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Ethnomathematics: Exploration at The Great Mosque of Demak

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Abstract
Conceptual understanding of mathematics in elementary schools greatly influences students' problem-solving abilities. This study aims to find and describe the results of the exploration of ethnomathematics forms in the building of the Great Mosque of Demak, especially in the material of flat shapes. In addition, students can understand abstract mathematical concepts through concrete objects. This study is a descriptive qualitative study. Data collection techniques are by observation and documentation. The findings reveal that the structure of the Great Mosque of Demak contains rich elements of mathematical concepts, especially related to flat shapes such as triangles (seen in the shape of the roof structure), rectangles (visible in the windows and door frames), and circles (present in decorative motifs and ornaments). These geometric patterns not only reflect the cultural identity of the region but also offer meaningful contexts for introducing mathematical concepts in elementary school.

Keywords: *ethnomathematics, solving mathematics problems, elementary school, geometric*

Introduction

The Great Mosque of Demak is one of the historical sites reflecting the Javanese people's rich cultural and intellectual heritage during the early spread of Islam in Indonesia. Built-in the 15th century, this mosque not only symbolizes spirituality but also serves as evidence of the technical and artistic ingenuity of the people at that time. Its design and construction reveal various patterns and forms that can be analyzed using mathematical concepts, demonstrating the practical application of mathematics in local culture. This aligns with ethnomathematics, which links cultural traditions with the application of mathematics (D'Ambrosio, 1985).

Ethnomathematics, first introduced by Ubiratan D'Ambrosio, studies how mathematics is understood, developed, and used in various cultures. This field highlights the connections between modern mathematical concepts and traditional activities, such as architecture, art, and technology. According Rosa & Orey (2011) in the context of the Great Mosque of Demak, the ethnomathematical approach can be used to

study geometric patterns on the roof, symmetrical structures in the main pillars (*saka guru*), and other aesthetic elements rooted in Javanese traditions.

The ethnomathematical approach is also relevant in modern mathematics education. According to Gerdes (1994), studying mathematics in a cultural context helps students understand that mathematics is not just an abstract discipline but also an integral part of everyday life. Thus, Nailatusy Syifa & Salafudin (2021) explained ethnomath is a reflection of cultural anthropology (cultural anthropology of mathematics) and mathematics from the standpoint of studies Incorporating cultural elements, such as the architectural design of the Great Mosque of Demak, can make mathematics learning more meaningful and contextual. This also strengthens students' connection to their cultural heritage while fostering appreciation for local wisdom.

The Great Mosque of Demak offers numerous elements that can be analyzed mathematically. For instance, the tiered roof structure, symbolizing spiritual hierarchy in Islam, can be studied through geometric concepts, while the proportions and arrangements of the mosque's main pillars indicate a deep understanding of symmetry and balance. Previous studies have shown that these elements are often based on mathematical principles passed down through generations, albeit in informal forms.

The study of ethnomathematics at the Great Mosque of Demak is significant not only in uncovering cultural contributions to the development of mathematics but also in enriching pedagogical approaches in mathematics education. According to Zaslavsky (1999), problem-solving concepts can be introduced by exploring complex cultural patterns that require critical analysis. For example, students can be guided to understand the symmetry of building structures or calculate the area and volume of architectural elements using empirical data from the mosque

Thus, this research aims to explore the ethnomathematical elements embedded in the architectural structure of the Great Mosque of Demak and relate them to mathematical problem-solving concepts in elementary education. The novelty of this study lies in its attempt to explicitly connect ethnomathematics with students' problem-solving abilities—an aspect that has been largely overlooked in previous discussions, which often focus solely on identifying cultural mathematical patterns without linking them to cognitive learning outcomes. By establishing this connection, the study not only broadens the theoretical discourse on ethnomathematics but also offers practical implications for mathematics instruction. Furthermore, it contributes to the relatively

limited body of literature that examines ethnomathematics within the context of Indonesian cultural heritage, reinforcing the value of local wisdom as a contextual and meaningful resource in mathematics learning.

Research Methods

This research is a descriptive qualitative study using an ethnographic approach, focusing on field observation and documentation of the architectural elements of the Great Mosque of Demak. The research was conducted through several stages: initial observation of the mosque's structure, identification of architectural features related to flat shapes, documentation through photographs and field notes, and analysis by categorizing the identified elements based on their geometric properties. The analysis involved matching each architectural feature such as windows, roof patterns, ornaments, and floor motifs with relevant mathematical concepts, particularly two-dimensional shapes. The goal was to interpret how these elements can be used as contextual tools for teaching mathematics in elementary education.

Results and Discussion

The exploration of ethnomathematical forms in the structure of the Great Mosque of Demak reveals the application of basic geometric concepts in its construction. As the oldest mosque on the island of Java, the Great Mosque of Demak is a historical legacy of the Wali Songo. The mosque's architecture incorporates various plane geometric shapes. For instance, the mosque's roof appears as a triangular plane when viewed from a specific direction, while the porch section resembles a parallelogram. The findings of this ethnomathematical exploration of the Great Mosque of Demak are detailed as follows.

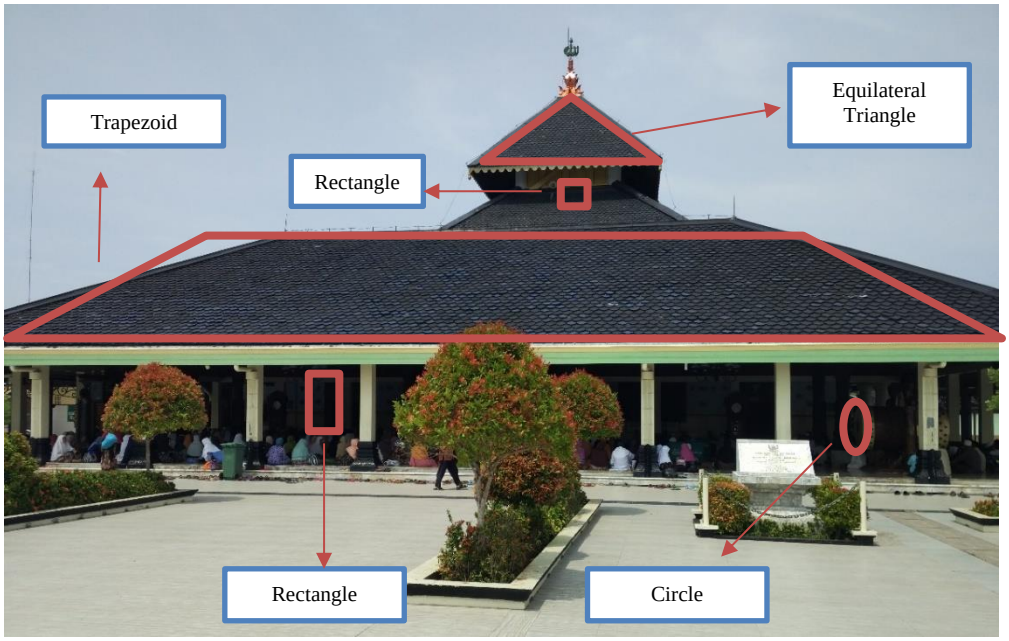

Figure 1 Building Flat at the Great Mosque of Demak

From Figure 1, it can be seen that in the building of the Great Mosque of Demak there are several concepts of flat buildings, including: equirectangular triangles, squares, rectangles, parallelograms, and circles. By using a cultural approach around students such as the Great Mosque of Demak, students will better understand mathematical concepts and their application in real life. In addition, the existence of concrete examples will help students at each stage of solving mathematical problems.

Based on the analysis of the results of observations and documentation on the Demak Great Mosque Building, parts that have mathematical aspects and can be associated with mathematical materials in schools were obtained. The relationship between mathematical concepts in the building of the Great Mosque of Demak is presented in Table 1.

Table 1 Mathematical Concepts in the Demak Grand Mosque Building

Section of the Great Mosque of Demak	Mathematical Concepts (Flat Build)
	The *bledeg* door of the Great Mosque of Demak contains the concept of a rectangle. A rectangle is a flat rectangle formed by 2 pairs of sides that are each equal in length and parallel to their counterparts. Culturally, the *bledeg* door holds deep symbolic meaning in Javanese Islamic tradition. Rectangular $formula$: $Area\ (L)\ =\ p\ x\ l$ $Circumference$ (K) = 2 (p + l)
	The roof building of the Great Mosque of Demak contains the concept of a triangle. A triangle is a flat figure that is bounded by 3 sides and has 3 corner points. The types of triangles based on their side length are divided into 3, including: equilateral triangles, isosceles triangles, arbitrary triangles. The three-tiered roof symbolizes the three stages of spiritual life in Javanese philosophy: *sangkan paraning dumadi*, *kawulo gusti*, and *manunggaling kawula lan gusti*. Triangle $formula$: $Area\ (L)\ =\ \frac{1}{2}\ x\ a\ x\ t$ $Circumf$erence (K) = a + b + c
	The roof building of the Great Mosque of Demak contains the concept of a Parallelogram. Trapes is a flat shape formed by four sides, two of which are parallel to each other but not the same length. Trapezoidal formula: Area $(L)\ =\ \frac{1}{2}\ x\ (a\ +\ b)\ x\ t$ $Circu$mference (K) = AB + BC + CD +DA
	The side of the *beduk* at the Great Mosque of Demak is in the shape of a circle. The circular shape reinforces the idea of inclusivity and harmony, aligning with the Javanese philosophical value of "memayu hayuning bawana" Circle formula: Area (L) = π x r x r Circumference (K) = 2 x π x r

Mathematics learning aims to develop students' overall mathematical abilities to achieve optimal learning outcomes, with one of the key focuses being the enhancement of problem-solving skills. According to Polya, effective problem solving involves four steps: (1) understanding the problem, (2) devising a plan, (3) carrying out the plan, and (4) reviewing the results. Research conducted by Andi Saparuddin Nur, et al., (2023),

contextual learning with ethnomathematics fosters problem-solving abilities based on the thinking levels.

In this context, ethnomathematics serves as a powerful bridge between culture and mathematical thinking by providing real-life, culturally rooted problems that are meaningful to students. For example, when analyzing geometric patterns found in the architecture of the Great Mosque of Demak, students engage in the first step by observing and understanding the cultural artifact. They then plan and solve problems by identifying shapes, calculating areas, or analyzing symmetry, all grounded in a familiar cultural context. Finally, they evaluate their solutions in light of both mathematical accuracy and cultural relevance. Thus, integrating ethnomathematics into learning not only enriches cultural appreciation but also strengthens each stage of students' mathematical problem-solving processes.

Conclusion

Based on the discussion above, it can be concluded that there is culture in Demak district as literacy of local wisdom in solving problems. The application of ethnomathematics as an approach in the mathematics learning process, especially in solving mathematical problems, needs to be done. The ethnomathematics found in the Demak Grand Mosque building is very helpful in learning resources and solving mathematical problems. There are several forms of flat buildings in the Great Mosque of Demak, including: square, rectangle, triangle, parallelogram, and circle.

Therefore, it is recommended that mathematics teachers incorporate ethnomathematical contexts into their instruction, curriculum developers embed local cultural elements into learning materials, and further research be conducted to explore other cultural sites as sources of mathematical learning, thereby strengthening the connection between mathematics, culture, and education.

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