Sustainability of Indigenous Community Education Through Baduy Tribe Ethnomathematics: Integrating Local Wisdom in 21st Century Mathematics Learning

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The Asian Conference on Education 2025
Official Conference Proceedings

Abstract

This study explores the ethnomathematical practices of the Baduy indigenous community and examines their potential as a foundation for developing culturally contextualized geometry teaching materials for junior high school students in Indonesia. Using a qualitative ethnographic approach, data were collected through participant observation, in-depth interviews with community elders and craftsmen, and documentation of cultural artifacts. The findings reveal that Baduy cultural practices embody rich geometric concepts, particularly through artifacts such as the *Adu Mancung* weaving motif and the *Dudukuy* headgear, which represent rhombus patterns, symmetry, circles, radial structures, and proportional reasoning. These ethnomathematical elements were mapped onto the junior high school geometry curriculum and transformed into contextual learning tasks that connect formal mathematical concepts with authentic cultural experiences. The integration of Baduy ethnomathematics into geometry instruction offers meaningful learning opportunities that enhance students' conceptual understanding, spatial reasoning, and problem-solving skills while fostering appreciation of local wisdom. This study concludes that Baduy ethnomathematics provides a strong pedagogical foundation for culturally responsive geometry education and supports the sustainability of indigenous community knowledge in the context of 21st-century mathematics learning.

Keywords: ethnomathematics, Baduy tribe, geometry education, indigenous knowledge, culturally responsive teaching

Introduction

In the era of rapid globalization and digital transformation, students are increasingly exposed to foreign cultures through social media, entertainment platforms, and global information networks (Becker & Park, 2011; Drozdikova-Zaripova, 2020; Kadirbayeva et al., 2022; Nadarajan et al., 2023). While such exposure provides opportunities for intercultural exchange, it also contributes to the gradual marginalization of local cultures in students' daily lives. Many young learners tend to adopt global popular culture as their primary cultural reference, while indigenous traditions, values, and knowledge systems are progressively overlooked. This phenomenon has raised serious concerns regarding the sustainability of indigenous community education and the intergenerational transmission of local wisdom, which are essential for maintaining cultural identity and social cohesion (Adonis & Silinda, 2021; Dewantara, 2025; Knijnik, 2002; Sianturi et al., 2025).

Education plays a strategic role in preserving cultural heritage, particularly through the integration of local wisdom into school curricula (Adonis & Silinda, 2021; Hilaliyah et al., 2019; Sakinah et al., 2023). However, in many formal education contexts, especially in mathematics education, learning remains largely decontextualized from students' cultural environments. Mathematics is often presented as a universal and abstract body of knowledge, detached from the socio-cultural realities in which students live. As a result, students frequently perceive mathematics as irrelevant to their everyday experiences, which may reduce learning motivation and hinder conceptual understanding (Kadarisma et al., 2020). This situation is exacerbated by the limited availability of instructional materials that incorporate local cultural contexts as meaningful learning resources.

In Indonesia, most mathematics teaching materials used at the junior high school level are still dominated by standardized textbooks that emphasize procedural competence and symbolic manipulation (Hilaliyah et al., 2019; Muhtadi et al., 2021; Nuraeni et al., 2021). Although these materials are aligned with national curriculum standards, they rarely reflect the rich cultural diversity of Indonesian society. The absence of culturally responsive learning resources not only weakens students' cultural literacy but also limits opportunities to develop contextual and meaningful mathematical understanding. Consequently, there is a growing need to design mathematics learning materials that bridge formal mathematical concepts with students' cultural backgrounds.

One promising approach to addressing this challenge is ethnomathematics, which examines mathematical ideas embedded in cultural practices, artifacts, and social activities (D'Ambrosio, 1985, 1997). Ethnomathematics positions culture as a legitimate source of mathematical knowledge and recognizes that different communities develop their own ways of quantifying, measuring, designing, and organizing space. Through ethnomathematics, mathematics learning can be contextualized within students' lived experiences, thereby promoting conceptual understanding, cultural appreciation, and critical thinking (Sari et al., 2025).

The Baduy tribe is an indigenous community in Indonesia that has preserved its traditional way of life for generations. The Baduy people strictly adhere to customary laws and maintain harmonious relationships with nature, social structures, and spiritual values. Their daily activities, including house construction, weaving, farming, and spatial organization of settlements, implicitly embody a variety of mathematical concepts. For example, the architecture of traditional Baduy houses reflects geometric structures such as prisms, pyramids, and rectangular forms, while weaving patterns demonstrate symmetry, repetition, and geometric transformations. In addition, traditional measurement systems based on body proportions and natural units reveal indigenous approaches to quantification and proportional reasoning.

These cultural practices represent a rich source of ethnomathematical knowledge that is highly relevant to school mathematics, particularly geometry. Geometry plays a central role in developing students' spatial reasoning, visualization, and problem-solving skills. However, geometry is often perceived as one of the most difficult topics by junior high school students due to its abstract nature and heavy reliance on symbolic representations (Hodiyanto & Santoso, 2019; Subekhi & Nindiasari, 2021). Integrating geometric concepts with concrete cultural contexts, such as those found in Baduy culture, may help students construct more meaningful and intuitive understandings of geometric ideas.

Several previous studies have explored ethnomathematics in the Baduy community from different perspectives (Arisetyawan & Yuda, 2019; Bukhori Muslim, 2021; Eliza & Pujiastuti, 2022; Farokhah et al., 2023; Firmansyah & Septiani, 2019a, 2019b; Megantari & Setyawan, 2020; Muhibah et al., 2023; Yulyani et al., 2023). Researchers have documented geometric concepts in traditional house architecture, analyzed patterns and symmetries in weaving crafts, and examined indigenous systems of measurement and spatial organization. These studies consistently demonstrate that Baduy culture contains abundant mathematical representations that can serve as valuable learning resources. However, most of these studies remain at the level of cultural documentation and conceptual identification. The transformation of ethnomathematical findings into structured instructional materials for formal classroom use is still limited.

Furthermore, previous research has rarely addressed the issue of sustainability in indigenous community education by linking ethnomathematics to curriculum development. While ethnomathematical studies contribute to cultural preservation, their impact on formal education practices remains marginal if they are not translated into practical teaching resources. There is a critical gap between ethnomathematical research and classroom implementation, particularly in the development of geometry teaching materials that are aligned with curriculum standards and pedagogical principles.

Therefore, this study seeks to address this gap by positioning Baduy ethnomathematics not only as an object of cultural investigation but also as a foundation for curriculum-oriented instructional design. This research aims to explore and analyze geometric concepts embedded in Baduy cultural practices and to use these findings as the basis for developing geometry teaching materials for Indonesian junior high school students. By integrating local wisdom into formal mathematics learning, this study is expected to contribute to culturally responsive education, promote meaningful learning experiences, and support the sustainability of indigenous community education in the context of 21st-century mathematics learning.

Method

This study employed a qualitative research approach with an ethnographic orientation to explore ethnomathematical practices within the Baduy indigenous community and to use these findings as the foundation for designing geometry teaching materials for junior high school students in Indonesia. The ethnographic approach was selected to capture the cultural meanings, social practices, and contextual realities in which mathematical ideas are embedded in the daily life of the indegenious Community (d'Ambrosio, 2006).

The research was conducted in the Baduy community, Banten Province, Indonesia, which is well known for its strong adherence to customary laws and preservation of traditional lifestyles. The participants included community elders, traditional leaders, craftsmen, and local residents who possess extensive knowledge of Baduy cultural practices. Participants were selected through purposive sampling to ensure that the data reflected authentic cultural representations and indigenous knowledge systems.

Data were collected through participant observation, in-depth semi-structured interviews, and documentation of cultural artifacts. Participant observation focused on daily activities such as house construction, weaving, farming, and settlement organization, with particular attention to practices that reflect geometric concepts. In-depth interviews were conducted with community leaders and craftsmen to explore indigenous perspectives on measurement, spatial organization, and traditional construction techniques. Cultural artifacts, including traditional houses, weaving products, and village layouts, were documented through photographs, sketches, and detailed field notes.

The data were analyzed using thematic analysis with an ethnomathematical perspective. The analysis process involved data reduction, coding, and categorization of mathematical concepts embedded in cultural practices. Identified concepts were then mapped onto the junior high school geometry curriculum to examine their relevance and alignment with learning objectives. This mapping process served as the basis for designing culturally contextualized geometry teaching materials.

To ensure the trustworthiness of the findings, data triangulation was applied by comparing information obtained from observations, interviews, and documentation. Member checking was also conducted by discussing preliminary interpretations with community representatives to confirm the accuracy of the cultural and mathematical interpretations.

Through this methodological framework, the study integrates ethnographic exploration with curriculum-oriented instructional design, ensuring that Baduy ethnomathematics is systematically documented and translated into meaningful geometry learning contexts for junior high school students.

Result and Discussion

This section presents the main findings of the study on ethnomathematical practices within the Baduy community and discusses their implications for junior high school geometry learning. The results highlight the geometric concepts embedded in Baduy cultural activities, artifacts, and spatial organization, and examine how these concepts can be meaningfully integrated into culturally contextualized teaching materials. Furthermore, this section discusses the role of Baduy ethnomathematics in supporting culturally responsive mathematics education and contributing to the sustainability of indigenous community education in the context of 21st-century learning.

The discussion interprets the findings through an ethnomathematical and educational perspective by relating indigenous mathematical knowledge to formal geometry concepts in the school curriculum. It also elaborates on how cultural contexts can serve as powerful learning resources that enhance students' conceptual understanding, engagement, and appreciation of local wisdom. Through this discussion, the study demonstrates that Baduy culture is not only a repository of rich mathematical ideas but also a valuable foundation for developing meaningful and relevant geometry learning experiences for junior high school students.

One of the main ethnomathematical artifacts identified in this study is the traditional Baduy weaving motif known as *Adu Mancung*. This motif is widely found in woven fabrics used by the Baduy community, particularly among the Baduy Luar, and carries strong cultural, social, and philosophical meanings. The Adu Mancung motif is characterized by a repeated arrangement of diamond-shaped patterns formed by symmetrical geometric structures that resemble a sequence of rhombuses aligned horizontally.

From an ethnomathematical perspective, the Adu Mancung motif represents a clear manifestation of geometric concepts embedded in Baduy cultural practices. The basic structure of the motif consists of a sequence of congruent rhombuses arranged in a regular and repetitive pattern. Each rhombus is formed by four equal sides and diagonals that intersect perpendicularly, reflecting fundamental properties of plane geometry. The motif also exhibits translational symmetry, as the pattern is generated through the repetition of a single geometric unit along a linear direction. In addition, reflective symmetry can be observed in the arrangement of the shapes, indicating an intuitive understanding of geometric balance and proportion within Baduy weaving traditions.

The process of producing the Adu Mancung motif involves precise spatial reasoning, proportional thinking, and pattern recognition. Weavers determine the size, alignment, and spacing of each rhombus based on traditional rules that have been transmitted across generations. Although these rules are not formally expressed using mathematical symbols, they reflect an indigenous mathematical system that governs consistency, regularity, and aesthetic harmony in textile production. This demonstrates that the Baduy community possesses an implicit form of geometric knowledge that is deeply rooted in their cultural practices.

The Adu Mancung motif holds not only aesthetic value but also cultural and philosophical significance. In Baduy tradition, the motif symbolizes harmony, balance, and unity, reflecting the community's social values and worldview. The repetitive interlocking rhombus shapes represent togetherness and continuity, which are essential principles in Baduy social life. This cultural meaning further strengthens the relevance of the motif as a contextual learning resource, as it allows students to explore geometry while simultaneously understanding the values embedded in indigenous culture.

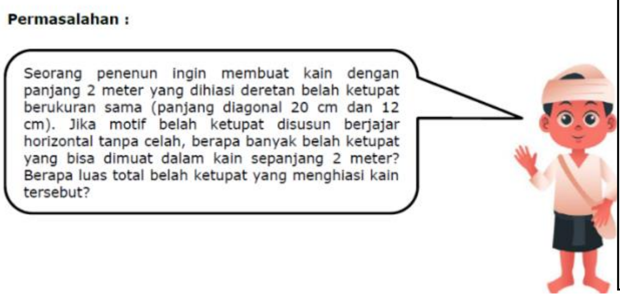
Based on these findings, the Adu Mancung motif can be systematically transformed into a contextual learning resource for junior high school geometry instruction. The repeated rhombus patterns provide concrete representations for introducing concepts such as quadrilaterals, properties of rhombuses, perimeter and area, symmetry, and geometric transformations. For example, students can be guided to identify the properties of rhombuses from the motif, calculate the area of each geometric unit, analyze the symmetry of the pattern, and investigate the effects of translation and reflection in the motif's arrangement.

Figure 1
Geometric Representation of the Adu Mancung Weaving Motif in Baduy Culture

The *Adu Mancung* motif is one of the traditional Baduy weaving motifs characterized by a simple design in the form of a diamond or half-diamond shape arranged sequentially. The Baduy Luar community adopts the songket weaving technique in producing the Adu Mancung woven fabric, which possesses sacred value and is specifically intended for Baduy Luar men. This fabric is used during traditional and cultural ceremonies of the Baduy Luar community. The uniqueness of the Adu Mancung woven motif lies in its use in religious activities, as it contains philosophical meanings of the Baduy Luar people, who uphold a monogamous marriage system and emphasize harmony within newly married Baduy Luar families.
If we observe the arrangement of the Adu Mancung motif pattern, it forms a rhombus shape, as illustrated in the adjacent figure.

Furthermore, the Adu Mancung motif can be incorporated into geometry learning activities through visual exploration, pattern reconstruction, and project-based tasks. Students may be asked to redesign the motif using coordinate geometry, create tessellation patterns based on the rhombus structure, or model the motif using dynamic geometry software. Such activities promote meaningful learning by connecting abstract geometric concepts with authentic cultural artifacts.

Figure 2
Contextual Geometry Problem Based on the Adu Mancung Weaving Motif



A weaver wants to make a piece of fabric with a length of 2 meters that is decorated with a sequence of identical rhombus motifs (with diagonal lengths of 20 cm and 12 cm). If the rhombus motifs are arranged horizontally without any gaps, how many rhombuses can fit along the 2-meter fabric? What is the total area of the rhombuses that decorate the fabric?

The learning content presents a contextual geometry problem that connects mathematical concepts with traditional weaving activities. Students are introduced to a real-life situation in which a weaver plans to produce a two-meter-long fabric decorated with a horizontal sequence of identical rhombus motifs, each having diagonals of 20 cm and 12 cm. The motifs are arranged side by side without gaps, and students are asked to determine how many rhombuses can fit along the length of the fabric and to calculate the total area covered by the motifs. Through this problem, students are encouraged to apply their understanding of rhombus properties, area formulas, and unit conversions in a meaningful cultural context. Such tasks help students develop problem-solving skills, spatial reasoning, and mathematical modeling abilities while simultaneously fostering an appreciation of local cultural heritage and demonstrating the relevance of mathematics in everyday life.

These results indicate that the Adu Mancung weaving motif represents a rich ethnomathematical resource that can serve as a strong foundation for developing culturally contextualized geometry teaching materials. By integrating this indigenous pattern into formal mathematics instruction, geometry learning becomes more concrete, relevant, and culturally responsive, while simultaneously contributing to the preservation and appreciation of Baduy cultural heritage (Fitri et al., 2020; Kehi et al., 2019).

The second ethnomathematical artifact identified in this study is *Dudukuy*, a traditional woven bamboo headgear used by the Baduy community. *Dudukuy* is a large circular hat specifically worn by Baduy Luar women, while Baduy men commonly use *Iket* (or Blangkon/Lomar), a triangular-shaped headcloth. In addition, the Baduy community also uses *Caping* (farmer's hat), another circular woven bamboo hat designed to protect farmers from sunlight while working in the fields. These traditional head coverings demonstrate a strong representation of geometric concepts, particularly circles and triangles, embedded in Baduy cultural practices.

From a geometric perspective, *Dudukuy* exhibits the properties of a circle, including a central point, radius, diameter, and circumference. The weaving pattern radiates outward from the center, forming concentric circular structures that reflect an intuitive understanding of radial symmetry and proportional spacing. The structural design of *Dudukuy* requires careful measurement and spatial reasoning to ensure balance, stability, and comfort when worn. Meanwhile, the Iket headcloth represents a triangular form when folded and tied, illustrating the application of triangular geometry in traditional clothing design.

The production of *Dudukuy* involves precise weaving techniques that rely on consistent spacing and uniform curvature, indicating an implicit understanding of circular geometry and symmetry. The radial weaving pattern also demonstrates repeated angular divisions around the center, which can be interpreted as a practical application of angle concepts and partitioning of a circle into equal sectors. Although these concepts are not formally expressed in mathematical notation, they reflect indigenous mathematical reasoning developed through cultural experience and craftsmanship.

Figure 3
Dudukuy as an Ethnomathematical Artifact of Circular Geometry

Masyarakat Suku Baduy menggunakan beberapa jenis penutup kepala, termasuk **Dudukuy** (atau Tudung) yang merupakan topi anyaman bambu berbentuk bundar besar yang khusus untuk wanita Baduy Luar, dan Iket (atau Blangkon/Lomar) yang merupakan kain ikat kepala berbentuk segitiga yang digunakan oleh pria, baik di Baduy Dalam maupun Baduy Luar. Selain itu, ada juga Caping (atau Tudung Petani), topi anyaman bambu berbentuk bundar besar yang fungsinya lebih untuk melindungi dari sinar matahari saat berladang.

Figure 4
Contextual Geometry Problem Based on the Baduy Dudukuy Headgear

Sebuah *dudukuy* (tutup anyaman bundar) dibuat oleh perajin Baduy. *Dudukuy* berbentuk lingkaran dengan **diameter 40 cm**. Perajin menenun dudukuy dengan menggunakan **strip bambu** (lebar strip = **2 cm**) yang ditata secara berlapis (seperti kisi sederhana: arah mendatar dan arah tegak lurus, dua orientasi), sehingga pada akhirnya ada susunan strip horizontal dan strip vertikal yang saling bertumpuk.

Asumsikan setiap strip bambu dipotong memanjang sepanjang **diameter dudukuy** (untuk perhitungan sederhana kita anggap semua strip memiliki panjang sama = diameter). Satu batang bambu utuh dapat dipotong menjadi **2 potongan panjang 1 m** yang siap dipakai (jadi setiap batang memberikan 2 meter bambu total yang bisa dipakai dalam potongan-potongan).

Hitung:

1. Luas dudukuy dalam **cm²** dan **m²**.
2. Berapa banyak **strip** (bambu) yang diperlukan pada satu orientasi (mis. arah horizontal)? Berapa total strip jika ada dua orientasi (horizontal + vertikal)?
3. Jika setiap strip panjangnya = diameter (40 cm), berapa **jumlah total panjang bambu** yang dibutuhkan (dalam meter)?
4. Berapa **batang bambu** yang diperlukan ?

A *Dudukuy* (a circular woven head covering) is made by Baduy craftsmen. The *Dudukuy* has a circular shape with a diameter of 40 cm. The craftsmen weave the *Dudukuy* using bamboo strips (each strip is 2 cm wide) that are arranged in layers, similar to a simple grid pattern with two orientations: horizontal and vertical. As a result, the final structure consists of overlapping horizontal and vertical bamboo strips.
Assume that each bamboo strip is cut with a length equal to the diameter of the *Dudukuy* (for simplicity, assume all strips have the same length as the diameter). One whole bamboo pole can be cut into two pieces of 1 meter each, meaning that each pole provides a total of 2 meters of usable bamboo.
Calculate:

1. The area of the *Dudukuy* in square centimeters (cm²) and square meters (m²).
2. The number of bamboo strips required for one orientation (e.g., horizontal). How many strips are needed in total if there are two orientations (horizontal and vertical)?
3. If each strip has a length equal to the diameter (40 cm), what is the total length of bamboo required (in meters)?
4. How many bamboo poles are needed?

The figure illustrates a contextual geometry learning task based on the traditional Baduy headgear known as *Dudukuy*. The image presents a circular woven bamboo hat with a diameter of 40 cm, constructed using layered bamboo strips arranged in horizontal and vertical orientations. The accompanying problem guides students to explore geometric concepts such as the area of a circle, unit conversion, grid arrangement, and linear measurement through the process of estimating the number of bamboo strips required and calculating the total length of bamboo used. This learning context connects formal geometry concepts with indigenous craftsmanship, enabling students to understand mathematics through authentic cultural practices.

These findings indicate that *Dudukuy* can serve as meaningful ethnomathematical resources for junior high school geometry learning. The circular structure of *Dudukuy* provides a concrete representation for introducing concepts such as radius, diameter, circumference, area of a circle, and rotational symmetry. Similarly, the triangular form of the Iket can be used to explore properties of triangles, perimeter, area, and angle relationships. By using these cultural artifacts as learning contexts, students can visualize abstract geometric concepts through real objects that are closely connected to Indonesian cultural heritage.

Furthermore, integrating *Dudukuy* into geometry teaching materials allows students to explore mathematical ideas through observation, measurement, and reconstruction activities. For example, students can analyze the weaving pattern to estimate the number of radial divisions, calculate the circumference and area of the hat, or design their own circular weaving patterns based on geometric principles. Such activities promote meaningful learning, enhance spatial reasoning, and foster cultural awareness.

Conclusions

This study demonstrates that the Baduy indigenous community possesses rich ethnomathematical knowledge that is deeply embedded in their daily cultural practices and traditional craftsmanship. The findings reveal that cultural artifacts such as the *Adu Mancung* weaving motif and the *Dudukuy* headgear represent fundamental geometric concepts, including rhombus patterns, symmetry, circles, radial structures, and proportional reasoning. These cultural forms embody an implicit mathematical system that reflects the community's spatial reasoning, measurement practices, and pattern construction skills developed through generations of experience.

By transforming these ethnomathematical findings into contextual geometry learning tasks, this study highlights the potential of Baduy culture as a meaningful and authentic learning resource for junior high school mathematics education in Indonesia. The integration of indigenous artifacts into geometry instruction enables students to visualize abstract concepts through concrete cultural representations, thereby enhancing conceptual understanding, problem-solving skills, and spatial reasoning. Moreover, culturally contextualized learning promotes students' appreciation of local wisdom and strengthens their cultural identity in the midst of global cultural influences.

Furthermore, this study contributes to the sustainability of indigenous community education by positioning Baduy ethnomathematics not only as cultural heritage but also as an integral component of formal school curricula. Integrating local wisdom into mathematics learning supports culturally responsive pedagogy and encourages the preservation of indigenous knowledge through intergenerational transmission within educational contexts.

In conclusion, Baduy ethnomathematics provides a strong foundation for developing culturally meaningful geometry teaching materials that align with 21st-century learning principles. Future research may extend this work by implementing and evaluating these materials in classroom settings to examine their impact on students' mathematical achievement, cultural literacy, and learning motivation.

Acknowledgment

The authors gratefully acknowledge the financial support provided by the Directorate of Research and Community Service, Directorate General of Research and Development, Ministry of Education, Science, and Technology of the Republic of Indonesia. The authors also express their sincere appreciation to the Baduy indigenous community for their valuable participation and cooperation during the research process.

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