

Batik Ratu Banten in an ethnomathematics lens: Historical value and mathematical value

Vidya Ayuningtyas^{1*}, Yuke Andriani¹, Sulistiawati¹, Destri Astrianingsih¹,
Anggi Rahmani²

¹Universitas Bina Bangsa, Indonesia

²Universitas Sultan Ageng Tirtayasa, Indonesia

Email: vidyaayuningtyas20@gmail.com

ABSTRACT

Mathematics is a basic science that is very necessary in daily activities, and contributes to the advancement of science and technology. In addition to the functional aspect, mathematics also has an aesthetic side that can be combined with cultural elements in a work of batik art, namely Batik Ratu Banten. This approach involving mathematical and cultural concepts is known as ethnomathematics, which can be used as a source in contextual mathematics learning that is interesting for students by connecting abstract mathematical concepts with real cultural artifacts. However, learning in schools in Banten has not fully integrated cultural elements into mathematics learning. Therefore, this study aims to examine Batik Ratu Banten from historical and mathematical values. The research method is qualitative with an ethnographic approach. Research data were obtained from interviews, observations, and documentation, with the subject data source being the Batik Ratu Banten UMKM actors. The data received is analyzed to dissect and clarify the philosophy and describe batik motifs using a geometric approach, using data reduction techniques, data presentation, and concluding so that research conclusions are obtained. The results of the study concluded that Batik Ratu Banten not only contains historical elements of Banten, but also mathematical values. Behind the beautiful carvings of the artwork of Batik Ratu Banten, there are mathematical values in the form of the concept of number patterns, the concept of circles in the material of flat shapes, the concept of lines and angles, and the concept of reflection, translation, and rotation in the material of transformation geometry. This finding shows that Batik Ratu Banten can function as a source of learning mathematics in understanding the material to be more contextual and meaningful.

Keywords: Ethnomathematics, Batik Ratu Banten, Cultural Context, Mathematical Education, Transformation Geometry

* Corresponding Author Email: vidyaayuningtyas20@gmail.com

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INTRODUCTION

Activities in everyday life are actually tied to mathematical activities. Starting from simple activities such as counting the number of items to complex applications in technology, mathematics is the foundation of various aspects of life. Mathematics is a branch of basic science whose role is important in everyday life and in the development of science and technology (Anwar, 2018; La'ia & Harefa, 2021). Therefore, mathematics is called the "queen of sciences" because the source of all knowledge is mathematics. However, behind its

complexity, mathematics also has an aesthetic and historical side that is found in culture, including batik.

The international world recognized Indonesian batik through UNESCO on October 2 2009 by designating it as Indonesia's original cultural heritage (Septiani, 2022). Batik is not only beautiful art, but also reflects cultural richness that contains deep values, both historical and mathematical. One of Indonesia's cultural heritages that is interesting to study is Banten Province. This is illustrated by historical heritage, one of which is in the Banten Lama area. Apart from the history of the region, Banten's wealth can be seen from the tribes that inhabit it, consisting of Sundanese, Javanese and Cirebonese, Betawi, and immigrants (Zaenuri et al., 2021). Banten's cultural diversity is also reflected in the art of batik. The motifs not only convey the history and identity of Banten, but also show how mathematical values are applied in everyday life through geometric patterns and structures.

In relation to mathematics, the patterns found in batik often involve geometric concepts such as symmetry, transformation geometry, and two-dimensional and three-dimensional shapes. This concept is not only relevant for learning mathematics, but can also be a medium for introducing cultural aspects to students. This approach is known as ethnomathematics.

Ethnomathematics is a particular way of doing mathematical activities by linking mathematical concepts to cultural practices (Muhtadi et al., 2017). The existence of studies on ethnomathematics is able to connect two different disciplines between mathematics and culture into a meaningful unity. Ethnomathematics activities are interconnected with mathematics learning, such as counting, measuring, determining direction and location, planning, playing, and explaining (Astuti et al., 2019). Without realizing it, these activities are daily activities carried out by the community (Mahuda, 2020). Therefore, through ethnomathematics, mathematics can be taught in a more contextual, relevant, and interesting way for students. Ethnomathematics allows abstract mathematics learning to be connected to the concrete local cultural context where by studying patterns in local culture, students are invited to analyze, compile generalizations, and discover hidden mathematical concepts, such as lines and angles, transformations, and number patterns.

However, learning activities in schools in Banten have not fully integrated cultural elements into mathematics learning. In fact, integrating cultural elements is part of contextual learning (Laksana et al., 2021). In addition, by using culture as a learning resource, students can more easily understand mathematical concepts that are often considered difficult. Findings in research by Pane et al., (2022) show that LKPD containing local wisdom integrated with TPACK is effective in improving student learning outcomes. This is also a place to introduce Banten history and culture to students. The facts on the ground are based on information obtained from students at one of the elementary schools in Serang City, they do not know the history of Banten and have never even visited it. Therefore, this research was conducted to examine the historical value and mathematical value of Batik Ratu Banten.

METHOD

This Batik ethnomathematics research uses qualitative methods with an ethnographic approach. The aim is to explore Batik Ratu Banten's cultural values and their relationship to mathematical concepts. The ethnographic approach in ethnomathematics is the study of certain cultures that are associated with mathematical objects (Prahmana, 2020; Sardin & Rosjanuardi, 2024). In this study, data was obtained through observation, interviews, and documentation with the subject data source being the Batik Ratu Banten UMKM actors.

Observations were conducted in the Banten Lama area to find out in detail the historical heritage of Banten and continued to the Banten Batik UMKM actors where the researcher was a non-participant observer. At the interview stage, the researcher used a semi-structured type so that the instrument in the form of a list of questions that had been prepared could adjust the

explanation of the informant further. The interview was conducted by meeting directly with the Batik Ratu Banten UMKM actor where he was one of the batik craftsmen in Banten who also still had a family tree with the Banten Sultanate. In addition, documentation activities were carried out in Banten Lama and at the Batik Ratu Banten UMKM. The results of the data collected were analyzed to dissect and clarify the philosophy and describe batik motifs using a geometric approach using data reduction techniques, data presentation, and drawing conclusions so that research conclusions were obtained.

RESULT AND DISCUSSION

The results of this ethnomathematics research on Batik Ratu Banten are in the form of a study of historical values and mathematical values. It will be explained more clearly as follows.

1. Historical Value

a. Teluk Banten Batik Motifs

The motifs on Teluk Banten Batik are inspired by a small island located in Teluk Banten called Pulo Panjang. It depicts the elements that exist in Pulo Panjang, such as the Teluk Banten Sea, rabbitfish, anchovies which are typical souvenirs from Pulo Panjang, fishing boats, Pulo Panjang itself, and coconut trees which are characteristic of Banten Beach. Administratively, this island is in the Serang Regency, Banten. The majority of residents are fishermen and coconut pickers.

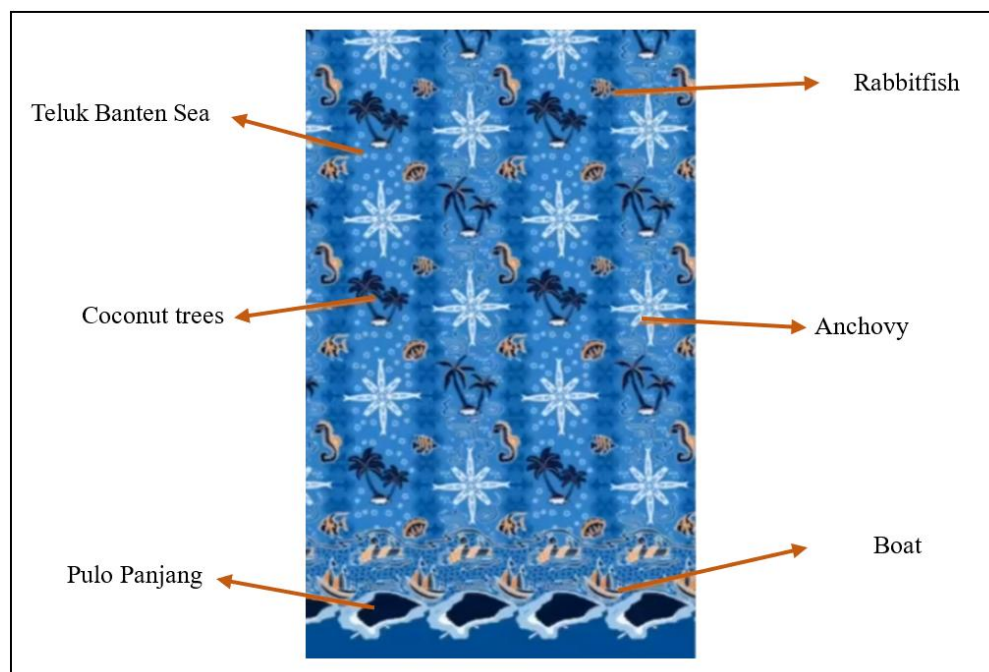


Figure 1. Historical Value of Teluk Banten Batik

b. Lada Batik Motifs

The pepper plant motif is included in the batik, giving it the name Batik Lada. This started because of Banten's strategic location as an international shipping and trade route. Furthermore, Banten is one of the regions that plays an important role in the world spice trade route, namely pepper. In fact, Banten is known as the second largest pepper exporter in Southeast Asia. Apart from that, Banten is also a producer of the best quality pepper (Nurlidianti et al., 2023).



Figure 2. Historical Value of Lada Batik

c. ORIDAB Batik Motifs

ORIDAB batik is an abbreviation of the word Oeang Republik Indonesia Daerah Banten. Based on the elements of its name, this batik was made based on the history of the first money issued on the island of Java during the time of the Resident of Banten. This is related to the incident where the Banten Residency was isolated by the Dutch colonialists who controlled most of the borders in West Java and blockaded the Banten coast so that relations between the Banten Government and Yogyakarta were cut off and resulted in the need for payment instruments not being met. To overcome this problem, the central government ordered K.H. Achmad Chatib as resident of Banten issued ORIDAB in December 1947 (Usmaedi, 2023). ORIDAB issuance consists of denominations of Rp1, Rp5, Rp10, Rp25 and Rp50. ORIDAB Batik is one of the best seller collections from Batik Ratu Banten. This batik motif was inspired by the ORIDAB Rp25 denominations.



Figure 3. Historical Value of ORIDAB Batik

d. Geger Cilegon Batik Motifs

The Cilegon commotion was one of the historical events in Banten, especially Cilegon in 1988. This rebellion was a form of resistance by the Cilegon people against the Dutch government for occupying the Banten area. There was an imbalance in the number of troops and weapons with the invaders, where the people only used simple weapons, one of which was the machete. Despite this, the rebel troops led by Kiai Wasyid remained enthusiastic about fighting for territory. This event was even presented in a book entitled "The Peasant Revolt of Banten" (Ansor & Muttahidah, 2020).



Figure 4. Historical Value of Geger Banten Batik

2. Mathematics Value

a. Teluk Banten Batik Motifs

The Teluk Banten Batik motif is engraved with a pattern. The pattern itself can be interpreted as an arrangement of objects in sequence (Ge'e et al., 2023). On the piece of cloth there are motifs of anchovies and coconut trees as shown in Figure 6. The anchovy motif has patterns 1, 3, 5, and so on. This shows that each term of the anchovy motif pattern has a difference of 2 to the next term. The arithmetic sequence pattern for odd numbers can be written as:

$$Un = 2n - 1 \quad (1)$$

Meanwhile, the coconut tree motif has patterns 2, 4, 6, and so on, where each term for the coconut tree motif pattern has a difference of 2 to the next term. The arithmetic sequence pattern for even numbers can be written as:

$$Un = 2n \quad (2)$$

From Batik Teluk Banten we can observe that almost all motifs in a piece of cloth have a pattern that is 2 different from the following tribes. For more details, look at Figure 5.

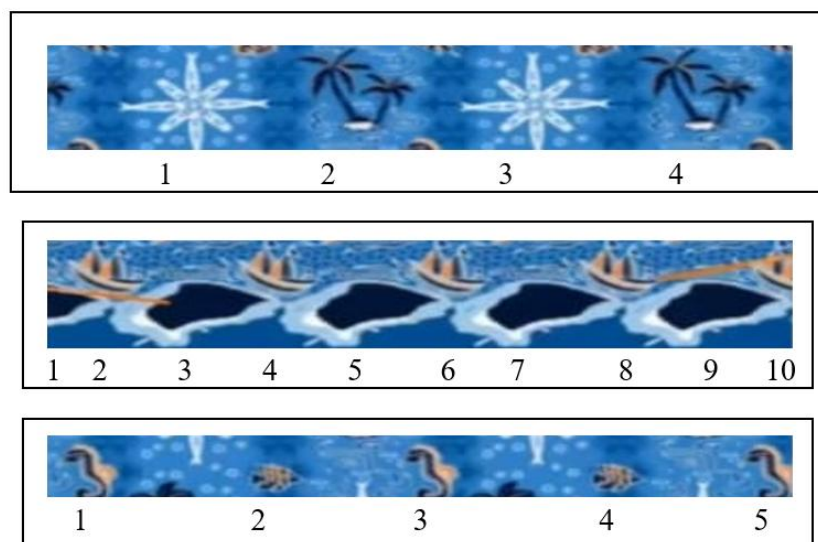


Figure 5. Patterns Concept in Teluk Banten Batik Motifs

Furthermore, the anchovy motif has the reflection concept as seen in Figure 6. If the anchovy head is the central point (0,0) then the mirroring process can occur through reflection on the x-axis:

$$G(x, y) \rightarrow G'(x, -y) \quad (3)$$

reflection on the y-axis:

$$G(x, y) \rightarrow G'(-x, y) \quad (4)$$

reflection on the $y = x$ line:

$$G(x, y) \rightarrow G'(y, x) \quad (5)$$

and reflection on the $y = -x$ line:

$$G(x, y) \rightarrow G'(-y, -x) \quad (6)$$

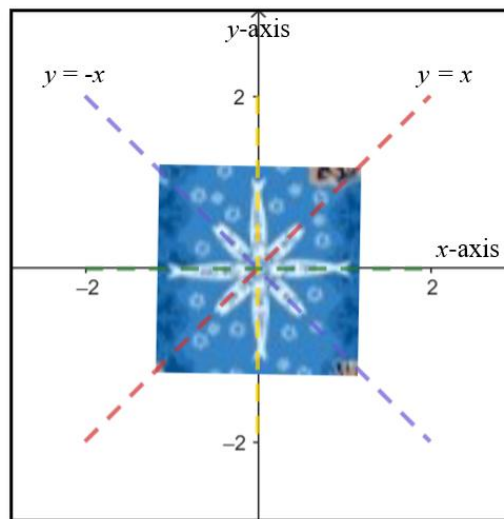


Figure 6. Reflection Concept of Anchovy Motifs in Teluk Banten Batik

The anchovy motif also fulfills the rotation concept in geometric transformation where the coconut tree motif is the central point. The anchovy motif can be rotated 90° with center (a, b) . It can be written as:

$$G(x, y) \xrightarrow{R_{90^\circ}} G'(-y + a + b, x - a + b) \quad (7)$$

$$G(x, y) \xrightarrow{R-90^\circ} G'(y + a - b, -x + a + b) \quad (8)$$

Rotation can be done clockwise or counterclockwise as seen in Figure 7.

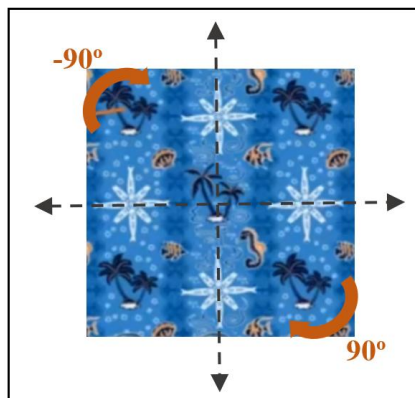


Figure 7. Rotation Concept of Anchovy Motifs in Teluk Banten Batik

b. Lada Batik Motifs

We can see from Figure 8 that there is a translation process contained in Batik Lada. Formulaically, translation concept can be written as:

$$G(x, y) \xrightarrow{(a, b)} G'(x + a, y + b) \quad (9)$$

In the Cartesian coordinate image, point A and point B are displaced a distance a where the images of point A and point B are exactly at point C and point D.

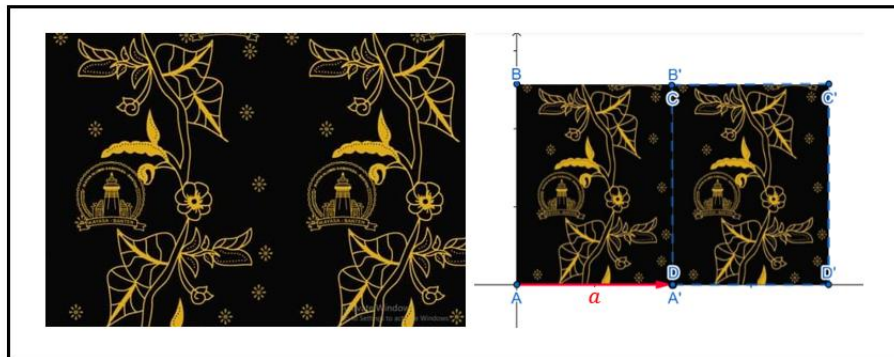


Figure 8. Translation Concept in Batik Lada

Another concept can be seen in Figure 9, where there is a Banten Tower surrounded by a circular motif. Circles are included in the mathematical material of two dimension.



Figure 9. Circle Concept in Lada Batik

c. ORIDAB Batik Motifs

The leaf motif is depicted dominantly surrounding the Banten Tower motif. If the Banten Tower is a line $x = k$ then you will see the concept of reflection as presented in Figure 10 and can be written as:

$$G(x, y) \xrightarrow{(a, b)} G'(2k - x, y) \quad (10)$$



Figure 10. Reflection Concept of Leaf Motifs in ORIDAB Batik

Apart from the leaf motif, there is also a circular motif on ORIDAB Batik. The concept of a circle is part of the two dimensions in the mathematical material. Look at Figure 11.



Figure 11. Circle Concept in ORIDAB Batik

The concept of translation is also present in ORIDAB Batik. This can be found in the leaf motif located on the bottom side as shown in Figure 12.



Figure 12. Translation Concept of Leaf Motifs in ORIDAB Batik

d. Geger Cilegon Batik Motifs

Geger Cilegon Batik has the main motif in the form of a machete. If examined closely, the machete motif resembles two lines that are perpendicular to each other. The concept of the intersection of two lines will produce four corners. Two perpendicular lines will have the same angle size and form a right angle, namely 90° (Fitriani, 2022).



Figure 13. Lines and Angles Concept of the Golok Motif in Batik Geger Cilegon

Furthermore, the fish motif is an application of the concept of mirroring the $x = k$ line. The fish motif that circles the Banten Tower in Figure 14 forms a reflection concept where reflection is one of the materials contained in the transformation geometry material.

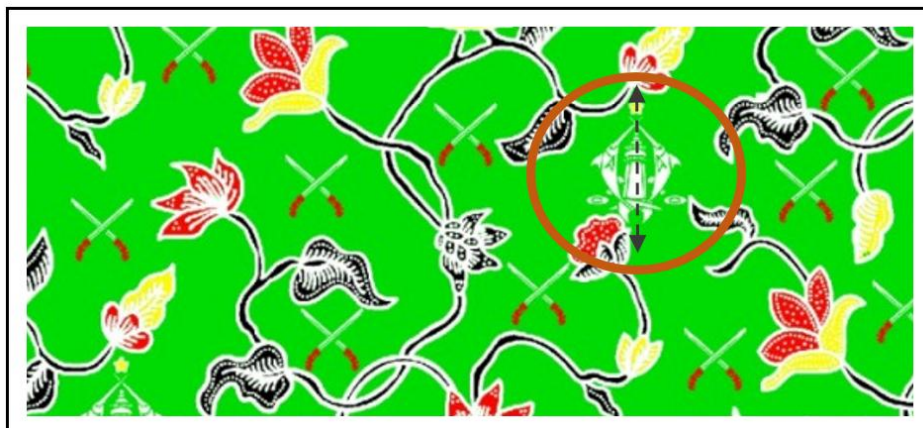


Figure 14. Reflection Concept of Fish Motifs in Geger Cilegon Batik

From the results of the above explanation, ethnomathematics activities were found in Batik Ratu Banten. Each motif in Batik Ratu Banten not only contains the historical value of Banten but also applies several mathematical values. This is in line with the research of Nuryami & Apriosa (2024) where his research in Probolinggo batik for each batik motif consists of several geometric concepts, both flat shapes, spatial shapes, and geometric transformations. Likewise, the ethnomathematics research of Batik Gajah Mada Tulungagung by Afifah et al. (2020) where the Sekar Jagad motif batik pours mathematical concepts in the form of flat shapes, geometric transformations, and angles.

CONCLUSION AND SUGGESTIONS

The results and discussion of this study concluded that the artwork of Batik Ratu Banten contains several historical values of Banten in the past. Behind the historical value, there is also

a mathematical value of the beautiful batik artwork. The mathematical value consists of several concepts, including the concept of a circle in the material of flat shapes, the concept of lines and angles, and the concept of reflection, translation, and rotation in the material of transformation geometry.

The results of this study can be used by teachers, especially in Banten, as a source of learning mathematics in understanding the material of number patterns, transformation geometry, flat shapes, and lines and angles. In the process, students can be invited to analyze, compile generalizations, and find these mathematical concepts. The learning process can also be carried out outside the classroom by visiting areas in Banten or visiting the Batik Ratu Banten UMKM so that learning becomes more meaningful. The results of this study can certainly be developed by further researchers in investigating more deeply the historical values in other Banten areas along with their mathematical values. In addition, other research can be in the form of developing learning media based on Batik Ratu Banten ethnomathematics.

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