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Exploration of Ethnomathematics in the Mandar Traditional House as A Source of Deep Learning Based Instruction in Schools

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ABSTRACT

Mathematics learning is often delivered through procedural approaches that make mathematical concepts abstract and disconnected from students' cultural experiences, limiting meaningful learning. Integrating ethnomathematics into the Deep Learning curriculum offers a contextual approach that connects mathematics with local culture to promote meaningful, mindful, and joyful learning. This study aimed to identify the ethnomathematical concepts embedded in the Mandar Traditional House (Boyang) and explore their potential for Deep Learning–based mathematics instruction. A qualitative ethnographic approach was employed using one key informant, A'ba Tammalele, a traditional leader purposively selected for his extensive knowledge of Mandar culture and traditional architecture. Data were collected through participant observation, semi-structured interviews, architectural measurements, and documentation using observation guidelines, interview protocols, documentation sheets, and ethnographic field notes. Data were analyzed using Spradley's ethnographic model, including domain, taxonomic, componential, and cultural theme analyses. The findings revealed mathematical concepts related to geometry, measurement, spatial orientation, numerical symbolism, and geometric transformations embedded in the architectural elements of the Mandar Traditional House. These concepts reflect the cultural values and local knowledge of the Mandar community and provide authentic contexts for mathematics learning. The novelty of this study lies in integrating ethnographic findings with mathematical modeling and transforming them into a framework for Deep Learning–based mathematics instruction, thereby supporting both conceptual understanding and the preservation of local cultural heritage.

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Introduction

Mathematics plays a fundamental role in developing logical thinking, reasoning, and problem solving skills that are needed in everyday life as well as in various professional fields (Avila & Caballes, 2024). Understanding mathematical concepts enables individuals to develop analytical abilities, data-driven decision-making, and abstract thinking, which are essential skills in the modern era (Apriliyana et al., 2023). In practice, however, mathematics is still often perceived as a difficult, abstract subject that is not relevant to students' real life experiences (Dwiguningtyas et al., 2025). This problem is inseparable from the learning process, which is still dominated by conventional approaches that emphasize procedural memorization and mechanistic exercises without meaningful context (Sahroni et al., 2024). As a result, students tend to be passive, less engaged in the learning process, and experience difficulties in understanding concepts in depth (Septiana et al., 2022). This condition leads to low learning motivation and the emergence of negative perceptions toward mathematics (Purbaningrum et al., 2023). Therefore, this situation highlights the need for a learning approach that can promote deeper conceptual understanding, is contextual, and actively involves students.

One relevant approach is deep learning, which emphasizes meaningful learning, active student engagement, and a joyful learning environment. Various studies have shown that this approach is effective in improving conceptual understanding, critical thinking skills, and students' mathematics learning outcomes (Sitompul et al., 2025). Therefore, deep learning becomes a strategic alternative for addressing the weaknesses of conventional learning (Hayati & Almuslim, 2025). Meanwhile, the ethnomathematics approach views mathematics as a part of culture that is reflected in the social practices of society (Wardani & Budiarto, 2022). Through ethnomathematics, mathematical concepts can be connected to local cultural contexts, making learning more concrete and meaningful (Yudhi & Septiani, 2024). Various studies have shown that the integration of local culture in mathematics learning can enhance conceptual understanding as well as students' learning motivation Dhema et al. (2025) and Rua et al. (2025). Therefore, ethnomathematics has great potential to bridge the gap between formal mathematical concepts and students' real-life experiences

One form of culture that contains mathematical values is traditional houses (Maulida et al., 2026). The Mandar traditional house, known as Boyang, is a stilt house with a symmetrical structure and incorporates various mathematical concepts such as geometry, patterns, and proportions. The building structure, spatial arrangement, and ornaments of this traditional house reflect mathematical principles that can be utilized as contextual learning resources in mathematics education (Anindya et al., 2026). Although ethnomathematics studies have been widely conducted in various cultural contexts, most previous research has primarily focused on identifying mathematical concepts embedded in cultural artifacts, such as traditional houses, ornaments, and local practices. Several studies have demonstrated that traditional houses contain mathematical elements related to geometry, patterns, symmetry, and measurement. However, research on the Mandar Traditional House (Boyang) remains limited and generally provides only descriptive explanations of its cultural and architectural characteristics. Furthermore, previous studies have not comprehensively explored the relationship between specific architectural elements of the Mandar Traditional House and formal mathematical concepts, particularly geometric transformations and analytic geometry. In addition, studies on ethnomathematics and deep learning-based instruction have largely developed independently, with limited efforts to integrate ethnomathematical findings into a systematic instructional framework that promotes meaningful, engaged, and joyful learning. Therefore, there remains a research gap in understanding how the ethnomathematical concepts embedded in the Mandar

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Traditional House can be systematically identified and transformed into learning activities that support deep learning-based mathematics instruction.

The novelty of this study lies in three main aspects. First, this study provides a comprehensive exploration of mathematical concepts embedded in the architectural structure of the Mandar Traditional House, including plane geometry, line relationships, analytic geometry, and geometric transformations such as rotation, reflection, and translation. Second, unlike previous ethnomathematics studies that primarily focus on identifying mathematical elements within cultural objects Serepinah et al. (2021) this research establishes explicit connections between cultural architectural elements and formal mathematical representations through mathematical modeling and GeoGebra visualization. Third, this study develops a deep learning-based instructional design derived from the ethnomathematical exploration of the Mandar Traditional House, thereby offering an innovative framework for integrating local cultural heritage into meaningful, contextual, and student-centered mathematics learning. Based on this gap, this study aims to explore the mathematical concepts embedded in the Mandar traditional house and examine their application within a deep learning based instructional framework. This research is expected to contribute to the development of mathematics learning that is more meaningful, contextual, and promotes active student engagement, while also strengthening understanding of local culture.

Method

Settings

This study employed a qualitative research design with an ethnographic approach. Ethnography focuses on the study of culture and community life, providing a comprehensive understanding of the patterns of life, values, and social practices within a particular community (Aras & B, 2025). This approach was considered the most appropriate for the present study because the Mandar traditional house is not merely a physical structure but also a cultural artifact that embodies local knowledge, beliefs, values, and practices passed down through generations. Through an ethnographic approach, the researcher was able to explore the cultural meanings embedded in the architectural elements of the house and examine how these cultural elements are related to mathematical concepts within the framework of ethnomathematics. Therefore, ethnography enabled a deeper understanding of the relationship between cultural practices and mathematical knowledge represented in the Mandar traditional house.

The study was conducted in Ondongan, Pangali-ali Village, Banggae District, Majene Regency, West Sulawesi Province, Indonesia. This location was selected because it has preserved the Mandar traditional house in its original form and is supported by a community that continues to maintain and understand the cultural values associated with it. The study focused on a single Mandar traditional house (Boyang), which was purposively selected as the research object due to its well-preserved architectural characteristics and its representation of traditional Mandar cultural values. Focusing on one traditional house allowed the researcher to conduct an in-depth ethnographic investigation of the cultural meanings and mathematical concepts embedded in its architectural structure.

Participants

Participants were selected using purposive sampling, a technique commonly employed in ethnographic research to identify individuals who possess extensive knowledge and experience relevant to the phenomenon under investigation. This study involved one key informant, namely A'ba Tammalele (AT), a traditional leader who has comprehensive knowledge of the

history, philosophy, cultural values, and construction of the Mandar traditional house (Boyang). He was selected based on three criteria: (1) recognized status as a traditional leader within the local community, (2) direct involvement in preserving Mandar cultural heritage, and (3) extensive understanding of the architectural and symbolic aspects of the traditional house.

The use of a single key informant was considered adequate because the study focused on an in-depth ethnographic exploration of one Mandar traditional house rather than a comparative investigation involving multiple houses or communities. In ethnographic research, the richness, relevance, and cultural authenticity of information are more important than the number of participants. As a cultural authority and custodian of local traditions, A'ba Tammalele was able to provide detailed explanations regarding the meanings, functions, construction principles, and cultural practices associated with the traditional house, making him a sufficient source of information for achieving the objectives of this study. The data used in this study consisted of primary and secondary data. Primary data were obtained through direct observation of the traditional house and in-depth interviews with the key informant. Secondary data were collected through books, scientific articles, research journals, and relevant documentation related to the Mandar traditional house and ethnomathematics.

Instruments

The primary research instrument was the researcher, who functioned as a human instrument responsible for collecting, interpreting, and analyzing the research data. To support the data collection process, several supplementary instruments were employed, including observation sheets, semi-structured interview guidelines, documentation tools (camera and audio recorder), and a measuring tape used to obtain geometric data from specific parts of a Mandar traditional house (Boyang), which served as the focus of the study. The observation sheets were designed to identify mathematical elements embedded in the structure of the traditional house, such as plane figures, line relationships, patterns, symmetry, and geometric transformations. The interview guidelines were used to explore information regarding the history of the traditional house, the symbolic meanings of its architectural components, the construction process, and the cultural values embodied within it. Examples of interview questions included: “Could you explain the history or origin of this Mandar traditional house?”, “What is the philosophical meaning of the roof shape and the spatial arrangement of the traditional house?”, “Are there any specific rules for determining the dimensions, number of pillars, or architectural forms of the building?”, and “How is the traditional construction process of this house carried out?”.

Table 1. Interview Aspects and Indicators Explored

Related Interview Questions	Indicators Explored
Could you explain the history or origin of the Mandar Traditional House in this area? Have there been any changes in the construction from the past to the present? What has changed and why?	Exploring the history, origin, function of the traditional house, and changes in its construction from the past to the present.
How is the process of determining the length, width, and height of the building carried out? Are there any traditional measurement standards used?	Identifying the methods used to determine the length, width, and height of the building, traditional measurement standards, and measurement techniques applied by the community.

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Related Interview Questions	Indicators Explored
How is the spatial arrangement inside the house organized? Why is it divided in such a way? Are there any customary rules regarding the direction the house should face?	Examining the division of spaces, the function of each part of the house, and traditional rules related to the orientation of the house.
How is the roof shape determined? Are there certain calculations involved in determining the slope or length of the roof structure? Are there any symmetrical patterns or specific motifs in the house ornaments? If so, what is their meaning? What technical difficulties usually arise during the construction process of the traditional house? How is the roof shape determined?	Exploring the process of determining the roof shape, roof slope, length of the roof structure, ornament motifs, symmetry patterns, and construction techniques.
How is the number of pillars determined? Does it have any specific meaning?	Examining the method of determining the number of pillars, the number of building components, and the cultural meaning behind the use of certain numbers.

The measuring tape was used to measure several structural components related to mathematical concepts, including the length and width of the floor, distances between pillars, dimensions of the staircase, and roof measurements. The findings obtained from interviews and measurements were subsequently modeled using GeoGebra software to visualize the mathematical concepts identified, such as plane geometry, analytic geometry, line relationships, and geometric transformations. Documentation in the form of photographs, audio recordings, and field notes was utilized to record and preserve visual and verbal data that supported the research findings.

Collections

Data were collected through observation, interviews, measurements, documentation, and literature review. Observations were conducted directly on a single Mandar Traditional House (Boyang) to identify cultural and architectural elements containing mathematical concepts. The observation sheet focused on several aspects, including: (1) geometric shapes found in the roof, stairs, pillars, fences, and floor structures; (2) line relationships such as parallel and intersecting lines; (3) symmetry and geometric transformations reflected in decorative motifs and architectural components; (4) repetitive patterns in floorboard arrangements and structural elements; and (5) spatial organization and proportional relationships among different parts of the building (Dhiki et al., 2025). Semi-structured interviews were conducted with the key informant to obtain information regarding the history, symbolic meanings, construction processes, architectural philosophy, and cultural values embedded in the Mandar Traditional House. Examples of interview questions included: “Could you explain the history and function of the Mandar Traditional House?”, “What is the cultural meaning of the tumba’ layar roof structure?”, “Are there specific traditional rules for determining the dimensions and arrangement of building components?”, “What is the significance of the pillar arrangement and spatial division within the house?”, and “How are traditional values reflected in the architectural design of the house?”.

To obtain accurate geometric data, measurements were conducted using a folding measuring tape. Measurements were recorded in meters (m) and centimeters (cm), depending on the size of the architectural component being measured. The measured components included

the length and width of the floor, the height and spacing of the pillars, the dimensions of the stairs, the dimensions of the roof structure, and selected decorative elements related to mathematical concepts. These measurements were used to model geometric shapes, determine distances between points, and analyze proportional relationships within the building structure. Documentation consisted of photographs, videos, audio recordings, and field notes that supported and validated the findings obtained through observations, interviews, and measurements. In addition, a literature review was conducted by examining books, scientific articles, research reports, and other relevant written sources to support data interpretation and strengthen the ethnomathematical analysis.

Analysis

Data were analyzed using Spradley's ethnographic analysis model, which consists of four stages: domain analysis, taxonomic analysis, componential analysis, and cultural theme analysis (Qomaruddin & Sa'diyah, 2024). To provide transparency regarding the analytical process, examples of coding, categorization, and theme development are presented below. In the domain analysis stage, interview transcripts, observation notes, and documentation were examined to identify cultural elements of the Mandar Traditional House that potentially contained mathematical concepts. For example, the interview statement, "the tumba layar is designed to resemble a boat sail because the Mandar people are known as seafarers," was coded as roof shape and maritime identity. Similarly, the statement "the distance between pillars is made equal so that the house remains balanced and strong" was coded as pillar spacing and structural stability. These initial codes served as the basis for identifying domains related to architectural structures, spatial arrangements, construction patterns, and cultural symbolism.

The second stage, taxonomic analysis, was conducted to classify the identified domains into hierarchical categories. For instance, the codes roof shape, pillar spacing, cross-shaped fence pattern, and repetitive floorboards were grouped under the broader category of architectural elements. Within this category, the roof was associated with plane geometry, the pillars with analytic geometry, the fence with line relationships and rotational transformations, and the floorboards with translation patterns. This classification enabled the researcher to systematically organize the mathematical concepts embedded in the traditional house. The third stage, componential analysis, focused on identifying distinctive characteristics among architectural elements. For example, the roof structure was characterized by triangular forms and angular relationships, the pillars by equal distances and spatial positioning, the fence motifs by intersecting lines and rotational symmetry, and the floorboards by repetitive patterns and translational movements. Through this comparison, each architectural component was found to represent different mathematical properties while simultaneously reflecting particular cultural meanings.

Finally, cultural theme analysis was conducted to identify broader cultural themes emerging from the data. The codes roof shape and maritime identity formed the category of architectural symbolism, which contributed to the cultural theme of the representation of Mandar maritime culture in traditional architecture. Likewise, the codes pillar spacing and structural stability formed the category of construction principles, leading to the theme of harmony and balance in Mandar traditional architecture. The codes repetition and uniformity formed the category of spatial patterns, which generated the theme of regularity in traditional construction practices. These themes demonstrate that mathematical concepts identified in the Mandar Traditional House are closely related to the cultural values and worldview of the Mandar community.

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The ethnographic findings were subsequently translated into mathematical learning contexts and used as the foundation for developing deep learning–based instruction. Cultural elements identified through ethnographic analysis were transformed into learning activities that encourage students to explore, interpret, and reflect upon mathematical concepts within meaningful cultural contexts. For example, the triangular roof structure can be used as a context for learning geometric properties of triangles, the spacing between pillars can be explored through analytic geometry, fence motifs can be used to investigate rotational transformations, and floorboard arrangements can be utilized to study translation. Through this process, ethnographic data were not only used to identify mathematical concepts but also to design learning experiences that support meaningful learning, mindful learning, and joyful learning, which are central principles of deep learning–based instruction. To ensure the trustworthiness of the data, source triangulation, technique triangulation, prolonged engagement, and peer debriefing were employed. In addition, member checking was conducted with the key informant to ensure that the researcher's interpretations accurately reflected the information obtained during the fieldwork process.

Research Findings

The Mandar Traditional House has a unique characteristic as a stilt house that functions not only as a gathering place but also as a center for deliberation among traditional leaders. This house differs from the king's house because it is used by customary authorities to discuss governmental systems. As stated by A'ba Tammalele (informant), "the traditional house is a house inhabited by traditional leaders … a gathering place to provide input to the king." In addition, the size of the traditional house is flexible, depending on the number of community members involved, "depending on the capacity of the region … according to the number of people." The Mandar Traditional House also possesses philosophical values reflected in its spatial division and building orientation. The house is divided into three sections that demonstrate an organized spatial function, consisting of public and private spaces. A'ba Tammalele stated, "it is divided into three sections … some matters are discussed confidentially." In addition, the orientation of the house toward the sunrise symbolizes hope and new life, "it usually faces the direction of the sunrise."

From an architectural perspective, this traditional house also contains symbolic values in its roof shape and building structure. The roof form, such as butung-butung (tumba' layar), which resembles a triangle, represents a particular social status, while the use of odd-numbered dimensions carries cultural significance. In addition, there is a main pillar (posi ariang) that serves as the center of activities, as stated, "all activities are centered in the middle." Based on the interview results, the informant (AT) explained that "the house is built facing east because it is believed to bring blessings and follows the direction of the sunrise." This statement reflects the category of building orientation based on cultural beliefs. In Mandar culture, the orientation of a house is not determined solely by technical considerations but is also influenced by traditional values and beliefs that have been passed down through generations. Therefore, this excerpt represents the cultural theme of philosophical values in determining the spatial layout of traditional houses. From an ethnomathematical perspective, this practice is related to the concepts of spatial orientation and direction, demonstrating how the community applies spatial understanding in determining the position of a building.

(AT) also stated that "the number of stairs is usually made odd because it follows ancestral customs." This statement falls under the category of numerical symbolism in Mandar tradition. The use of odd numbers reflects certain cultural beliefs that are still maintained in the construction of traditional houses. This finding represents the cultural theme of the symbolic

meaning of numbers in community life. In ethnomathematics, this practice is associated with the concept of numbers, particularly the use of odd numbers as part of cultural activities and traditions. In addition, (AT) explained that "the pillars are arranged at equal distances so that the building remains strong and balanced." This excerpt can be classified into the category of traditional construction patterns, which reflect the local knowledge of the Mandar community in building traditional houses. The cultural theme that emerges is traditional architectural knowledge transmitted across generations. From an ethnomathematical perspective, the equal spacing of the pillars demonstrates the application of concepts such as measurement, geometric patterns, and spatial regularity in traditional house construction practices.

Overall, the interview findings indicate that the cultural elements embedded in the Mandar traditional house possess not only social and philosophical meanings but also reflect the application of mathematical concepts such as spatial orientation, numbers, measurement, patterns, and geometry. These findings demonstrate the close relationship between the local culture of the Mandar community and the mathematical practices embedded in their daily lives and traditional architectural knowledge.

Figure 1. Mandar Traditional House

In the roof structure of the Mandar Traditional House, there is a connection to mathematics, namely the tumba' layar shape, which resembles a triangular plane figure as shown in the figure. A triangle is a two-dimensional shape that has three sides and three angles. Geometrically, the triangular shape of the roof functions to provide structural stability to the building. In mathematical concepts, the area and perimeter of a triangle can be expressed as follow:

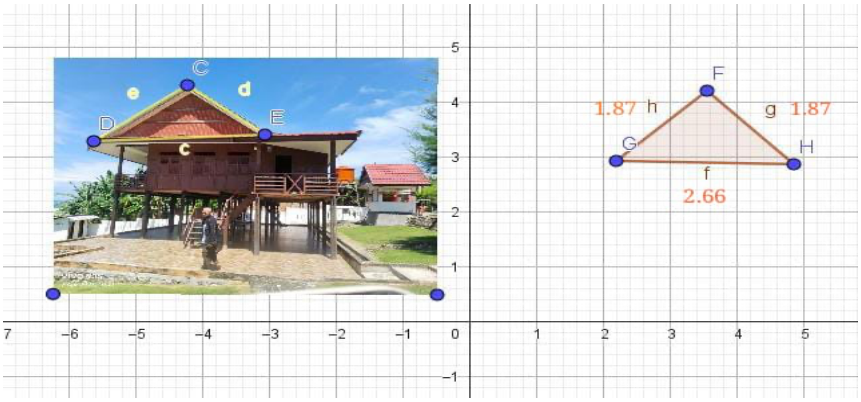

Figure 2. Representation of the Roof of the Mandar Traditional House in Relation to a Right Triangle

$$L = \frac{1}{2}at, \quad K = a + b + c$$

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In addition, if the roof structure forms a right triangle, then the following relationship applies: $a^2 + b^2 = c^2$.

Figure 3. Representation of the Lego-lego of the Mandar Traditional House in Relation to a Rotation Matrix

The cross-shaped fence motif (X) also contains concepts of geometric transformation, particularly rotation and matrix representation, which can be modeled as the result of a 90° rotation of a diagonal line about the center point (a, b). Mathematically, this transformation can be represented using a rotation matrix.

$$\begin{pmatrix} x' \\ y' \end{pmatrix} = \begin{pmatrix} (x-a)\cos\alpha - (y-b)\sin\alpha + a \\ (x-a)\sin\alpha + (y-b)\cos\alpha + b \end{pmatrix}$$

$$A' = \begin{pmatrix} x' \\ y' \end{pmatrix} = \begin{pmatrix} (1-2.5)\cos(-90°) - (1-2.5)\sin(-90°) + 2.5 \\ (1-2.5)\sin(-90°) + (1-2.5)\cos(-90°) + 2.5 \end{pmatrix} = \begin{pmatrix} 1 \\ 4 \end{pmatrix}$$

$$B' = \begin{pmatrix} x' \\ y' \end{pmatrix} = \begin{pmatrix} (4-2.5)\cos(-90°) - (4-2.5)\sin(-90°) + 2.5 \\ (4-2.5)\sin(-90°) + (4-2.5)\cos(-90°) + 2.5 \end{pmatrix} = \begin{pmatrix} 4 \\ 1 \end{pmatrix}$$

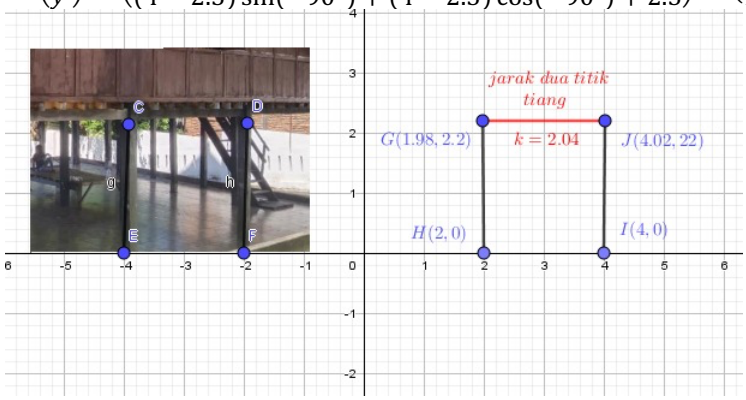

Figure 4. Representation of the Pillars of the Mandar Traditional House in Relation to the Distance Between Two Points

The distance between the pillars of the Mandar Traditional House can be modeled using the concept of the distance between two points in analytic geometry. For example, if two pillars are represented as points $A(1.98, 2.2)$ and $B(4.0, 2.2)$ then the distance between the two points can be calculated using the distance formula between two points.

$$d = (4.02 - 1.98)2 + (2.2 - 2.2)2$$
$$d = (\sqrt{(2.04^2)} + (0)^2$$
$$d = \sqrt{4.1616} = 2.04$$

Based on the visualization using GeoGebra, the distance value obtained was 2.04 units. This demonstrates that mathematical concepts can be used to quantitatively analyze the regularity and distances within building structures.

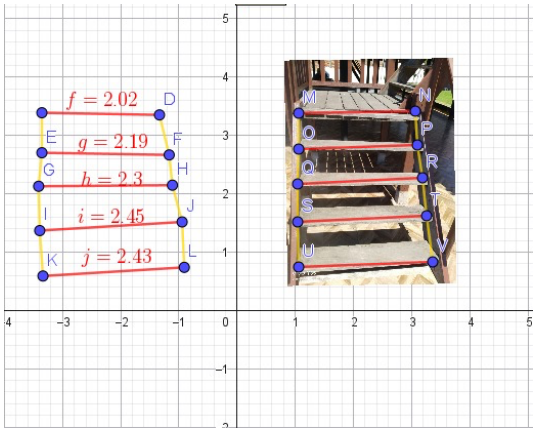

Figure 5. Representation of the Stairs of the Mandar Traditional House in Relation to Intersecting Straight Lines

In the staircase section of the house, the arrangement of the steps forms a pattern of parallel straight lines. The sides of the staircase demonstrate the concept of parallel lines, where the distance between the steps is relatively equal and the inclination is consistent. This reflects regularity in the geometric concept of lines. It also illustrates the concept of parallel lines, in which the gradients of the two lines satisfy the following relationship

$$m_1 = m_2$$

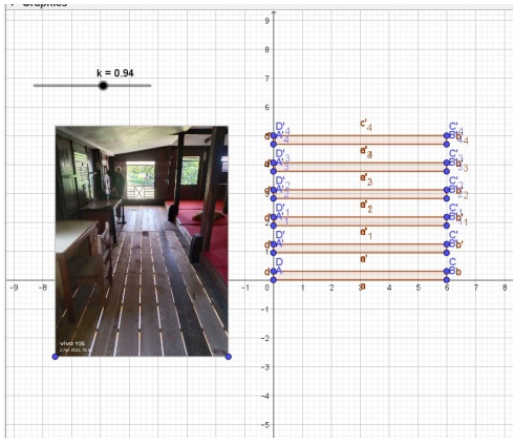

Figure 6. Representation of the Floor of the Mandar Traditional House in Relation to Translation Geometry

The floorboards of the traditional house represent a concrete example of the concept of translation, in which one object (the board) is repeatedly shifted by a constant distance to form a regular parallel pattern. Mathematically, this process is modeled by adding a constant value to certain coordinates, resulting in a series of congruent objects without changes in shape or size.

$$(x, y) \rightarrow (x, y + k)$$
$$(0,2.82) \rightarrow (0,2.82 + 0.94)$$
$$(0,2.82) \rightarrow (0,3.76)$$

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$$A' = (0,3.76)$$
$$(6,2.82) \rightarrow (6,2.82 + 0.94)$$
$$(6,2.82) \rightarrow (6,3.76)$$
$$B' = (6,3.76)$$
$$P_n = \{(x, y) \mid 0 \leq x \leq 6, nk \leq y \leq nk + 0.3\}.$$

Based on these findings, the mathematical concepts found in the Mandar Traditional House can not only be understood as part of the building structure but also have the potential to be integrated into mathematics learning in schools. The concepts of geometry, patterns, and spatial relationships identified in this study can serve as learning contexts that support a deep learning approach, enabling students not only to understand concepts abstractly but also through meaningful and contextual experiences.

Table 2. Design of Mathematics Learning Activities Using the Context of the Mandar Traditional House Based on Deep Learning

Activity Stage	Learning Activities	Mathematical Concepts	Deep Learning Aspect	Output / Competency
Contextual Exploration	Observing the Mandar Traditional House (roof, pillars, fences, stairs, floor)	Triangles, lines, patterns	Meaningful learning	Identifying mathematical concepts
	Discussion: the presence of mathematics in the traditional house	Patterns, relations, transformations	Engaged learning	Students actively discover concepts
Visual Exploration	Drawing the roof (triangle)	Plane geometry	Meaningful learning	Understanding geometric shapes
	Drawing fence patterns (X)	Intersecting lines, rotation	Engaged learning	Visual representation of concepts
	Drawing floor patterns	Translation	Meaningful learning	Understanding repetitive patterns
Mathematical Investigation	Determining the coordinates of fence points	Cartesian coordinates	Engaged learning	Determining (x. y)
	Calculating the distance between pillars	Distance between two points	Meaningful learning	Understanding distance
	Identifying staircase lines	Parallel lines	Meaningful learning	Understanding gradients
	Analyzing floor patterns	Translation $(x, y) \rightarrow (x, y + k)$	Engaged learning	Understanding shifts
Concept Construction	Concluding the reflection formula	Reflection	Meaningful learning	Discovering concepts
	Concluding translation concepts	Translation	Meaningful learning	Understanding transformations
	Relating concepts to the traditional house	Geometric transformations	Meaningful learning	Connecting concepts and culture
Application	Designing traditional house motifs	Patterns, reflection, translation	Engaged learning	Applying concepts
	GeoGebra simulation	Visualization	Joyful learning	Interactive understanding

Activity Stage	Learning Activities	Mathematical Concepts	Deep Learning Aspect	Output / Competency
Reflection	Discussion of mathematics in culture Relating concepts to real life	Generalization Concept transfer	Meaningful learning Joyful learning	Understanding meaning Real-life application

Discussion

The findings of this study indicate that the architectural structure of the Mandar Traditional House contains various mathematical concepts, including plane geometry, line relationships, analytic geometry, and geometric transformations such as rotation, reflection, and translation. These findings were obtained through ethnographic analysis of observations, interviews, measurements, and documentation. For example, the key informant explained that "the tumba layar is designed to resemble a boat sail because the Mandar people are known as seafarers." This statement was coded as roof shape and maritime identity, categorized under architectural form and cultural symbolism, and interpreted within the cultural theme of the representation of maritime culture in Mandar architecture. From a mathematical perspective, the roof structure can be modeled as a triangle representing concepts such as angles, area, and perimeter. Furthermore, the additional finding regarding floor patterns modeled through translation strengthens the argument that mathematical concepts embedded in the traditional house are not merely static but also dynamic through repeated transformation processes. These findings are consistent with the study by Pratama et al. (2025) which suggests that elements of local culture can be utilized as contextual and meaningful resources for mathematics learning.

Mathematically, these concepts are not only visually observable but can also be represented through formal mathematical models. The roof structure is modeled as a triangle illustrating the concept of structural stability, the cross-shaped fence pattern (X) is modeled as two intersecting straight lines and can also be explained through rotational transformation, the distance between pillars is analyzed using the concept of analytic geometry, while the floor pattern is modeled as the result of repeated translations of a rectangle by a specific vector. Interview data revealed that "the distance between pillars is made equal so that the house remains balanced and strong." This statement was coded as pillar spacing and structural stability, categorized under measurement and construction principles, and interpreted through the cultural theme of harmony and balance in traditional Mandar architecture. These mathematical representations demonstrate that traditional building structures have a close relationship with formal mathematical concepts. These findings are consistent with the view of Dari & Jatmiko (2024) which states that mathematics is an inherent part of community cultural practices and is manifested in various daily-life activities.

The integration of mathematical concepts and cultural structures in the Mandar Traditional House demonstrates that ethnomathematics can function as a conceptual framework for contextualizing mathematics learning. The triangular roof reflects the maritime identity of the Mandar people, the intersecting fence patterns indicate relationships among structural elements, the regular spacing between pillars represents principles of order and harmony, and the repetitive floor patterns demonstrate spatial regularity within cultural construction practices. In addition, interview findings revealed that floorboards are arranged repeatedly using uniform dimensions. This statement was coded as repetition and uniformity, categorized under patterns and spatial organization, and interpreted through the cultural theme of regularity in traditional construction practices. These findings are consistent with Khaerani et al. (2024) which states

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that connecting mathematics with culture can enhance conceptual understanding while strengthening students' connection to their social environment.

The presence of various geometric transformations, such as rotation in fence motifs, reflection in symmetrical decorative patterns, and translation in the arrangement of floorboards, indicates that transformation concepts are not merely abstract mathematical objects but are concretely embedded in cultural practices. In this context, the translation of floorboards, modeled as repeated shifts at constant distances, demonstrates a linear pattern that follows an arithmetic sequence along specific coordinates. This finding enriches ethnomathematics research by providing a deeper analytical perspective on the structure of traditional buildings. The relationship between mathematical concepts and cultural contexts provides a strong foundation for the implementation of deep learning–based instruction. From the cognitive perspective, the use of the Mandar Traditional House as a learning context enables students to understand mathematical concepts more concretely because they are connected to real-world objects (Mendrofa & Mendrofa, 2026). From the metacognitive perspective, students are encouraged to reflect on their thinking processes when identifying concepts such as rotation, reflection, translation, and other geometric relationships in everyday life (Arifin, 2025). From the motivational perspective, the connection between mathematics and local culture can increase students' interest in learning because the subject matter becomes more relevant to their lives (Widodo & Budi, 2025). Furthermore, from the behavioral perspective, understanding that mathematics is embedded within culture can encourage students to appreciate cultural heritage more deeply and develop an open attitude toward diversity (Serepinah et al., 2021).

These findings are also consistent with the sociocultural perspective, which emphasizes that knowledge is constructed through interaction with the cultural environment (Pratama et al., 2025). The Mandar Traditional House functions as a cultural tool that mediates students' understanding of mathematical concepts. This is consistent with the theory of Lev Vygotsky, which emphasizes the important role of cultural tools in the learning process (Saputra & Suryandi, n.d.). Therefore, the mathematical concepts identified in this study are understood not merely as abstract symbols but as meaningful components of students' real-life experiences. The implications of these findings suggest that the integration of ethnomathematics into deep learning based mathematics instruction has the potential to create meaningful, engaging, and enjoyable learning experiences for students (Efendi et al., 2025). Therefore, mathematics learning is not only focused on procedures but also on deep and contextual conceptual understanding.

The novelty of this study lies in its systematic integration of ethnographic data, cultural meanings, architectural elements, mathematical concepts, and deep learning–based instructional design within a single analytical framework. Unlike previous ethnomathematics studies that primarily focused on identifying mathematical concepts embedded in cultural artifacts, this study demonstrates how ethnographic findings can be translated into formal mathematical models and subsequently implemented in learning activities that promote meaningful learning, mindful learning, and joyful learning. Therefore, this study not only contributes to the development of ethnomathematics research but also provides a practical framework for integrating local cultural heritage into contextualized and conceptually rich mathematics instruction.

Conclusion

Based on the findings of this study, the Mandar Traditional House (Boyang) contains various mathematical concepts embedded in its architectural structure, including plane geometry (triangles on the roof), line relationships (parallel and intersecting lines on the stairs

and fences), analytic geometry (the distance between two points represented by the pillars), as well as geometric transformations such as rotation, reflection, and translation. In particular, the floorboard patterns illustrate repeated translations, forming arrangements of congruent objects at constant intervals that reflect spatial regularity and linear patterns within the building structure. These findings suggest that the Mandar Traditional House may serve as a valuable cultural context for connecting formal mathematical concepts with students' real-life experiences. The identified mathematical concepts can be represented through formal mathematical models and have the potential to be integrated into deep learning–based mathematics instruction. Such integration may contribute to the development of more contextual, meaningful, and engaging learning experiences while simultaneously supporting students' awareness of local cultural values. However, this study is exploratory in nature and was limited to the investigation of a single Mandar Traditional House. Therefore, the findings should be interpreted within the context of the studied case and should not be generalized to all Mandar traditional houses or other cultural settings. In addition, the deep learning–based instructional design proposed in this study has not yet been empirically implemented or evaluated in classroom practice. Future research is recommended to validate the proposed instructional design through expert review and to examine its effectiveness in actual learning environments. Further studies involving a larger number of traditional houses, participants, and cultural contexts may also provide a broader understanding of the relationship between ethnomathematics and deep learning–based mathematics instruction.

Conflict of Interest

The authors declare that there are no conflicts of interest

Auhor Contributions

N.F. conceptualized the research idea presented, collected and organized the data, and prepared the initial draft of the manuscript. A.A. actively contributed to the development of the methodology, data analysis, and discussion of the findings. The other two authors (B. and M.A.) contributed to the development of the theoretical framework, revision of the manuscript, validation of the results, and approval of the final version of the work. All authors confirm that they have read and approved the final version of this manuscript. The percentage contributions for the conceptualization, drafting, analysis, and revision of this paper are as follows: N.F.: 35%, A.A.: 25%, B.: 20%, and M.A.: 20%.

Data Availability Statement

The authors state that the data supporting the findings of this study will be made available by the corresponding author, [N.F], upon reasonable request

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