

CROSS-CULTURAL ETHNOMATHEMATICS IN SOUTHEAST ASIA: MATHEMATICAL PRACTICES EMBEDDED IN INDONESIAN AND THAI CULTURAL PHENOMENA

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Abstract

This study explores cross-cultural ethnomathematical practices embedded in cultural phenomena across Southeast Asia, with a focus on Indonesia and Thailand. The primary objective is to identify and analyze mathematical practices inherent in various cultural aspects, including batik motifs, traditional house architecture, and traditional games in Indonesia, as well as temple architecture, woodcarving, and traditional dance in Thailand. This study employs a case-study approach, with data collected through participant observation, in-depth interviews, and document analysis. The findings indicate that mathematical practices such as geometry, proportion, symmetry, and patterns are consistently found in cultural artifacts and activities. The research results indicate that contextual learning incorporating ethnomathematics influences problem-solving abilities based on students' levels of thinking. Additionally, this study provides insights into the interrelation between cultural values and mathematical symbolism. Cross-cultural analysis revealed common themes and significant differences in the application of mathematics, influenced by historical, religious, and environmental factors. The implications of this research include a deeper understanding of how culture shapes mathematical practices and how ethnomathematics can be integrated into education to enhance culturally relevant mathematics learning and improve students' numeracy skills.

Keywords: Ethnomathematics, Indonesia, Thailand, Culture, Mathematics, Southeast Asia, Case Studies.

INTRODUCTION

Ethnomathematics is the study of how different cultures understand, conceptualize, and practice mathematics (D'Ambrosio, 1985). It recognizes that mathematics is not a universal, culture-neutral field, but is embedded in specific cultural contexts. This approach offers a way to understand mathematics not merely as a set of abstract rules and formulas, but as a meaningful human activity rooted in cultural experience. Research on ethnomathematics has flourished over the past few decades, providing insights into mathematical practices embedded in diverse cultures worldwide.

Southeast Asia, with its rich cultural diversity, offers fertile ground for ethnomathematical exploration. Indonesia and Thailand, in particular, are home to diverse ethnic groups, each with its own unique traditions, arts, and architecture. Mathematical practices are deeply interwoven with these cultural aspects, often hidden within designs,

constructions, and daily activities. Understanding these practices can provide valuable insights into how people understand and use mathematics in their everyday lives.

Cross-cultural significance in Indonesia and Thailand is particularly important. Both countries have a long history of cultural interaction, with influences from various civilizations, including India, China, and the Middle East. This has resulted in a dynamic and diverse cultural landscape, with mathematical practices influenced by a variety of sources. Furthermore, an ethnomathematics perspective can contribute to a broader understanding of cultural diversity and promote inclusion in mathematics education. Skinner et al. (2023) discuss a systematic approach to the psychology of racial bias in individuals and society, which is relevant when considering how cultural perspectives shape mathematical understanding.

The main research question of this study is to identify, analyze, and compare mathematical practices embedded in specific cultural phenomena in Indonesia and Thailand. This involves exploring how mathematical concepts such as geometry, proportion, symmetry, and patterns are used and understood in different cultural contexts.

This study aims to explore and analyze mathematical practices internalized within cultural phenomena in Indonesian and Thai societies through an ethnomathematics perspective. Specifically, this study aims to identify cultural phenomena in both countries that reflect the presence of significant mathematical concepts, patterns, or activities within social life and societal traditions. Furthermore, this research seeks to conduct an in-depth examination of the forms of mathematical practices embedded in the selected cultural phenomena, whether evident in geometric patterns, number systems, measurement, symmetry, proportion, or logical structures that have been passed down through generations.

Additionally, this study aims to interpret the cultural meanings inherent in these mathematical practices, including the symbolism of values, philosophies, and social representations. This understanding is crucial to demonstrate that mathematics exists not only as a formal discipline but also as a living knowledge construct within a society's cultural practices. Furthermore, this study compares and contrasts cross-cultural mathematical practices between Indonesia and Thailand to identify similarities, local distinctiveness, and their potential contributions to the development of culture-based mathematics education.

A brief review of relevant literature reveals that ethnomathematics has become a growing field of study, with research focusing on various cultures worldwide. Previous studies have explored mathematical practices in art, architecture, games, and other cultural activities (Utami et al., 2022; Zuhri et al., 2023). However, there remains a need for further research focused on Southeast Asia, particularly Indonesia and Thailand. This

study aims to fill this gap by providing an in-depth analysis of mathematical practices embedded in specific cultural phenomena in both countries.

METHOD

This study employs a case-study approach to explore ethnomathematical practices in Indonesia and Thailand. Case studies were chosen because they allow for an in-depth investigation of specific cultural phenomena and related mathematical practices. The type of case study used is an instrumental case study, which focuses on gaining a broader understanding of ethnomathematics through specific case studies (Stake, 1995).

This study employs a comparative qualitative approach using multiple-case analysis to explore ethnomathematical practices embedded within cultural phenomena in Indonesia and Thailand. Case study locations were selected purposively for their rich cultural representation, mathematical relevance, and sufficient empirical data.

In Indonesia, the case studies focused on three main cultural phenomena: batik motifs, traditional house architecture, and traditional games. Research locations included regions with strong cultural heritage, such as Yogyakarta and Pekalongan for batik traditions, the Java region for Joglo houses, and West Sumatra for Gadang houses. Additionally, traditional games such as congklak and egrang were selected because they incorporate concepts of numeracy, strategy, and logical patterns relevant to ethnomathematics. Meanwhile, in Thailand, the case studies focused on temple architecture, woodcarving, and traditional dance, which embody symbolic richness and mathematical structures within local culture, particularly in geometry, symmetry, proportion, and repetitive patterns.

Case selection is based on three main criteria. First, data availability: the case must have sufficient data sources for analysis, including visual artifacts, historical records, cultural documentation, and access to relevant informants. Second, cultural significance: the selected phenomenon must possess strong cultural value and represent local traditions that are still alive in the community. Third, mathematical potential, meaning the presence of clearly identifiable mathematical elements, such as geometry, symmetry, patterns, proportions, measurements, and numerical structures.

Data collection techniques were carried out using several methods to obtain comprehensive data. First, participant observation, in which the researcher was directly involved in relevant cultural activities, such as batik-making workshops, visits to traditional houses, observation of temple architectural structures, and traditional dance performances. This approach allows for the direct identification of mathematical practices emerging within the community's cultural activities. Second, semi-structured in-depth interviews were conducted with various key informants, including cultural experts,

artisans, artists, community leaders, and practitioners of traditional arts. These interviews aimed to explore the informants' understanding of cultural meanings, symbolism, and the application of mathematical concepts in daily cultural practices. Third, a document analysis was conducted on various secondary sources, including historical manuscripts, journal articles, cultural books, museum archives, and promotional materials. This analysis was used to reinforce field findings and identify consistent conceptual patterns within the cultural practices under study.

The collected data were analyzed using content and thematic analyses. In the initial stage, data from interviews, observations, and documents were systematically coded to identify relevant units of meaning. Subsequently, main themes were developed through thematic analysis to uncover forms of mathematical practice, cultural symbolism, as well as cross-cultural similarities and differences between Indonesia and Thailand. To enhance the validity of the findings, this study employs source and method triangulation, specifically by comparing results from observations, interviews, and document analysis.

In its implementation, this study also strictly adheres to ethical considerations. All participants will provide informed consent prior to data collection. The confidentiality of informants' identities is safeguarded through the use of pseudonyms and secure data storage. Furthermore, this study prioritizes cultural sensitivity as a core principle, respecting the norms, values, and beliefs of local communities at each study site. The research will adhere to strict ethical guidelines to ensure it is conducted responsibly and respects the rights and dignity of all participants.

RESULTS AND DISCUSSION

Indonesia

Batik Motifs: Geometry and Symmetry in Cultural Heritage



Picture 1. Most Popular Batik Motifs in Indonesia

Batik, the traditional Indonesian art of decorating fabric using hot wax to resist dyeing, is a prime example of how mathematics is woven into culture. Batik motifs, often complex and intricate, reveal the underlying geometric and symmetrical principles. This study will explore the mathematical practices inherent in various batik motifs, focusing on regions renowned for their batik traditions, such as Yogyakarta and Pekalongan.

Batik motifs are often constructed from basic geometric elements such as lines, shapes, and patterns. For example, the iconic “parang rusak” motif, originating from Java, features a repeating diagonal pattern that creates an illusion of movement and dynamism. These patterns can be analyzed using geometric concepts such as parallel lines, angles, and shapes. Additionally, batik motifs often exhibit symmetry, such as reflection symmetry (mirror symmetry) and rotational symmetry. Symmetry is an important mathematical concept that helps create visual balance and harmony in batik designs.

The batik-making process itself involves the application of mathematical principles. The use of the *canting*, a specialized tool for applying wax, requires careful measurement and precision. Batik artisans must meticulously plan their designs, considering the size, proportions, and placement of geometric elements. Furthermore, the dyeing process involves an understanding of ratios and proportions to achieve the desired colors. The cultural significance and mathematical symbolism within batik motifs are rich and profound. Each motif often carries specific symbolic meanings linked to cultural values, beliefs, and history. For example, the “kawung” motif, resembling a lotus flower, symbolizes perfection, purity, and longevity. Understanding these symbolic meanings requires an appreciation of the history and cultural context of the batik motif.

The analysis of batik motifs in this study was conducted through a multidimensional approach that integrates visual, mathematical, and historical-cultural perspectives to gain a comprehensive understanding of the ethnomathematical practices embedded within them. First, visual analysis was used to identify the formal elements that constitute the structure of batik motifs, such as repeating patterns, geometric shapes, lines, curves, and principles of symmetry and transformation. At this stage, attention is focused on the presence of mathematical concepts such as translation, reflection, rotation, and tessellation that emerge in the arrangement of the motifs. This analysis aims to map how the visual elements of batik represent systematically arranged mathematical patterns. Second, mathematical analysis was conducted to quantify the geometric structure of the studied motifs. This process involves measuring angles, line lengths, areas, and the ratios and proportional relationships among motif elements. This approach enables the identification of Euclidean geometric principles, numerical regularity, and proportional relationships underlying batik design. In the context of ethnomathematics, this stage is crucial for demonstrating that traditional artistic practices also contain complex and

structured mathematical logic. Third, historical and cultural analysis is used to interpret the origins, development, and symbolic meanings of batik motifs within the community's sociocultural context. This analysis involves tracing the philosophical values, local symbolism, and social functions of specific motifs, thereby revealing how mathematical elements serve not only as structural forms but also as a medium for representing cultural identity, cosmology, and traditional values. Through the integration of these three approaches, this study aims to uncover the interconnections among visual aesthetics, mathematical structures, and cultural meanings in batik motifs, as a form of living ethnomathematics within Indonesian society. Previous research has highlighted the importance of ethnomathematics in education, focusing on the use of local culture in mathematics learning (Nur et al., 2020; Juhaevah, 2022). A case study of batik motifs will provide a concrete example of how mathematical concepts can be identified and understood within a cultural context. Using batik as a medium for mathematics education can increase students' interest in mathematics and enhance their understanding of mathematical concepts. The application of ethnomathematics strategies can strengthen character education elements such as honesty, solidarity, and a strong sense of sportsmanship in playing traditional games (Zuhri et al., 2023).

Traditional House Architecture: Geometry and Proportions in Cultural Space



Picture 2. Traditional House in Indonesia

Traditional house architecture in Indonesia, from the Joglo house in Java to the Gadang house in West Sumatra, is another example of how mathematics is embedded in culture. The construction of traditional houses involves the application of mathematical principles, including geometry, proportions, and structure. Traditional houses are often built using basic geometric elements such as rectangles, triangles, and circles. For example, the Joglo house features a complex pyramid-shaped roof constructed using

principles of spatial geometry. The Gadang house, with its upward-curving roof, demonstrates the careful use of proportion and balance. Proportions play a crucial role in the design of traditional houses. Artisans must consider the proportions between various parts of the house, such as wall height, room width, and window size. Proper proportions are essential for creating a sense of harmony and visual balance. The structure of traditional houses is also based on mathematical principles. Artisans must consider material weight, structural strength, and load distribution to ensure the house is safe and stable. The cultural significance and mathematical symbolism in traditional house architecture are highly significant. Each architectural element often carries specific symbolic meanings tied to cultural values, beliefs, and history. For example, the shape of a traditional house's roof often symbolizes the relationship between humans and the universe.

The architectural analysis of traditional houses in this study was conducted through an interdisciplinary approach that integrates visual, mathematical, and historical-cultural analyses to uncover ethnomathematical practices embedded in the design and construction of traditional buildings. First, visual analysis is used to identify geometric elements, form proportions, spatial patterns, and visual structures that shape the overall design of traditional houses. The analysis focuses on roof shapes, floor plans, column arrangements, symmetry patterns, and the relationships among building components. Through this approach, researchers can observe geometric concepts such as lines, angles, planes, and three-dimensional shapes, as well as the principles of similarity and symmetry that underpin architectural design. Second, mathematical analysis is conducted to explore the building's quantitative structure in greater depth. This stage involves measuring physical dimensions, such as building height, room width, roof pitch, column spacing, and floor area. Additionally, the analysis focuses on calculating ratios and proportions between building components to identify the mathematical principles of order used in traditional construction. For example, the ratio of a building's height to width, the slope of the roof angle, and the distribution of structural loads can be analyzed to demonstrate the application of mathematical concepts in the building's structural integrity and balance. Third, historical and cultural analysis traces the origins of traditional house architecture, the evolution of its forms over time, and the symbolic meanings attached to each building element. In this context, traditional houses are understood not only as physical structures but also as representations of cultural identity, philosophical values, and the community's social systems. For example, a specific roof shape may represent social status, cosmological orientation, or the relationship between humans and nature. Through the integration of these three approaches, this study aims to demonstrate that traditional house architecture is a tangible manifestation of ethnomathematics, where principles of

geometry, proportion, and mathematical structure are intertwined with culturally inherited meanings.

Previous research has shown that architecture can facilitate mathematical problem-solving (El Bedewy et al., 2021). A case study on traditional house architecture will provide a concrete example of how mathematical concepts can be identified and understood within a cultural context. The integration of traditional house cultural values into learning can help strengthen the Pancasila student profile (Taneo & Madu, 2023).

Traditional Games: Mathematics in Entertainment and Education



Picture 3. Most Indonesia Traditional Games

Indonesian traditional games, such as congklak and egrang, provide another example of how mathematics is embedded in culture. These games often involve mathematical concepts such as numbers, patterns, and strategies. Congklak, a popular board game throughout Indonesia, involves calculation, strategy, and an understanding of numbers. Players must count the seeds they collect and plan their moves to maximize their score. This game also involves an understanding of patterns and sequences. Egrang, a traditional game involving walking on tall stilts, involves an understanding of balance, distance, and speed. Players must coordinate their movements to maintain balance and move forward. Traditional games also hold significant cultural meaning and symbolism. These games are often passed down from generation to generation and symbolize cultural values such as cooperation, sportsmanship, and togetherness.

The analysis of traditional games in this study was conducted through observational, mathematical, and historical-cultural approaches to uncover ethnomathematical practices that emerge in play activities and social interactions within the community. First, direct observation was used as the primary technique to identify how players implicitly apply mathematical concepts during gameplay. Observations focused on decision-making patterns, step calculations, object grouping, distribution strategies, and outcome estimations performed by players. In traditional games such as congklak, for example, players naturally use numerical operations, repeated addition,

sequence patterns, and combinatorial logic to determine game strategies. Second, mathematical analysis was conducted to explore the logical and numerical structures underlying the game's mechanisms. This analysis includes identifying move patterns, optimization strategies, score calculations, winning probabilities, and numerical regularities that emerge in the flow of the game. At this stage, concepts such as number patterns, game theory, simple probability, and decision algorithms can be used to explain players' mathematical behavior. Third, historical and cultural analysis traces the origins of the game, its evolution within society, and the symbolic meanings embedded in its rules and practices. This approach aims to understand traditional games not only as recreational activities but also as a medium for transmitting cultural values, informal education, and the development of logical thinking patterns within the community.

Through the integration of these three methods, this study seeks to demonstrate that traditional games constitute a rich space for the practice of ethnomathematics, where concepts of numeracy, patterns, strategies, and logic develop naturally within the context of local culture. The application of traditional games in mathematics education can increase students' interest in mathematics and enhance their understanding of mathematical concepts (Tampubolon et al., 2023; Fatimatuszahro et al., 2024).

Thailand

Temple Architecture: Geometry and Symmetry in Sacred Spaces



Picture 4. Temple in Thailand

Temple architecture in Thailand, particularly Buddhist temples, is a prime example of how mathematics is interwoven into culture. Temple construction involves the application of mathematical principles, including geometry, proportion, and symmetry. Buddhist temples are often built using basic geometric elements such as

squares, circles, and triangles. For example, pagodas, the distinctive tower-like structures found in Thai temples, are often constructed using principles of spatial geometry. Temples also frequently feature symmetry, which creates a sense of harmony and visual balance. Proportions play a crucial role in temple design. Architects must consider the proportions between various parts of the temple, such as the height of the tower, the width of the hall, and the size of the Buddha statue. Proper proportions are essential for creating a sense of beauty and grandeur. The temple's structure is also based on mathematical principles. Architects must consider material weight, structural strength, and load distribution to ensure that the temple is safe and stable. Cultural meaning and mathematical symbolism in temple architecture are highly significant. Each architectural element often carries a specific symbolic meaning, linked to cultural values, beliefs, and history. For example, the shape of a stupa (a dome-like structure) often symbolizes the universe.

The analysis of temple architecture in this study is conducted through visual, mathematical, and historical-cultural approaches to uncover the interconnections between architectural forms, mathematical principles, and the cultural meanings embedded within them. This approach is crucial in ethnomathematics research because temple architecture represents the integration of aesthetics, spirituality, and mathematical order passed down through generations. First, visual analysis is used to identify geometric elements, form proportions, and visual structures that constitute the temple's overall design. The analysis focuses on the building's basic forms, symmetry patterns, column arrangements, tiered roof shapes, reliefs, and decorative ornaments that demonstrate pattern regularity. Elements such as vertical and horizontal lines, angles, polygonal shapes, domes, and axial symmetry are key aspects in identifying the representation of geometric concepts in temple architecture. Second, mathematical analysis is conducted to explore the building's quantitative structure in greater depth. This stage involves measuring building dimensions—such as tower height, main hall width, roof pitch, and column spacing—and calculating ratios and proportions among structural elements. This analysis demonstrates how mathematical principles, such as similarity, proportion, symmetry, and load distribution, are employed to maintain both the stability and aesthetic beauty of temple architecture. Third, historical and cultural analysis traces the origins of temple architecture, the evolution of building styles, and the symbolic meanings inherent in each design element. Within the Thai cultural context, temple structures often represent cosmology, spiritual hierarchies, and the religious values of society. For example, the soaring form of a tower can be interpreted as a symbol of the connection between the human world and the spiritual dimension.

Through the integration of these three approaches, this study aims to demonstrate that temple architecture not only represents artistic and religious expression but also serves as a tangible manifestation of ethnomathematics—practices that integrate geometric concepts, proportions, and cultural symbolism into a cohesive whole. Previous research has highlighted the importance of architecture in STEAM education (El Bedewy et al., 2021). A case study of temple architecture will provide a concrete example of how mathematical concepts can be identified and understood within a cultural context.

Carving Art: Patterns and Symmetry in Artistic Expression



Picture 5. Carving Art in Thailand

Carving art in Thailand, particularly wood carving and temple carvings, is another example of how mathematics is interwoven into culture. Carvings often feature intricate geometric patterns and beautiful symmetry. The geometric patterns in Thai carvings often feature lines, shapes, and repeating motifs. These patterns can be analyzed using mathematical concepts such as geometry, symmetry, and fractals. Symmetry plays a crucial role in carving design. Carvings often display reflection, rotation, and translation symmetry, creating a sense of balance and visual harmony. The carving process itself involves the application of mathematical principles. Artisans must carefully plan their designs, considering the size, proportions, and placement of geometric elements. The cultural significance and mathematical symbolism in carving art are highly significant. Each motif often carries a specific symbolic meaning, linked to cultural values, beliefs, and history. For example, the lotus flower motif symbolizes purity and enlightenment.

The analysis of carving art in this study employs visual, mathematical, and historical-cultural approaches to uncover the ethnomathematical practices embedded in motif structures, ornamental patterns, and the cultural symbolism inherent in traditional carved works. This approach enables a comprehensive understanding of the relationship between visual aesthetics, mathematical regularity, and cultural values passed down

through generations. First, visual analysis is used to identify geometric elements, symmetrical forms, and repetitive patterns that constitute the carving's structure. The analysis focuses on the presence of lines, curves, polygonal shapes, floral motifs, and repetitive patterns frequently found in traditional carving art. Additionally, geometric transformation principles such as reflection, rotation, translation, and pattern repetition are crucial aspects in understanding the visual construction of carvings. Second, mathematical analysis is conducted to explore the quantitative structure of carving elements. This stage involves measuring angles, line lengths, curve radii, and the area of specific motifs. Furthermore, the analysis includes calculating ratios and proportions among the carving elements to identify the visual harmony established by mathematical principles. This approach is crucial for demonstrating that traditional carving art contains complex geometric logic and numerical regularity. Third, historical and cultural analysis traces the origins of carving motifs, the evolution of their forms within local traditions, and the symbolic meanings inherent in each ornament. In a cultural context, carving art often represents ethnic identity, spiritual values, social status, and the community's philosophy of life. Therefore, this analysis positions carving not merely as an aesthetic object but also as a medium of cultural communication that embodies a local mathematical knowledge system.

Through the integration of these three approaches, this study aims to demonstrate that carving is a tangible manifestation of ethnomathematics, where concepts of geometry, symmetry, patterns, and proportions harmoniously blend with cultural meanings and traditional symbolism. Previous research has shown that art can enhance students' critical thinking skills (Idul & Fajardo, 2023). A case study on woodcarving will provide a concrete example of how mathematical concepts can be identified and understood within a cultural context.

Traditional Dance: Movement and Patterns in Cultural Expression



Picture 6. Traditional Dance in Thailand

Traditional dance in Thailand, such as classical Thai dance, provides another example of how mathematics is embedded in culture. These dances often involve

movement patterns, rhythm, and symmetry. Movement patterns in traditional Thai dance often use lines, shapes, and repeating motifs. Dancers must carefully coordinate their movements to create harmonious and aesthetically pleasing patterns. These patterns can be analyzed using mathematical concepts such as geometry and symmetry. Rhythm plays a crucial role in dance. Dancers must follow the musical rhythm precisely, which involves an understanding of timing, duration, and patterns. Symmetry is also frequently used in dance. Dancers often move in symmetrical patterns, creating a sense of balance and visual harmony. The cultural significance and mathematical symbolism in traditional dance are highly significant. Each movement and pattern often carries a specific symbolic meaning, linked to cultural values, beliefs, and history. For example, certain hand movements may symbolize specific emotions or stories.

The analysis of traditional dance in this study employs observational, mathematical, and historical-cultural approaches to uncover the ethnomathematical practices embedded in movement patterns, rhythm, and choreographic structures. This approach enables the exploration of the relationship between expressions in the performing arts and mathematical concepts that emerge implicitly within culture. First, direct observation is used to identify movement patterns, rhythms, tempos, and forms of symmetry present in traditional dance. The focus of observation is directed toward movement repetition, dancer formations, positional shifts, and synchronization among group members. Elements such as bilateral symmetry, circular patterns, repetition of movement sequences, and rhythmic regularity serve as key indicators in identifying ethnomathematical aspects in dance. Second, mathematical analysis is conducted to explore the quantitative dimensions of dance movement structures. This analysis includes measurements of time, the duration of each movement segment, intervals between rhythms, and the distance dancers travel within the performance space. Additionally, movement patterns are analyzed to identify numerical regularities, repetition frequencies, spatial symmetry, and the distribution of positions within dance formations. This approach demonstrates that traditional choreography is often built upon systematic mathematical patterns. Third, historical and cultural analysis traces the origins of the dance, the development of its choreographic forms, and the symbolic meanings embedded in each movement and formation. In a cultural context, dance movements serve not only as artistic expressions but also as representations of spiritual values, historical narratives, social identities, and local symbolism passed down from generation to generation.

Through the integration of these three approaches, this study aims to demonstrate that traditional dance is a complex form of ethnomathematics in which patterns of rhythm, symmetry, repetition, and spatial structure intertwine with cultural meanings and societal symbolism. Previous research has shown that dance can enhance students' cognitive skills

(Wiseman et al., 2020). A case study on traditional dance will provide a concrete example of how mathematical concepts can be discovered and understood within a cultural context

Cross-Cultural Analysis

A comparison and contrast of mathematical practices within cultural phenomena in Indonesia and Thailand reveals several common themes and significant differences. Both countries, despite their distinct histories and cultures, demonstrate a strong connection between mathematics and cultural expression. Based on cross-case study analysis in Indonesia and Thailand, this research identifies several key themes that demonstrate a close connection between cultural practices and mathematical concepts from an ethnomathematical perspective. The first theme is geometry and symmetry. These two concepts appear consistently in various forms of cultural expression in both countries and serve as the primary foundation for both aesthetic and functional constructions. In Indonesia, elements of geometry and symmetry are evident in the structural motifs of batik, the spatial arrangements of traditional houses, and the patterns of traditional games, which display regularity of form and visual balance. Batik motifs, for example, often demonstrate geometric transformations such as translation, reflection, and rotation arranged systematically. Meanwhile, traditional houses such as the Joglo and Gadang demonstrate the use of spatial symmetry and geometric regularity in their floor plans and roof structures. In Thailand, the same themes are also highly dominant in temple architecture and woodcarving, particularly in ornamental patterns, column arrangements, reliefs, and tiered roof structures that exhibit axial symmetry and complex geometric proportions. The second theme is proportion, which plays a crucial role in creating visual harmony and structural balance. In both Indonesia and Thailand, proportion serves not only as an aesthetic principle but also as a rational foundation for material cultural construction. In traditional house and temple architecture, the proportions between height, width, roof pitch, and spatial division reveal a deep mathematical understanding of formal harmony. This principle of proportion is also reflected in woodcarving and batik motifs, where the sizes of visual elements are arranged in a balanced manner to create a harmonious impression. The third theme is patterns, which emerge as a key element in various cultural manifestations. Repetitive patterns are found in batik motifs, woodcarving, and traditional dance movements. In the context of ethnomathematics, these patterns represent concepts of repetition, sequences, periodicity, and numerical regularity. The repetition of visual elements and movements indicates that local cultures internalize mathematical concepts in practical and aesthetic forms. The fourth theme is symbolic meaning, which demonstrates that mathematical practices in culture are not merely structural but are also rich in philosophical values and social symbolism. Geometric elements, patterns, and proportions often represent cultural values, belief

systems, social status, and the historical narratives of communities. Thus, mathematics in a cultural context functions as a symbolic language that connects visual forms with deeper meanings.

Overall, these themes demonstrate that mathematical practices in Indonesian and Thai cultures do not exist merely as abstract concepts but are organically integrated into cultural expressions, value systems, and societal identities. In addition to identifying several universal themes, this study also highlights significant differences in ethnomathematical practices between Indonesia and Thailand, reflecting the distinctive characteristics of each culture. The first difference relates to the influence of religion as the foundation for the formation of symbolic structures and cultural aesthetics. In Indonesia, the influence of Islam is quite dominant in the development of batik motifs and certain traditional house architectures, particularly in the use of geometric patterns, motif repetition, and symmetry, which often avoid figurative representation. These patterns often feature abstract, floral, and geometric forms that reflect spiritual values and the philosophy of harmony. Conversely, in Thailand, Buddhist influence is highly prominent in temple architecture and woodcarving, particularly in vertical, layered buildings rich in cosmological symbols. Geometric elements in temples often represent spiritual hierarchies, the journey toward enlightenment, and the relationship between sacred space and the profane world. The second difference lies in artistic style. Woodcarving in Thailand tends to exhibit greater visual complexity, with intricate ornamental details, dense, repetitive patterns, and precise decorative symmetry. In contrast, carving and visual motifs in Indonesia demonstrate a greater balance between symbolic function and local aesthetics, with an emphasis on patterns integrated with ethnic and regional identities. Similarly, traditional dance in both countries exhibits distinct styles in rhythm, movement structure, and spatial patterns. Dance in Thailand generally emphasizes smoother, more precise, and rhythmic movements, while traditional Indonesian dance displays a diversity of forms influenced by ethnic context and social function. The third difference relates to the cultural function of mathematical practices themselves. In Indonesia, mathematical practices, as manifested in batik motifs and traditional games, primarily serve social, ceremonial, and cultural identity contexts. Batik, for example, is used in various traditional rituals and social events, and it serves as a symbol of specific social status. Conversely, in Thailand, mathematical practices are predominantly expressed in temple architecture and woodcarving, serving spiritual and religious functions, particularly as a medium for representing Buddhist values and sacred spaces. Beyond these differences, this study also identifies several key factors influencing the development of cultural mathematical practices in both countries. First, historical factors play a crucial role. Cultural interactions with other civilizations—including

influences from India, the Arab world, China, and colonialism—have shaped the evolution of geometric patterns, architectural structures, and visual symbolism within local cultures. Second, religion is a dominant factor shaping the value systems and symbolic orientations of cultural practices. The influence of Islam in Indonesia and Buddhism in Thailand has significantly contributed to the selection of forms, patterns, and functions of mathematical elements in cultural expressions. Third, the physical environment also exerts a significant influence on the development of mathematical practices. Climatic conditions, topography, building materials, and local natural resources influence the design of traditional houses, temples, decorative motifs, and spatial structures. For example, the roof shapes of traditional houses and temples are often adapted to local rainfall patterns, air circulation, and available building materials.

Overall, these differences indicate that mathematical practices across cultures are not uniform but develop contextually, shaped in each society's history, religion, and environment. Previous research has shown that culture significantly influences how people understand and use mathematics (Bender, 2013; Owens, 2023). The cross-cultural analysis in this study provides further evidence to support this claim. An understanding of cross-cultural mathematical practices can promote inclusion in mathematics education and enhance understanding of cultural diversity.

CONCLUSION

This study has explored cross-cultural ethnomathematical practices embedded in various cultural phenomena in Indonesia and Thailand through a comparative case-study approach. The study focuses on batik motifs, traditional house architecture, and traditional games in Indonesia, as well as temple architecture, woodcarving, and traditional dance in Thailand. Through a multidimensional analysis of visual, mathematical, and historical-cultural aspects, this study successfully identified forms of mathematical practice that are inherently embedded in both cultural artifacts and community activities. Key findings indicate that mathematical concepts such as geometry, proportion, symmetry, and patterns are consistently present in various forms of cultural expression in both countries. These concepts not only function as formal structures in visual and spatial design but also serve as principles for organizing aesthetic and cultural order. Furthermore, this study affirms that mathematical practices within culture possess rich symbolic meanings closely tied to cultural values, belief systems, social identity, and societal history. Thus, mathematics in a cultural context cannot be understood merely as an abstract structure, but as part of a living local knowledge system passed down through generations. This study also identified both universal themes and significant differences in the cross-cultural application of mathematics between Indonesia

and Thailand. Similarities are evident in the consistent use of patterns, symmetry, and proportions as primary elements of cultural expression. Meanwhile, differences emerge in cultural functions, artistic styles, and religious influences that shape mathematical manifestations within each cultural context. These variations demonstrate that ethnomathematics practices develop contextually and are influenced by historical, religious, and physical environmental factors. Theoretically, this study reinforces the view that mathematics is a socio-cultural construct integrated into community life. In practice, these findings make an important contribution to the development of mathematics learning grounded in local culture and more contextual, inclusive, and relevant to students' cultural identities. This study makes a significant contribution to the fields of ethnomathematics and mathematics education. The findings of this study have the potential to enhance understanding of how culture shapes mathematical practices, increase students' interest in mathematics, and facilitate the development of culturally relevant and inclusive mathematics curricula.

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