An Exploration of Geometrical Concepts in Brunei Woven Textiles: An Ethnomathematical Study

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Abstract
The Brunei Woven Textiles are culturally significant artifacts in Brunei Darussalam, often used in traditional events such as Mandi Belawat and Hantaran Pernikahan. These textiles exhibit intricate motifs that incorporate mathematical concepts, a field known as ethnomathematics, offering a potential starting point for mathematics education. Despite their cultural importance and widespread use, ethnomathematics is not commonly integrated into Brunei's educational system. This study explores the geometric concepts within these textiles using ethnographic methods, gathering data from literature, documentation, and field notes. The findings suggest that these textiles contain valuable geometric patterns suitable for teaching mathematics and can also reinforce cultural identity and character development among students. By highlighting these insights, the research advocates for including culturally relevant materials like the Brunei Woven Textiles in mathematics curricula to make learning more engaging and accessible for Brunei students.

Keywords: Brunei Darussalam, Brunei Woven Textiles, Ethnomathematics, Geometrical Concept

Introduction

Mathematics arises from human ideas, methods, and techniques to face problems or phenomena in daily life (D'Ambrosio, 1985). These ideas, techniques, and methods are interpreted as human activity or culture (Risdiyanti & Prahmana, 2020). As Freudenthal (1991) states, mathematics is a human activity, and mathematics in schools must be related to real life. But nowadays, mathematics is seen as an abstract science that is far from human life (Prahmana, Kusuma, & Darhim, 2016). This perspective occurs because mathematics education in schools is often unrelated to students' daily activities and culture (Karnilah & Juandi, 2013). This creates a domino effect for students, such as not understanding the use of mathematics in daily life, anxiety when learning mathematics, and feeling that learning mathematics is unimportant.

To resolve the gap between mathematics and the life student reality, we need something to bridge both, one of which is ethnomathematics (Abdullah, 2017). Furthermore, D'Ambrosio (1985) explains that ethnomathematics explores mathematical ideas, techniques, and methods owned and used by a cultural community to face the reality of their life. Thus, when ethnomathematics is used at school as a context for learning mathematics, students will be able to see how mathematical ideas, techniques, and methods owned and used by their culture as an inheritance from their ancestors (Risdiyanti, Prahmana, & Shahrill,

2019). Students will more easily understand mathematical concepts rooted in what they own and use in their daily lives and culture (Rosa & Orey, 2016). So, students find it easier to interpret the knowledge they learn and understand how to use mathematics to face problems or phenomena in their daily lives.

Brunei Darussalam is a country with Malay and Islamic cultures (Sharbawi & Mabud, 2021). One of these forms of culture is interpreted as artifacts, such as Brunei woven textiles with Malay motifs (Wahsalfelah, 2005). For the Brunei society, Brunei woven textiles are usually used as clothing and wedding gifts (Wahsalfelah, 2014). Besides that, the Brunei woven textiles are essential in realizing and strengthening social relations and symbolizing social status (Renne, 1991; Wahsalfelah, 2003). Brunei woven textiles have ethnomathematics potential that can be used as contexts in learning mathematics, especially mathematics learning in Brunei. Several previous studies have proven that woven textiles contain mathematical concepts. Some of these prior studies, such as studies of Lakapu et al. (2021) exploring ethnomathematics on Buna Woven Textiles in the culture of East Nusa Tenggara, Indonesia; Nawawi et al. (2014) studied ethnomathematics in Malay Songket Textiles in Malaysian culture; Mukhopadhyay (2009) explores ethnomathematics on Tlingit in the culture of the people of Alaska, United States; and others. However, researchers have yet to study ethnomathematics exploration of woven textiles in Brunei Darussalam. Even educators in Brunei Darussalam have yet to use the ethnomathematics context in learning mathematics.

The use of woven textiles in mathematics learning aligns with Freudenthal's (1991) and D'Ambrosio's (1985) views. These two mathematicians believe that the mathematical concepts learned in school are the human response to face all the problems in their daily lives (Freudenthal, 1991; D'Ambrosio, 1985). Humans search for explanations, understandings, and solutions to face the realities of their lives (Rosa & Orey, 2016). Mathematics cannot be separated from the environment around humans because it was built and developed from the surrounding environment (Prahmana & Istiandaru, 2021). Mathematics education in schools that only transfer knowledge allows students to receive knowledge without being encouraged to think critically, creatively, and reflectively, which is the main problem in mathematics education that must be resolved immediately (D'Ambrosio, 2016).

Therefore, there needs to be an effort to bridge mathematics in schools with students' daily lives and culture, one of which is through ethnomathematics. This revolution in mathematics education cannot be applied only in several countries. It must be carried out in countries worldwide, including Brunei Darussalam country. So, human civilization worldwide can be more advanced, critical, creative, reflective, tolerant, and appreciate their culture and identity. So, this study aims to explore ethnomathematics in the cultural artifacts of Brunei Darussalam in the form of woven textiles with Malay motifs. This study can be used as a starting point for learning mathematics. In addition, the results of this exportation can also show how the social and cultural values of Brunei's woven textiles have the potential to develop good socio-

cultural values and strengthen the identity of Brunei Darussalam students.

Methods

The method used in this research is ethnography, which studies and describes a community's culture (Spradley & McCurdy, 1989). This method was chosen to get the Brunei society's view of their world and culture. This method aligns with ethnomathematics, which seeks to get opinions on mathematical ideas, techniques, procedures, and socio-cultural values owned and developed by a cultural community to face their reality of life (Risdiyanti & Prahmana, 2020). Data was collected using a literature review and photo documentation. The data collection results were analyzed using source triangulation techniques to comprehensively explore the relationship between mathematical knowledge systems and Brunei woven textiles to see the conceptions used and developed by the people of Brunei to make woven textiles. Finally, the findings and data analysis are described in this study.

Results and Discussion

The results of this research show that the Brunei Darussalam society interprets their ideas, one of which is in the form of Brunei woven textiles, which are commonly used in traditional ceremonies such as marriage, birth, death, and others as the identity of the greatness of the Brunei Kingdom (Walsefalah, 2014, Brahim et al., 2022). Apart from symbolizing cultural values, Brunei woven textiles in traditional ceremonies also preserve traditions (Renne, 1991). At the Brunei wedding ceremonies, Brunei woven textiles are usually used as a gift and symbol of affection (Tinkong & Mohamad, 2021). Besides that, the Brunei woven textiles are also essential in realizing and strengthening social relations (Walsafelah, 2006; Walsafelah, 2014). Another use of Brunei woven textiles is at the birth ceremony after the child is 40 days. This symbolizes gratitude and signifies the transitioning status into a mother. Brunei woven textiles are also used at funerals to cover the coffin as a tribute to the deceased and their families.

Brunei Darussalam, as a country with a monarchy system, traditions are still preserved. At formal events at the Sultan's Istana, Brunei woven textiles are usually used with gold motifs and a black base. Brunei woven textiles are essential in the Brunei Kingdom as a symbol of greatness. Brunei woven textiles are used by the nobility and the public society as symbols of social relations (Walsafelah, 2005). In addition, Brunei's woven textiles also form an identity that symbolizes power, sovereignty, and authority. Besides having socio-culture value, in creating Brunei woven textiles, the Brunei society has used mathematical concepts, such as:
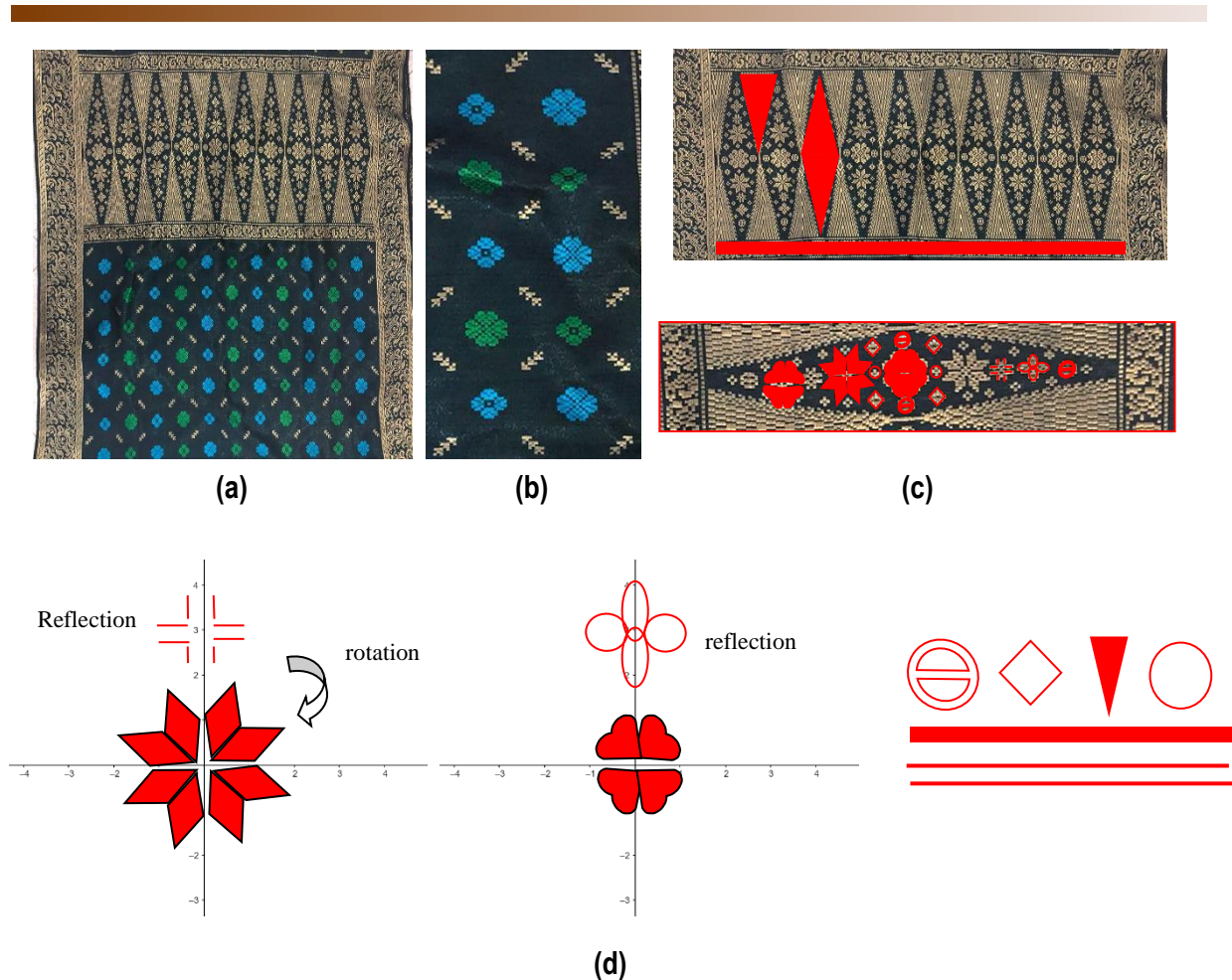
Figure 1. Brunei Woven Textile (a) and Illustration of Geometry Transformation & 2 Dimensional Geometric (b-d)

The exploration of mathematical concepts in Brunei woven textiles reveals that Brunei Darussalam society has been utilizing concepts from 2-dimensional geometry, curves, and geometric transformations—such as reflection and rotation—through intuitive learning. These concepts are derived from their experience identifying shapes and conveying their ideas. Moreover, the study indicates that Brunei woven textiles encompass socio-cultural values and identities that symbolize the rich heritage of Brunei Darussalam. The results from prior studies on ethnomathematics have shifted students' perceptions of the divide between formal mathematics and their everyday lives.

Several previous studies have successfully designed mathematics learning approaches using woven textiles, demonstrating that applying real-life contexts makes mathematics easier for students to understand (Bisri & Muchyidin, 2022; Dede & Amsikan, 2019; Febrian & Astuti, 2018). Bisri and Muchyidin (2022) showed that exploring Cirebon woven textiles could be applied to teach mathematics. Similarly, Dede and Amsikan's (2019) study demonstrated that Kafemenanu woven textiles are practical for teaching geometry. Febrian and Astuti's (2018) survey indicated that Malay woven textiles help teach

geometric transformations.

Ethnomathematics research extends beyond woven textiles, exploring other cultural artifacts across various countries (Nyoni, 2014; Albanese, 2015; de Freitas Madruga & Biembengut, 2015; Fouze & Amit, 2017; Araujo, 2015). These studies suggest that many countries have recognized the importance of ethnomathematics as a learning context, emphasizing that the essence of mathematics is deeply rooted in human thought and adapted to the realities of daily life.
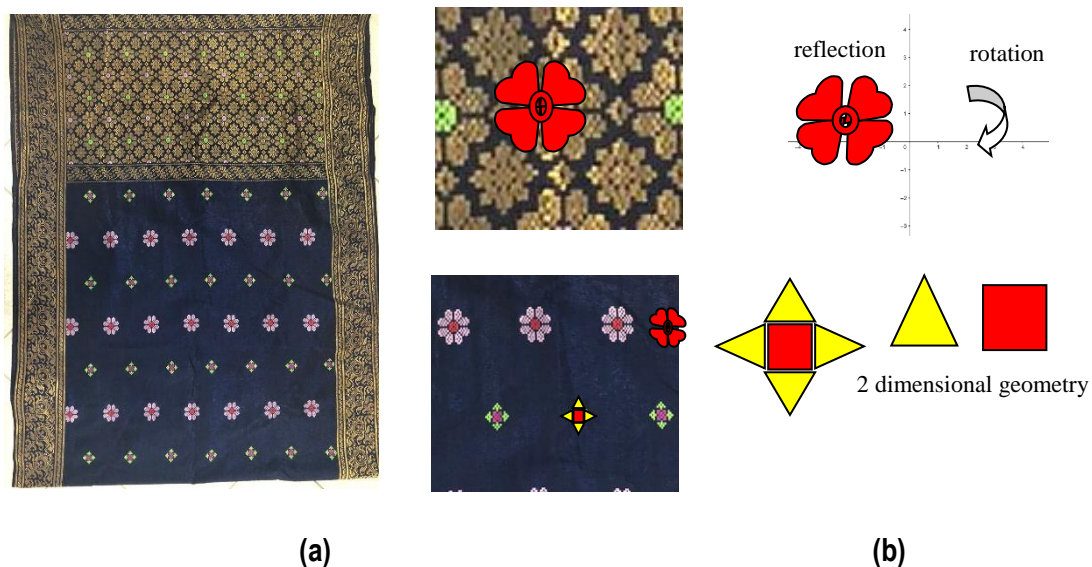

(a) (b)

Figure 2. Brunei Woven Textile (a) and Illustration of Geometry Transformation & 2-Dimensional Geometry (b)

This investigation into the geometric concepts embedded within Brunei's woven textiles seeks to fill critical gaps in the body of ethnomathematics research. The study focuses on extracting and examining mathematical principles derived from the everyday life and culture of Brunei Darussalam. This focus aligns with a broader movement in educational research toward contextual learning, recognizing that students often find abstract mathematical concepts more comprehensible when presented in a culturally relevant context. The research's emphasis on Brunei's textiles provides a unique perspective on how traditional crafts can be a valuable resource for mathematical education.

Brunei Darussalam has experienced a shortage of researchers and educators specializing in ethnomathematics. This scarcity contributes to the challenges students face in mathematics education, including heightened anxiety, misconceptions, and a lack of engagement with the subject. Addressing these challenges requires innovative approaches that connect formal mathematical concepts with real-world applications. This study aims to create pathways for integrating ethnomathematics into Brunei's

educational framework, thereby offering an alternative route for students to understand and appreciate mathematics.

The objectives of this study are wider than addressing students' difficulties in mathematics. The research also aims to reveal socio-cultural values deeply rooted in the nation's heritage by exploring the geometric concepts inherent in Brunei's woven textiles. The textiles, with their intricate patterns and designs, can bridge traditional cultural expressions and formal educational content. The potential to draw from such cultural artifacts to teach mathematical principles opens new possibilities for curriculum development, providing educators with innovative tools to engage students meaningfully.

Moreover, the study's findings could contribute to preserving and appreciating Brunei's cultural heritage. As students learn mathematics through the context of woven textiles, they are also exposed to the socio-cultural narratives embedded in these traditional crafts. This dual focus on education and culture can strengthen students' sense of identity and connection to their heritage, fostering a more profound respect for Brunei's traditions. The research thus represents a crucial step toward enhancing mathematics education and reinforcing the character and identity of Brunei Darussalam's students.
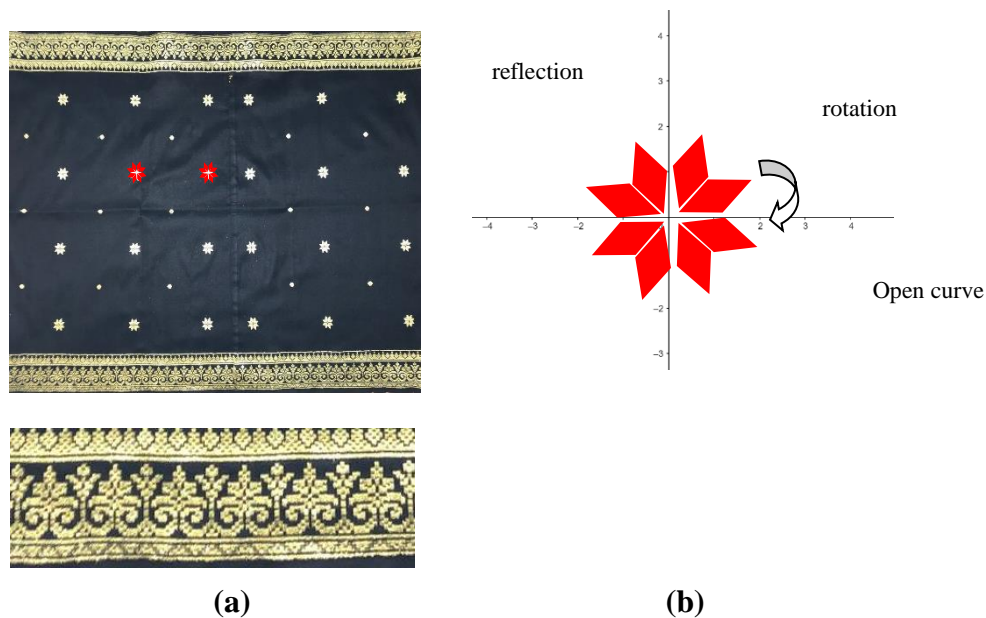

(a)   **(b)**

Figure 3. Brunei Woven Textile (a) and Illustration of Geometry Transformation & Open Curve (b)

Conclusion

The exploration of ethnomathematics in Brunei's woven textiles reveals the presence of several critical mathematical concepts, including 2-dimensional geometry, open curves, and geometric transformations such as reflection and rotation. The intricate patterns and designs within these textiles demonstrate a cultural understanding of these mathematical ideas, suggesting that traditional crafts in

Brunei Darussalam inherently contain significant mathematical knowledge. Moreover, the study highlights that these textiles are more than just objects of aesthetic value—they encapsulate socio-cultural identities and values that symbolize the grandeur and heritage of the state of Brunei Darussalam. The findings underscore the potential of integrating these traditional elements into educational contexts, thereby offering a more relatable and culturally significant approach to teaching mathematics.

The broader implications of this study extend beyond the local context, encouraging further research into ethnomathematics within Brunei's culture and potentially inspiring similar studies in other regions. Future investigations could delve deeper into additional cultural artifacts or practices that might hold ethnomathematical significance, thereby expanding the body of knowledge on Brunei's cultural heritage. This research can also serve as a model for international scholars, demonstrating how traditional crafts and cultural symbols can be used to enrich mathematical education. Educators and researchers can foster a deeper appreciation for mathematics by adopting a more culturally relevant approach, bridging the gap between formal concepts and real-world applications.

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