



# Ethnomathematics-Integrated process learning exploration to build math connections

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## Abstract

This research examines how integrating ethnomathematics strengthens real-world mathematical connections. Linking math to local culture helps students understand and apply concepts in daily life. This study used qualitative and quantitative methods to examine the impact of ethnomathematics integration on students' mathematical connections. With a One-Group Pretest-Posttest design, this study involved seventh-grade junior high school students in South Sulawesi. The pretest measured initial skills, while the posttest assessed improvements after ethnomathematics-based learning. The research instruments included tests, observations, and questionnaires. The test evaluated mathematical connection skills before and after the intervention, observations ensured the appropriateness of the learning, and the questionnaire captured students' responses. Teachers connected mathematical concepts with local culture in the learning process, such as weaving patterns and traditional measurements. Students explored these relationships through exercises and problem-solving and reflected on their applications. The pretest and posttest results were compared to assess the effectiveness of the learning, supported by observation and questionnaire analysis. The research findings show that students' understanding of mathematical concepts and skills is still not optimal when applied in real situations. This indicates a gap between conceptual knowledge and practical application in everyday life. To bridge this gap, a deeper integration of ethnomathematics is recommended. By connecting abstract mathematical concepts with local culture and students' everyday experiences, this approach increases the relevance of learning and strengthens the connection between mathematical theory and practice.

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## Introduction

Ethnomathematics connects mathematical concepts to local cultures, helping students understand mathematics within their cultural context. It examines mathematical practices in cultural groups and their relevance to classroom learning while addressing misconceptions about Indigenous mathematical systems (Hamidah & Kusuma, 2024; Rodríguez-Nieto & Alsina, 2022; Xu & Ball, 2024). Students' mathematical beliefs, influenced by social class, region, and school type, can impact academic performance (Malvasi & Gil-Quintana, 2022). Additionally, culture shapes how mathematicians think and solve problems (Lei et al., 2022). Research in ethnomathematics often relies on statistical analysis, such as Pearson's chi-squared test, to verify hypotheses (Buchcic, 2020; Kalay et al., 2020). The effectiveness of ethnomathematics-based learning, including the inverted classroom model, depends on its implementation and cultural context (Mohamed-Amar & Mohamed-Amar, 2024), while teachers' attitudes are influenced by social and school environments (Sweeney & Reid O'Connor, 2024). By exploring cultural elements such as weaving patterns, trade calculations, and traditional house structures, students connect mathematics to real-world applications. Contextual and project-based learning enhances their understanding, motivation, and appreciation of cultural heritage while fostering critical thinking skills.

Mathematical connections improve understanding of concepts and their real-life applications. The intersection of mathematical culture has attracted interest from mathematicians, historians, and educators (Lei et al., 2022). Ethnomathematics is being explored for its relationship with STEM education and the necessary technology for effective instruction (Rosa & Orey, 2021). Students often find mathematical concepts abstract and disconnected from their experiences, with no clear link between academic achievement and motivation (Onoshakpokaiye, 2024; Vos et al., 2024). They also struggle to connect images with reality, and learning extends beyond schools (Brisson et al., 2020; Kashina et al., 2020). Key mathematical skills include problem-solving, calculations, and data interpretation, while symbols aid in understanding cultural concepts (Buchcic, 2020; Janson & Feig, 2024; Nyman et al., 2024). Ethnomathematics helps by linking math to cultural practices like weaving and trading, making concepts more relatable. This approach enhances understanding, engagement, and meaningful learning.

Exploring ethnomathematics can bridge gaps in traditional math understanding by fostering diverse ideas through a more profound exploration of related concepts (Clancy et al., 2024). Incorporating media literacy into college education enhances students' development and critical thinking skills (Yang & Li, 2024). Ethnomathematics connects math with culture, making it more relatable and engaging for students (Espanola & Ouano, 2024). Teachers view ethnomathematics positively, as it helps students appreciate their local culture (Wiryanto et al., 2022). Feedback is essential for learning and achievement (Bjerknes et al., 2024), and integrating the arts into STEM subjects promotes engagement and creative thinking (An, 2020). Recent advancements in artificial neural networks (ANNs) have improved the accuracy of neural behavior predictions (Verhellen et al., 2024). Additionally, learning models in Western countries differ from virtue-oriented approaches (Lei et al., 2022). Our social engagement is linked to our understanding of global changes and awareness of surrounding phenomena, which knowledge enhances (Buchcic, 2020).

The effectiveness of ethnomathematics lies in connecting mathematical concepts to real-world applications. In public secondary schools, there seems to be no clear link between students' motivation and academic performance (Onoshakpokaiye, 2024). Experiments were analyzed using probability theory and statistical methods, such as Pearson's chi-squared test, to verify distribution hypotheses (Kalay et al., 2020). (Leung et al., 2024), note that learners focused solely on values change their prior strategies slowly, which does not impact decision-making. These ideas show that ethnomathematics can be both an educational tool and a research focus (Hariastuti et al., 2022). A case study explored Indonesian teachers' understanding of ethnomathematics and their practices (Mania & Alam, 2021). Additionally, societal developments and school mathematics culture influence students' views on the importance of math learning (Vos et al., 2024). While screencast feedback has improved accuracy and emotional engagement in higher education, its potential benefits in secondary schools are underexplored (Bjerknes et al., 2024). Moreover, when pre-trained model embeddings fail to capture specific term meanings, it negatively impacts applications like classification and clustering (Parker et al., 2024).

Mathematics learning that connects concepts with local culture has not yet helped students understand math in their cultural context. Many students struggle with adjusting to schoolwork at home and learning new

material independently (Komljanec & Šebalj, 2020). While negotiating education in schools, we should also consider learning outside school walls (Buchcic, 2020). This study shows that ethnomathematics aids in understanding mathematical thinking across cultures and solving everyday problems (Abidin & Usman, 2021). It promotes mathematical literacy through culture-based learning (Hariastuti et al., 2022). Rich cultures, including folk games, exist in diverse communities in highlands and coastal areas (Abay & Parola, 2024). Ethnomathematics is vital in community activities (Abidin & Usman, 2021). Collaboration among disciplines and teachers can enhance support for mathematical questions (Alatalo et al., 2024), and provide insights into the effects of flexibility on students, educators, and institutions (El Galad et al., 2024).

This study uses a framework that connects ethnomathematics with mathematical connections to strengthen students' understanding of mathematical concepts and their real-life applications. The Mathematical Connection Theory explains how relevant cultural experiences can enhance students' knowledge so that they can apply mathematics in a more contextual and meaningful way (Onoshakpokaiye, 2024; Vos et al., 2024). In addition, this study refers to the constructivist approach, which emphasizes that students build their understanding through exploration and culturally integrated learning experiences (An, 2020). This approach addresses the gap in traditional mathematics learning, which is often abstract and less related to students' daily experiences (Zuliana et al., 2023). This study also examines an ethnomathematics-based learning model, which integrates formal mathematics with local cultural practices to create a more relevant learning experience (Nuryadi et al., 2023). This approach helps students understand concepts theoretically and connects them to various aspects of real life. Therefore, this study highlights how ethnomathematics can build connections between mathematical concepts and their applications (Hortelano & Lapinid, 2024). Without a clear framework, this study would have lost a strong foothold (Hamidah & Kusuma, 2024). Therefore, the integration of mathematical connection theory, constructivism approach, and ethnomathematics-based learning model is the primary basis for exploring the role of ethnomathematics in mathematics learning.

Students must grasp mathematical concepts and skills beyond merely applying them in real situations. According to Alatalo et al. (2024), students should understand the tangible aspects of the systems they develop. A broader perspective on flexibility is essential

for comprehending its role in higher education (El Galad et al., 2024). Bjercknes et al. (2024), note that students reflected on their work and solutions while learning mathematical skills. This study defines mathematics test anxiety based on students' responses during testing scenarios (Onoshakpokaiye, 2024). Although organoids likely consist of various cell types, the mathematical models in this study assume that each organoid is a homogeneous cell population (Gunnarsson et al., 2024). We also explore realistic nowcasting scenarios that account for randomly missing symptom onset dates and reporting delays (Lison et al., 2024).

A gap exists between students' traditional understanding of mathematics and its teaching in schools. The traditional house of the Using culture reflects the customs of the Banyuwangi indigenous people (Hariastuti et al., 2022). Teachers utilize various media, including Buginese and Makassar traditional foods and games, to teach math through an ethnomathematics approach, which most participants support in the curriculum (Mania & Alam, 2021). This method studies the history of mathematical concepts and terms. Math questions in Gaokao exams often provide background context (Lei et al., 2022), but students' perceptions of this feedback are poorly understood. Considering students' views on teaching practices is essential, as they are critical stakeholders in education (Bjercknes et al., 2024). Problem-based learning (PBL) encourages students to research and apply knowledge to solve problems (An, 2020), and the shift to online learning reflects fundamental changes in higher education (Kashina et al., 2020). Learning specialized math is crucial for future translators and interpreters (Kalay et al., 2020).

Integrating mathematical concepts with practical applications can enhance learning outcomes. Research shows that students better understand abstract ideas when they start with familiar, concrete concepts (Hamidah & Kusuma, 2024). Teachers should emphasize essential concepts and collaborative learning to foster student autonomy (Komljanec & Šebalj, 2020). It is essential to understand how young people adapt to online learning based on their temperament (Kashina et al., 2020). Social media such as Instagram, Facebook, Twitter, and WhatsApp support social interaction by facilitating communication, collaboration, and idea sharing. Features like discussion groups, comments, and instant messaging help build networks, broaden horizons, and increase community engagement (Abidin, 2020). Virtual classroom presentations have been adapted to encourage peer feedback and sharing (Fleischmann, 2024), but fewer studies focus on transforming existing concepts

into new ones (Clancy et al., 2024).

Despite growing evidence that ethnomathematics enhances mathematical understanding, student achievement, and creativity, gaps remain in its practical implementation and integration with contemporary educational frameworks. (Johnson et al., 2022). While previous studies have highlighted the benefits of ethnomathematical approaches, there is limited research on how these methods can be effectively incorporated into thematic and connected learning models (Hariastuti et al., 2022). Additionally, frameworks like STEAM integration offer promising directions but lack specific strategies for embedding ethnomathematics in diverse educational contexts (Lison et al., 2024). Furthermore, while some models provide insights into learning behavior, they face challenges in real-time applicability, particularly in dynamic and evolving learning environments (An, 2020). This study addresses these gaps by exploring a more structured approach to integrating ethnomathematics to enhance mathematical connections and real-world problem-solving skills (Janson & Feig, 2024).

While ethnomathematics has been recognized for bridging the gap between mathematical understanding and real-world application, its integration into formal education remains underexplored. Studies have shown that mathematical modeling effectively addresses complex problems, such as cancer development, yet similar approaches in ethnomathematics are less developed (Gunnarsson et al., 2024). Research on Indigenous communities like the Baduy highlights the existence of mathematical knowledge outside formal education (Turmuzi et al., 2023). Still, there is a limited investigation into how these insights can be systematically incorporated into curricula (Xu & Ball, 2024). Additionally, while ethnomathematics is seen as a counterbalance to the universal nature of mathematics, its role in fostering deeper student reflection and problem-solving skills requires further study (Bjerknes et al., 2024). This research addresses these gaps by examining structured ways to integrate ethnomathematics into learning environments, enhancing conceptual understanding and application.

This research aims to explore the integration of ethnomathematics to strengthen mathematical connections in real-world contexts. Specifically, the study aims to investigate how ethnomathematical approaches can enhance students' engagement and motivation, which is often driven by interest in meaningful activities rather than external rewards (Onoshakpokaiye, 2024). Additionally, the research seeks to build on previous findings that highlight the positive impact of ethnomathematics in

mathematics education and its pedagogical applications in Indonesia (Mania & Alam, 2021; Runtu et al., 2023). Lastly, this study will examine the model's potential relevance beyond traditional learning approaches, particularly in real-world problem-solving and emerging fields like machine learning (Schwöbel et al., 2024).

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## Methodology

This study uses qualitative and quantitative methods to explore how integrating ethnomathematics enhances students' mathematical connections to real-world needs. An experimental approach allows the researcher to observe the direct impact of this integration on students' abilities. The One-Group Pretest-Posttest design involves randomly selecting one group of students without a control group. A pretest measures students' mathematical connection skills before applying the ethnomathematics treatment, followed by a posttest to assess improvements. This method enables objective evaluation of changes after the intervention. Conducted from 2023 to 2024 with Junior high school grade VII students in South Sulawesi, Indonesia, the research targets students aged 12 to 13, a critical transition period marked by significant physical, emotional, social, and cognitive development. The One-Group Pretest-Posttest design was chosen to measure changes in students' mathematical connection skills before and after ethnomathematics intervention without a control group. This method is suitable when comparisons with other groups are difficult due to time, resource, or school policy constraints. By comparing pretest and posttest results in 1 group, the study can more objectively assess the effectiveness of the intervention.

Of the 25 students, 17 had a medium category of mathematical connections, indicating a good understanding but needing improvement. Four students were in the high category, while 4 others were in the low category, suggesting difficulties linking mathematical concepts, especially in ethnomathematics. Improvement efforts are needed, especially for students in the medium and low categories. The mathematical connection and ethnomathematics approaches can help them understand the relationship of concepts in everyday life. This retrieval technique uses categorization-based retrieval to classify students' mathematical connections into low, medium, and high levels, helping to identify trends and areas for improvement. When based on established criteria, this technique aligns with criterion-referenced assessment, and when used to guide instructional strategies, it serves as a diagnostic assessment approach.

The One Group Pretest-Posttest Design was chosen because it allows researchers to assess changes in students' understanding or skills before and after the intervention. This approach effectively measures the impact of ethnomathematics integration in learning without comparing it with other groups. In addition, this design is more practical to apply in the classroom without dividing students into additional groups. However, this design has a significant limitation, namely, the absence of a control group. Without a comparison group, it is difficult to ensure that the changes are genuinely due to the intervention and not other factors such as additional learning experiences or the influence of time. This can reduce the validity of the research results.

The study uses test instruments, observation sheets, and student response questionnaires. The test measures students' mathematical connection abilities through a pretest and posttest: The pretest assesses initial skills, while the posttest evaluates improvements after ethnomathematics integration. Observation sheets gather information on implementing the ethnomathematics learning process to ensure it aligns with the planned objectives. Additionally, the questionnaire measures students' responses and perceptions regarding their experiences in developing mathematical connection skills through this integrated approach.

Three experts in Mathematics Education have reviewed the instrument to ensure content validity, with selection criteria based on experience and related

publications. As presented in Table 1, the analysis using Aiken's V shows that all items have values above .75, which indicates good validity. Furthermore, in terms of reliability, it shows that Cronbach's Alpha coefficient obtained a value of .875, indicating good internal consistency. We have also conducted exploratory factor analysis, with a KMO value of .85 and a significant Bartlett's Test ( $p < .05$ ), which supports the suitability of the data for factor analysis. Based on these results, it can be concluded that the instrument can be used to collect research data.

The question grid is presented in Table 1, which details the indicators of mathematical connection skills assessed in this study, including connections between mathematics, real-life situations, and local culture (ethnomathematics). Based on this framework, a pre-test was conducted to measure students' initial abilities. The learning process was then implemented using an ethnomathematics approach, where students actively explored the relationship between mathematical concepts and local cultural practices, such as weaving patterns and traditional measurement systems. Through observation, discussion, and reflection, students were encouraged to evaluate and apply mathematical concepts in real-life contexts critically. Following the intervention, a post-test was administered to measure improvement. The comparison of pre-test and post-test results served as the basis for evaluating the effectiveness of the learning process in enhancing students' mathematical connection abilities.

**Table 1** The question grid is outlined in the following table

| No | Question Indicators                                                                                                                                                                                                                                                                                                                                                       | Question Items                                                                                                                                                                                                                                                                                        |
|----|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1  | Students can understand the concept of cubes and their properties, express the volume of cubes in algebraic form, and determine the highest power of an algebraic form.                                                                                                                                                                                                   | A sikaporo cake has the shape of a cube with each side measuring $x$ cm. What is the volume of the sikaporo cake in $\text{cm}^3$ ? Express your answer in algebraic form and identify the highest power in the expression.                                                                           |
| 2  | Students understand the relationship between speed, time, and distance and can calculate distances using velocity in algebra. Students can express the distance travelled in algebraic form.                                                                                                                                                                              | In a traditional Bugis running race tradition, a participant runs for 4 min at a speed of $(x-24)$ m/min. Find the distance travelled by the participant in meters, then determine the algebraic form.                                                                                                |
| 3  | Students understand the concept of rectangular area and relate it to length and width. Using the information provided, students can use broad formulas to calculate size and simplify algebraic forms.                                                                                                                                                                    | In making traditional Bugis lipa Sabbe woven fabric, a rectangular piece of cloth has an area of $30 \text{ cm}^2$ and a width of 5 cm. Find the length of the fabric in cm.                                                                                                                          |
| 4  | Students can understand the concept of calculating the total price of several goods, the unit price, the total purchase price, and the total price difference.                                                                                                                                                                                                            | In a traditional Bugis market, there are 2 types of cakes, namely, Jompojomo for Rp. 3.000 and Ondeonde for Rp. 5.000 Aya buys 2 ondeonde and 4 jompojomo, while Sophia buys 3 ondeonde and 2 jompojomo. What is the difference in payment between Aya and Sophia?                                    |
| 5  | Students can understand the concepts of even and odd numbers and express them in algebraic form. Students can compose the expression of numbers between even and odd numbers. Students can simplify algebraic forms to prove the properties of numbers resulting from addition. Students can conclude that the sum of even and odd numbers always results in odd numbers. | In Bugi's traditional ceremonies, even and odd numbers are used to calculate goods. It is known that even numbers can be expressed as $2m$ and odd numbers as $2n + 1$ , and is an integer $m, n$ Prove that the sum between even numbers $2n$ and odd numbers $2n + 1$ , always produce odd numbers? |

At the same time, data from observations and questionnaires were analyzed to dig deeper into how the integration of ethnomathematics affects students' engagement, critical thinking development, and problem-solving abilities. The questionnaire consisted of closed, open, and a Likert scale. Closed-ended questions were used to obtain quantitative data on students' attitudes and perceptions, while open-ended questions allowed further exploration of their experiences and reflections on the learning. A Likert scale was used to measure students' level of understanding and engagement in various aspects of ethnomathematics-based learning. The questionnaire data were analyzed descriptively and inferentially to identify student response patterns and how the ethnomathematics approach influenced their understanding and application of mathematical concepts. For further research, a quasi-experimental design with a control group is recommended. By comparing students who received ethnomathematics intervention and those who did not, the study's results will provide more substantial evidence of the impact of the learning on students' mathematical understanding and skills.

In problem-solving exercises with students, it is crucial to maintain ethical research protection of personal data. For example, in a study of mathematics learning strategies, students are asked to solve contextual problems while researchers collect data about their thinking. Students should be given clear information about the purpose of the study, the use of the data, and their right to withdraw at any time without consequences. Personal data, such as names and work results, should be anonymized or encrypted to keep them confidential—ethical data collection methods and overcoming challenges, such as students' reluctance to share information. In addition to improving problem-solving skills, this exercise also raises awareness of the importance of protecting the rights and privacy of research participants.

## Results

This study evaluates the effectiveness of integrating ethnomathematics in building students' mathematical connections. Key indicators include implementing learning, categorized as adequate, sound, or very good; at least 60 percent of students giving positive feedback; and meeting the minimum classical completeness criteria (CCC) of 75 percent of students achieving learning mastery. The average score for ethnomathematics-integrated learning across all sessions was 3.35, indicating successful implementation of the learning model. Student

response percentages to integrating ethnomathematics are detailed in the following table.

Based on classical completeness, students achieving a CCC score of 80 percent met the 75 percent criteria. The normality test results showed a significance of 0.073 for the pretest and 0.090 for the posttest, both above 0.05, indicating customarily distributed data. A paired sample *t*-test yielded a significance (2-tailed) of 0.000, below 0.05, showing a significant difference between pretest and posttest scores. The posttest average score was higher, indicating improvement after the ethnomathematics-integrated learning intervention.

The improvement in students' mathematical connection abilities through ethnomathematics integration was measured using the N-Gain test, revealing an average increase of 61.3 percent, classified as medium and effective. This indicates that ethnomathematics-integrated learning effectively enhances students' mathematical connections. The learning process includes 7 stages: Building students' knowledge by linking algebra with cultural aspects like traditional Bugis games and foods; presenting problems for student-led discovery and fostering; peer interaction and guiding group work; providing cultural examples; reflecting on knowledge gained; and assessing student activities.

For the implementation of this study, the researcher looked at the scores obtained by students who aimed to find out the mathematical connections of students who integrated ethnomathematics in the algebra material of grade VII junior high school. The following are data on students' mathematical connection abilities obtained from posttest scores classified in high, medium, and low categories using standard deviations in determining actuarial.

The percentage of students' mathematical connection ability integrating ethnomathematics in each question is presented in [Table 2](#). The table provides an overview of students' performance across all items and highlights the variation in ability to relate mathematical concepts to ethnomathematical contexts

Based on [Table 2](#), the results of the mathematical connection test instrument show that students' abilities varied across the five question items. The highest percentage was obtained in item 3, with 80%, indicating that most students were able to solve the division of algebraic expressions containing variables by relating them to geometric concepts. This was followed by item 4 with 79 percent and item 2 with 77 percent, showing that students were relatively capable of connecting algebraic concepts with comparative material, physics, and everyday life contexts. Item 1 obtained 75 percent, which

**Table 2** Math connection test instrument grid

| Question Items | Question Indicators                                                                                            | Indicator Mathematical Connection                                                  | f  | Percentage |
|----------------|----------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|----|------------|
| 1              | Students can group algebraic forms by associating the concept of flat-shape geometry.                          | Connections between mathematics and<br>Connections between Mathematics and life    | 75 | 75         |
| 2              | Students solve physics problems by relating algebraic concepts.                                                | Mathematical connection with other fields and<br>Mathematical connection with life | 77 | 77         |
| 3              | Students can solve the division of single-term forms that contain variables by associating geometric concepts. | Connections between mathematics and<br>Connections between Mathematics and life    | 80 | 80         |
| 4              | Students can determine the value of algebraic forms by associating comparative material.                       | Connections between mathematics and<br>Connections between Mathematics and life    | 79 | 79         |
| 5              | Students can explain the properties of numbers using algebraic concepts.                                       | Connections between mathematics and<br>Connections between Mathematics and life    | 60 | 60         |

also reflects a fairly good ability to group algebraic forms by associating them with flat-shape geometry. In contrast, item 5 showed the lowest percentage, at 60 percent, indicating that students still experienced difficulties in explaining number properties through algebraic concepts. Overall, these findings suggest that students tended to perform better on items involving contextual and procedural connections between mathematics, geometry, and other fields. Still, they were less successful when required to provide conceptual explanations of number properties using algebra.

The results of students' performance on mathematical connection tasks, categorized into high, medium, and low levels, are presented in [Figure 1](#), which illustrates the distribution of students across these categories.

cake, they still experienced difficulty in connecting all aspects of the problem with the relevant mathematical concepts. In particular, students had not clearly explained how the value of  $xy$  was obtained, which affected their ability to determine the value related to  $4x$  correctly. This suggests that students have not yet fully connected the given information in the problem with the mathematical concepts required to produce an accurate solution.

The results of students' responses to the mathematical connection questions for item number 2 are presented in [Figure 2](#), showing their distribution across high, medium, and low categories.

Students' responses to the mathematical connection problem for item number 2 are presented in [Figure 2](#). The figure shows that some students were able to determine

Jawaban :  $V = s \times s \times s$  Dik : panjang rusuk ( $x$  cm)  
 $= x \times x \times x$  Dit : carilah volume kue katrisala  
 $= x^3$  kemudian tentukan bentuk aljabarnya  
 dan tentukan derajatnya.  
 Bilangan ini termasuk suku tunggal  $= x^3$   
 Derajatnya adalah : 3 (Derajat tiga)  
 $\Rightarrow$  Suku tunggal derajat 3

**Figure 1** Students' answers to question number 1

Students' responses to the mathematical connection problem for item number 1 are presented in [Figure 1](#). The figure shows that students were able to relate algebraic concepts to real-life situations, particularly in determining the volume of a cube-shaped cake. This finding indicates that students have begun to connect mathematical concepts with everyday experiences. However, the figure also reveals that students have not yet fully identified the algebraic form involved in the problem, whether it consists of a single term or more than one term. Although some students were able to partially complete the solution by calculating the volume of the

the distance travelled by children playing by applying the distance formula from physics and expressing the solution in a simplified form. This finding indicates

Dik :  $t = 4$  menit  
 $v = (x + 2y)$  m / menit  
 Dit : 5  
 peny :  
 $s = t \cdot v$   
 $= 4(x + 2y)$  jadi jarak yang ditempuh Raba  
 $= 4x + 8y$  adalah  $(4x + 8y)$  m/menit

**Figure 2** Students' answers to question number 2

that students have begun to demonstrate the ability to connect mathematical concepts with other disciplines, particularly physics, as well as with everyday situations. However, the figure also reveals that students still made errors in performing algebraic operations, which led to incorrect answers. This suggests that although students were able to relate algebra to physics concepts, their understanding of how to integrate mathematical concepts with other fields of knowledge remains limited. In addition, difficulties in interpreting the question caused students to be less accurate in connecting the information provided in the problem with the mathematical concepts required to solve it.

Students' responses to the mathematical connection questions for item number 3 are presented in Figure 3, showing the classification into high, medium, and low categories.

Students' responses to the mathematical connection problem for item number 3 are presented in Figure 3. The figure shows that some students were able to divide algebraic expressions involving a single variable term correctly by relating geometric concepts to real-life situations, such as determining the length of a traditional Bugis lipa' sabbe cloth and a rectangular table when the area and width were represented algebraically. This finding indicates that students were able to connect mathematical concepts with everyday contexts and identify the relevant information needed to solve the problem. However, the figure also reveals that several students still experienced difficulty in understanding the concept of a square when determining the length of the lipa' sabbe, which resulted in inaccurate answers. This suggests that although students demonstrated an initial ability to relate mathematics to real-life situations, their mathematical connection ability remains incomplete because some of them have not yet fully understood the meaning of the problem and the underlying geometric concepts.

The results of students' responses to the mathematical connection problems for item number 4 are presented in Figure 4, showing the distribution of students across high, medium, and low categories.

Students' responses to the mathematical connection problem for item number 4 are presented in Figure 4. The figure shows that students are generally able to identify the price difference problem and represent it using algebraic expressions. This indicates that they have begun to connect mathematical concepts with everyday situations, particularly in understanding the information provided in the problem and selecting relevant concepts to solve it. However, the figure also

reveals that students still experience difficulties in performing accurate calculations and interpreting the question precisely. Instead of determining the difference between the amounts paid by Aya and Sofia, some students calculated each amount separately without clearly showing the process that led to the result of Rp 43,000. This finding suggests that students have not yet fully connected the information in the problem with the appropriate sequence of solution steps, resulting in incomplete or incorrect answers.

Students' responses to the mathematical connection questions for item number 5 are presented in Figure 5, showing their distribution across high, medium, and low categories.

Students' responses to the mathematical connection problem for item number 5 are presented in Figure 5. The figure shows that several students are able to use algebraic representations to explain why the sum of odd and even numbers results in an odd number. This indicates that they can relate algebraic concepts to the properties of numbers and connect mathematical ideas

Luas : Panjang x Lebar      Dik : Luas :  $30xy$   
 lebar :  $5y$   
 Dit : panjang ?

Panjang :  $\frac{\text{Luas}}{\text{lebar}}$   
 $= \frac{30xy}{5y}$   
 $= 6y$

Jadi panjang kain tersebut adalah  $6m \cdot y$  cm

Figure 3 Students' answers to question number 3

Dik : ~~Orde~~ Orde =  $x \rightarrow 5.000$   
 Jompo - Jompo =  $y \rightarrow 3.000$   
 Aya  
 Sofia =  $2x + 4y$   
 Sofia =  $3x + 2y$

Dit : ?  
 Pen : Aya :  $2x + 4y$   
 $= 2(5.000) + 4(3.000)$   
 $= 10.000 + 12.000$   
 $= 22.000$   
 Sofia :  $3x + 2y$   
 $= 2(5.000) + 2(3.000)$

$= 15.000 + 6.000$   
 $= 21.000$   
 Selisih =  $22.000 - 21.000$   
 $= 1.000$   
 Jadi, selisih harga yg dibayar dan Sofia adalah Rp.1.000

Figure 4 Students' answers to question number 4

Bilangan genap :  $2m$   
 Bilangan ganjil :  $2n + 1$   
 Jumlah genap dan ganjil  
 $= 2m + (2n + 1)$   
 $= 2m + 2n + 1$   
 $= 2(m + n) + 1$   
 karena  $(m + n)$  bilangan bulat, maka  $2(m + n) + 1$  bilangan ganjil. sehingga genap + ganjil = bilangan ganjil

Figure 5 Students' answers to question number 5

with everyday reasoning. However, the figure also reveals that many students experience difficulties in simplifying algebraic expressions correctly, which leads to inaccurate conclusions. This suggests that students have not yet fully understood the meaning of the problem or identified the appropriate mathematical concepts required for its solution. In addition, they are not able to clearly explain the relationship between algebraic representations and the conceptual understanding of odd and even numbers. The results of the students' work provide an overview of the differences between students with high, medium and low-category mathematical connection skills. Students who do the steps correctly can create a mathematical model based on the problem presented. Students solve problems with improper solving steps when they need to understand the problem being solved clearly. Procedural errors make the completion less precise, even though students can understand the concepts to be applied and compile mathematical models correctly. The steps to solve student problems need to be more structured because they do not include instructions and known information. Students with low abilities often only guess without logical reasons and are not careful when solving problems.

The improvement of students' mathematical connection ability in applying ethnomathematics can be measured using the N-Gain test, which analyzes the difference in pretest and posttest results. The N-Gain test is used to determine the effectiveness of learning by looking at the improvement in student understanding after a specific intervention or treatment. N-Gain values are categorized into 3 levels: Low ( $g < .3$ ), medium ( $.3 \leq g < .7$ ), and high ( $g \geq .7$ ). The results of the N-Gain test in this study are presented in the following Table 3, which shows the category of N-Gain score acquisition based on students' pretest and posttest data.

The results of the N-Gain analysis are presented in Table 3, which classifies the improvement in students' mathematical connection ability into specific categories. The analysis shows that the average N-Gain score reached 61.3 percent, which falls into the moderate category,

indicating that the learning approach is practically effective. This finding suggests that the integration of ethnomathematics contributes to improving students' ability to connect mathematical concepts with real-life situations. The improvement is evident from the comparison between pretest and posttest results, which demonstrate a better understanding and application of mathematical concepts after the implementation of ethnomathematics-based learning. In addition, the learning process was successfully carried out, as reflected in the average implementation score of 3.35, with 80 percent of students achieving the minimum mastery criteria of 75 percent. Positive student responses, reaching at least 60 percent, further support the effectiveness of this approach. Statistical testing also confirmed that the data were normally distributed and showed a significant increase in posttest scores ( $p = .000$ ). The learning process was structured through several stages, including connecting algebraic concepts with Bugis cultural elements, engaging in problem-solving activities, peer interaction, contextual cultural examples, reflection, and assessment. Furthermore, the posttest results categorized students' mathematical connection abilities into high, medium, and low levels, reinforcing the conclusion that ethnomathematics-based learning is effective in enhancing students' mathematical understanding.

## Discussion

The collected results highlight the ongoing challenge of applying mathematical knowledge in practical contexts. Many students struggle to connect abstract mathematical concepts with real-world applications, indicating a gap in traditional instructional methods. To address this, incorporating ethnomathematics into education can enhance students' comprehension by linking mathematics to cultural practices, making learning more meaningful and relevant (El Abbadi & Alaoui, 2023; Sunarti et al., 2022). A multidisciplinary approach that integrates various competencies across subjects through thematic learning can further support this connection (Thamrin Tahir et al., 2020). Activities promoting active participation help students develop critical thinking and problem-solving skills (Rahmawati et al., 2020). Additionally, research suggests that incorporating cultural values into mathematics education strengthens reasoning and mathematical communication skills and enriches students' learning experiences (Hariastuti et al., 2022; Kalay et al., 2020; Nychkalo et al., 2020). These findings

**Table 3** N-Gain value acquisition categories.

| No | N-Gain Score Interval | Category | Frequency | Percentage |
|----|-----------------------|----------|-----------|------------|
| 1. | $g > .7$              | Tall     | 8         | 32         |
| 2. | $.3 \leq g \leq .7$   | Keep     | 16        | 64         |
| 3. | $g < .3$              | Low      | 1         | 1          |
|    |                       | Sum      | 25        | 100        |
|    |                       | Average  |           | .613       |

underscore the need for innovative educational strategies to bridge the gap between mathematical theory and practical application, ensuring students gain conceptual understanding and applicable skills.

When ethnomathematics is not included in the curriculum, students may find their education less relevant and meaningful. Ethnomathematics connects math to local traditions, helping students understand concepts and feel a sense of belonging. This approach prepares students to succeed in a globalized world by interacting with people from diverse backgrounds (Hariastuti et al., 2022; Rosa & Orey, 2021). Culture-based math education, which integrates contextual learning, deserves further study (Rodríguez-Nieto & Alsina, 2022; Turmuzi et al., 2023). Avoiding stereotypes in education while promoting critical thinking and civic engagement is essential (Johnson et al., 2022; Rosa & Orey, 2021; Wiryanto et al., 2022). Strategies such as repeated exercises, group discussions, feedback, double-checking answers, and using concrete materials—like cultural elements in learning—support this goal (Hamidah & Kusuma, 2024; Hortelano & Lapinid, 2024; Zuliana et al., 2023). Without ethnomathematics, students may struggle to see math's relevance in daily life, making learning feel abstract and disconnected. Integrating ethnomathematics is vital to building meaningful mathematical connections.

Efforts to integrate math with local culture in education often fall short in helping students understand math within their cultural context. Math education at all levels should include opportunities to solve problems rooted in real-world contexts (Komljanec & Šebalj, 2020; Rodríguez-Nieto & Alsina, 2022; Yılmaz et al., 2020). Culture-based math education, which incorporates contextual learning, needs further research (Hariastuti et al., 2022; Turmuzi et al., 2023; Umbara et al., 2021). These findings add to research on mathematical understanding through cultural activities like folk games (Abay & Parola, 2024; Runtu et al., 2023). To assess how well ethnomathematics fosters math literacy, this study must explore the methods, challenges, and processes students use to apply math concepts (Runtu et al., 2023; Tesfamicael & Enge, 2024; Yang & Li, 2024). Contextual learning is more engaging for students when their cultural elements, such as local measurement units, are used in teaching math.

The gap between students' traditional math thinking and current teaching methods suggests that students struggle to link abstract math ideas with their cultural and real-world contexts. This can be improved by emphasizing connections between math concepts and local cultural practices through ethnomathematics. Teachers can better meet students' needs, increase engagement, and reach

learning goals by incorporating the Tribium curriculum (Hariastuti et al., 2022; Mumpuni & Marsigit, 2022; Turmuzi et al., 2023). Using hands-on learning and guiding questions, these approaches encourage students to discover key math and science concepts actively, helping them build knowledge through experience (Hamidah & Kusuma, 2024; Rosa & Orey, 2021; Wiryanto et al., 2022). Ethnomathematics allows students to engage with real-life questions, drawing evidence-based conclusions (Rosa & Orey, 2021). Connecting math to students' lives and cultures can make math more understandable, provide context, and improve real-world problem-solving (Mumpuni & Marsigit, 2022), strengthening the link between theory and application across cultural settings.

There is a gap between theory and practice because mathematical concepts are not fully integrated into learning through practical applications. To address this, it is important to improve how ethnomathematics is incorporated into education. Active collaboration from both teachers and students is crucial for effectively applying these techniques (Hariastuti et al., 2022; Mohamed-Amar & Mohamed-Amar, 2024). Most teachers believe that involving students in the assessment process leads to better outcomes (El Galad et al., 2024; Johnson et al., 2022; Mumpuni & Marsigit, 2022). They can use mathematical concepts, methods, and models to explain why certain behaviors are unsustainable and suggest alternatives (Abay & Parola, 2024; Hariastuti et al., 2022; Runtu et al., 2023; Tesfamicael & Enge, 2024). Thus, teachers and students need to work together to connect local culture with mathematics learning. Teachers are advised to involve students in assessments so that they better understand the relationship between mathematics and culture. Ethnomathematics methods and models can help students evaluate concepts in everyday life and find solutions that are more relevant to their culture.

For instance, an intervention using read-aloud activities helps kindergarten students grasp geometry concepts like part-whole relations (Powell et al., 2024). Similarly, studies show that using Arduino tools for programming activities enhances conceptual understanding (Akış, 2024; Hamidah & Kusuma, 2024; Hariastuti et al., 2022; Mumpuni & Marsigit, 2022; Wiryanto et al., 2022). By connecting mathematical ideas with cultural norms and everyday needs, students can better understand the practical applications of math. This approach makes learning more relevant and meaningful, bridging the gap between mathematics and real-world applications.

## Conclusion and Recommendation

The conclusions highlight challenges linking math learning with local culture and real-life contexts. While approaches like ethnomathematics have been introduced, they have not yet effectively helped students deeply understand math in a way that feels relevant. The gap between traditional math learning and real-world application limits students' ability to use math in daily life. Learning can feel less meaningful without an ethnomathematics-based approach, reducing student engagement and motivation. This research aims to create a more effective learning process by integrating ethnomathematics to connect math with real-world needs and bridge the gap between theory and practical application.

Further research can focus on developing and implementing more effective ethnomathematics-based learning models to address the gap between mathematical concepts and their real-life applications. This study can explore local cultural integration strategies in mathematics learning, analyze their impact on conceptual understanding, and measure students' engagement and motivation levels. In addition, research can examine how students' critical thinking and problem-solving skills develop through this approach. The role of teachers in adapting ethnomathematics methods also needs to be further studied, including the challenges faced in its implementation. Thus, this study can provide deeper insights into the effectiveness of ethnomathematics in improving the relevance and quality of mathematics learning.

## Conflict of Interest

The researcher clarifies that this study is purely academic, with no financial interests that could impact its outcomes. Any involvement of schools or communities solely promotes culturally relevant math learning (ethnomathematics) and enhances students' math understanding. The researcher has no commercial ties or agreements with organizations that might benefit from the findings. All measures have been taken to ensure the research is conducted objectively and without bias. The researcher is committed to upholding the integrity of the results, aiming to advance science and education, particularly in ethnomathematics.

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