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Ethnomathematics in the Bissu Traditional House of Pangkep Regency in Mathematics Learning Activities

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ABSTRACT

This study aims to explore the application of ethnomathematics in the Bissu Traditional House in Pangkep Regency, South Sulawesi, by examining the various mathematical concepts embedded in the design and structure of the building. A qualitative method with an ethnographic approach was employed. Data were collected through direct observation, interviews with the guardians of the traditional house (Puang Matoa), and field documentation. The data were analyzed through the stages of reduction, presentation, and conclusion drawing. The findings reveal that the Bissu Traditional House incorporates concepts such as geometry, numerical patterns, proportionality, symmetry, and measurement. These concepts were then adapted into questions and contextual learning activities for the classroom, including calculating the volume of a triangular prism, analyzing symmetry, and determining stair gradients. This study demonstrates that ethnomathematics can serve as a bridge between mathematics learning and cultural preservation, fostering relevant, contextual, and meaningful learning experiences for students.

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INTRODUCTION

Education is one of the most important components in human life because it can be used to pass on knowledge, values, and skills from one generation to the next. According to Sulistyani, et al. (2019), education is a basic need for society because humans continue to learn throughout their lives. Education plays a role in increasing intellectual capacity while preserving cultural diversity in Indonesia. Cultural preservation in education can be achieved by integrating local culture into the curriculum, known as education based on local wisdom. In line with the opinion of Andrian et al. (2018), who stated that a strategy is needed to preserve culture and customs because advancements in science and technology cause young people or students to neglect the culture and customs of a particular region. Cultural preservation is important to counteract the distracting effects of technological advancements on students' attention toward local customs and culture, one of which is by integrating them into educational materials. Educational materials that can be integrated with culture include mathematics education.

Mathematics education plays a crucial role in developing students' logical, analytical, and creative thinking skills, which form the foundation for solving problems in daily life and across various fields of science (Ahmadi & Ary, 2022). According to Fajriah and Suryaningsih (2021), mathematics is often regarded as one of the purest, most rational, and universally applicable fields of study within formal education. However, despite the perception of mathematics as universal, the culture and perspectives of specific societies often influence it. This is in line with Yudanti et al. (2022), who state that there is a close relationship between mathematics and social life, because indirectly, society has implemented various activities that involve mathematical concepts. The mathematical practices carried out by local communities can be studied in more depth by linking culture and mathematics. One way to link culture with mathematics is through the concept of ethnomathematics.

The term ethnomathematics was introduced by Ubiratan D'Ambrosio around 1960. Ethnomathematics is the study of how mathematics is embedded in various cultures. In this case, how individuals or groups within a culture use, master, and implement mathematical principles in their daily lives (Kiky, et al. 2024). Ethnomathematics is an approach that involves local culture with mathematical concepts that can be incorporated into the learning process at school (Fitriyah & Dasari, 2023). Ethnomathematics shows that mathematics is not merely a product of abstract thinking in the academic world, but is also influenced and practiced by traditional societies in various cultural contexts. This opens up the perspective that mathematics has broader historical and philosophical dimensions, encompassing how various cultural groups use mathematical concepts to solve everyday problems. Ethnomathematics shows that mathematics is an integral part of human life and develops alongside the culture present in society.

One form of ethnomathematics can be found in traditional houses in Indonesia. These traditional buildings incorporate mathematical concepts into their structures, including flat shapes, spatial shapes, and symmetrical patterns (Yustinaningrum, 2024). For example, in the traditional houses of Kampung Pulo in Garut Regency, geometric concepts such as triangles, squares, and straight lines are applied in the structural design of the houses (Nurhasanah & Puspitasari, 2022). Similarly, in the traditional houses of the Bugis-Makassar people, the concept of triangles plays an important role in roof design, symbols of social strata, and other geometric elements (Laukum et al. 2024). This study demonstrates that ethnomathematics not only aids in preserving culture but also has the potential to serve as relevant contextual mathematics learning material for students. This approach also contributes to strengthening cultural identity while enhancing students' analytical skills in understanding mathematical concepts through real-life experiences they encounter daily.

Various studies on ethnomathematics in traditional houses in Indonesia have been conducted, such as the exploration of geometric shapes in the Bubungan Tinggi Traditional House in South Kalimantan (Ruek & Padmasari, 2022), the motifs of the Kajang Lako Traditional House in Jambi (Sartika et al. 2024), and the structure of the Baduy Traditional House in Banten (Sekarpandan et al. 2022). However, most of these studies have focused more on identifying geometric shapes or cultural values without developing the results into contextual mathematics learning problems. Additionally, there has been no research specifically examining ethnomathematics in the Bissu Traditional House, so this study aims to fill that gap.

The Bissu Traditional House in Pangkep Regency, South Sulawesi, is an important part of Bugis culture that is still preserved today. In addition to serving as a venue for traditional ceremonies, the architectural structure of this house demonstrates the application of various traditional mathematical concepts, such as the triangular prism shape of the roof, the beams in the body of the house, and the numerical patterns and symmetry in its layout. This potential underscores the importance of exploring ethnomathematics in the Bissu Traditional House in relation to contextual mathematics education. The traditional ceremony led by the Bissu is held at the "bola arajang" (ancestral house) in Segeri, located in the area of a Dutch colonial-era fortress. This brown-painted raised house is not only a traditional house but also serves as a storage place for ancestral artifacts and a venue for traditional ceremonies.

(a) (b) (c)

Figure 1. (a) The Shape of the Bissu Traditional House (b) The roof of a traditional Bissu house is triangular in shape (c) Side View of the Bissu Traditional House
(Personal Documentation, 2024)

Based on field observations, the Bissu Traditional House in Pangkep Regency, South Sulawesi, is one of the cultural heritages of the Bugis people that has not been widely explored from an ethnomathematical perspective. This study aims to examine the relationship between mathematical concepts and local cultural values reflected in the architectural design of the traditional house. Unlike previous studies that typically focus on Bugis-Makassar traditional houses or other regions, this study specifically identifies mathematical elements such as geometric shapes, number patterns, symmetry, proportionality, and measurement, and integrates them into contextual mathematics problems and learning activities. Thus, this research is expected to enrich the field of ethnomathematics in Indonesia and make a tangible contribution to the development of learning media based on local culture.

METHOD

The type of research used in this study is exploratory qualitative research with an ethnographic approach. Ethnography is an empirical and theoretical approach aimed at providing in-depth descriptions and analyses of a culture based on intensive field research by the researcher (Kusumayanti et al. 2024). This study is referred to as exploratory qualitative research because the researcher aims to explore mathematical concepts found in the traditional Bissu Pangkep house. The research was conducted in Segeri District, Pangkep Regency, South Sulawesi. The researcher conducted direct observations of the Bissu Traditional House to identify architectural forms containing mathematical elements such as spatial structures, symmetry, and numerical patterns. Observations were conducted for approximately one hour, noting various structural elements of the building such as the roof, stairs, pillars, and window arrangements, as well as the relevance of these elements to mathematical concepts.

The interview was conducted in a semi-structured manner with one main informant, Puang Matoa, the official guardian and traditional leader of the Bissu Traditional House. The interview lasted approximately 35 minutes and focused on exploring the symbolic and functional meanings of each element of the building, which could potentially be linked to mathematical concepts. The selection of Puang Matoa as the informant was based on his role as a traditional leader with in-depth knowledge of the history, structure, and cultural philosophy of the Bissu Traditional House. He was chosen as the sole informant because he is the official person appointed to guard the traditional house and has full authority to provide information about the building. Based on traditional rules that are strictly upheld by the local community, no other residents are allowed to guard or explain the Bissu Traditional House. Thus, all valid and authentic information related to this traditional house can only be obtained through Puang Matoa.

In addition to interviews and observations, researchers also collected data through documentation in the form of photographs, field notes, and copies of written information found in the traditional house environment. To strengthen data validity and minimize potential bias from the use of a single informant, triangulation was carried out by comparing interview results with direct observation data and visual documentation.

Researchers also matched field findings with literature discussing Bugis culture and the structure of traditional houses as a form of source triangulation.

The data obtained was analyzed through three stages, namely data reduction, data presentation, and conclusion drawing. In the data reduction stage, researchers filtered the data based on its relevance to mathematical concepts such as geometry, symmetry, proportionality, and measurement. The data presentation stage was carried out by organizing the information into narrative descriptions and visual tables, which grouped the findings based on mathematical concept categories. Furthermore, in the conclusion drawing stage, the researcher compiled the relationship between traditional house structures and mathematical concepts and developed the results of this exploration into teaching materials in the form of questions and contextual mathematics learning activities based on local culture.

RESULTS AND DISCUSSION

This study aims to integrate local culture into mathematics learning activities through an ethnomathematics approach. One example of the application of ethnomathematics can be seen in traditional houses in Indonesia, such as the Bissu Traditional House located in Segeri, Pangkep Regency, South Sulawesi. The Bissu Traditional House reflects the culture of the Pangkep community, including in the performance of traditional ceremonies. The structure of the Bissu Traditional House mirrors the distinctive architecture of Bugis traditional houses, consisting of three parts with philosophical values believed by the Bugis people: 1) Rakkeang (the roof section) is the highest part and considered sacred by the Bugis people, often used to store rice and heirlooms. 2) Alle bola (the middle section) is seen as a symbol of human life, with the belief that human life is at the center of the world. 3) Yawa bola (the lower section) is believed to be the dwelling place of the Dewa uwae, considered the underworld and a symbol of all things that are less than good and impure (Carina et al. 2023). Therefore, this study focuses on mathematical analysis of the main architectural elements of traditional houses, as well as their connection to local cultural values and learning activities.

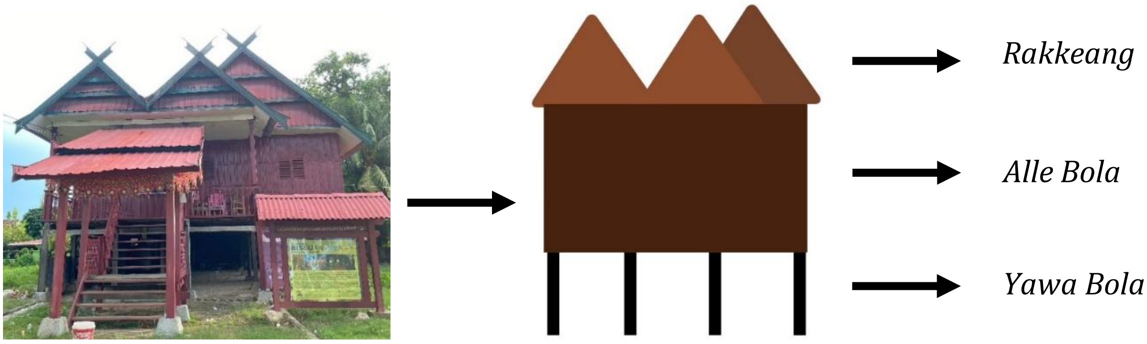


Figure 2. Three Parts of a Traditional Bissu House
(Personal Documentation, 2024)

1. Rakkeang (House Roof): Analysis of Triangular Prism Geometry and Trigonometry

The roof of the Bissu Traditional House has geometric elements in the form of triangular prisms because there are two congruent sides, namely ΔABC ≅ΔPQR, and all other sides are parallelograms. The quadrilaterals ABPQ, ACPR, and BCRQ are parallelograms because they have two pairs of sides of equal length (Sekarpandan et al. 2022).

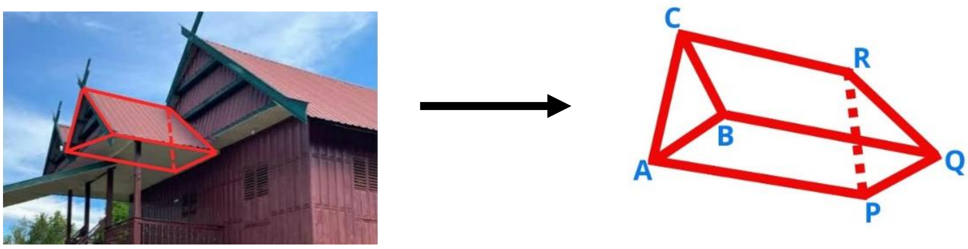


Figure 3. The upper part of the house is shaped like a triangular prism
(Personal Documentation, 2024)

Based on field documentation, if we assume that the roof of the house has a triangular base with a length of 6 meters, a height of 4 meters, and a prism length (roof length) of 10 meters, then the volume of the roof can be calculated using the following formula for the volume of a triangular prism:

$$V = \frac{1}{2} \times base \times triangle\ height \times length = \frac{1}{2} \times 6 \times 4 \times 10 = 120m^3$$

This volume can be used as practice questions on spatial geometry. In addition, the angle of the roof slope can also be calculated using trigonometric functions. If the length of the sloping side of the triangle is 5 meters, then:

$$\sin(\theta) = \frac{4}{5} \rightarrow \theta \approx 53{,}13°$$

These results indicate that local communities have intuitively applied the principles of geometry and trigonometry in the design of traditional roofs. This finding opens up opportunities for teachers to utilize traditional architectural designs as a medium for contextual learning in teaching mathematical concepts such as volume, surface area, and slope. Through a problem-based approach relevant to the students' environment, learning becomes more concrete and easier to understand. As a form of integration between culture and education, ethnomathematics derived from roof design not only strengthens mathematical concept understanding but also instills the importance of understanding the local context in the application of mathematics. By studying how triangular prisms are used in traditional roof structures, students are encouraged to see that mathematics is a relevant tool in real life. This approach makes mathematics learning more meaningful and engaging, while fostering appreciation for the local wisdom that thrives within the community (Mahmudah & Arif, 2022).

2. Alle Bola (Middle Section): Representation of Block Structures and the Principle of Symmetry

The central part of the house, or Alle Bola, has a structure resembling a rectangular prism that can be analyzed mathematically using geometric concepts. A block is a type of three-dimensional shape in mathematics that has three dimensions: length, width, and height. This shape consists of six rectangular sides, with pairs of sides that are parallel and of equal size (Sipahutar & Reflina, 2023). By knowing the length, width, and height of the block, the volume of Alle Bola can be calculated using the formula:

$$V = p \times l \times t$$

Figure 4. The Middle Part of the House (*Alle Bola)*
(Personal Documentation, 2024)

This structure reflects the efficient use of geometric shapes in the division of space, while also providing opportunities to link the concepts of volume, surface area, and the properties of spatial figures in mathematics learning. Additionally, the windows and doors symmetrically positioned on the left and right sides of the building demonstrate the application of fold symmetry and reflection symmetry principles. This phenomenon can be utilized by teachers in teaching symmetry concepts as part of plane geometry through a culturally contextual approach.

The use of symmetry in house design reflects the philosophical values of the Bugis people, who emphasize balance and harmony in daily life. Thus, the integration of mathematical concepts and local cultural philosophy enriches students' learning experiences not only cognitively but also affectively and contextually.

3. Yawa Bola (Lower Section): Support Poles and Structural Stability Concepts

The lower part of the house (Yawa Bola) also has ethnomathematical elements that can be used in mathematics learning activities. In the context of mathematics, the structure of the house pillars can be used as a learning medium to teach various concepts, such as geometry, symmetry, proportionality, and even the concept of material strength, which involves measurement and data analysis (Meyundasari et al. 2023).

Figure 5. The Lower Part of the House (*Yawa Bola)*
(Personal Documentation, 2024)

The pillars of this traditional house are geometrically shaped like blocks with bases in the form of rectangular or pentagonal prisms. In mathematics lessons, students can learn about the properties of blocks, such as the formulas for volume and surface area. For example, if the base of the pillar is a square with sides measuring 20 cm and the height of the pillar is 2 meters, students can calculate the volume of the pillar using the formula $V = p \times l \times t$. This calculation helps students understand the application of the concept of volume in real life. In addition, the trapezoidal or pentagonal base design, which strengthens the column's bearing capacity, can be used as learning material about irregular flat shapes.

Apart from geometry, measurement, and proportionality, the structure of this traditional house also introduces the concepts of space and optimization. The space under the raised house is typically used for various activities, such as storage, shelter, or social activities (Ayudya et al. 2019). Teachers can guide students to calculate the area of the space under the house using the formula $L = p \times l$, and compare the ratio between the utilized space and the total available space.

Through analyzing the structure of Bissu traditional houses, students can learn that mathematics is a living science that is closely connected to culture and the practical needs of society. This ethnomathematics approach makes learning more contextual, interesting, and meaningful, so that students not only understand mathematical concepts, but also appreciate the local wisdom that is part of their identity (Mahmudah & Arif, 2022).

4. House Stairs: Gradient, Slope Angle, and Number Patterns

In addition to the three parts of the Bissu traditional house, the stairs of the traditional house also have ethnomathematics concepts in math learning activities. Each step in Figure 6 has a relatively uniform size, which can be used to introduce concepts such as arithmetic sequence, number patterns, and measurement (Assidiqi & Atiah, 2024). For example, the distance between steps can be analyzed using the concept of number or ratio, while the total number of steps can be used as a basis for introducing patterns or simple calculations.

Figure 6. Bissu Traditional House Stairs
(Personal Documentation, 2024)

In addition, the slope of the stairs can be used as a discussion material to learn the concept of gradient or angle in geometry, where students can calculate the ratio between the height and length of the stair base to find the slope value (Ahmad & Ashari, 2024). For example, if the staircase has a vertical height of 4 meters and a horizontal length of 5 meters, then the slope angle θ can be calculated by:

$$tan(\theta) = \frac{4}{5} \Rightarrow \theta \approx 38{,}66°\, m$$

This calculation can be developed into a learning activity that integrates geometry, measurement and trigonometric functions in the context of local culture. In addition, students can also be asked to analyze the number and distance between steps as a repeating number pattern, such as an arithmetic sequence.

This learning activity not only strengthens students' arithmetic skills, but also provides an understanding of the importance of safe and functional design in traditional architecture. Through this approach, students can learn that math is not only abstract, but also plays an important role in the practical aspects of everyday life.

5. Cultural Symbols and Ethnomathematical Attributes

In addition to the building structure, cultural symbols found in Bissu traditional houses, such as ornaments on traditional clothing and patterns on information boards, also contain mathematical elements. Many of them contain symmetrical patterns, repetition and simple geometric shapes such as squares, triangles or circles.

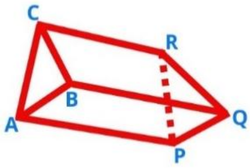
For example, a square-shaped information board with an area of 16 m^2 has a side length of 4 meters. Teachers can use this element to teach the concepts of area, perimeter and symmetry. In addition, the social structure and ritual order of the Bissu custom can also be used as a context to introduce the concepts of order, sequence or probability.

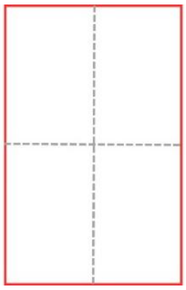
Figure 7. Information Board about Bissu Traditional House
(Personal Documentation, 2024)

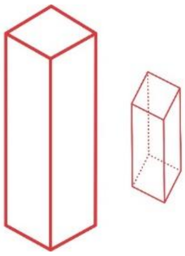
This picture shows the Bissu community, a traditional cultural group in South Sulawesi with high historical, social and spiritual values. In ethnomathematics-based mathematics learning, Bissu cultural elements such as traditional clothing, traditional tools and symbolic ornaments can be utilized to teach concepts of geometry, symmetry and number patterns. Ornaments on traditional clothing, for example, feature symmetrical or repetitive patterns that are relevant to the concepts of symmetry, rotation, and translation (Hartono & Aisyah, 2024). Sequence structures in traditional rituals can also be analyzed as representations of rows or time intervals. Meanwhile, traditional tools such as weapons and heirlooms reflect the intuitive application of the concepts of measurement and geometric shapes (Yolanda & Asrul, 2024). In addition, the social structure of Bissu can be related to the concepts of statistics and chance, such as the distribution of gender roles in society.

From several mathematical concepts contained in the Bissu traditional house, it can be applied to the form of problems as in table 1.

Table 1. Ethnomathematics in the Bissu Traditional House of Pangkep Regency and Application in the Form of Mathematical Problems

<table>
<tr><th>No</th><th>picture</th><th>Link to Ethnomathematics</th><th>Soal dan Pembahasan</th></tr>
<tr><td>1</td><td></td><td>

On the roof of the Bissu traditional house, there are elements of geometry, namely in the form of a triangular prism. In mathematics, a triangular prism is one of the spaces that has two bases in the form of congruent triangles and the other sides are rectangles.</td><td>Bissu Traditional House is one of the traditional traditional houses typical of the Bugis community located in Segeri sub-district, Pangkep Regency, South Sulawesi Province. The traditional house has a triangular prism-shaped roof. If the length of the base of the triangle is 12 m and the height is x meters. The volume of the roof is 576 m^3, with a prism length (roof height) of 12 m. Determine the height of the base of the triangle!
Answer:
Given:
Base length = 12 m
Roof volume = 576 m^3
Prism length (roof height) = 12 m
Asked:
Height of the base?
Solution:
Suppose:
• $x =$ height of the triangle
From the problem, we can create an equation.
$V = base\ area\ \Delta \times prisma\ height$
$576 = \left(\frac{1}{2} \times 12 \times x\right) \times 12$
$576 = 72x$
$x = 8\ m$
So, the height of the base of the triangle on the roof of the house is 8 meters.</td></tr>
<tr><td>2</td><td></td><td>
The window of a traditional Bissu house is rectangular, one of the flat shapes that has two pairs of parallel and equal-length sides and four right angles. It also has two folding symmetries, horizontal and vertical</td><td>The center of the Bissu traditional house, called Alle Bola, is surrounded by solid walls as the main protection. On these walls there are several windows designed in a symmetrical pattern. When the length of the window is 120 cm, and the width is 80 cm. Then the window is folded along its vertical centerline, what is the length of the side that covers each other?
Answer:
If the window is folded along its vertical centerline:
The length of the side that covers each other is half the width of the window
$side\ length = \frac{window\ width}{2}$
$= \frac{80}{2} = 40\ cm$
Then, the right and left sides of the window, each 40 cm long, will cover each other.</td></tr>
</table>

3		 The pole of a traditional Bissu house can be analyzed as a block because it is three-dimensional with length, width and height that are perpendicular to each other. The sides are flat, square or rectangular, with right angles. The shape is symmetrical and designed to support the roof and floor loads, reflecting the beam's function of resisting compressive and tensile forces..	The lower part of the Bissu Traditional House, called Yawa Bola, is supported by strong wooden poles. These poles are in the form of beams that function to support the stilt house so that the house remains stable and safe, even though it is in an area at risk of flooding. If the stilt house is built on flat land with 10 wooden poles in the form of beams. Each pole is 2.5 meters long, 20 cm wide, and 20 cm high. What is the volume of wood needed to make all the poles? **Answer:** Given: Side length = 2,5 m Width = 0,2 m Heigth = 0,2 m Asked: Wood volume for 10 poles? Solution: Wood volume for one pole: $V = p \times l \times t$ $= 2{,}5 \times 0{,}2 \times 0{,}2$ $= 0{,}1\ m^3$ Wood volume for 10 poles: $V_{total} = 10 \times 0{,}1 = 1\ m^3$ So, the volume of wood required to make 10 poles is 1 m^3
4		 The stairs of the Bissu traditional house contain a mathematical concept in the form of a slope angle element, which is the angle between the surface of the stairs and a flat plane. This angle is formed from the ratio of the height of the stairs and the length of the stairs, thus forming a right triangle.	At the bottom of the Bissu traditional house, there is a staircase designed with a precise slope for comfort and safety. If the ladder is leaned against a wall so that the top of the ladder touches the wall at a height of 4 meters from the ground and the ladder is 5 meters long. What is the angle of inclination of the ladder with respect to the ground? **Answer**: Use trigonometric functions. Suppose the angle of inclination is θ, then: $\tan\theta = \frac{ladder\ height\ against\ the\ wall}{long}$ $= \frac{4}{5}$ $\theta = \arctan\frac{4}{5}$ $= 38{,}65°$ So, the angle of inclination of the stairs to the ground is 38,65°

5		 The information board in the Bissu traditional house has a square shape, which is a flat shape with four equal sides and four right angles (90°). In geometry, a square is known to have special properties, such as four lines of symmetry (vertical, horizontal and two diagonals) that divide the board into equal parts.	The Bissu Traditional House, as one of the cultural heritages of the Bugis people in South Sulawesi, is equipped with a square information board. If the information board has an area of $16\ m^2$ and someone wants to install a frame around the information board. How long does the frame need to be? **Answer:** Given: $L_{square} = 16\ m^2$ Asked: Required frame length? Solution: $broad = side \times side$ $16\ m^2 = s^2$ $s = \sqrt{16} = 4\ m$ $around = 4 \times side$ $= 4 \times 4 = 16\ m$ So, the required frame length is 16 meters

Exploration of the Bissu Traditional House in Pangkep Regency shows that the geometric structure of this building includes various shapes such as triangular prisms, blocks, jajargenjang, trapezoids, and number patterns. These elements provide contextual opportunities for math learning, particularly in the topics of geometry, symmetry, measurement, gradient and trigonometry. For example, the triangular prism-shaped roof reflects the concepts of volume and surface area, the middle section as a beam can be used to study spatial figures, while the stairs and poles present jajargenjang and trapezoidal shapes that can be analyzed in terms of structural stability and material efficiency.

These structures not only function practically and aesthetically, but also reflect Bugis cultural values that can be utilized as contextual learning media. In line with the opinion of (Dahlan & Permatasari, 2018), Understanding mathematical concepts through cultural contexts allows students to apply this knowledge in real life. This ethnomathematics approach not only deepens mathematical understanding, but also strengthens appreciation of local culture and student identity.

CONCLUSION

This research shows that the Bissu Traditional House in Pangkep Regency contains various mathematical concepts that are naturally integrated in its building structure. Key findings include a roof shape that resembles a triangular prism, a block-shaped center of the house, columns with square or trapezoidal cross-sections, and a staircase with a slope angle that can be analyzed using trigonometry. These elements not only reflect the community's intuitive understanding of form and function, but also show great potential for relating them to mathematical concepts such as geometry, symmetry, measurement, number patterns and gradients.

The implication of this research for the world of education is that the ethnomathematics elements contained in the Bissu traditional house can be utilized as contextual teaching materials in mathematics learning. Teachers can integrate the structure of traditional houses as a local culture-based learning media to improve students' conceptual understanding and foster appreciation for local wisdom. This approach supports meaningful, relevant learning, and brings math closer to students' real lives.

However, this study has limitations, namely the limited number of informants (only one main informant) and the focus of observation on only one traditional house. In addition, the analysis was conducted qualitatively without further testing the effectiveness of its use in the classroom learning process.

Therefore, further research is recommended to involve more traditional informants and compare traditional houses from various regions to enrich the exploration of ethnomathematics concepts. Further research can also develop learning models or teaching tools based on ethnomathematics that are empirically validated in the teaching and learning process at school.

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