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ETHNOMATHEMATICAL EXPLORATION IN THE BUILDING OF THE GLASS BUILDING OF THE PALACE OF YOGYAKARTA

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ABSTRACT

Ethnomatematics has an important role in learning mathematics. Ethnomatematics can make learning mathematics more meaningful because it is related to problems that exist around students. An example of a place steeped in history and culture is the Yogyakarta Palace. Inside the Yogyakarta Palace there are various buildings, one of which is Gedhong Kaca. This study aims to explore the mathematical concepts contained in the Gedhong Kaca building at the Yogyakarta Palace. The method used in this study is explorative with an ethnographic approach. Data collection was carried out by means of observation, documentation, and literature study. The results obtained show that there are several mathematical concepts in the Gedhong Kaca building that can be used in learning mathematics, namely the concept of triangles, quadrilateral concepts, circle concepts, space concepts, straight line concepts, congruence concepts, congruence concepts, and geometric transformation concepts.

Keywords: *Ethnomathematics, Gedhong Kaca, Learning, Yogyakarta Palace.*

INTRODUCTION

Math plays an important role in future life, but it is also still a topic that most students find scary (Ginanjar, 2019). The majority of students believe that mathematics is a complex science to understand and always deals with numbers, calculations and complicated formulas (Aprilia & Fitriana, 2022). Even at this time, mathematics learning seems theoretical, less real, feels dry, and virtual (Masamah, 2018). Mathematics learning at school will be more meaningful when it is connected to the life around students, as well as there is a positive interaction between students and teachers that can make students have good confidence in mathematics (Retnodari et al., 2020).

In order for the current mathematics learning to be interactive and innovative, teachers can use an approach related to the surrounding culture or very familiar with the term Ethnomathematics (Zulaekhoh & Hakim, 2021). According to D'Ambrosio (2001) in (Nurhasanah & Puspitasari, 2022), ethnomathematics is a research program related to the history and philosophy of mathematics, with the aim of science, focusing on engineering (*tics*) explain and art, deepen and overcome (*mathema*) a socio-cultural area that is not the same (*ethno*). Ethnomathematics is a collection of sciences that originate from the view of mathematics in an area of a community group (Kristial et al., 2021). In mathematics activities, there is also an activity of abstraction from students' experiences in real life into mathematical concepts. So it can be concluded that ethnomathematics is a mathematics learning activity that makes culture as the object of study.

The ethnomathematics program aims to show that there are different ways of learning "mathematics" by paying attention to the mathematical insights that develop in different areas of society (Pratiwi & Pujiastuti, 2020). According to Putri (2017) in (Soebagyo et al., 2021) With an ethnomathematical approach, learning will feel more

meaningful and can also publish regional traditions or cultures that are still developing and carried out by a group of community groups. In every culture, there must be a concept of mathematics that can be used by teachers as objects used in learning so that ethnomathematics becomes very important (Sari et al., 2021). The application of ethnomathematics as one of the approaches in learning can be related between learning materials and the culture around students, so that students' understanding of a material will be easier to accept because the material is directly related to the culture that is close to students which is their daily activity in society (Sunandar, 2016).

One example of ethnomathematics learning is to apply the history and culture found in the Yogyakarta Palace to the mathematics learning process in the classroom. This is because the Yogyakarta Palace is a building steeped in history and culture. In addition, Kraton is also one of the cultures around students, so students can learn mathematics easily if the cultural object is very close to the student. The palace is the residence of the queens, which is derived from the word "*Ka*", "*queen*", and "*an*" or Kraton can also be said to be kadaton, namely "*to*", "*Düsseldorf*" and "*an*" or Kedaton, the residence of the datu or the queens (Putra & Kumalasari, 2018). The Yogyakarta Sultanate Palace was established on February 13, 1755 which was located in the center of Yogyakarta and was the result of the Giyanti agreement between the Dutch and Prince Mangkubumi who was the younger brother of Sunan Pakubuwono II (king of the Surakarta Palace) (Prabasmara et al., 2019).

The function of the Yogyakarta Palace is to be used as a residence for kings and used as a historical tourist attraction in the city of Yogyakarta (Widyakusuma & Arief, 2023). According to (Wardoyo & Sulaeman, 2017) The appointment of the king as Panatagama or Khalifatullah who is a religious activist, proves that the function of the Palace as a center of spirituality. In addition, the palace also functions as one of the government centers in Yogyakarta City (Ahmad & Hanum, 2021). Inside the Yogyakarta Palace there are banvak buildings and courtyards in the form of wards, tratags, gedong, and regols (Tohar & Istijanto, 2021).

The importance of culture-based mathematics learning in the classroom can be used as a reference for the implementation of the next mathematics learning. Moreover, Indonesia is a country that has a variety of arts and cultures. The advantages possessed by the Indonesian state can be applied by educators to teach mathematics materials to students. This makes the researcher interested in conducting research on Ethnomathematical Exploration on the Gedhong Kaca building at the Yogyakarta Palace. This research aims to explore the mathematical concepts that exist in the Gedhong Kaca building in the Yogyakarta Palace.

METHODS

This type of research is qualitative research in an exploratory way. In this study, the researcher used an ethnographic approach. Exploratory research is research conducted to find new concepts or relationships of certain facts (Purba & Simanjuntak, 2012). Meanwhile, ethnographic research is one of the qualitative research methods that aims to describe, explain and study the cultural elements of a group or ethnic group (Sari et al., 2023).

This research focuses on the discovery of mathematical ideas in the Gedhong Kaca building of the Yogyakarta Palace. Data collection is carried out by means of observation, documentation, and literature studies. Researchers obtain data by coming directly to the field to get accurate data and be able to see the situation where the subject to be studied is located. Documentation is done carefully to get clear results. In this study, the analysis technique according to Miles and Huberman was

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used which consisted of several stages, namely data collection, data reduction, data presentation, and conclusion drawing (Saleh, 2017).

RESULTS AND DISCUSSION

Gedhong Kaca is one of the buildings in the Yogyakarta Palace. Gedhong Kaca is used as a special museum used to store historical relics belonging to Sultan Hamengku Buwono IX. This is because Sultan Hamengku Buwono IX is a figure who plays an important role in defending the sovereignty and independence of the Indonesian nation and also Yogyakarta itself. In addition, he has also held several positions in the field of government. Various photos about the activities he has done, the equipment he has used, award certificates, traditional clothes and so on are also displayed in this museum.

Gambar 1. Gedhong Kaca

Based on the analysis of the results of observations and documentation about the Gedhong Kaca building in the Yogyakarta Palace, it can be seen that various forms of roofs, poles, and fences are related to mathematical concepts. The following is an explanation of the mathematical ideas that exist in the building.

a. Triangle Concept

The concept of a triangle is closely related to the Gedhong Kaca building in the Yogyakarta Palace, which can be seen from the shape of the building's roof. The concept of triangles found here can be used to teach the properties of triangles, Pythagorean theorems, circumference formulas, and triangle area formulas.

Gambar 2. Konsep Segitiga

b. Concept of Quadrangle

The concept of a quadrangle found here can be used to teach about the

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properties of a quadrilateral, the circumference formula and the quadrilateral area formula. The rectangular buildings are square, rectangle, rhombus, trapezoidal and parallelogram.

Figure 3. Concept of Quadrupuses (Square, Rectangle, and Rhombus)

Figure 4. Concept of Quadrangle (Trapezoid and Parallel)

c. Circle Concept

The concept of the circle is found in the motif found on the roof of the Gedhong Kaca building in the central part, precisely on the table and chair that was used to formulate the March 1 general attack. The concept of circles found here includes the elements of circles, properties of circles, angles in circles, circumference formulas and circle area.

Gambar 5. Konsep Lingkaran

d. The Concept of Building Space

On the pillars of the Gedhong Kaca building, several concepts of building space were found. The concept of building space found can be used to teach material properties, surface area formulas, and volume formulas. Build the space is cubes, blocks, and prisms.

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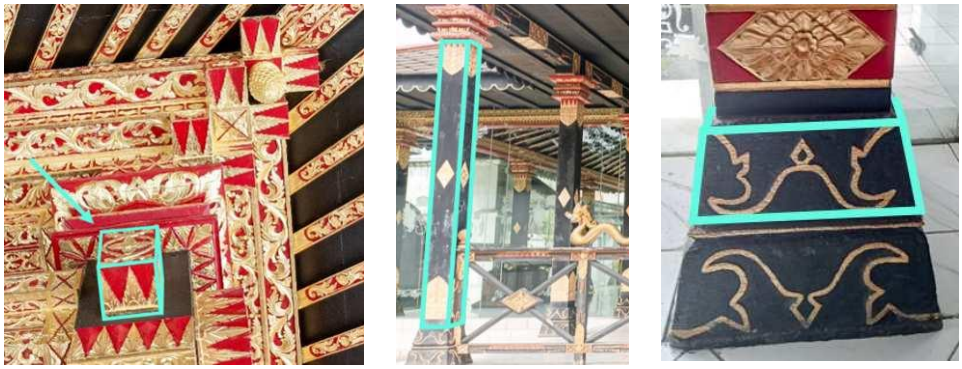

Figure 6. The Concept of Building Space (Cubes, Beams, and Prisms)

e. Straight Line Concept

The concept of straight lines is often found in the motifs found on the roof of Gedhong Kaca. The concept of straight lines found includes parallel lines, intersecting lines, and perpendicular lines.

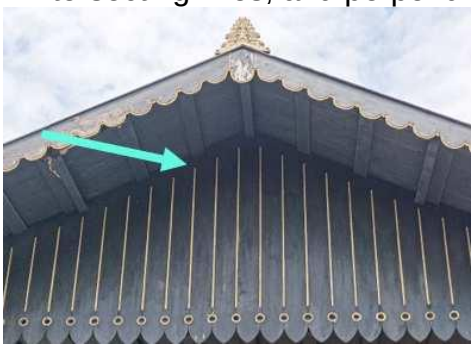

Figure 7. Parallel Lines

Figure 8. Intersecting Lines

Figure 9. Perpendicular Lines

f. The Concept of Revival

If the shape of the two shapes is the same, the corresponding angles are identical, and the length of the corresponding sides is proportional, then the two shapes can be said to be the same. The concept of regeneration is found in the motifs found on the roof of the Gedhong Kaca building.

Figure 10. The Concept of Revival

g. The Concept of Congruence

If two shapes have the same shape, the corresponding sides are the same size and the corresponding angles are the same, then the two shapes can be said to be congruent. The concept of congruence is found in the motifs found on the pillars of the Gedhong Kaca building.

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Figure 11. The Concept of Congruence

h. Concept of Geometric Transformation

Transformation plays a role in the displacement of points or geometric construction in a plane. The concept of transformation found in the Gedhong Kaca building is reflection (reflection), rotation (rotation), translation (shift), and dilation (enlargement or shrinking).

1. Reflection

   All points in the geometric plane shift in the direction of the line (mirror) at the same distance and twice the distance from point to mirror is called reflection (Bustan et al., 2021). The concept of reflection is often found in the motifs found on the pillars of the Gedhong Kaca building.

Figure 12. Concept of Reflection

2. Rotation

   Rotation is a transformation that juxtaposes a point to another set of points by rotating (Hanafi et al., 2017). The concept of rotation was found in the motif in the middle of the roof of the Gedhong Kaca building, precisely on the table and chairs that were once used to formulate the March 1 general attack.

Figure 13. Rotation Concept

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3. Translasi
   Translation is a shift that only changes the position of a point, not its size or shape (Hada et al., 2021). The concept of translation is often found on the roof of the Gedhong Kaca building.

Figure 14. Translation Concept

4. Dilation
   Geometric transformation in the form of shrinking or magnifying a geometric building is called dilation (Bustan et al., 2021). The concept of dilation is found in the circular motif found in the middle of the roof of the Gedhong Kaca building.

Figure 15. The Concept of Dilation

After conducting this research, the researcher has an idea that can be applied in mathematics learning activities by relating it to culture. The learning idea is to make Gedhong Kaca an object of study and learning activities applying *the Contextual Teaching Learning* (CTL) approach. The learning stages that must be carried out begin by presenting problems related to the Gedhong Kaca building as a beginning for students to learn mathematics subject material. The second stage is to provide opportunities for students to discuss together with their groups regarding the mathematical concepts contained in the Gedhong Kaca building. The last stage is the provision of practice questions to determine students' understanding of the material that has been studied. The following are examples of problems related to the Gedhong Kaca building and examples of practice questions that can be given to students.

Table 1. Examples of Problems and Practice Questions

Example Problems	Example of Practice Questions

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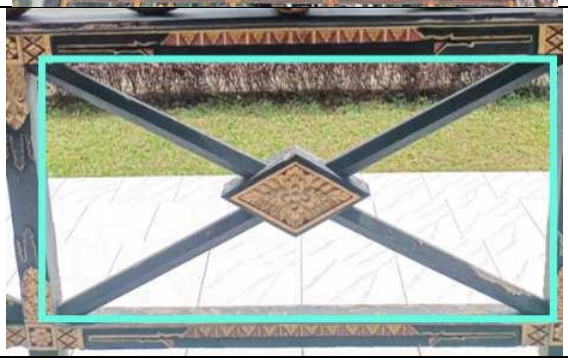
	An isosceles triangle-shaped roof has a height of 2.4 m and a base of 4 m. Determine the length of the slope of the roof!
	A fence made of wood is rectangular in shape. The fence is 1 m long and 60 cm wide. Determine the circumference and area of the wooden fence!

CONCLUSION

The Yogyakarta Palace is a building that became the residence of Sri Sultan Hamengku Buwono and is the center of government and cultural center. One of the buildings in the Yogyakarta Palace is the Gedhong Kaca. This Glass Building is a special museum used to store historical objects left by Sultan HB IX. Various mathematical concepts were found in this Gedhong Kaca building, namely the concept of triangles, the concept of squares, the concept of circles, the concept of building spaces, the concept of straight lines, the concept of cohesion, the concept of consensus, and the concept of geometric transformation.

The suggestion for further research is to focus on researching one of the buildings that will be explored regarding the ethnomathematics in it, because there are many historical buildings in the Yogyakarta Palace. So it would be better to focus on one of the buildings and dig deeper into the history and mathematical concepts of that building.

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