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Ethnomathematics in the Main Building of Pendapa Sabha Swagata Blambangan

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Abstrak

Substansi dari etnomatematika erat kaitannya dengan matematika dan budaya. Etnomatematika adalah penerapan konsep matematika berdasarkan budaya sebagai hasil dari kebiasaan masyarakat. Etnomatematika dibutuhkan karena keberadaannya dekat dengan lingkungan sekitar dan dapat memberikan pemahaman pada peserta didik bahwa matematika tidak hanya dijumpai di sekolah. Tujuan penelitian ini adalah untuk menggali etnomatematika pada bangunan utama Pendapa Sabha Swagata Blambangan. Penelitian ini merupakan penelitian kualitatif dengan pendekatan etnografi. Metode pengumpulan data yang digunakan adalah observasi, wawancara, dan dokumentasi. Subjek penelitian yaitu observer dan dua narasumber. Dua narasumber tersebut adalah sejarawan dan arkeolog Banyuwangi. Dokumentasi dilakukan oleh peneliti sendiri dengan menggunakan kamera perekam. Hasil penelitian menunjukkan bahwa pada bagian-bagian bangunan utama Pendapa Sabha Swagata Blambangan Banyuwangi terdapat konsep-konsep matematika yang terdiri dari konsep sudut pada pintu dan jendela, segitiga dan trapesium pada ventilasi, limas segi empat pada atap, kongruen pada fasad dan langit-langit, refleksi dan rotasi pada motif lantai, serta konsep geometri lainnya.
Kata Kunci: Etnomatematika; Pendapa Sabha Swagata Blambangan; Konsep Geometri.

Abstract

The principle of ethnomathematics is related to mathematics and culture. Ethnomathematics is the application of mathematics concepts based on culture due to people's habits. Ethnomatematics is necessary because its existence surrounding the environment might provide students with understanding that mathematics is not only found in schools. This study aimed to explore ethnomathematics in the main building of Pendapa Sabha Swagata Blambangan. This qualitative research used an ethnographic approach. The data collection methods used were observation, interviews, and documentation. The research participants were an observer and two sources. Observations were conducted at Penpada Sabha Swagata Blambangan. The two sources in the interview activities are historians and archaeologists from Banyuwangi. Documentation was carried out by the researcher himself using a camera recorder. The results of the study show that in the main building of Pendapa Sabha Swagata Blambangan, Banyuwangi there are mathematical concepts such as angles in the doors and the windows, triangles and trapezoids in the ventilations, cuboids in the pillars, rectangular pyramids in the roofs, congruence in the facade and ceiling, reflections and rotations in the floor motifs, and other geometric concepts.
Keywords: Ethnomathematics; Pendapa Sabha Swagata Blambangan; Geometric Concepts.

I. INTRODUCTION

Ki Hajar Dewantara (in Sugiarta et al., 2019) argued that education was a foundation that every individual must have in order to achieve safety and happiness in life. Over time, improving the quality of education has been motivated by the increasing contribution of technological development (Fajriyah, 2018; Aspi, & Syahrani, 2022; Tafonao, 2018; Sonia, 2020). One of the supports for the development of education is mathematics.

Mathematics is provided from preschool to high school education. Regulation of the Minister of Education, Culture, Research and Technology (Permendikbudristek) No. 22 of 2016 states that mathematics learning aims to understand mathematical concepts, describe relationships between concepts, and apply concepts or logarithms flexibly, efficiently, precisely and accurately in solving problems. This goal could be achieved through various kinds of challenging processes. This is also encouraged by the perspectives that mathematics is a difficult science to learn. One strategy to achieve the meaningfulness of mathematics learning is to learn mathematics from the local wisdom or based on students' daily habits (culture) (Yudianto et al., 2021; Mustika, 2022; Afriansyah, 2022; Finariyati, Rahman, & Amalia, 2020).

Abrasodo (in Sarwoedi et al., 2018) defined culture as habitual human behavior, such as the behavior of work groups, professions, urban or rural communities, natives, age, and other groups. Each region has characteristics that become its identity and it is possible that it will experience changes in line with the existing mindset and conditions. The current modernization process has resulted in cultural changes corrupting culture as the nation's identity (Irmania, Trisiana, & Salsabila, 2021; Nuqthy, Nityana, & Navia, 2022). Based on the issue, according to Ernest (in Abroriy, 2020) studies related to mathematics in culture are necessary because mathematics is a cultural product, sociocultural construction, and contained in culture. This culture-based math learning is called ethnomathematics (Maulida & Jatmiko, 2019; Mustika, 2022; Edi, 2021; Khofifah, Sugiarti, & Setiawan, 2018; Evi, Febrianti, & Imron, 2023).

According to D'Ambrosio (1985), ethnomathematics is defined as mathematics practiced in cultural groups, identified as ethnic national communities, labor groups, children of certain age groups, and professional classes. Ethnomathematics is the culture or habits of a community with mathematical elements or concepts (Krismonita, Sunardi & Yudianto, 2021; Meilina, Mariana, & Rahmawati, 2023). The principle of ethnomathematics is closely related to mathematics and culture. The goals of ethnomathematics according to Barton (1996) are to understand, formulate, process and ultimately apply mathematical ideas, concepts and practices that enable students to solve problems related to everyday life. At this time, ethnomathematics is promoted because of its close proximity to the surrounding environment and providing students an understanding of mathematics beyond school contexts (Yudianto et al., 2021; Iqrima, Zulkarnain, & Kamaliyah, 2023). The relationship between mathematics and

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culture presented in learning will create meaning for students so that they can understand the material well. Ethnomathematics can also be a bridge between culture and mathematics (Safrida et al., 2022). Ethnomathematics can be presented through the Sabha Swagata Blambangan pendapa.

Pendapa Sabha Swagata Blambangan is located in Banyuwangi Regency, East Java Province, Indonesia. This historical landmark is the pride of Banyuwangi which is located in the city center and has a typical joglo house shape. The building of Pendapa Sabha Swagata Blambangan Banyuwangi is included in the historical building which was founded in 1771 or during the Dutch occupation in Indonesia. This building functions as an official residence for the Banyuwangi regent so that it has a vital role to the present days. Historically, this landmark was built in the form of a joglo house since it was the style of the regent's house in Java during the Dutch colonial period as a miniature of the palaces of Yogyakarta and Surakarta. This traditional Javanese architecture was intended to attract indigenous sympathy to the Dutch colonials. The Dutch colonial style can certainly be noticed in the building, so that Pandapa Sabha Swagata Blambangan presents the combination of traditional Javanese and Dutch colonial styles.

The identity of a building is a visualization of the existing environmental conditions. The characteristics related to Banyuwangi were only seen when the second renovation was carried out in 2006 by presenting an oling elephant batik ornament located at the end of the upper roof and a snake ornament with a glass gathot-shaped head at the end of the lower roof (Fitriana & Mohammad, 2018; Septia & Wahyu, 2023). Until now, Pendapa Sabha Swagata Blambangan building has maintained the characteristics of Javanese and Dutch cultural design. Studies by Fitriana and Mohammad (2018) concluded that the visual identity of Pandapa Sabha Swagata Blambangan emphasized the symmetry of the building with the dominance of square geometric shapes on the building facade. This is one form of geometry that is presented in Pandapa Sabha Swagata Blambangan, but it does not rule out the possibility that other geometric shapes will be found.

Previous studies related to ethnomathematics in a building could be used as a reference in this study as relevant studies to mention: Ethnomathematics in the Tulungagung Joglo traditional house (Sulistyani et al., 2019), ethnomathematics in the design of the Lengkong traditional house (Yuningsih, Nursuprianah, & Manfaat, 2021), ethnomathematics on the Great Temple of Gumuk Kancil Banyuwangi as a Student Worksheet (Krismonita, Sunardi & Yudianto, 2021).

Based on this explanation, ethnomathematics on traditional buildings could be used as interesting teaching materials and provide comprehensive understanding. Pendapa Sabha Swagata Blambangan is a rare joglo house-shaped building so it is expected that the existence of mathematics learning based on Pendapa Sabha Swagata Blambangan will make students understand their culture better.

To explore Pendapa Sabha Swagata Blambangan, a study was conducted on the parts of the building such as the facade, roof, ceiling, floor, doors, windows, and ventilation.

II. METHOD

This study used a qualitative method with an ethnographic approach. Ethnography emphasized the meaning of the actions of an event (culture). The data collection methods were observation, interview, and documentation. The observation was conducted on December 8, 2022 at Pendapa Sabha Swagata Blambangan, Banyuwangi Regency. Observation was carried out in conjunction with documenting the objects seen and encountered then classified in the form of geometry concepts such as the concept of two-dimensional buildings, space, geometry transformation, congruence, and kesebangunan. The study instruments used were observation guidelines and interview guidelines. Both instruments were validated through the validation process by two mathematics education lecturers at the University of Jember. Observation was carried out with an observation guideline sheet containing the name of the building part and its description. Documentation was taken by a cell phone camera. The particpants of this study were Banyuwangi historians and archaeologists. On December 10, 2022, interviews were conducted with historians, while on December 9, 2022, interviews were conducted with archaeologists. This interview used an audio-visual recorder and followed an interview guideline sheet containing several questions about the shape of the facade, roof, ceiling, floor, doors, windows, and ventilation.

III. RESULT AND DISCUSSION

Based on the results of data collection, the results revealed that there were ethnomathematics values in several parts of the Pendapa Sabha Swagata Blambangan building. The parts of the Pendapa Sabha Swagata Blambangan building that were studied were: 1). Facade; 2). Roof; 3). Ceiling; 4). Floor motifs; 5). Door; 6). Window; 7). Ventilation.

A. Facade

Pendapa Sabha Swagata Blambangan was desined with the characteristics of traditional Javanese buildings as a form of acculturation of Hindu culture that imitated temple and mountain buildings. This was related to the philosophy of divinity and trimandala in Hinduism. The symmetrical facade of the building reflected the mountain shape which must be symmetrical to inspire the construction.

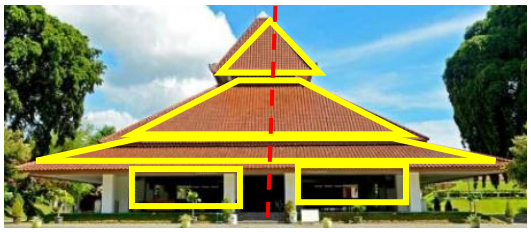

Figure 1. The facade of the main building

The left and right facades of the Sabha Swagata Blambangan building were symmetrical. In this section, the congruence of the left and right parts was clearly visible. Through observation activities, geometry concepts were also found, including the concept of two-

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dimensional shapes (triangles, trapezoids and rectangles) and congruence. An illustration of the symmetry of this main building is presented in Figure 1.

B. Roof

The shape of the stepped tajug roof is an implementation of the shape of the mountain and trimandala. The roof was designed in a pyramid-shaped with a rectangular base in order to facilitate the room zone in the building. The roof of the top pendapa (peak) imitated the shape of a mountain as a manifestation of the philosophy of divinity which in the context of Javanese culture is *ana, urip, mati* which means birth, life, and death. Meanwhile, the three levels of the roof were the implementation of the trimandala as the lower, middle and upper worlds. This trimandala was closely related to Hindu religious beliefs. The roof of the Pendapa Sabha Swagata Blambangan building is presented in the following figure.

Figure 2. The roof of the main building

The concept of geometry on the roof of the Sabha Swagata Blambangan consisted of the concept of flat-sided space (rectangular pyramid and pointed pyramid) and congruence. The roof of this building consists of three levels. The highest level was in the form of a rectangular pyramid, while the second and third levels were in the form of a truncated pyramid with a rectangular base. Then the oling elephant batik ornament at each end of the highest roof had been constructed in the same shape and size to be congruent.

C. Ceiling

The ceiling of the Sabha Swagata Blambangan emphasized space and its own philosophy. The philosophy was related to the square-shaped ceiling because the average building identical to Hinduism had a rectangular ceiling; this was also a symbol of the four directions of the wind, namely west, north, east and south. While the empty center was intended to be a manifestation of oneself in the pendapa which was aimed to be a meeting place and a place of devotion to God. The ceiling of the Sabha Swagata Blambangan pendapa building is presented in the following picture.

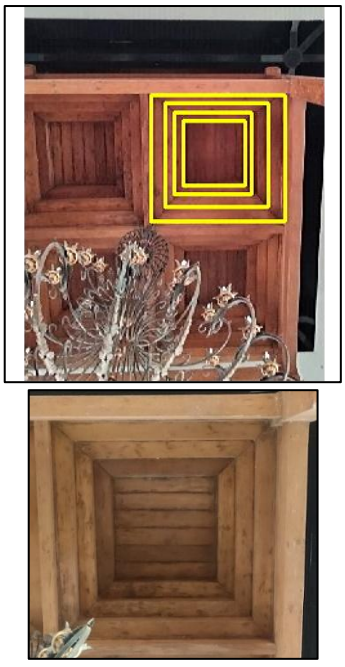

Figure 3. The ceiling of the main building

The concept of geometry on the ceiling of the Sabha Swagata Blambangan encompassed the concepts of two-dimensional shapes (square and rectangle), congruence, and symmetry. The ceiling of the building was constructed in four congruent squares. Each square was designed with four congruent squares. In addition, the center of one of the ceiling squares consisted of six congruent rectangles.

D. Tile Pattern

The tile pattern of the Sabha Swagata Blambangan is identical to the original floor at the time it was built and follows the existing culture. The pattern was usually divided into three different patterns, namely the center, left and right, and front motifs. However, the Pendapa Sabha Swagata Blambangan consisted of two different patterns, namely the center and edge (left and right) motifs. The center of the building was decorated with a more beautiful pattern as a performance venue. The performance was a dance performance to welcome guests. The tile pattern of the Sabha Swagata Blambangan is presented in the following picture.

(a) (b)

Figure 4. (a) the pattern in the center; (b) the tile pattern at the edge

The concept of geometry on the tile pattern of Pendapa Sabha Swagata Blambangan encompassed the concept of two-dimensional shapes (circle, square, and rhombus), geometric transformation (reflection and rotation), and congruence. There were two tile patterns, namely the center and edge floors. The center floor had a floral pattern with four flower crowns. The flower crowns were semicircles of the same size. In addition, when the four points of the flower crown were put together, it formed a square. While the rhombus shape was found on the edge floor motif. There were four congruent rhombuses on the edge floor. The concept of reflection or mirroring was presented at the center and edge of the floors. On the flower crown the center floor was mirrored. Then on the edge tile pattern, it was likely mirrored between the left and right.

E. Door

The door of the regent's official residence was designed based on the characteristics of a Dutch colonial building. There were three types of doors in the regent's official residence. The door with a garuda bird symbol was the original door without renovation, while the other two doors were relatively new. The door that had never been renovated was a type of *kupu tarung* door with the characteristics of a Dutch colonial building door. These doors were high and wide. Hide and wide doors were usually placed in buildings that stored important assets or documents. In addition, the *kupu tarung* type was the characteristic of 18th-19th century buildings. The door of the regent's official residence is presented in the following picture.

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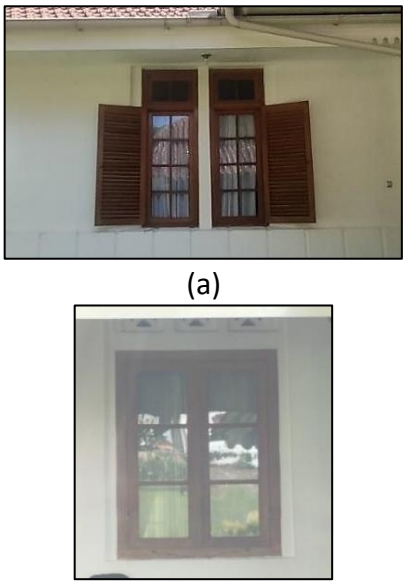
Figure 5. The door of the regent's official residence

The geometrical concept on the door of the regent's official residence consisted of two-dimensional shapes (rectangles), angles, congruence, and geometric transformation (reflection). The concept of rectangular shapes was found in all three types of doors. On the *kupu tarung* door there were other geometry concepts, namely the concept of congruence and the concept of reflection. This was observed from the similarity of shape and size on the left and right side of the *kupu tarung* door so that the door can be said to be congruent. The concept of congruence was also presented in the other two doors with congruent rectangular glass holes. In addition, on the *kupu tarung* door there were wind holes like the shape of a *krepyak* which had an angular concept. Then another geometry concept was present on the left and right of the *kupu tarung* door that was mirrored.

F. Window

The windows in the regent's official residence building were a combination of colonial and local elements. The local element was present in the addition of window coverings in the regent's official residence building. While colonial and European elements could be observed from the high window size to facilitate air circulation. This was due to the tropical climate in Indonesia and the thickness of the building which ranges from 3-5 layers further increased the temperature in the colonial buildings. The thickness of 3-5 layers on the building walls were considered as a mathematical error at that time. This main reason behind the design was actually not related to the temperature, but it was aimed to strengthen the building to survive the possible attacks that might occur.



(a)

(b)

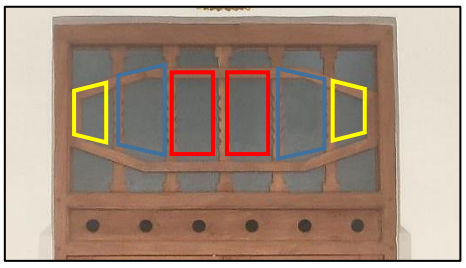
Figure 6. (a) the window with covering; (b) the window without covering

The geometrical concept in the windows of the regent's official residence encompassed two-dimensional shapes (rectangle and square), congruence, uniformity, angle, and geometric transformation (reflection). The window with a cover was designed in a rectangular shape with eight congruent rectangular glass holes. The windows with this cover were mirrored each other because they

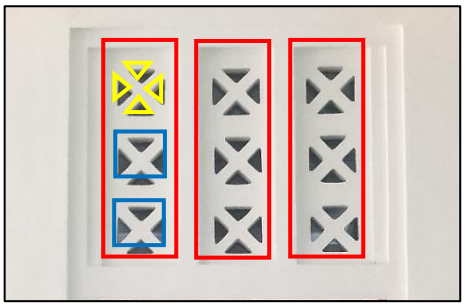
had the same size and shape on the left and right sides of the window. Then the window cover was in the shape of a crepe that has the concept of an angle. In addition, the window and its cover had a congruent shape, which was rectangular, but the size of the window cover was smaller than the size of the window. Meanwhile, the window without a cover was a rectangle with three squares of congruent glass. Furthermore, the left and right parts of the window without a cover were possibly reflected.

G. Ventilation

The ventilation of the regent's official residence was an adaptation of local and colonial buildings. The ventilas section of the regent's official residence was one part of the original building that had not undergone any renovation. There were two types of ventilation in the regent's official residence building. The front of the official residence ventilation had the characteristics of colonial building ventilation illustrated from the presence of circle ornaments. While the back of the official residence ventilation was more modern. The ventilation of the regent's official residence building was presented in the following picture.



(a)



(b)

Figure 7. (a) front side of the ventilation; (b) back side of the ventilation

The conceptual geometry in the ventilation of the regent's official residence consisted of the concept of geometric transformation (reflection and rotation), two-dimensional shapes (trapezoid, rectangle, circle, triangle, and square), and congruence. The vents at the front of the building were made from wood in the form of several two-dimensional shapes, namely trapezoids, rectangles, and circles. In this vent, the concept of reflection was present from the congruence of the trapezoidal and rectangular shapes on the left and right. Meanwhile, the concept of triangle, square, and rectangle was found in the shape of the back vent. The concept of rotation in this vent could be observed from the triangle that was rotated 90o three times. In addition, there were concepts of congruence such as congruent triangular shapes, congruent square shapes, and congruent rectangular shapes.

Based on the results of this study, it was concluded that the main building of Pendapa Sabha Swagata Blambangan had elements of geometry. The elements or concepts of geometry found included the concept of angles, two-dimensional shapes, flat-sided spaces, congruence, and geometric transformations. Pendapa Sabha Swagata Blambangan was a type of a joglo

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house supported by the studies from Sulistyani et al. (2019) that stated that the parts and shapes of the Tulungagung Joglo Traditional House implemented the concept of two-dimensional shapes on the door and roof, the concept of space on the pillars of the building, and reflection on the door carvings. A further study conducted by Yuningsih, Nursuprianah, and Manfaat (2021) showed that the geometry elements contained in the design of the Lengkong traditional house consisted of the concepts of two-dimensional shapes, spatial shapes, lines, and geometric transformations. The two-dimensional concept was found on the facade, roof, window and door ornaments. Meanwhile, the concept of space was found on the supporting poles of the building. The concept of line was found on the facade, pillars, and roof. In addition, the concept of dilation and reflection on the facade of the building. The acculturation of Hinduism in Banyuwangi was not only found in the Sabha Swagata Blambangan pendapa, but could also be found in the Great Gumuk Kancil temple which had been studied by Krismonita, Sunardi, and Yudianto (2021) related to ethnomathematics at the Great Gumuk Kancil Banyuwangi Temple which explained that the concept of geometry in each temple component consisted of the concept of arithmetic sequence, two-dimensional buildings, space buildings, congruence, equality, and geometric transformations (reflection and translation), then the results of the study would become sources to make Student Worksheets.

IV. CONCLUSION

Based on the results and discussion, the study concluded that there were ethnomathematics values found in Pendapa Sabha Swagata Blambangan. Ethnomathematics appeared in parts of the pendapa. These parts are the facade, roof, ceiling, floor motif, doors, windows, and ventilation. The mathematical concepts found in this building were the concepts of angles, two-dimensional shapes (triangles, trapezoids, rhombuses, rectangles, squares, and circles), two-dimensional-sided spaces (rectangular pyramids and truncated pyramids), congruence, and geometric transformations (reflection and rotation). The concept of angles could be found in the doors and windows. Triangular and trapezoidal two-dimensional shapes were found on the facades and vents. Rhombuses were found on the ceiling. Rectangles were found on the facade, ceiling, doors, windows, and vents. Square shapes were found on the ceiling, floor motifs, windows and vents. Circle was on the tile pattern and vents. Two-dimensional-sided spaces, namely rectangular pyramids and truncated pyramids, could be observed on the roof of the building. The concept of congruence was present on the ceiling and windows. Congruence was found on the facade, roof, ceiling, tile patterns, doors, windows, and vents. Geometric transformation, namely reflection, could be found on the tile patterns, doors, windows and vents. While the concept of rotation was found on the floor and ventilation patterns. The results of this study were expected to be ethnomathematics teaching materials at

Pendapa Sabha Swagata Blambangan and sources to conduct studies on the other parts of the main building of Pendapa Sabha Swagata Blambangan, namely the musala building, guest house which served a bunker, gazebo as a banquet venue, and traditional houses of using.

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