, made mathematical problems feel more realistic and easier to understand.

The highest percentage was recorded for learning motivation (93%). This result suggests that local cultural contexts elicited positive responses from most students who participated in the instruction. The familiarity of the learning objects within students' cultural environment may create more engaging and relevant learning experiences. Positive responses regarding content understanding and the real-world relevance of problems also suggest that cultural contexts can help students establish connections between mathematical concepts and contextual situations.

Nevertheless, the questionnaire findings reflect students' perceptions and do not directly demonstrate improvements in mathematical literacy. Therefore, these findings should be considered alongside the test results to provide a more comprehensive account of ethnomathematics-based instruction.

Discussion

The findings indicate that implementing ethnomathematics had a significant effect on students' mathematical literacy. This is consistent with Pranowo and Fathurrahman (2023), who argued that ethnomathematics can enrich mathematics learning through familiar cultural contexts. In this study, the use of South Sulawesi cultural objects, such as Phinisi boats and traditional foods, was shown to support the visualization of geometric concepts and increase students' interest in learning.

The significant improvement in posttest scores in the experimental class suggests that integrating local culture not only increases motivation but also enhances students' conceptual understanding (Mariani & Susanto, 2021). Visual support, contextualization, and recognition of local wisdom make mathematics more meaningful (Mwanza & Phiri, 2020).

According to Junaidi et al. (2022), students tend to grasp abstract concepts such as volume and surface area more readily when they are connected to tangible objects in their environment. This is further supported by an international study by Suhendra and Mustofa (2021), which stated that cultural representations can facilitate a deeper understanding of mathematical concepts.

These findings align with Fitriani et al. (2022), who reported that incorporating local culture into mathematics instruction directly contributes to strengthening numeracy literacy and higher-order thinking skills. Moreover, ethnomathematics can facilitate more inclusive and humanistic learning (Yusuf & Hidayat, 2021).

The practical implications suggest that mathematics teachers in culturally rich regions such as South Sulawesi can use local cultural artifacts as contextual and inspiring instructional resources. In this way, learning can improve not only academic abilities but also students' cultural identity (Lubis & Rahayu, 2023).

Conclusion

Based on the study findings and supported by previous research, it can be concluded that implementing an ethnomathematics approach has a significant effect on improving students' mathematical literacy. Integrating local cultural elements, including Phinisi boats, badik, and traditional South Sulawesi foods, was shown to enrich the context of geometry instruction and increase students' interest in and conceptual understanding of the subject.

Culturally based instruction not only makes mathematical concepts more concrete and easier to understand but also strengthens students' emotional and cognitive engagement. The increase in posttest scores in the experimental class indicates that ethnomathematics is effective in promoting mathematical literacy and higher-order thinking skills. These findings reinforce the importance of local contexts in education, as emphasized in various national and international studies.

Consequently, mathematics teachers are encouraged to draw on local cultural resources as contextual and inspiring teaching materials. Instruction can thereby focus not only on academic achievement but also on cultural preservation and the holistic development of students' identities.

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