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Geometric Patterns in the Hena Puan Traditional House as a Context for Ethnomathematics Based Mathematics Learning

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Abstract

This study aims to examine the geometric concepts embedded in the Baeleo Hena Puan traditional house as a context for ethnomathematics-based mathematics learning. The research employs a qualitative approach with an exploratory descriptive method through visual analysis of the architectural structures of the traditional house. The results of the analysis indicate that the Baeleo Hena Puan traditional house incorporates various geometric concepts, including two-dimensional shapes such as rectangles, triangles, and trapezoids, as well as three-dimensional solids in the form of rectangular prisms and triangular prisms. In addition, patterns of repetition and reflectional symmetry were identified in the arrangement of columns and building openings. From the perspective of D'Ambrosio's ethnomathematics, these findings represent mathematical activities that have developed within the cultural practices of the local community. The integration of traditional architecture as a context for mathematics learning has the potential to bridge formal mathematics with students' cultural experiences, thereby supporting meaningful, contextual, and culturally inclusive learning. This study recommends the use of the Baeleo Hena Puan traditional house as a contextual learning resource in geometry instruction at schools

Keywords: *Ethnomathematics, Geometric Patterns, Hena Puan Traditional House, Mathematics Learning*

1. Introduction

Mathematics learning plays a fundamental role in equipping students with logical, systematic, and critical thinking skills necessary to address various problems in everyday life (Dwirahayu et al., 2025). Nevertheless, mathematics is often perceived as an abstract discipline detached from students' real-life contexts, which leads to low levels of interest, motivation, and conceptual understanding among learners, particularly in geometry topics that require strong visualization and spatial reasoning skills (Oktaviana et al., 2025). This condition calls for a learning approach that is able to connect mathematical concepts with students' real-life experiences and cultural backgrounds (Tanase, 2020)

Ethnomathematics is one relevant approach for bridging formal mathematics with social and cultural life contexts. D'Ambrosio emphasizes that mathematics is the product of human activities that develop within specific cultural environments, such as measuring, classifying, modeling, and constructing (Jojo, 2024; Fouze & Amit, 2023; Manolino, 2024). UNESCO also emphasizes the importance of synergy between culture and education in strengthening the

preservation of cultural heritage, broadening understanding of history and society, and fostering intercultural appreciation and understanding (Wiktor-Mach, 2020).

Various recent studies indicate that the integration of ethnomathematics into learning can enhance students' motivation, conceptual understanding, and positive attitudes toward mathematics, while also serving as a means of preserving local culture amid the forces of globalization (Battiibwe, 2024). Recent research trends reveal that ethnomathematics is not only applied in the context of arts and crafts but also across a wide range of cultural object, such as traditional dances, clothing motifs, trading activities, traditional cakes, games, and traditional houses in various regions of Indonesia, which are used as contexts for learning mathematics (Dominikus et al., 2024). One form of culture that is rich in mathematical concepts is traditional architecture. Traditional buildings often represent various geometric concepts, such as two-dimensional shapes, three-dimensional solids, symmetry, and repetitive patterns, which are intuitively applied by communities in the construction process (Xu & Huang, 2020).

The use of traditional architecture as a context for mathematics learning provides opportunities for students to connect geometric concepts with real objects, thereby making learning more contextual and meaningful. (Sunzuma & Maharaj, 2020). Therefore, culture needs to be integrated into mathematics learning. (Fauzi et al., 2022 ; Nursyahidah et al., 2025 ; Zuhri et al., 2023). Learning through an ethnomathematics approach can actively engage students in discovering local culture related to geometry, and teachers can use culture-related learning tools, thereby increasing students' motivation (Putri & Junaedi, 2022). These studies generally find the presence of geometric concepts, patterns, symmetry, ratios, and proportions that can be developed as contexts for mathematics learning in schools (Rizos & Gkrekas, 2024)

Traditional houses have been described as one of the important symbols in the social order of Maluku indigenous communities, serving not merely as physical buildings but also as social, religious, and political spaces of the community. The architectural structure, roof forms, arrangement of pillars, spatial organization, and ornaments contain rich potential for mathematical concepts, particularly in the aspects of geometry and measurement (Ratau et al., 2025). Different cultural backgrounds open opportunities for the creation of meaning and perspectives (Nguyen & Tran, 2023). The integration of local wisdom into education is increasingly emphasized to make learning more aligned with students' cultural contexts; in mathematics, this approach enriches learning experiences by connecting abstract concepts to everyday life through cultural examples (Susanti et al., 2025). Local wisdom, which encompasses traditional knowledge, values, and practices, helps contextualize mathematical concepts, making it easier for students to understand their application in real-life situations. (Manjani, 2024; Usman & Wijaya, 2024). These cultural differences can significantly influence how students understand and interact with mathematical problems, highlighting the importance for teachers to consider cultural contexts in their teaching practices (Umeh, 2025).

One approach to integrating indigenous knowledge into mathematics education is through the use of ethnomathematics (Kusaeri et al., 2025). Ethnomathematics is the study of mathematical practices and concepts embedded within different cultural contexts (Sugiman et al., 2025). This approach acknowledges that mathematics is not a universal and abstract discipline, but one that is culturally situated and socially constructed (Kadonasi et al., 2023). Ethnomathematics is a field of study that links mathematical concepts with the culture and local practices of a particular community (Dewi et al., 2025; Umbara et al., 2025). Mathematics is now understood not as an absolute science, but as a human activity that develops historically and is closely related to social and cultural contexts. (Gula & Jojo, 2024). Mathematical concepts can be learned through students' cultural backgrounds. For example, geometry can be linked to traditional art or architecture, while measurement can be connected to activities such as cooking or carpentry within their culture (Singh & Prasad, 2025). The implementation

of ethnomathematics becomes a learning strategy that can restore students' interest and engagement while encouraging creativity in the use of mathematics (Mei et al., 2025).

Mathematics is a form of culture that has, in fact, been integrated into all aspects of society's life (Rodríguez-Nieto & Alsina, 2022). The integration of culture into mathematics learning can broaden students' perspectives, demonstrate the application of mathematics across various fields, encourage interdisciplinary thinking, and enhance their overall literacy (Hu, 2025 ; Rodríguez-Nieto et al., 2023). This approach not only connects mathematics with culture but also encourages critical reflection on the nature of mathematics and its role in society(de Castro, 2024). Furthermore, the integration of cultural education can enrich students' academic experiences by fostering skills of analysis, evaluation, and synthesis of information; moreover, it enhances the quality of learning and prepares students to face the challenges of 21st-century education (Medina et al., 2024).

Research shows that the integration of local cultural elements into mathematics learning is strongly supported by educators in Indonesia. Ethnomathematics helps students understand and apply mathematical concepts through cultural contexts that are close to their everyday lives, such as textile motifs, traditional houses, games, and local artifacts (Wulandari et al., 2024; Sape & Syamsuddin, 2025 ;Leton et al., 2025; Kusaeri et al., 2025). The integration of ethnomathematics programs into mathematics education enhances students' cognitive abilities because they realize that their communities are valued for what they already know, do, and express. (Battiibwe, 2024). The ethnomathematics approach has been proven to enhance creative thinking skills, mathematical literacy, and students' motivation and engagement. (Fouze & Amit, 2018). Mathematics problems based on local culture can assess higher-order thinking skills such as analysis, evaluation, and creativity. (Wulandari et al., 2024) In addition, students can more easily understand abstract concepts because the material is linked to real-life experiences (Pongoliu, 2025). This approach aims to make mathematics education more meaningful, contextual, and inclusive by connecting abstract concepts with students' lived experiences and cultural heritage (Nst & Batubara, 2024).

Negeri Buano Utara, traditionally known as Hena Puan, carries meanings rich in cultural values. In the local language, the word *"hena"* means "village" and *"puan"* means "original," so Hena Puan can be interpreted as "original village," a symbol of community identity that reflects authenticity, continuity, and their cultural roots (Ratau et al., 2025). Local wisdom, which contains cultural values, traditions, and community knowledge, can serve as an important resource in mathematics learning. The integration of local wisdom makes learning materials more relevant, thereby helping students better understand mathematical concepts. (Harefa & Suastra, 2024). Diverse cultural environments in which traditional science education methods may not fully align with students' lived experiences and cultural backgrounds (Dewi & Wibawa, 2024).

Hena Puan culture, as part of the customary system in Maluku, represents a set of values, social structures, customary spaces, and symbols that are embedded in the community's everyday practices. Within this cultural system, there are various artifacts, rituals, spatial patterns, and customary rules that potentially contain mathematical concepts that can be explored, for example, through the organization of customary spaces, seating arrangements in ceremonies, the forms and arrangements of ornaments, and rules for resource distribution. However, studies on ethnomathematics that examine Hena Puan culture remain very limited, particularly those that explicitly link it to the development of mathematics learning in secondary schools and the strengthening of students' numeracy literacy. Mathematics and culture become an engaging scholarly context when students learn mathematics based on cultural practices they understand and that are relevant to their everyday lives. Consequently, students can more easily understand mathematics through the acculturation between mathematics and culture (Hamidah & Kusuma, 2024). Connecting cultural contexts with

mathematical concepts helps students understand mathematics in a more meaningful, relevant, and contextual way that aligns with their cultural experiences (Rodríguez-Nieto et al., 2023). The integration of ethnomathematics, including the exploration of Hena Puan culture in this study, seeks to identify local cultural heritage objects within the Baeleo Hena Puan traditional house that illustrate relationships with mathematical concepts embedded in the local wisdom of Buano Utara Village. Therefore, this study aims to identify and analyze the geometric patterns found in the Hena Puan traditional house and to explore their potential as a context for ethnomathematics-based mathematics learning. This research is expected to contribute theoretically to the development of ethnomathematics studies and practically to more contextual, meaningful, and culturally inclusive geometry learning.

2. Method

This study employed a qualitative approach with an exploratory descriptive design, which is appropriate for gaining an in-depth understanding of the phenomenon under investigation in a context that has been underexplored (Makhado et al., 2022 ; Villamin et al., 2025). This approach was chosen to identify and describe the geometric concepts embedded in the Hena Puan traditional house and to analyze its potential as a context for ethnomathematics-based mathematics learning. The study is grounded in D'Ambrosio's ethnomathematics perspective, which views mathematics as a human activity that develops within social and cultural contexts. The object of the study is the Hena Puan traditional house, which serves important social and cultural functions within the local community. The focus of the analysis is directed at the architectural elements of the traditional house, including wall structures, windows, supporting pillars, floors, and roof forms. These elements are analyzed as representations of local mathematical knowledge, particularly in the domain of geometry.

The research was conducted in Buano Utara Village, West Seram Regency, Maluku Province, as a community that continues to preserve Hena Puan local wisdom. The research subjects include traditional leaders, village elders, and members of the local community who possess in-depth knowledge of the construction process and the philosophy of the Baeleo Hena Puan house. They were selected because they are considered the most knowledgeable about the symbolic values, technical aspects, and cultural meanings embedded in the structure and architectural patterns of the traditional house. The expertise and direct experience of these informants make an important contribution to the researcher in uncovering ethnomathematical concepts integrated into the construction and spatial organization of Hena Puan.

The following research flowchart is presented in Figure 1.

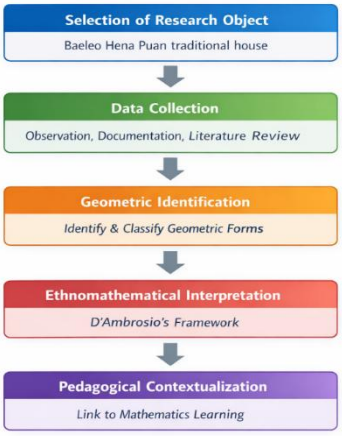

Figure 1. Research Flow Diagram

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Data were collected using three main techniques. First, participatory observation was conducted to observe cultural activities, the structure of the Baeleo Hena Puan, symbols and, decorative patterns, as well as everyday practices that contain mathematical values. Second, semi-structured interviews were carried out with traditional elders and teachers to explore cultural meanings, traditional practices, and perceptions of cultural integration in mathematics learning. Third, documentation in the form of photographs and records of cultural artifacts relevant to the identification of mathematical concepts was collected. The primary research instrument was the researcher, supported by observation guidelines, interview protocols, and documentation sheets. Data analysis involved data condensation, data display, and conclusion drawing.

Data were reduced through coding and categorization to identify themes such as geometric patterns, symmetry, proportions, and Hena Puan cultural spatial patterns. Data presentation was carried out in the form of narratives, images, and mathematical interpretations of artifacts. Data trustworthiness was ensured through source and technique triangulation, member checking, and prolonged engagement in the field. Validity was further maintained through technique triangulation by comparing results from visual observations, documentation, and literature review. In addition, the use of geometric sketches aimed to enhance clarity and consistency in the analysis process. The validity of interpretations was strengthened by referring to ethnomathematics theory and relevant previous studies.

3. Results and Discussion

Traditional houses, as one form of Maluku local wisdom, have great potential to be integrated into mathematics learning. The cultural values and practices within Hena Puan contain rich geometric concepts.

Figure 2. Baeleo Hena Puan Traditional House

The Baeleo traditional house of Maluku is a symbol of unity and deliberation within indigenous communities, reflecting values of openness, equality, and social harmony. In addition to functioning as a center for customary activities, the structure of the Baeleo represents local knowledge manifested in geometric patterns, making it a potential context for ethnomathematics-based mathematics learning. The analysis of the Hena Puan traditional house shows that this traditional building contains various geometric concepts that can be clearly identified in its architectural elements. These findings were obtained through visual observation, documentation, and geometric sketch analysis of the building structure.

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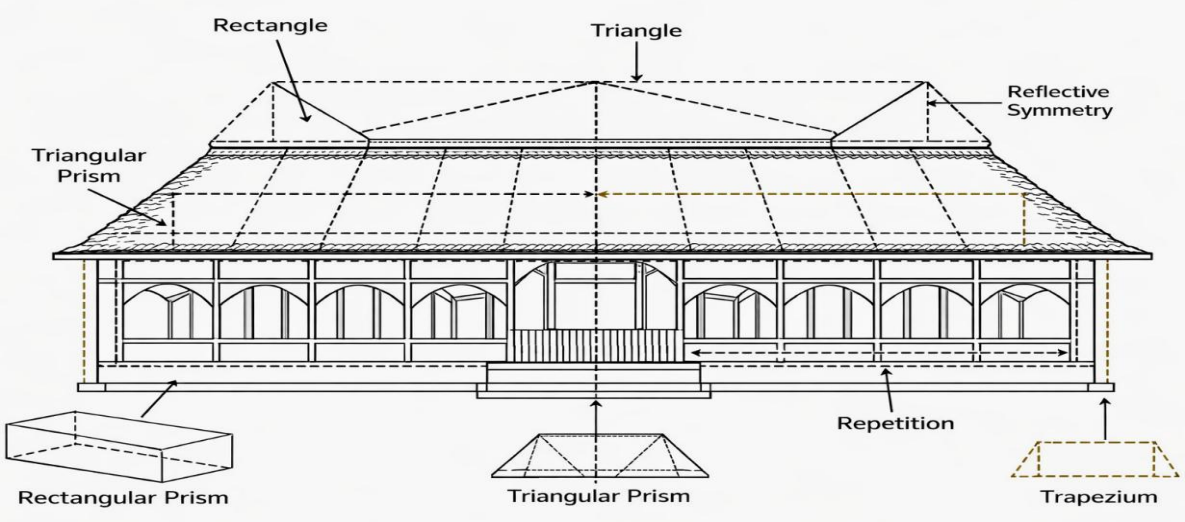

Figure 3. Identification of Geometric Patterns in the Architecture of the Baeleo Hena Puan House

3.1 Findings on Two Dimensional Shapes

The analysis shows that rectangular shapes are found in wall elements, windows, and horizontal supporting beams of the building, and these shapes appear repeatedly with relatively uniform dimensions.

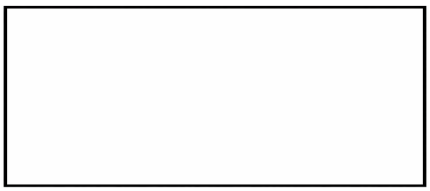

Figure 4. Rectangle

In addition, triangular shapes are identified in the roof framework of the house, particularly on the front and side parts of the building. The triangles formed tend to resemble isosceles triangles. Meanwhile, trapezoidal shapes are visible on the roof planes when viewed from the side and the front.

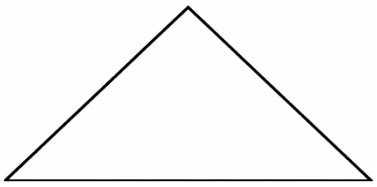

Figure 5. Triangle

Meanwhile, trapezoidal shapes are visible on the roof planes when viewed from the side and front elevations.

Figure 6. Trapezium

3.2 Findings on Three-Dimensional Shapes

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The main structure of the Hena Puan traditional house exhibits the characteristics of a rectangular prism (cuboid), which can be observed in the body of the house and the floor of the stilted structure.

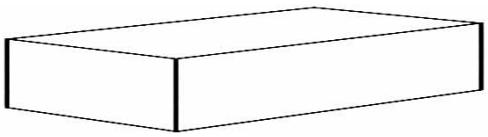

Figure 7. Rectangular Prism

In addition, triangular prism shapes are identified in the roof structure, which extends from the front to the back of the house.

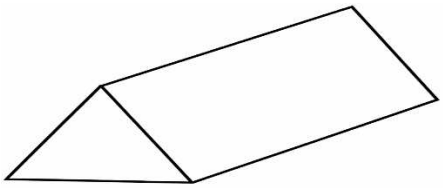

Figure 8. Triangular Prism

3.3 Patterns and Repetition

The observation results indicate the presence of repetitive patterns in the arrangement of supporting pillars and building openings. The pillars are arranged at relatively equal intervals, forming a horizontal linear pattern. Repetitive patterns are also visible in the windows and the arches at the front of the house.

3.4 Symmetry

The analysis of the front elevation of the building indicates the presence of reflection symmetry with a vertical axis of symmetry. Building elements on the left and right sides of the house exhibit balanced forms and arrangements, particularly in the placement of the main entrance, windows, and supporting pillars.

3.5 Mapping Geometric Findings to Learning Concepts

Based on the identification results, the geometric concepts found in the Hena Puan traditional house include two-dimensional shapes (rectangles, triangles, and trapezoids), three-dimensional solids (rectangular prisms and triangular prisms), as well as geometric transformation concepts in the form of repetition and symmetry. These concepts are relevant to geometry topics in school mathematics learning and have the potential to be used as contexts for ethnomathematics-based instruction. The findings on geometric patterns in the Hena Puan traditional house are presented in Table 1.

Table1. Geometric Patterns in the Baeleo Hena Puan Traditional House

Architectural Elements of the Traditional House	Geometric Forms	Identified Geometric Concepts	Description
Walls and Main Structure of the House	Rectangle	Area and Perimeter of a Rectangle	The wall planes and the main structure of the house exhibit a rectangular shape.

Windows and Openings	Repeated Rectangles	Similarity and Measurement	The windows exhibit relatively consistent shapes and dimensions.
Roof Framework	Triangle	Types of Triangles and Angles	The roof structure approximates the form of an isosceles triangle
Roof Planes	Trapezium	Area of a Trapezium	From the side and front perspectives, the roof exhibits a trapezoidal form
Main Structure of the House	Rectangular Prism	Volume and Surface Area	The house structure demonstrates the properties of a quadrilateral prism
Roof Structure	Triangular Prism	Volume and Nets of Prisms	The roof extends longitudinally, forming a triangular prism
Supporting Pillars	Repeated Pattern (Linear Repetition)	Patterns and Translation	The pillars are arranged parallel to one another with relatively uniform spacing
Front Elevation of the House	Reflection Symmetry	axis of symmetry	The arrangement of the building's left and right sides appears symmetrical and balanced

The analysis results indicate that the Hena Puan traditional house contains various geometric concepts integrated into its architectural elements. Rectangular shapes are found in the walls, main body of the house, as well as in windows and openings arranged repetitively, representing concepts of area, perimeter, similarity, and measurement. The roof structure displays triangular and trapezoidal forms related to types of triangles, angles, and the area of trapezoids, while the main structure of the building and the roof represent three-dimensional solids in the form of rectangular prisms and triangular prisms associated with concepts of volume and surface area. In addition, the arrangement of supporting pillars shows a linear repetition pattern reflecting the concept of translation, and the front elevation of the building exhibits reflection symmetry with a vertical axis of symmetry. These findings confirm that the architecture of the Hena Puan traditional house represents relevant geometric concepts that can be utilized as a context for ethnomathematics-based mathematics learning.

The results of this study on the Hena Puan traditional house indicate that the local community's traditional architecture serves as a very rich medium for revealing geometric concepts within the framework of ethnomathematics. Various two-dimensional and three-dimensional shapes do not appear by chance, but are naturally integrated into traditional architectural practices that simultaneously fulfill practical, aesthetic, and symbolic needs. These findings are consistent with numerous ethnomathematics studies on other traditional houses, such as the Pacenan house, Tanean Lanjang, Rumah Gadang, Balla Lompoa, and Istana Dalam Loka, all of which similarly demonstrate that geometry is an inherent part of local knowledge that is operationalized through activities of building, decorating, and organizing space (Fauzi et al., 2022; Sari et al., 2022).

The presence of two-dimensional shapes such as rectangles, triangles, and trapezoids, as well as three-dimensional solids in the form of rectangular prisms and triangular prisms,

reflects mathematical activities that develop from both functional needs and cultural aesthetics. These findings reinforce the ethnomathematics perspective, as proposed by D'Ambrosio, that mathematical concepts do not arise solely from formal systems; rather, they also emerge and develop from the social and cultural practices of communities. Accordingly, mathematical concepts are not produced exclusively within formal school systems, but also grow out of the social and cultural practices of society (Rosa & Orey, 2021). The dominance of rectangular shapes on walls and windows indicates the community's understanding of order, proportion, and spatial efficiency. From an ethnomathematics perspective, the use of this form can be understood as intuitive activities of measurement and classification. This is in line with D'Ambrosio's idea that activities such as measuring and classifying are part of universal human mathematical activities, yet they are expressed contextually within specific cultures (Shannon, 2021; Enun & Iyaji, 2025). The triangular and trapezoidal forms in the roof structure of the Hena Puan traditional house reflect local understandings of structural stability and balance. From an ethnomathematical perspective, the selection of these shapes is not merely technical but also represents traditional knowledge passed down through generations. These findings indicate that formal geometric concepts taught in schools have strong roots in community cultural practices, and therefore have the potential to serve as a bridge between school mathematics and students' cultural experiences (Sunzuma, 2019).

The analysis of three-dimensional forms, particularly the rectangular prism in the main body of the house and the triangular prism in the roof, indicates the representation of spatial modeling in traditional architecture. Within the ethnomathematics framework, this modeling can be understood as a form of spatial abstraction carried out by the community to meet functional needs, such as protection from weather and the organization of social space. These findings further emphasize that traditional architecture can be utilized as an authentic context for mathematics learning, especially to develop understanding of volume, surface area, and the conceptual relationships between two-dimensional and three-dimensional shapes. In addition, the identification of repetitive patterns in the arrangement of pillars and building openings, as well as reflection symmetry on the front elevation of the house, indicates the presence of principles of order and balance (Azemati et al., 2020). From an ethnomathematics perspective, patterns of repetition, symmetry, and spatial organization in traditional buildings represent the ways communities systematically and harmoniously organize space, in line with the view that mathematics is a cultural product manifested in how communities measure, map, and arrange space. Repetitive patterns can be associated with the concepts of sequences and translation, while reflection symmetry relates to geometric transformation concepts that reflect a deep understanding of geometric forms and their practical applications, all of which are relevant to the school mathematics curriculum (Kho et al., 2025).

The identification of various geometric concepts in the Hena Puan traditional house strengthens the argument that traditional architecture is a rich learning resource for understanding concepts of volume, surface area, and the relationships between two-dimensional and three-dimensional shapes. Numerous ethnomathematics studies on traditional houses in Indonesia and other contexts indicate that integrating local cultural elements into mathematics learning can:

1. Enhance students' conceptual understanding of geometry,
2. Bridge the gap between formal mathematics and everyday experiences, and
3. Foster appreciation of cultural identity and local wisdom.

Within the theoretical framework of D'Ambrosio and Rosa & Orey, mathematics is understood as a cultural product that emerges from human efforts to count, measure, map, design, and explain the surrounding reality (Fauzi et al., 2022). The findings from the Hena Puan traditional house indicate that these activities are concretely manifested through processes

such as designing floor plans, determining spatial proportions, arranging pillar structures, and constructing stable roof forms.

Consequently, the geometric concepts taught in schools no longer appear as abstract knowledge detached from everyday life, but rather as knowledge that has strong roots in cultural practices closely connected to students' lives. Integrating these findings into mathematics learning has the potential to help students understand geometric concepts contextually, strengthen the connection between formal mathematics and local culture, and support inclusive learning oriented toward students' real-life experiences.

4. Conclusion

From D'Ambrosio's ethnomathematics perspective, this study demonstrates that the Baeleo Hena Puan traditional house contains various geometric concepts that represent mathematical knowledge developed within a local cultural context. The presence of two-dimensional and three-dimensional shapes in architectural elements such as walls, windows, the main body of the house, and roof structures indicates that the community has intuitively applied concepts of measurement, spatial organization, and shape modeling in the practice of constructing traditional houses. In addition, the identified patterns of repetition and symmetry reflect principles of order and balance that are part of human mathematical activity in the social and cultural life of the local community. These findings affirm that traditional architecture functions not only as cultural heritage but also as a rich and meaningful source of mathematical knowledge. The use of the Baeleo Hena Puan traditional house as a context for mathematics learning enables students to connect formal geometric concepts with cultural experiences that are close to their everyday lives. Thus, the ethnomathematics approach has the potential to make mathematics learning more contextual, enhance conceptual understanding, and support culturally inclusive learning in line with the diversity of students' backgrounds.

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