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ETHNOMATHEMATICS EXPLORATION OF MULTIPLYING AND MEASURING ACTIVITIES ON THE DOME OF THE GREAT MOSQUE OF BAITUL HAKIM, MADIUN CITY

Ainun Fisabilillah[1], Ika Krisdiana[2*], Indra Puji Astuti[3]
[1,2,3] Universitas PGRI Madiun, Indonesia
Email: *[1] fissabilillah931@gmail.com, [2] ikakrisdiana@unipma.ac.id, [3] indra.pa@unipma.ac.id*

ABSTRACT
Ethnomathematics is a study that explains the relationship between culture and mathematics. Ethnomathematics is applied as a means to motivate, stimulate, overcome saturation, and give a new feel to mathematical learning. One of the cultures that can be studied with ethnomathematics is the mosque. This study aims to learn mathematical concepts and explore ethnomathematics in the building of the Grand Mosque of Baitul Hakim Kota Madiun, the explored building, namely the dome of the mosque. This qualitative research uses an ethnographic approach with data retrieval using observation, interview, and documentation techniques. The research was conducted at the Grand Mosque of Baitul Hakim City of Madiun with 3 subjects being mosque administrators (secretariat admin, takmir, and marbot). The results of the research were obtained from mathematical concepts and ethnomathematics activities at the Grand Mosque of Baitul Hakim. The mathematical concept obtained is the geometric concept related to the flat construction of isosceles triangles, isosceles trapezoids, ellipses, and Pyramid space structures. The ethnomathematics activity obtained is the activity of measuring and enumerating. Therefore, it can be concluded that there is ethnomathematic activity and there are mathematical concepts in the Grand Mosque of Baitul Hakim Kota Madiun that can be used as a learning resource by educators.

Keywords: Ethnomathematics, Grand Mosque, Mathematics

*** Corresponding Author Email:** ikakrisdiana@unipma.ac.id

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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 as well as increase the potential of human resources to be more advanced is mathematical learning. Mathematics is one of the branches of science that has an important role in the development of science and technology both as an aid in the application of other fields of science and in the development of mathematics (Istiqomah & Nurulhaq, 2021; Khairunisa & Basuki, 2021).

Mathematics can be learned by a variety of methods including through culture. Culture cannot be isolated from mathematics because mathematics exists in the components of human activity, including social, cultural, and universal activities (Muzakkir, 2021). Cultural awareness can be incorporated into mathematical learning by integrating subject content and local culture. However, learning by utilizing around is rare in learning (Luthfi & Rakhmawati, 2022).

Culture (art) in people's lives has a very close relationship with mathematics. The relationship between the two is called ethnomathematics. (Afnenda, 2021). Ethnomathematics is also called an activity involving numbers, geometric patterns, counting and so on which it is considered as an application of knowledge of the field of mathematics involving local cultures (Pusvita et al., 2019). Menurut Sirate (dalam Yudianto et al., 2021) Ethnomathematics is applied as a means to motivate, stimulate, overcome saturation, and give a new feel to mathematical learning. Cultural objects whose presence is close to everyday life are necessary as an attempt to realize this. Formal learning of mathematics and less variety can decrease a student's interest in learning mathematics. For this, it is necessary to make use of mathematics outside the school connected with school mathematics, that is, to use the ethnomathematics approach as the beginning of the teaching of formal mathematics that corresponds to the development of students. It is equally argued that culturally nuanced maths can make a huge contribution to school maths (Harahap & Mujib, 2022). One of the objects of culture 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 sales and sales 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 (Fadlilah et al., 2017). Mathematics plays an important role in solving problems ranging from simple to complex problems. The application of ethnomathematics to a mosque building generally applies the science of geometry (Faturrahman & Soro, 2021).

A mosque is a special building or place for Muslims to worship. Each region has a wide variety of mosque buildings with their unique and distinctive character according to the meaning of their philosophy, for example Sheikh Zayed Grand Mosque in Solo. Madiun is famous for its largest mosque, the Grand Mosque of Baitul Hakim Madiun which is located west of Madiun City square. One of the distinctive features of the grandeur of the Grand Mosque of Baitul Hakim lies in the number of pillars scattered in every corner of the room.

Figure 1. Grand Mosque of Baitul Hakim City of Madiun

Mosques as the application of culture to mathematical learning leading to the study of ethnomathematics. Ethnomathematics are mathematical concepts applied, referring to the activities, habits, or customs of people's lives in solving problems (Utami et al., 2020). The study of ethnomathematics has two objectives: to recognize the idea of the practice of cultural groups and to know different ways about quantity, space and relations in cultural groups (Astriandini & Kristanto, 2021).

Research related to the exploration of ethnomathematics has been widely carried out. Research conducted by (Musbaiti et al., 2023) related to the ethnomathematics exploration of the Great Mosque of Al-Muhtaram, which led to the conclusion that there is ethnomathematics in the mosque that can be used as a learning resource for learners. Research conducted by (Soebagyo & Haya, 2023) stated that the Jami Cikini Al-Ma'mur Mosque can be utilized as a source of school mathematics learning on geometry materials. Research conducted by (Faruq, 2023) who used Masjid Jami' Sultan Syarif Abdurrahman of Pontianak City as an ethnomathematic exploratory study concluded that in the mosque there are mathematical concepts of flat field and space plane.

This study aims to know mathematical concepts and to explore ethnomathematics on the dome of the Grand Mosque of Baitul Hakim Kota Madiun. The success of the study will have a good impact in the world of education and culture. The importance of this research for education, especially mathematical learning, is as a new learning resource in mathematical learning that can be used to improve insight and delivery of material. Therefore, it is necessary to conduct a study related to ethnomathematics entitled "Ethnomathematics Exploration of Multiplying Activity and Measuring Activity on the Dome of the Great Mosque of Baitul Hakim, Madiun City".

METHOD

This research is a type of qualitative research with an ethnographic approach. An ethnographic approach is a qualitative research procedure for describing and analyzing various cultural groups that interpret patterns of behavior, beliefs and language that develop and are used by a group of people over time (Miftahurrahmah et al., 2023). The data collection methods used in this study were observation, interviews, and documentation. The researcher as the main instrument in the study served as a planner, data collector and analyzed the research data. Observation activities were carried out directly to observe the building at the Grand Mosque of Baitul Hakim Kota Madiun. Subsequently, interview activities were conducted to obtain information related to the dome of the Mosque. The subjects of this study were Mr. Eko Purwanto (S1), Mr. Sumanto (S2), and Mr. Sugiharsono (S3) as the stewardship of the Grand Mosque of Baitul Hakim. Documentation activities are carried out in the building of the Grand Mosque of Baitul Hakim, where the data obtained is triangulated, that is, triangulation of methods to obtain valid data. After the research data is obtained, then the data will be analyzed using the techniques of data reduction, presentation of data, drawing conclusions and obtaining conclusions from the results of the research.

RESULTS AND DISCUSSION

Table 1. Results of Triangulation Method

Indicators	Observation Data	Interview Data	Documentation Data	Triangulation Results
		Multiplication Activity		
Number of mosque domes	The number of domes that the Grand Mosque of Baitul Hakim has is 5 and 1 roof in the form of a limas.	S1, S2, S3 state that the number of domes that the Grand Mosque of Baitul Hakim has is 5. S2 also added that the Grand Mosque of Baitul Hakim has 1 limasan roof in the main mosque building.	 	Based on the results of observations and interviews, it was obtained that the number of domes owned by the Grand Mosque of Baitul Hakim is 5 domes and 1 limasan roof.
		Measuring Activity		
The size of the dome of the mosque	The size of the dome of the Grand Mosque of Baitul Hakim is 3 small domes having a diameter of 13 m with a height of 8 m, while the 2 large domes have a diameter of 15 m with a height of 10 m. For the roof of the mosque, the lower side has a length of 30 m with a height of 3 m, the middle side is 17 m with a height of 3 m, the top side is 13 m with a height of 6 m.	S1, S2, S3 state that the size of 3 small domes is 13 m in diameter, for 2 large domes 15 m in diameter. For the height of the small dome is 8 m while the height of the large dome is 10 m. S2 adds that the lower side has a length of 30 m with a height of 3 m, the middle side 17 m with a height of 3 m, the uppermost side 13 m with a height of 6 m.	 	Based on the results of observations and interviews, it was obtained that the size of 3 small domes of diameter 13 m with a height of 8 m, for 2 large domes of diameter 15 m with a height of 10 m. The size of the six roof has a side length of 30 m with a height of 3 m, the middle side 17 m with a height of 3 m, the uppermost side 13 m with a height of 6 m.

After obtaining valid data, the next stage is data analysis. Analysis of data on ethnomathematic activity, namely enumeration activity and measuring activity on the dome of the Grand Mosque of Baitul Hakim Kota Madiun. Based on the results of observations and interviews, researchers analyzed the data as follows:

1. Multiplication Activity
   a. Dome of the Mosque

      Based on the data of the results of observations, interviews with all three subjects of the study, and the results of the documentation obtained that all three subjects had the same opinion. From all the data that have been obtained, the dome owned by the Grand Mosque of Baitul Hakim has 5 domes and S2 adds that the Great Mosque of Baitul Hakim has 1 limasan roof. It is known that 5 domes were built during the restoration of the mosque, while 1 roof of the limasan has existed since ancient times and is still preserved today. Lastly, on the dome and roof of the mosque there is ethnomathematics activity, namely the mathematical concept of geometry related to the flat construction of isosceles triangles, isosceles trapezoids, ellipses, and the construction of pyramid spaces on the dome and roof of the mosque.
2. Measuring Activity
   a. Dome of the Mosque

      Based on data from observation results, interviews with all three study subjects, and documentation results obtained that all three subjects had the same opinion regarding the size of the dome. For the size of 3 small domes with a diameter of 13 m, for 2 large domes a diameter of 15 m. For the height of the small dome it is 8 m while the height of the large dome is 10 m. Then according to S2 Masjid Agung Baitul Hakim has a roof in the form of a limasan, the pyramid are in the form of stacked square pyramid. For the lower side length is 30 m, the middle side is 17 m, then for the uppermost side 13 m. This roof has a height of the lowest level of 3 m, then for the middle one it has a height of 3 m, and the height of the upper tier 6 m. Therefore, the study mentioned that the size of the dome and roof of the Grand Mosque of Baitul Hakim showed ethnomathematics activity. This activity is measuring activity.

Masjid Agung or called Masjid Agung Baitul Hakim is the largest mosque in Madiun City. Grand Mosque of Baitul Hakim is located at Jalan Aloon-Aloon Barat, Pangongangan, Manguharjo Subdistrict, Madiun City, East Java. The mosque building is predominantly blue with 5 large domes with many pillars at the corners of the building and has 1 high minaret in front of the mosque that serves as a loudspeaker. When the dome of the Great Mosque of Baitul Hakim is examined, there is a mathematical concept. Emerging mathematical concepts such as the concept of multiple flat waking and multiple waking spaces. In addition, there are several ethnomathematic activities in the dome of the Grand Mosque of Baitul Hakim.

1. Mathematical Concepts on the Grand Mosque of Baitul Hakim
   a. Equilateral Triangle Flat Construction Concept

      The Grand Mosque of Baitul Hakim also has a building that contains elements of the mathematical concept, namely flat construction of isosceles triangles. The shape of the isosceles triangle is taken from the pole ornament of the mosque's central portico of the Grand Mosque of Baitul Hakim. An isosceles triangle is a triangle that has two sides of equal length and an angle at the base of the same length (Sa'o et al., 2022).

Figure 2. Equal Triangle on the Roof of the Mosque

An application of flat waking isosceles triangles in mathematics is to find the circumference and area of an isosceles triangle. If the application looks for the circumference of an isosceles triangle, then the formula used is to sum the three sides of the isosceles triangle or use the formula $periphery = side \times side \times side$. If looking for the area then the formula used is $wide = \frac{1}{2} side\ plinth \times height.$

b. Trapezoidal Flat Build Concept

The Grand Mosque of Baitul Hakim also has a building that contains elements of the mathematical concept, namely flat construction of isosceles trapezoids. The shape of the isosceles trapezoid is taken from the ornament on the female ablution place and the ornament of the minaret of the Great Mosque of Baitul Hakim. An isosceles trapezoid is a trapezoid that has four sides with a pair of parallel sides, and a pair of opposite sides of equal length (Puspadewi & Wulandari, 2018).

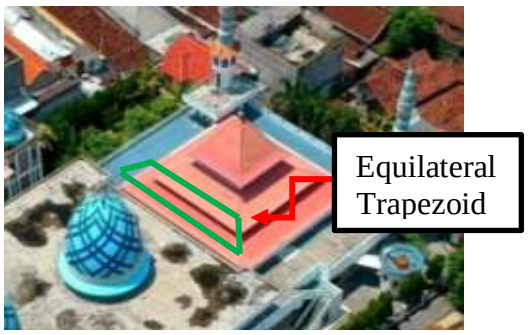

Figure 3. Equilateral Trapezoid on the Roof of the Mosque

An application of flat waking isosceles trapezoids in mathematics is to find the circumference and area of an isosceles trapezoid. If the application is to find the circumference of an isosceles trapezoid, then the formula used is by summing all sides or by the formula periphery $= AB + BC + CD + AD$. If looking for the area of an isosceles trapezoid then the formula used is $Wide = \frac{1}{2} \times (a + b) \times height$ with the height formula is $t = \frac{2 \times L}{a+b}$.

c. Elliptical Flat Build Concept

The Grand Mosque of Baitul Hakim also has a building that contains elements of mathematical concept, namely flat elliptical construction. The elliptical shape is taken

from a wedge of the dome of the Great Mosque of Baitul Hakim. Such mathematical concepts can be seen in the following picture:

Figure 4. Ellipse on the Dome of the Mosque

An ellipse can be defined as the locus or set of all points in a single plane that have the same number of distances from two fixed points referred to as the focus (double focus) (Chaeruddin et al., 2020). These two foci are points along the main axis of the ellipse. The distance from each point on the ellipse to those two foci has a constant sum. In addition to the two foci, the ellipse also has other parameters, such as the length of the main axis and the short axis, which affect the shape and size of the ellipse. The ellipse has the following equation: $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$.

d. Concept of Building a Pyramid Room

The Grand Mosque of Baitul Hakim also has a building that contains elements of the mathematical concept, namely building a Pyramid room. The shape of the Pyramid is taken from the roof building of the parent mosque inside the Grand Mosque of Baitul Hakim. Pyramid is the construction of a space that has a base in the shape of a polygon and its perpendicular plane in the form of a triangle whose corners meet at a point (Rohma & Sholihah, 2021). Such mathematical concepts can be seen in the following picture:

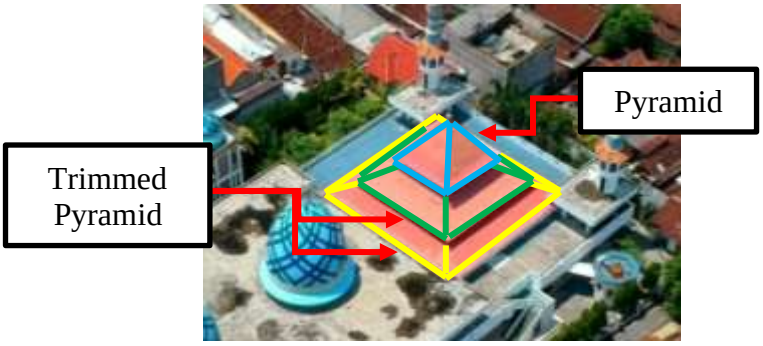

Figure 5. Pyramid and Trimmed Pyramid on Roof of Mother Mosque

The application of building a Pyramid space and building an enclosed Pyramid space in mathematics is to look for surface area and volume. If in the application to search the surface area of limas, then the formula used is

Surface area $= (base\ area) + (amount\ of\ upright\ side\ area)$. If looking for the volume of Pyramid then use the formula $Volumes = \frac{1}{3} \times (base\ area) \times height$. Then applying to find the surface area of the enclosed limas, then using the formula $Surface = bottom\ area + upper\ area + \sum Upright\ side\ area$. Whereas if to find the volume of stored limas, the formula used is $Volume = \frac{1}{3} t \times (bottom\ area + upper\ area + \sqrt{upper\ area \times bottom\ area})$.

2. Ethnomathematics activity at the Grand Mosque of Baitul Hakim

In addition to mathematical concepts, in the building of the Grand Mosque of Baitul Hakim there is ethnomathematics activity. Ethnomathematics activity is an activity in which the process of abstracting real experiences in everyday life into mathematics or vice versa takes place (Rakhmawati dalam Sarwoedi et al., 2018). Ethnomathematics activities include enumerating, measuring, determining location and direction, creating building designs, and playing (Ajmain et al., 2020). When examining the ethnomathematics activity in the Great Mosque of Baitul Hakim on the dome, they include the following:

1. Multiplying activity. This activity can be seen when the study subject mentions the number of domes of the Great Mosque of Baitul Hakim.
2. Measure activity. This activity could be seen when the study subjects estimated the size of the dome of the Great Mosque of Baitul Hakim.

Based on the above exposition, there is ethnomathematic activity in the building of the Grand Mosque of Baitul Hakim. This is in line with previous research that has been reported by (Soebagyo & Haya, 2023) that in the building of a mosque there is ethnomathematic activity. So this discovery is in line with what was proposed by (Sarwoedi et al., 2018) that in a cultural context is found the activity of ethnomathematics.

CONCLUSION AND SUGGESTIONS

Based on the results of the research and discussion related to ethnomathematics on the dome of the Grand Mosque of Baitul Hakim City of Madiun, it can be concluded that the numerous activities in the Grand Mosque of Baitul Hakim are indicated by the number of mosque buildings including 5 domes and 1 mosque roof. While the measuring activity in the Grand Mosque of Baitul Hakim is indicated by the size of the mosque building includes a dome with a size of 3 small domes with a diameter of 13 m and a height of 8 m, for 2 large domes 15 m in diameter and 10 m in height. Limasan roof with a lower side length of 30 m, middle side 17 m, top side 13 m. This limasan roof has a height of the bottom 3 m, then for the middle one it has a height of 3 m, and the height of the tiers top 6 m.

Ethnomathematics exploration of the dome of the Great Mosque of Baitul Hakim is the existence of mathematical concepts of geometry related to flat construction of isosceles triangles, isosceles trapezoids, ellipses, and Pyramid space structures. The concept of isosceles triangle, isosceles trapezoid can be used for material explanation of circumference and area, then the concept of ellipse can be used to search for elliptic equations. Pyramid concept for material explanation of surface area and volume.

Based on the results of the research obtained, researchers put forward several suggestions, including that for other researchers who want to conduct research related to the ethnomathematics of the building of the Grand Mosque of Baitul Hakim, it is recommended to delve deeper into the mathematical concepts contained in the mosque building. Other researchers can also explore other cultures, so that mathematical learning resources are more innovative.

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