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## ETHNOMATHEMATICAL INSIGHTS FROM THE CULTURAL HERITAGE OF THE GREAT MOSQUE OF MADIUN

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### Abstract

Ethnomathematics integrates mathematical concepts such as counting, measuring, geometric patterns, and spatial structures with local culture to create more meaningful and contextual learning. This study aims to explore the concept of ethnomathematics in the architecture of the Baitul Hakim Grand Mosque in Madiun City and assess its potential as a learning resource in mathematics learning. Using a qualitative ethnographic approach, data were collected through direct observation of the mosque building, interviews with mosque administrators, and architectural documentation. Data analysis was carried out systematically through method triangulation to ensure the validity of the findings. The results of the study revealed real mathematical activities in the mosque building, namely counting activities (the number of 120 pillars, 5 ablution places, and 1 tower), measuring (the height of the main pillar is 12m, the diameter of the pillar is 50cm, the ablution places are 3×3 m and 5×12 m, and the tower is 35m high with various diameters), and designing the building (combining elements of Javanese, Arabic, and European architecture). Further exploration shows the existence of flat geometry concepts (rectangle, isosceles triangle, trapezoid), solid shapes (cylinder, cuboid, cone, pyramid), and geometric transformation (reflection on the axis). The conclusion of this study shows that the structure of the mosque can function as a medium for learning mathematics based on culture that can increase learning interest and facilitate student understanding.

**Keywords:** architecture, contextual learning, ethnomathematics, geometry, mosque

### Abstrak

Etnomatematika mengintegrasikan konsep-konsep matematika seperti menghitung, mengukur, pola geometri, dan bangun ruang dengan kebudayaan lokal untuk menciptakan pembelajaran yang lebih bermakna dan kontekstual. Penelitian ini bertujuan menggali wawasan etnomatematika dari warisan budaya masjid agung madiun sebagai sumber belajar dalam pembelajaran matematika. Dengan menggunakan pendekatan kualitatif etnografi, data dikumpulkan melalui observasi langsung pada bangunan masjid, wawancara dengan pengurus masjid, dan dokumentasi arsitektur. Analisis data dilakukan secara sistematis melalui triangulasi metode untuk menjamin validitas temuan. Hasil penelitian mengungkap adanya aktivitas matematis nyata dalam bangunan masjid, yaitu kegiatan membilang (jumlah 120 tiang, 5 tempat wudhu, dan 1 menara), mengukur (tinggi tiang induk 12 m, diameter tiang 50 cm, tempat wudhu berukuran 3×3 m dan 5×12 m, serta menara setinggi 35 m dengan diameter beragam), dan merancang bangunan (menggabungkan unsur arsitektur Jawa, Arab, dan Eropa). Eksplorasi lebih lanjut menunjukkan keberadaan konsep-konsep geometri datar (persegi panjang, segitiga sama kaki, trapesium), bangun ruang (tabung, balok, kerucut, limas), dan transformasi geometri (refleksi terhadap sumbu y). Simpulan penelitian ini menunjukkan bahwa struktur masjid dapat difungsikan sebagai media pembelajaran matematika berbasis budaya yang mampu meningkatkan minat belajar dan mempermudah pemahaman siswa.

**Kata kunci:** arsitektur, pembelajaran kontekstual, etnomatematika, geometri, masjid



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## INTRODUCTION

Education is one of the efforts to develop the potential of human resources to be better and superior. Education plays a very important role in preparing high-quality human resources in the development of science and technology (Sutarsa & Puspitasari, 2021). One of the learnings that can develop and increase the potential of human resources to be more advanced is mathematics learning. Mathematics is one of the branches of science that has an important role in the development of science and technology both as a tool in the application of other fields of science and in the development of mathematics (Khairunisa & Basuki, 2021).

Mathematics can be learned by various methods including through culture. Culture cannot be isolated from mathematics because mathematics exists in the components of human activities, including social, cultural, and universal activities (Muzakkir, 2021). Cultural awareness can be incorporated into math learning by integrating subject content and local culture. However, learning by utilizing surroundings is rare in learning (Kusno et al., 2023; Luthfi & Rakhmawati, 2022),

Culture in people's lives has a very close relationship with mathematics. The relationship between the two is called ethnomathematics (Afnenda, 2021; Prahmana & D'Ambrosio, 2020). Ethnomathematics is also called an activity that involves numbers, geometric patterns, counts and so on which is considered the application of knowledge in the field of mathematics involving local culture (Pusvita et al., 2019). According to Sirate Ethnomathematics is applied as a means to motivate, simulate, overcome boredom, and give a new nuance to mathematics learning (Pusvita et al.,

2019). Cultural objects whose presence is close to daily life are needed as an effort to realize this (Yudianto et al., 2021). Formal and lack of variety in mathematics learning can reduce students' interest in learning mathematics (Zhu & Kaiser, 2022). For this reason, it is necessary to use mathematics outside the school that is connected to school mathematics, namely utilizing the ethnomathematics approach as the beginning of formal mathematics teaching that is in accordance with student development (Iskandar et al., 2022). It is equally stated that mathematics with cultural nuances can make a great contribution to school mathematics (Harahap & Mujib, 2022). One of the cultural objects that is very close to life is the mosque.

In everyday life, mathematics can be used to calculate, reason or solve problems. For example, in activities in buying and selling transactions using the concept of social arithmetic, in the construction of houses, mosques, and buildings using the concept of geometry, planting rice in rice fields related to the concept of arithmetic rows (Musbaiti et al., 2023). Mathematics has an important role in solving problems ranging from simple to complex problems (Faturrahman & Soro, 2021; Ika Krisdiana et al., 2025). The application of ethnomathematics in a mosque building generally applies the science of geometry.

A mosque is a building or a special place for Muslims to worship. Each region has a variety of mosque buildings with their own uniqueness and characteristics according to their philosophical meaning, for example, the Sheikh Zayed Grand Mosque in Solo (Purniati et al., 2022). Madiun is famous for its largest mosque, the Great Mosque of Baitul Hakim Madiun which

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is located to the west of the Madiun City Square. One of the characteristics of the splendor of the Great Mosque of Baitul Hakim lies in the number of pillars scattered in each corner of the room.

Mosque as a cultural application to mathematics learning that leads to the study of ethnomathematics (Alghar & Marhayati, 2023). Ethnomathematics is mathematical concepts that are applied, referring to the activities, habits, or customs of people's lives in solving problems (Faturrahman & Soro, 2021; Kusno et al., 2025). The study of ethnomathematics has two objectives, namely to recognize the idea of cultural group practices and to find out various ways about quantity, space and relationships in cultural groups (Astriandini & Kristanto, 2021).

Research related to ethnomathematical exploration has been carried out extensively. Research conducted by related to the exploration of ethnomathematics at the Al-Muhtaram Grand Mosque, which resulted in the conclusion that there is ethnomathematics in the mosque that can be used as a learning resource for students (Musbaiti et al., 2023). Research conducted by stated that the Jami Cikini Al-Ma'mur Mosque can be used as a source of school mathematics learning on geometry materials. Research conducted by who used the Jami' Sultan Syarif Abdurrahman Mosque in Pontianak City as an ethnomathematical exploration study concluded that in the mosque there is a mathematical concept of flat planes and spatial planes.

This research aims to find out the concept of mathematics and to explore ethnomathematics in the building of the Great Mosque of Baitul Hakim Madiun City. The success of the study will have a good impact on the world of education

and culture. The importance of this research for education, especially mathematics learning, is that it can be used by educators as a new learning resource in mathematics learning that can be developed into a learning medium to increase students' interest in learning and facilitate the delivery of material. Therefore, it is necessary to conduct research related to ethnomathematics entitled "Ethnomathematical Exploration at the Great Mosque of Baitul Hakim Madiun City".

## RESEARCH METHODS

This research is a qualitative research type with an ethnographic approach. The ethnographic approach is a qualitative research procedure for describing and analysing various cultural groups that interpret patterns of behaviour, beliefs and language that have evolved and been used by a group of people over time (Musbaiti et al., 2023). The research was conducted at the Baitul Hakim Grand Mosque in Madiun City, located on Jl. Aloon-Aloon Barat, Pangongangan, Manguharjo District, Madiun City. This mosque was chosen as the research location because it is a historic building that not only functions as a place of worship, but also represents rich local cultural values. The architecture and ornaments in this mosque reflect a combination of aesthetic values, religious symbols, and mathematical understanding of the local community, such as the concepts of symmetry, patterns, and repetition. The data collection methods used were observation, interviews, and documentation. Observation activities were carried out directly to observe the shape of building ornaments in the mosque. Furthermore, interviews were carried out to obtain information guided by Table 1.

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Tabel 1. Interview guide

No	Ethnomathematics Indicator	Description of Ethnomathematics Indicator
1	Counting	Mention the number of pillars, ablution places and towers
2	Measuring	Mention the dimensions of the pillars, the size of the ablution area and the size of the tower
3	Make a building plan	Mention the building pattern design

The subjects in this study were three administrators of the Grand Mosque. Documentation activities were conducted inside the Grand Mosque building, where the collected data was triangulated, using a triangulation method to obtain valid data. Once the research data was collected, it was analyzed to draw conclusions based on the results.

## RESULTS AND DISCUSSION

Mathematical activities are cognitive processes that involve transforming real-life contextual experiences into mathematical concepts. These activities include calculations, measurements, determining position and direction, designing building plans, and play activities that contain mathematical elements (Wanguway et al., 2025). Mathematical activities in the Baitul Hakim Grand Mosque relate to numbers, sizes, and mathematical concepts in the pillars, ablution areas, and minarets.

The results of the observation show that the number of pillars in the grand mosque is 120, divided into 3 places, namely in the main mosque, the central porch and the front porch. The first pillar in the main mosque has 16 teak wood pillars, consisting of 4 main pillars and 12 other supporting pillars.

Geometrically, the shape of the pillars is included in the cylindrical geometric shape, namely a shape that has a circular base and cap and curved vertical sides (Angraini et al., 2021).

The number 4 gives meaning as the 4 pillars in the Islamic religion (the creed, prayer, zakat and fasting) and the number 4 gives meaning as the main directions in Javanese cosmology (east, west, north, and south). The 12 main supporting pillars (supports) give meaning that they support the 12 main values of humanity (faith, piety, knowledge, charity, patience, gratitude, justice, honesty, sincerity, ukhuwah, istikhomah, and tawakal). From an ethnomathematics perspective, this cylindrical shape is not just a geometric representation, but a reflection of local knowledge of the community about spatial structure, building strength, and symbolic value (Soebagyo & Luthfiyyah, 2023; Wiryanto et al., 2022). The cylindrical shape carries philosophical significance, signifying symmetry and steadfastness. The pillars are angled, reflecting humility and reminding us that perfection belongs only to God. The pillars are shown in Figure 1.

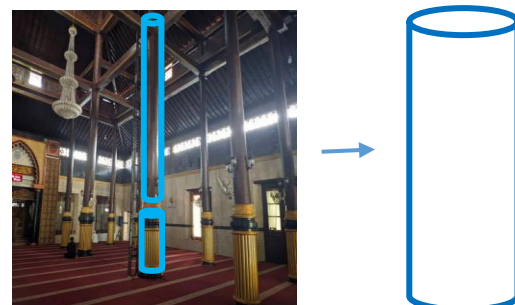


Figure 1. Main pillar of the mosque

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The second pillar in the central porch, which has a characteristic green color and has geometric elements of rectangular, triangular and circular plane shapes. The green color means purity, freshness and spiritual peace, which creates a calm, cool and calming atmosphere. In the ethnomathematics framework, the circular element found on the pillar symbolizes perfection, eternity, and the center of spirituality as found in the context of traditional mosque buildings in Malang and Sukoharjo (Susanti et al., 2022), the rectangle represents social order and morally ordered worldly structures, this is supported by their research (Permata et al., 2021), while the triangle found in the carved ornaments reflects physical stability and spiritual meaning as a bridge between humans, moral values, and God, in line with ethnomathematic findings from other Indonesian mosques (Yudianto et al., 2021). Shown in Figure 2.

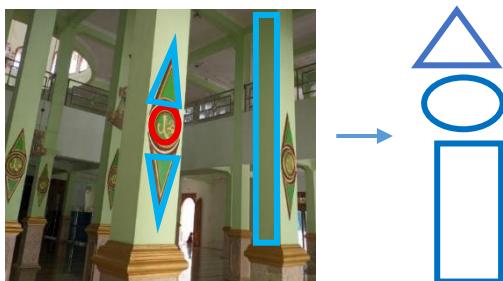


Figure 2. Center porch pillar

The third pillar is located in the front porch of the mosque and is cylindrical in shape. The cylindrical shape of this pillar supports the porch structure, reflecting stability and sturdiness. This pillar is visible in Figure 3.

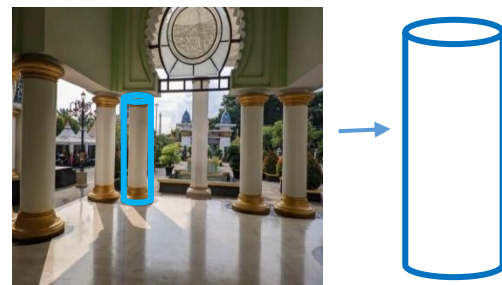


Figure 3. Front porch pillars

The next observation is on the ablution area. The Baitul Hakim Grand Mosque has five ablution areas, consisting of three for women and two for men. The number 3 reflects the threefold washing during ablution and the three phases of women's roles in family life (children, wives, and mothers), while the number 2 reflects the two sentences of the shahada, which are the foundation of a Muslim's faith. The ablution areas vary in size, with the women's area measuring 3 x 3 m, while the men's area measures 5 x 12 m and 3 x 3 m, respectively. The women's area features ornaments in the shape of an isosceles trapezoid and a rectangle. The isosceles trapezoid and rectangle ornaments in the women's ablution area are not merely aesthetic, but are symbolic representations that teach spiritual and social values through geometric shapes. The isosceles trapezoid shape, with two parallel sides and two hypotenuses of equal length, reflects symmetry and balance that symbolizes the spiritual transition from worldly to purity before prayer, especially reflecting the role of women who are fundamentalist and spiritual (Purniati et al., 2022), while the rectangle reflects order and continuity that depicts a systematic purification process and the values of responsibility and social discipline in the Muslim community (Salsabila & Soebagyo, 2023). This can be seen in Figure 4.

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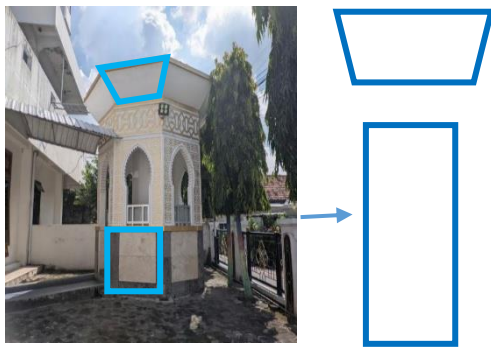


Figure 4. Women's ablution area

The ablution area for men has rectangular flat ornaments as shown in Figure 5. Rectangular ornaments function not only as decorative elements, but also imply deep symbolic meanings related to the values of order, stability, and spiritual orientation. The rectangular shape, with parallel sides and sharp right angles, reflects a systematic and disciplined ablution worship pattern, in accordance with Islamic values of cleanliness and order (Angraini et al., 2021). This is supported by the article (Susanti et al., 2022) that the ethnomathematics study at the Kediri Grand Mosque found rectangular elements in architectural ornaments as a symbol of Islamic structure and contextual mathematics education media, and is also supported by international studies in the Aceh journal also emphasized that geometry such as rectangles in mosque architecture reflects the synergy between mathematical aesthetics and religious and social values.

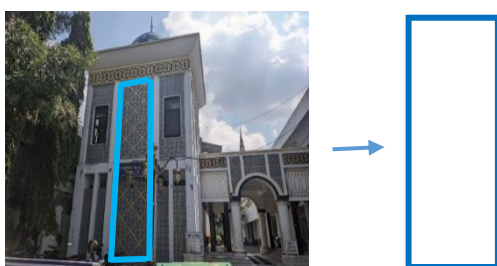


Figure 5. Men's ablution area

In addition to observations on the pillars and ablution area, observations were also made on the minaret of the Grand Mosque. This mosque has one minaret with a height of 35 m, a diameter of the base building of 12 m and a diameter of the middle building of 4 m. The minaret is one of the architectural elements that reflects the integration of Islamic values, local culture, and mathematical concepts. The shape of the minaret consists of a tube structure (cylinder) and a conical peak. This form is not only a symbol of spiritual verticality in Islam, but can also be analyzed through an ethnomathematics perspective. Ethnomathematics sees that geometric forms in traditional and religious buildings do not stand alone as decorative elements, but are the result of the mathematical thinking of the community shaped by culture, religious values, and historical experiences (Rofiq et al., 2022; Rosa & Orey, 2016).

Mathematically, a cylinder is a geometric shape that reflects stability and continuity. This shape symbolizes a strong foundation for life, a solid foundation of faith, and equality due to its uniform surface. Meanwhile, the upward-pointing cone reflects the vertical orientation of Muslims facing God, becoming a symbol of monotheism and ever-higher spiritual attainment (Musbaiti et al., 2023). The tower is shown in Figure 6.

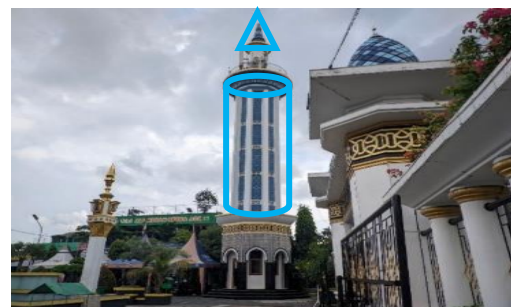


Figure 6. Mosque tower

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## CONCLUSIONS AND SUGGESTIONS

Based on the research and discussion related to ethnomathematics insights at the Great Mosque of Madiun City, the following conclusions can be drawn:

1. The counting activity revealed 120 pillars, 5 ablution areas, and 1 minaret.
2. The measuring activity revealed the dimensions of the mosque, including the height of the main pillar (12 m), the height of the tallest pillar in the central porch (4 m), the height of the pillars in the central porch and the shortest front porch (2.5 m), and all pillars having a diameter of 50 cm. There are four ablution areas measuring  $3 \times 3$  m. The single ablution area for men measures  $5 \times 12$  m. The minaret is 35 m high, with a diameter of 12 m at the base, 4 m in the middle, and 1,5 m at the top.
3. The design activity revealed that the Grand Mosque retains its original Javanese architectural design, despite restorations oriented toward the Middle East, Arabs, and Europe. Arab architecture can be seen from each end of the mosque, with its minarets and large pillars, while European architecture is evident in its numerous domes and simple, block-shaped design.
4. Ethnomathematics insights are reflected in geometric mathematical concepts related to the plane shapes of rectangles, isosceles triangles, circles, isosceles trapezoids, cylinders, cones, and transformation geometry.

Based on the findings of this study, it is recommended that ethnomathematics studies of local cultural heritage, such as the Great Mosque of Madiun, continue to be developed with

a broader and more in-depth approach, including analysis of proportions, fractal patterns, and comparisons with other traditional mosques in the Indonesian archipelago. Furthermore, mathematics teachers can utilize the architectural elements of the mosque as a contextual learning resource that enriches students' learning experiences and strengthens the connection between mathematics and culture.

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