Mimin Ninawati, The Effectiveness of Ethnomathematics-Based

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The Effectiveness of Ethnomathematics-Based Teaching Materials to Improve Elementary School Students' Understanding of Mathematics Concepts

Abstract

This study aims to test the effectiveness of ethnomathematics-based teaching materials in improving the understanding of mathematics concepts in SD SDN 2 Suruh, Trenggalek Regency, by integrating the local cultural context of Trenggalek Regency. The method used is quasi-experimental with a one-group pretest-posttest design. The population in this study is students of SDN 2 Suruh. The sampling technique in this study was Purposive sampling of 65 students in grade V of SDN 2 Suruh. The selection of sampling was based on the ability to understand mathematical concepts. The research instruments include a concept understanding test with data analysis using Shapiro Wilk normality, Homogeneity, Paired Sample T-Test, and N-Gain. The data analyzed is a test of understanding of mathematical concepts. The results showed a significant difference between the pretest and posttest values (sig. 0.000 <0.05), with an average N-Gain of 58.60% which was included in the effective category. Ethnomathematics-based teaching materials have been proven to be able to increase students' understanding of mathematical concepts while fostering interest in learning through the introduction of local cultural elements. These findings recommend the use of ethnomathematics-based teaching materials as a relevant and contextual learning strategy in primary schools.

INTRODUCTION

The teaching and learning process requires teaching materials as a tool to convey information and knowledge to students. Teaching materials are tools or means that contain subject matter, both written and unwritten, to help students and teachers understand lessons. Teaching materials are all materials that are systematically arranged and display the skills that students will master (Rufika et al., 2024). During the learning process, this ability is used to design learning activities. The teaching materials were developed over a long period of time and faced many problems.

There are a number of factors that can cause difficulties in developing teaching materials. Teachers said that the thematic books used were considered too general and less effective in helping students understand math concepts correctly, thus hindering the development of teaching materials that were more suited to their needs (Afrianti, 2022); (Fitriati & Lisa, 2015) . Elementary school mathematics curriculum that generally uses a general-to-specific approach also has implications for students' difficulty in reaching the concept discovery stage, because the presentation of general materials does not sufficiently encourage in-depth exploration of concepts (K. Siregar et al., 2024). Furthermore, research on the development of mathematics teaching materials based on a scientific approach shows that teaching materials designed with expert validation, trials, and relevance to the learning context have been proven to be valid and practical, and are able to improve students' problem-solving skills. This emphasizes that the development of teaching materials does not only rely on general textbooks, but must go through a systematic process to facilitate the understanding of concepts, to the discovery stage (Nurmaya, 2021); (Hariyati & Rachmadyanti, 2022). Teaching materials in the form of textbooks must include activities that can help students find ideas through learning activities (Adelia Putri Lubis et al., 2024); (Nasoha et al., 2022). These problems show that the learning management used is not interesting and is not able to build students' knowledge to the concept stage. Teachers only teach without paying attention to whether students understand the concept of the material. As a result, students often memorize materials and formulas without understanding the concepts.

A field study through interviews with grade IV teachers of SDN 2 Suruh showed that during the learning process, only worksheets, teacher's books, and student books were used in mathematics learning. Students have a lot of difficulty in understanding the concepts of Mathematics material because they tend to memorize formulas, so Mathematics formulas are difficult for students to understand. In addition, students lack understanding of mathematical

concepts, which causes students to get low grades.

The results of observations and interviews with grade IV teachers at SDN 2 Suruh show that students still have difficulties in understanding mathematical concepts, especially because the learning process only relies on worksheets, teacher's books, and student books. The limitations of this teaching material make students tend to memorize formulas without really understanding the concepts learned, thus having an impact on the low math scores they obtain. The factors behind this difficulty include the use of teaching materials that are too general, a monotonous learning approach, and the lack of integration of local cultural contexts in the material. This condition is exacerbated by the tendency of teachers who focus more on completing curriculum targets than ensuring student understanding, so that students often repeat the same mistakes. School institutions and teachers have responded to this problem by providing additional guidance, but these efforts have not been optimal because they still use conventional learning resources that do not attract the attention of students (Afrianti. 2022); (K. Siregar et al., 2024).

The above problem emphasizes that mathematics learning at SDN 2 Suruh requires more contextual teaching material innovations, one of which is by integrating ethnomathematics. Local culture-based materials not only help students visualize abstract concepts, but also increase motivation to learn because they are close to students' daily lives (K. Siregar et al., 2024); (Yonantha et al., 2024). The application of ethnomathematics teaching materials is very important to be taught at SDN 2 Suruh to equip students with a deeper understanding of concepts, reduce dependence on memorization of formulas, and foster critical and creative thinking skills. Thus, the development of teaching materials based on local culture is expected to be able to overcome students' conceptual difficulties while improving students' mathematics learning outcomes (Nurmaya, 2021); (Wulandari et al., 2024).

Many students struggle to understand basic math concepts due to the sheer number of formulas and rules that must be memorized and understood. Statistics, which includes the concepts of averages, medians, and modes, as well as problem-solving in the form of word problems, is one of the areas that is often considered challenging (Ayu et al., 2021; Hulu et al., 2023). Mathematical comprehension refers to a student's ability to answer mathematical questions, including their reasoning about their answers or their assumptions about the correctness of their answers based on logical reasoning (Hani et al., 2024). Previous research has shown that using ethnomathematics in mathematics learning can improve students' understanding of abstract mathematical concepts such

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as fractions and geometry. Ethnomathematics can help students visualize and conceptualize concepts that previously seemed abstract. It can also foster students' respect for their local culture, encourage critical and creative thinking, and increase their desire to learn (Yonantha et al., 2024). Ethnomathematics is mathematics used by specific cultural groups, such as indigenous peoples, workers, and children at a certain age (Rahmawati & Margunayasa, 2022). It is hoped that ethnomathematics can be used to improve mathematics learning ability and increase the desire to learn mathematics (Fitriyah, 2024).

Learning math requires students to have numeracy skills. There are some problems with learning math and how to solve it. Ethnomathematics-based teaching materials are one way to overcome mathematics learning problems (Nurmaya, 2021); (Turmuzi et al., 2022); (Andriono, 2021). The ethnomathematical study connects mathematics to the social sphere, specifically about how mathematics is created, transmitted, distributed, and specialized in various cultural systems. Textbooks that are integrated with ethnomathematics are a type of ethnomathematics teaching material that helps students understand mathematical concepts, especially flat building materials (Apriliyani & Mulyatna, 2021), (Putra & Prasetyo, 2022); (A. R. Siregar et al., 2024). Basically, flat buildings are found by many students in social life, such as buildings, temples, and others in East Java. Temple and batik buildings have their own uniqueness, which, when viewed, resembles flat buildings used as substances in teaching materials.

Ethnomathematics-based teaching materials are used very well in learning activities. The research entitled Development of Ethnomathematics-Based Mathematics Teaching Materials to Improve Mathematics Understanding of Grade III Elementary School Students showed that student scores in the range of 0-74 were 76.3%, 75-80 were 16.9%, and 80-85 were 6.8% (Wulandari et al., 2024). This study aims to test the effectiveness of ethnomathematics-based teaching materials to improve the understanding of Mathematics concepts of elementary school students. The novelty in this study is to integrate the local cultural context of Trenggalek Regency into teaching materials.

Until now, learning mathematics in elementary schools still faces many challenges, especially in conceptual understanding. Many students memorize formulas and techniques without really understanding the mathematical concepts they are learning. This situation prevents students from applying mathematics in their daily lives. In contrast, learning mathematics that is contextual and relevant to the local culture is rarely used effectively. Because ethnomathematics connects learning materials with local cultures, traditions, and practices that are familiar to students, this approach is

thought to help bridge the gap between abstract mathematical concepts and students' daily lives.

However, the problem that arises is that ethnomathematics-based teaching materials are still very limited in terms of availability and development. Most educators continue to use conventional textbooks that ignore aspects of the local culture (Setiyadi, 2021); (Berliana Nur Oktaviana et al., 2023); (Lisgianto & Mulyatna, 2021). This creates academic anxiety about how to create teaching materials that not only align with the curriculum but also help students better understand math concepts. Therefore, this study is very important to determine the effectiveness of ethnomathematics-based teaching materials in improving students' understanding of mathematics in elementary schools. This research is expected to help develop new teaching materials that are more contextual, meaningful, and relevant to students' real lives.

METHOD

This study uses a quasi-experimental method with a one-group pretest-posttest design. This design was used to measure the effectiveness of ethnomathematics-based teaching materials on students' understanding of mathematical concepts. In this design, the research subjects are given a pretest before treatment, then receive learning using ethnomathematics-based teaching materials, and end with a final test (posttest).

The research design can be described as follows (Hidawati et al. 2024)

Table 1. Research Design

Defend	Treatment (X)	Post-tests
O_1	X	O_2

Information:

O_1: Pretest score of students' understanding of mathematical concepts before treatment

X: Learning using ethnomathematics-based teaching materials

O_2: Post-Exam Score Student's Comprehension of Mathematical Concepts after Treatment

This research was carried out at SDN 2 Suruh with a total of 65 students. The population in this study is all 106 students at SDN 2 Suruh. This population includes students of all grade levels enrolled in the 2024/2025 academic year. The sampling technique used is purposive sampling, which is based on a low level of conceptual understanding of mathematics among elementary school students. This selection is done to ensure that the sample is truly relevant to the research problem.

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Based on this technique, a research sample of 65 students was obtained. Samples were selected from class V, which met the research criteria for having a low level of mathematical conceptual understanding. Therefore, it is hoped that the data will be representative. The characteristics of the sample included students in the appropriate age range for the primary school level and with a relatively low academic background in conceptual understanding of mathematics. In this study, the data collection method was in the form of tests; The instruments used include the Test. The data analysis technique used is the Paired Sample T-Test, which is carried out with the help of the SPSS 25.0 program.

Data collection in this study was carried out using a mathematical concept understanding test. The test was chosen because it was able to directly measure the extent to which students understood the mathematical concepts that had been learned, not just memorizing formulas or problem-solving procedures.

The test instruments used are description questions that are compiled based on indicators of understanding mathematical concepts, including: reaffirming a concept, classifying objects according to certain properties, providing examples and non-examples, and applying concepts in simple problem solving. The grid of test instruments is described in Table 2.

Table 2. Grid of Mathematical Concept Comprehension Test Instruments

Concept Understanding Indicators	Material/Topics	Inquiry Form	Inquiry Number
Reaffirming the concept in your own words	Operation of integer sums	Description	1
Classify objects based on specific properties	Flat buildings (square, rectangular, triangle)	Description	2
Provide examples and non-examples of concepts	Fractional	Description	3
Applying concepts in simple problem-solving	Fractional multiplication and division	Description	4, 5
Presenting concepts in various forms of representation	Simple data (tables and charts)	Description	6

The assessment guidelines for the math concept understanding test are described in Table 3

Table 3. Assessment Guidelines for the Mathematical Concept Comprehension Test

Score	Assessment Criteria
4	The answers are very complete and correct: students are able to answer according to the concept, give logical reasons, and write down the steps to solve it in a concise way.
3	The answer is correct but not complete: the concept used is correct, but the steps or explanations are not detailed.
2	The answer is partly correct: there are errors in the application of the concept, but it still shows a basic understanding.
1	Incorrect answer: the student tries to answer, but the concept used is wrong or inappropriate.
0	Answer/irrelevant: the student did not answer, or the answer did not match the question at all.

Before use, the test instruments are validated by experts and piloted on students outside of the research sample to ensure their validity and reliability.

The procedure for implementing the test is carried out in a conducive classroom atmosphere. Students are given enough time to complete the questions, according to the level of difficulty and the number of test items given. The test results are then corrected using assessment guidelines that have been prepared beforehand, so that quantitative data is obtained at the level of understanding of mathematical concepts for each student.

The selection of this test technique is based on the consideration that conceptual understanding is the most appropriate cognitive aspect to be measured through tasks that require logical and systematic thinking skills, as well as the ability to relate concepts to their application in problem solving.

The hypothesis in this study is explained as follows.

$H0_a$: There was no difference in the average score of mathematical concept comprehension between the pretest and posttest in the group using ethnomathematics-based teaching materials.

$H1_a$: There is a difference in the average score of understanding mathematical concepts between the pretest and the posttest in the group.

Furthermore, the N Gain test was carried out, which aimed to measure the improvement in the understanding of mathematics concepts of elementary school students.

The N-Gain formula can be written:

$$N - Gain = \frac{Nilai\ Posttest - Nilai\ Pretest}{Nilai\ Maksimum - Nilai\ Pretest}$$

Figure 1. N Reinforcement Formula

Source: Hake (1998)

The classification of the results of the N Gain Test is explained into three categories:

- High Category, if N-Gain > 0.7
- Medium Category, if $0.3 \leq$ N-Gain ≤ 0.7
- Low category, if N-Gain < 0.3

FINDINGS AND DISCUSSION

Findings

The pretest measures students' understanding of concepts before using teaching materials. Posttest measures students' understanding of concepts after using ethnomathematics-based teaching materials. Figure 2 shows the results of the pretest and posttest of small-scale tests.

Figure 2. *Small-Scale Post-Results*

Figure 2 shows that the average score of students increased. This shows that ethnomathematics-based teaching materials can be used effectively in the learning process. The results of the pretest and posttest of the field scale test are shown in Figure 2 below.

Figure 3. Results *of Pretest and Posttest* of the field scale tests

As shown in Figure 3, the average score increased after a field-scale test was administered to 46 students. This shows that ethnomathematics-based subject matter can be used effectively for

teaching.

The results of the normality test used in this study to determine whether the data used are normally distributed are described in Table 4

Table 4. Normality Test

Normality Test		VALUE	Shapiro-Wilk		
			Stat istics	f	S ig.
Understandin g Mathematical Concepts	E	Defond	.974 6	4	. 379
		Post-tesis	.959 6	4	. 105

According to Table 1, the study of the normality test was conducted with the Shapiro-Wilk test and a significance level of 0.05. The data shows a normal distribution with a significance value above 0.05. The significance value of the pretest is 0.379, and the significance value of the posttest is 0.105. The paired sample t-test formula, shown in Table 5, was used to test the hypothesis of this study.

Table 5 Hypothesis Test

Paired Sample Test									
				Installation Differences					
					95% Difference SConfidence Interval				
		ean	St td. u. Deviation	Signific nt Error	l ower	A bove	f	S ig. (2-tailed)	
		P	9.	1		1			
ouple 1	osttest Pretest	-0.022	032	.332	.340	2.704	.526	5	000

The value of sig. The pretest and posttest of two tails were 0.00, according to the results of Table 2. Thus, it can be concluded that Ho was rejected, indicating that students understood different concepts before and after using the teaching materials. To find out how effective the teaching materials that have been developed are, an N-Gain test is carried out. The results are shown in the following Table 6.

Table 6. N-Gain Test (Effectiveness)

Description					Statis tics.	Std. Error
NGain_ Persen	Mean				58.60 90	3.38 117
	95% Confidence Interval for Average	Lower Limit			51.79 90	
		Upper Limit			65.41 91	

	5% Trimmed Red		59.14 86	
	Median		62.43 00	
	Variance		525.8 86	
	Std. Deviation		22.93 221	
	Minimum		9.09	
	Maximum		100.0 0	
	Range		90.91	
	Interquartile Range		40.65	
	Slope		-.368	.350
	Kurtosis		-.729	.688

The results of the N-Gain test for the use of teaching materials showed that the average or average value of 58.60% was included in the effective category as shown in Table 3. Thus, it can be concluded that using textbooks as a learning resource is effective in improving students' understanding of concepts.

Discussion

The learning conditions at SDN 2 Suruh are still centered on teachers. In learning, teachers usually use lecture methods. There are not many media used in learning activities, as well as teaching materials. The teaching materials used are only LKS books and package or theme books from the government. Teaching materials are a collection of educational materials that are systematically compiled that describe ideas that help students achieve competence (Nur Amalia Ramadhani et al., 2024). Teaching materials are important because they are used by teachers to help students learn. Teaching materials are an important part of the implementation of education (Rahmawati & Margunayasa, 2022). With the help of teaching materials, teachers can carry out Mathematic learning activities more easily, and students will be helped and learn easily.

Understanding mathematical concepts is essential for solving math problems and in daily life. In fact, there are many reasons why students in elementary school do not understand math well. One of them is that they do not make good use of teaching materials. Good teaching materials must be in accordance with competency standards and basic competencies, have an element of knowledge, motivate students, be systematic, practical, useful, and keep up with the times (Puspita & Setyaningtyas, 2022). Teaching materials make it easier for students to absorb knowledge transfer

Not all teaching materials are suitable for use in teaching and learning activities or as

teaching materials. Teachers must have the ability to choose effective learning materials and types of teaching materials that suit the needs of students in order to help students understand the concepts being taught (Bognar et al., 2025). Taking into account the above issues, the researcher developed teaching materials that aim to improve elementary school students' understanding of mathematics concepts (Santosa et al., 2019); (Sartono et al., 2021).

Ethnomathematics-based teaching materials can improve students' understanding of mathematical concepts, so that they can be used as a solution for students who lack understanding of mathematics concepts in elementary school (Dhiki & Bantas, 2021). In addition to improving students' understanding of concepts, these teaching materials can also attract students' attention, motivation, and interest in learning mathematics. Teaching materials must meet the following standards in terms of content coverage, presentation, readability, and graphics. It is intended to improve students' understanding of concepts, interests, and their desire to learn (Hani et al., 2024).

The purpose of applying textbook teaching materials is for students to understand the concept of mathematics, which will make it very easy for them to learn mathematics and use it in their daily lives. Students are considered to understand concepts if they can define concepts, identify and provide examples or non-examples of those concepts, understand how mathematical concepts relate to each other to gain a better understanding, and use mathematics in non-mathematical contexts (Basic Education Flobamorata et al., 2024); (U. Hasanah et al., 2023); (Hulu et al., 2023); (Nebraska, 2024); (Faradina, 2024); (Fitriana et al., 2024).

The material has been tested for normality and homogeneity, and the teaching materials are normal and homogeneous. Next, a hypothesis test was carried out to find out the difference before and after the application of teaching materials. In addition, the N Gain test was carried out to test the improvement of understanding of Mathematics concepts using teaching materials. Students' understanding of mathematical concepts was initially in the low category before the treatment, but increased to the high category after the application of ethnomathematics-based teaching materials. The results of the hypothesis test showed that there was a significant difference in students' conceptual understanding before and after treatment with ethnomathematics-based material (Apriliyana et al., 2023); (Apriyanti et al., 2023); (Nurhayanti et al., 2022). Thus, it can be concluded that the use of textbooks as a learning resource has a positive impact on improving the understanding of mathematics concepts of elementary school students. In addition, teachers provide recommendations and comments that the material in ethnomathematics-based teaching materials is

appropriate to the local cultural context of students and is able to attract their interest in learning. This reinforces the finding that teaching materials have an important role in determining the level of learning success (Yonantha et al., 2024), (Fitriana et al., 2024), (Adelia Putri Lubis et al., 2024), (Putri et al., 2025)

The N-Gain test is used to determine whether students' skills improve before and after treatment, as has been widely applied in research to improve understanding of mathematical concepts (Pratiwi et al., 2019). This instrument is effectively used to measure the extent to which students progress in understanding mathematical concepts. The results of the study showed that students' mathematical comprehension improved after the use of ethnomathematics-based teaching materials, in line with the findings (Priyanti Sularso et al., 2021) which shows the effectiveness of learning media in improving concept understanding through the N-Gain test. In addition, classroom action research conducted by (Priyanti Sularso et al., 2021) It also proves that learning interventions based on contextual approaches can shift students' understanding from the low category to the higher category. The results of the N-Gain test in this study confirm that the average score is in the effective category, so that textbooks designed as learning resources are proven to be able to improve students' understanding of mathematical concepts. Furthermore, the research (Bognar et al., 2025) emphasizes the importance of teaching material innovations, such as gamification, to support improved understanding of concepts. Thus, the use of teaching materials that meet learning criteria and connect to the local cultural context can have a significant impact on the success of mathematics learning (Basic Education Flohamorata et al., 2024).

CONCLUSION

This study shows that grade IV students still face challenges in learning field geometry. The main difficulty lies in the lack of a deep conceptual understanding, resulting in students memorizing formulas without understanding their meaning and application. This condition results in poor learning outcomes, as evidenced by relatively low pre-test scores before treatment. After using ethnomathematics-based teaching materials in the learning process, there is a significant increase in students' understanding of mathematical concepts. This is evidenced by the post-test results, which show a higher average score compared to the pre-test. Statistical tests also support these findings by showing significant differences between learning outcomes before and after treatment. Therefore, it can be concluded that ethnomathematics-based teaching materials are effective in improving

elementary school students' understanding of mathematical concepts, especially in the field of geometry. These teaching materials can help students understand concepts more meaningfully, more than just memorizing formulas, resulting in better learning outcomes.

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