

ANALYSIS OF GEOMETRIC CONCEPTS IN THE KABIR OF WEHALI VILLAGE COMMUNITY: AN ETHNOMATHEMATICS STUDY

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Abstract

Ethnomathematics is a learning strategy by linking cultural elements in mathematics learning. This research explores the significance of geometric symbolism in Kabir architecture as a cultural heritage in Indonesia. Using an ethnomathematics approach, this study analyzes how geometric shapes found in Kabir buildings not only serve as aesthetic elements but also contain deep cultural, philosophical, and spiritual meanings. The focus of the study includes the identification of geometric patterns such as square, rectangle, space, translation and reflection. Using observation, interviews, and documentation, the researcher obtained various mathematical elements in Kabir. This study contributes to the field of ethnomathematics by documenting the mathematical knowledge hidden in traditional practices, while highlighting the importance of preserving and understanding the symbolic dimensions of cultural heritage as in kabir, there are mathematical elements in the form of geometric concepts such as blocks, cubes, number patterns, translations and reflections that can be implemented in the world of education in learning mathematics at school.

Keywords: Cultural Heritage; Ethnomathematics; Kabir; Mathematical Patterns

Abstract

Etnomatematika merupakan strategi pembelajaran dengan mengaitkan unsur budaya dalam pembelajaran matematika. Penelitian ini mengeksplorasi signifikansi simbolisme geometri dalam arsitektur kabir sebagai warisan budaya di Indonesia. Dengan menggunakan pendekatan etnomatematika, studi ini menganalisis bagaimana bentuk geometri yang ditemukan dalam bangunan kabir tidak hanya berfungsi sebagai elemen estetika, tetapi juga mengandung makna budaya, filosofis, dan spiritual yang mendalam. Fokus penelitian meliputi identifikasi pola-pola geometris seperti persegi, persegi panjang, bangun ruang, translasi dan refleksi. Dengan menggunakan metode observasi, wawancara, dan dokumentasi, peneliti mendapatkan berbagai unsur matematis yang ada dalam kabir. Studi ini berkontribusi pada bidang etnomatematika dengan mendokumentasikan pengetahuan matematika yang tersembunyi dalam praktik tradisional, sekaligus menyoroti pentingnya melestarikan dan memahami dimensi simbolis dari warisan budaya, seperti dalam kabir ditemukan adanya unsur matematika berupa konsep-konsep geometri seperti balok, kubus, pola bilangan, translasi dan refleksi yang dapat diimplementasikan dalam dunia pendidikan dalam pembelajaran matematika di sekolah.

Keywords: Etnomatematika; Kabir; Pola Matematis; Warisan Budaya

INTRODUCTION

Modern mathematics in the 21st century can be considered a cultural language, rooted in the Mediterranean use of quantity, size, and shape. Like other cultures, mathematics has a unique perspective on the world and is now beginning to interact with other ways of thinking as the world becomes increasingly interconnected. The appeal of mathematics lies not only in its scientific, cultural, and artistic value, which has given rise to numerous extraordinary scientific achievements. However, mathematics has also caused cultural and scientific disasters that deserve attention in history.

Mathematics has long been considered a neutral, culture-free discipline, detached from the social values practised in everyday life. Mathematics in schools is taught as a universal subject containing generally accepted facts, concepts, and content. However, ethnomathematics programs emerged to counter the view that mathematics is universal and acculturated (Orey, DC, & Rosa, 2006). Mathematics and culture are an inseparable whole in everyday life, applicable from generation to generation in society. In line with the view Zayyadi (2017) state that mathematics is cultural knowledge that grows and develops to meet human needs. Mathematics is an important subject for developing knowledge, creativity, and attitudes (morals, character). In addition, mathematics also trains thinking and work skills. Formally, mathematics organises reasoning, and materially, it develops knowledge and its application in everyday life (Agbata et al. 2024).

Ethnomathematics is mathematics used by a particular cultural or professional group (Zaenuri & Dwidayati, 2018). This allows mathematical concepts to develop through cultural practices. Ethnomathematics includes various mathematical activities such as grouping, counting, measuring, designing, playing, and locating (Khairunnisa et al., 2022). Forms of ethnomathematics in community culture can be linked to formal mathematical concepts, such as the sine and cosine rules, calculating the area and perimeter of plane figures (rectangles, squares, parallelograms, rhombuses), the surface area and volume of solid figures (cubes, prisms, pyramids, cylinders), and sets (Kaaronen, 2026). These concepts can be integrated into mathematics learning from elementary to secondary education.

Ethnomathematics is now important and requires comprehensive development efforts, not just enrichment. By integrating ethnomathematics in learning, students will more easily solve complex problems relevant to their culture and use cultural context to understand mathematics (Fouze & Amit, 2018). In line with this, ethnomathematics learning can stimulate students' reasoning abilities by forming a cultural identity, making it easier for them to remember the essential characteristics of the objects being studied (Yanti, 2025). D'Ambrosio (2006) explicitly identifies ethnomathematics as a research program in the history and philosophy of mathematics that influences learning, emphasising the importance of studying traditional mathematical stories. Previous research on ethnomathematics has indirectly highlighted Indonesia's cultural richness, particularly across regions. Indonesia is a country rich in local wisdom (Gawen et al., 2021; Gheta et al., 2021; Wae et al., 2022; Sewa et al., 2023). One manifestation of this local wisdom is traditional architecture. In East Nusa Tenggara (NTT), in Wehali Village, Malaka Regency, there is a tradition of using betel quid containers, called kabir by the local community.

The Kabir tradition continues and serves as a starting point for the development of society over time. The Kabir tradition is not merely viewed as knowledge but is also embodied in the attitudes of daily life. The Kabir tradition is not just an ordinary container; it holds significant cultural and social value for the local community. Kabir plays an important role in society as a symbol of respect and in traditional ceremonies, such as weddings and guest welcome. In this context, Kabir architecture is interesting to study, especially from an ethnomathematics perspective. Ethnomathematics, as the study of mathematical practices within a particular culture (D'Ambrosio, 2006), offers a unique lens for understanding how mathematical concepts, particularly geometry, are embodied in cultural artefacts. This study seeks to understand how mathematical and geometric concepts are embodied in the physical form of the kabir and their cultural significance. This research aims to analyze mathematical concepts, particularly geometric elements, within Kabir architecture. Furthermore, it aims to explore the cultural values inherent in Kabir architecture itself. This research is expected to enrich the ethnomathematics literature, particularly regarding weavings like Kabir, and to be implemented in schools.

METHOD

This study uses a qualitative research design with an ethnographic approach to explore and understand how mathematical concepts are applied in Kabir architecture. This study allows researchers to delve deeper into the culture, especially the culture of Wehali Village, related to the way it is made and presented in traditional containers. In this study, the instrument used is the researcher himself, such as the view of humans as researchers who act as tools themselves to collect data needed in research until the conclusion. The subjects of this study are the Wehali Village Community, who have expertise in making kabir. The object of this study is a betel nut container or Kabir. The techniques in data collection are 1) observation, researchers have observed the traditional kabir container, which was chosen because, in addition to being rich in cultural values, kabir architecture also contains mathematical elements, including geometric elements. 2) interviews, with semi-structured interview techniques and selecting respondents who are kabir makers or craftsmen. 3) documentation that includes taking pictures of the kabir shape.

The research procedure used in this study adopted the ethnographic research cycle procedure by Spradley (2016), namely 1) project selection, 2) asking questions, 3) data collection, 4) making ethnographic recordings, 5) ethnographic data analysis, and 6) writing research results. The data analysis used triangulation to ensure the validity of the information obtained about Kabir architecture.

RESULTS AND DISCUSSION

This study discusses the kabir, a traditional container for storing betel and areca nuts originating from the Wehali Village community, Malaka Regency. Kabir not only serves as a storage container but also holds significant cultural and social value in community life, particularly as a symbol of respect in traditional ceremonies, such as weddings and guest welcome. In addition to embodying cultural values, Kabir also demonstrates the presence of mathematical activities that naturally develop within the community's cultural practices. This finding reinforces the view that mathematics is inseparable from society's social and cultural context, as ethnomathematics holds that cultural practices contain mathematical ideas and activities that develop from generation to generation (D'Ambrosio, 2006). The results of this study align with research by Beti et al. (2021), which found that the *Oko Mama cultural artefact* of the South Central Timor community not only has a social function but also contains mathematical concepts, expressed as geometric structures that reflect the cultural values of the local community. Thus, the existence of kabir demonstrates that local culture can be a concrete representation of the application of mathematical concepts in people's daily lives.

Kabir plays a crucial role as a symbol of harmony, unity, and simplicity in the lives of the people of Wehali Village. Kabir is made using palm-leaf weaving techniques, with a regular pattern and a specific structure. Observations revealed that various mathematical elements, particularly geometric concepts, are present in Kabir architecture, evident in the weaving patterns and spatial forms. These findings suggest that the weaving process indirectly involves geometric understanding, including pattern regularity, symmetry, and the spatial relationships between woven parts. These findings align with research by Fauzi & Setiawan (2020), which states that traditional weaving-based crafts incorporate geometric concepts such as plane figures and symmetrical patterns that can serve as resources for contextual mathematics learning. Furthermore, research by Gawen et al. (2021) on Lamaholot culture's palm-leaf weaving found that weaving activities incorporate mathematical concepts through geometric patterns and systematically formed structural regularities. These similar findings confirm that traditional weaving crafts represent a concrete application of mathematical concepts that are alive in local culture.

Table 1. Cultural Values in Kbair

No	Cultural Values
1	Cuboid and spherical shapes. The basic shape of Kabir A cube-like spatial structure, reflects balance. In the context of the Wehali Village community, this symbolizes community integrity and social cohesion.
2	Symmetrical woven patterns reflect the value of harmony in life and society, and symbolise reciprocal relations between individuals in the community.
3	The use of colours includes red, which symbolizes courage, green, which is synonymous with fertility and blue, which symbolizes peace and tranquillity.

Based on Table 1, it can be seen that, overall, every element of the architecture and design of the kabir reflects profound cultural values, reflecting the community's outlook on life, social structure, and beliefs. In addition to its rich cultural values, each part of the Kabir contains interesting mathematical elements. The mathematical elements in the Kabir can be seen in the following figure:



Figure 1. Kabir Base

In Figure 1, the base of the Kabir is shown. The base of the kabir will be woven first during the weaving process. The weaving process, a rich handicraft tradition steeped in cultural heritage, often harbours subtle mathematical principles. In Kabir architecture, a container made through a weaving technique, the initial weaving stage of the base plays a crucial role as a structural foundation. A close examination of the base of a kabir reveals significant mathematical elements, particularly in understanding the concept of area. Researchers observed that the area of the kabir base can be calculated by analyzing the weaving pattern formed on its surface. This finding aligns with research (Fouze & Amit, 2018). which states that ethnomathematics allows the concepts of measurement and geometry to be understood through real cultural activities, thus facilitating the understanding of formal mathematical concepts.

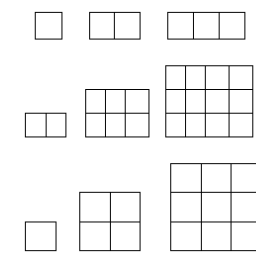


Figure 2. Weaving Pattern

In Figure 2, it can be specifically seen that the woven patterns appearing on the base of the kabir include straight lines, rectangular patterns, and square patterns. The existence of these geometric patterns allows the application of basic mathematical concepts to calculate areas (Hakim et al., 2024). For example, each woven unit that forms a square pattern can represent a certain unit of area. Research by Tandililing (2013) also confirms that local culture-based mathematics learning can bridge abstract

concepts such as area and size into concrete learning experiences. By counting the total number of square patterns and considering the dimensions of the rectangular patterns and their accompanying straight lines, one can accurately determine the total area of the kabir base (Dabbour, 2012). This approach not only confirms the presence of mathematics in traditional crafts but also provides a practical method for measuring and understanding an object's dimensions through visual analysis (Orhani, 2025).



Figure 3. Kabir Wall

In general, as shown in Figure 3, the Kabir wall is typically shaped like a cube or block. A cube, as a perfect geometric shape with equal sides, inherently reflects balance and stability. In the context of the Wehali Village community, this cube shape symbolizes community integrity and strong social ties or strengthens relationships between individuals and groups. The block is also an important geometric element on the Kabir wall. Although its sides are not always equal in length to those of a cube, the block still follows the basic principles of spatial geometry. The block can represent more dynamic variations or extensions of the concepts of balance and integrity. These results align with research (Beti et al., 2021) on *the Oke Mama* community in South Central Timor, which identified the cube and block spatial shapes in traditional containers. This research argues that geometric shapes in cultural artefacts result from the community's spatial understanding that has developed over generations (Wijayanti & Ratnaningsih, 2026).

The use of basic geometric shapes, such as cubes and blocks, on kabir walls is not merely an aesthetic choice but a manifestation of the local community's spatial understanding and philosophy of life. This aligns with the concept of ethnomathematics, which examines how everyday cultural practices contain deep mathematical knowledge. Other studies also show that geometric shapes in traditional artefacts often have deep philosophical meanings and reflect the worldview of the community that created them, such as in kabir walls, which not only function as protection or support but also serve as a medium that conveys social and philosophical values through the language of geometry.



Figure 4. Square and Triangle Patterns

Figure 4 shows that the Kabir walls also contain geometric concepts such as squares and triangles. These geometric patterns are not merely decorative; they are the mathematical foundation of the woven structure. Furthermore, research (Simarmata et al., 2022) also shows that cultural artefacts

of the West Insana community contain concepts of plane shapes formed from systematically arranged traditional decorative patterns. This similarity of results suggests that local cultural activities naturally develop geometric understanding through traditional craft practices. Squares and rectangles are often associated with stability, order, and a solid foundation. Meanwhile, the triangle motif, with its three sides, can symbolize various concepts such as unity, the balance of three elements (e.g., past, present, and future), or even hierarchy in social structures. Ethnomathematical explorations indicate that geometric shapes in handicrafts often carry specific cultural meanings relevant to the community's worldview.

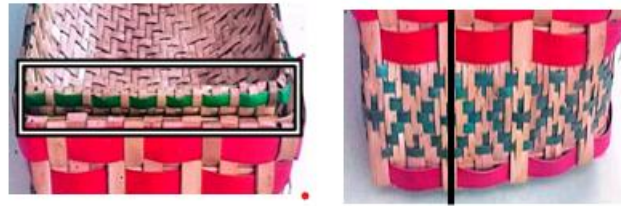


Figure 5. Translation and Reflection

Figure 5 demonstrates the concept of translation and reflection on the Kabir wall. A similar sentiment was expressed by (Zani & Maat, 2021) that ethnomathematical elements in traditional cultures often display the concepts of symmetry and geometric transformations that play a role in constructing aesthetic and mathematical patterns. In mathematics, translation is a type of isometry. This transformation preserves distances between points and angle magnitudes, so that the shape and size of an object remain unchanged. At the same time, reflection is another isometric transformation that reverses an object across a reflection line (or axis of symmetry) (Libeskind & Jubran, 2024). If we illustrate the image above by assuming a motif M is located at the initial coordinate (x_0, y_0) , and is repeated to the right with a distance a at each step, then the position of the next motif will be at $(x_0 + a, y_0)$, then $(x_0 + 2a, y_0)$, and so on. This is a series of translations with the vector $(a, 0)$. Many weaves exhibit clear line symmetry, where one part of the pattern is a mirror image of the other part along an imaginary vertical or horizontal axis that passes through the centre of the weave (Kang et al., 1999). This creates a strong sense of balance and harmony.

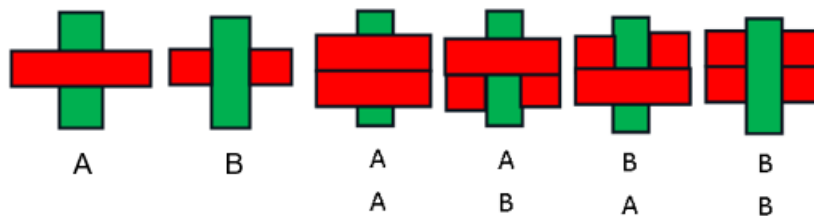


Figure 6. Conditional Probability

Figure 6 shows the possible weaving patterns. Fajriyah (2018) explains that cultural activities such as pattern repetition and the arrangement of traditional motifs are concrete forms of the application of discrete mathematical concepts that have developed in people's lives. To form a pattern from 1 red leaf and 1 green leaf, namely top-bottom, means there are 2 possibilities to make a woven pattern from the leaves. When the woven pattern is continued for 2 red leaves and 1 green leaf, the patterns that can be formed are AA, AB, BA, BB. From the patterns formed for 1 green leaf and 2 red leaves, there are 4 patterns. The relationship with the pattern formed from one 1 red and 1 green leaf means that the more red leaves there are, the more the pattern formed is 2^n . And for green leaves, the next pattern will also

be 2^n . So if the number of red leaves is n and the number of green leaves is p , the pattern formed is 2^{pn} .

CONCLUSION

Based on the results of the study on Kabir, it can be concluded that Kabir, A traditional vessel from Wehali Village, Malacca Regency, holds profound cultural value and contains significant mathematical concepts, particularly geometry. This study uses an ethnomathematics approach to demonstrate that mathematics exists not only in formal learning but also hidden in traditional practices and cultural heritage. The mathematical concepts found in Kabir include plane and spatial shapes such as squares, rectangles, triangles, cubes, and cuboids, which represent the values of balance and social integrity. Furthermore, Kabir weaving patterns also demonstrate geometric transformations, such as translations and reflections, resulting in symmetrical and harmonious patterns. The weaving process even exhibits numerical patterns that can be modelled mathematically through the relationship between the number of leaves and variations in the resulting patterns. The findings of this study confirm that local culture can be a contextual learning resource in mathematics. The integration of ethnomathematics concepts based on Kabir has the potential to help students understand geometric concepts in a more concrete, meaningful, and culturally relevant way, while simultaneously preserving local cultural wisdom.

Based on the results of this study, several suggestions that can be given are as follows for the world of education, the geometric concepts contained in Kabir can be developed into teaching materials or mathematics learning media based on local culture, so that learning becomes contextual and increases students' learning motivation. For future researchers, this study is still limited to identifying geometric concepts. Therefore, further research can develop and expand the study not only on geometric aspects but also on other mathematical concepts such as measurement, advanced symmetry, and mathematical modelling involved in the kabir-making process.

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