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Ethnomathematics: Mathematical Exploration on Batik Gedog Tuban

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ABSTRACT

Batik Gedog Tuban has been one of prominent Batik types in Tuban. This batik has a variety of patterns with diverse colors. This study aimed to analyze the mathematical value within Batik Gedog Tuban. This study used a qualitative descriptive with an ethnographic approach. Data were collected by the study of literature, observation, interview, note, and documentation. The results showed that there were several mathematical concepts contained in Batik Gedog Tuban such as geometry concepts, geometry transformation, and congruence.

***Keywords*: *Ethnomathematics, Batik Gedog Tuban, Mathematical Concept*.**

ABSTRAK

Batik Gedog Tuban merupakan salah satu pola batik yang terkenal di Tuban, Indonesia. Batik ini mempunyai motif yang bervariasi dan kaya warna. Penelitian ini bertujuan untuk menganalisa nilai matematis yang terdapat pada Batik Gedog Tuban. Pengumpulan data dilakukan melalui studi pustaka, observasi, wawancara, catatan lapangan dan dokumentasi. Hasil menunjukkan bahwa terdapat beberapa konsep matematika pada Batik Gedog Tuban seperti geometri, transformasi, dan kongruensi.

Keywords*: *Ethnomathematics, Batik Gedog Tuban, Konsep Matematika.

1. Introduction

Mathematics is one of the main and essential subjects in school. It also becomes one branch of science that is closely related to human life [1]. Several studies indicate that students' interest in mathematics was low due to the fact that many students feel that mathematics is difficult, tedious, abstract, and too theoretical with difficult formulas to comprehend. This rationale rises since mathematics taught at school is sometimes different from the mathematical problems found in everyday life [2]. Therefore, most of them feel that learning mathematics is a waste of time.

Developing and applying mathematical concepts based on daily-life problems are parts of the student learning process [3][4]. Learning is an active process of constructing understanding and knowledge especially through social interaction [5][6][7]. Students' interest is one of the internal factors that can improve student learning achievement [8]. Students' interest in mathematics is strongly influenced by the teacher and the approach

used in teaching [9]. Students' interest is needed in the learning process because interest can create a condition where students feel the need and want to learn. The higher learning interest, the more positive students' attitudes toward mathematics. Interest does not occur spontaneously but it exists because of participation, experience, and habit while learning.

To increase the students' interest, mathematics learning should be based on the surrounding culture because of the difficulty of students in understanding mathematics obtained in school and the difficulty of students connecting mathematics with real life [10]. For this reason, a connection between mathematics applied outside of school and implemented mathematics in school is necessary. D'Ambrosio (1985:44) said that "Making a bridge between anthropologists and historians of culture and mathematicians is an important step towards recognizing that different modes of thoughts may lead to different forms of mathematics; this is the field which we may call ethnomathematics [11], [12][13] [14][15]."

Making a bridge between culture and mathematics is an important step to recognize various ways of thinking that can lead to various forms of mathematics. This issue is called ethnomathematics. Ethnomathematics is used to express the relationship between culture and mathematics [16][17]. This ethnomathematics can be interpreted that in the culture, there can be found various mathematical concepts so it shows that mathematics and culture are two things related to each other. Therefore, learning mathematics in schools needs to be updated by applying cultural elements in the learning of ethnomathematics [18]. So, ethnomathematics can make students understand mathematics more efficiently.

Batik Gedog is a famous Batik in Tuban. There are several types of batik Gedog, like Kijing Miring, Likasan Kothong, Owal Awil, Panji Konang, Panji Serong, Panji Ori, Srigunting, Kembang Kluwih, Ganggeng, and Kembang Waluh. In this study, the researcher discusses mathematical concepts contained in Batik Gedog Tuban motifs, especially on the motifs of Kijing Miring, Owal Awil, and Panji Ori motifs.

2. Research Methods

This study used a qualitative descriptive research approach with an ethnographic design. The instruments used in this study were the main instrument, observation guidelines, interview guidelines, and documentation. Data were collected using literatures, observation, interview, note, and documentation [19][20]. The data validity technique in this study was triangulation.

3. Result and Discussion

The original name of Batik Tuban was Batik Tenun Tradisional. There was a sound like "dog dog dog" in the weaving process so people used to call it "Tenun Gedog". "Tenun Gedog" in Indonesia only existed in Tuban and the center was located in Kerek village. Batik Gedog was believed to have existed since the Majapahit kingdom. A long time ago, batik was used for royal traditional ceremonies and other important events.

Because of the infertile natural conditions, there was a large amount of cotton planted by the local community [21]. Then this cotton was made into a lawn, then the weaving process was done traditionally. Since long time ago in Tuban, especially in Kerek District, it had been producing woven fabrics. Even now in this area there were still some residents making lawns and weaving.

Only Tuban made batik on woven fabrics. Many people referred to Tuban's Batik with "Batik Gedog", whereas the truth was "Batik Tulis Kain Tenun Gedog". This batik was very distinctive in its appearance. In addition to the patterns mentioned above, Batik Gedog displayed a color scheme that contained a specific meaning and it's used by certain groups. Some important terms included *bangrod*, *pipitan*, *putihan*, and *irengan* [22].

Most Tuban batik Gedog motif was the symbolic expression of plants, animals, and cultural-social life that grew and developed in coastal Tuban area [23][24]. Every motif contained in Batik Gedog had described the character of the batik. The meaning of the batik could be seen from the symbols or patterns and colors of batik. The motif found in Batik Gedog had their own meaning according to the functions and values that developed in society.

3.1 Kijing Miring Motif

Figure 1 Kijing Miring Motif

Kijing Miring Motif was one of the motifs of Gedog Tuban batik that had existed since the time of the Majapahit kingdom. The name Kijing Miring came from a triangle-shaped image or symbol that resembled the shape of a gravestone in a cemetery [25][26][27]. So, the purpose of this batik was about death or reminding someone of death [28][29]. The use of the Kijing Miring motif in the past until now was for the death ceremony. The Kijing Miring motif was a motif that could be used by all people, nobles, and ordinary people. There were a number of mathematical concepts found in the Batik Gedog Kijing Miring.

3.1.1 Geometry

In the Kijing Miring motif, there were geometric concepts such as points, lines, triangles, and squares. The triangle pattern created was an equilateral triangle arranged by 10 points, with each side of a triangle consisting of 4 points. While the sides of the square pattern made were arranged by 4 points.

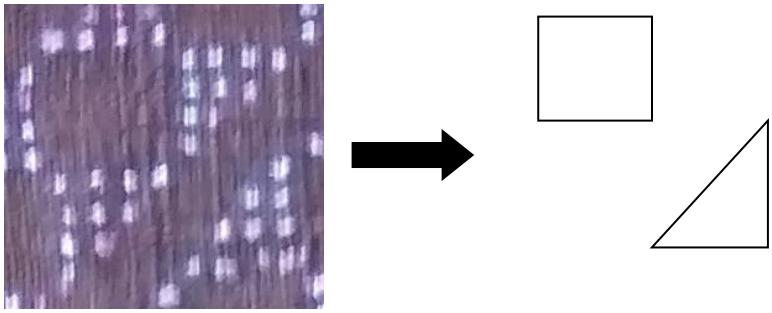


Figure 2 Triangle and Square on Kijing Miring Motif

3.1.2 Translation

There were concepts of transformation in the Kijing Miring motif, namely translation, which was found in triangular and square patterns by moving or sliding the pattern to a particular position and then being translated to vectors $\binom{a}{b}$, $\binom{a}{0}$, and $\binom{0}{b}$. The translation result was a pattern with the same size and shape at the certain position.

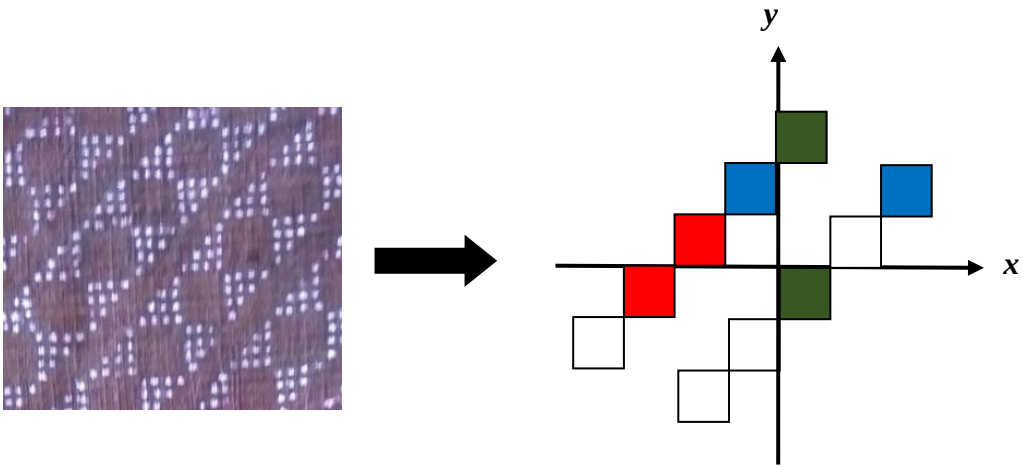


Figure 3 Translation on Kijing Miring Motif

Note:
Translation to vector $\binom{a}{b}$
- Translated to the *x*-axis and followed by the *y*-axis

Translation to vector $\binom{a}{0}$
- Translated to the *x*-axis

Translation to vector $\binom{0}{b}$
- Translated to the *y*-axis

3.1.3 Reflection

In the Kijing Miring motif, there was a concept of transformation, namely reflection contained in the triangle pattern, such as reflection on the *y* axis and reflection on the *x* axis. Reflection produced the same object as the original object while maintaining a fixed distance to the symmetry axis.

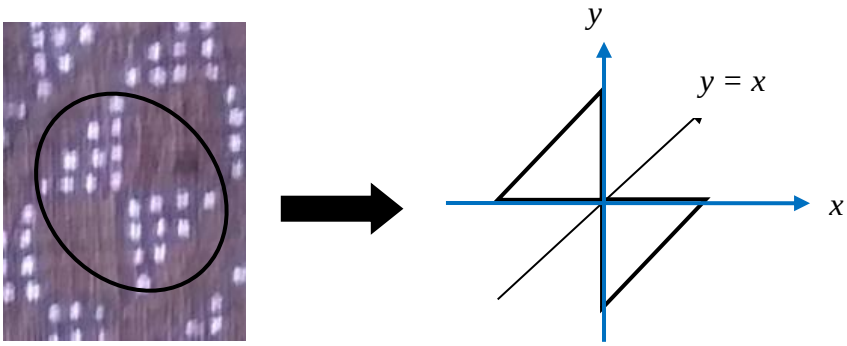


Figure 4 Reflection on the *y* axis then reflection on the *x* axis
(Reflection on line $y = x$)

3.1.4 Sliding Reflection

In the motif of Kijing Miring, there was also the concept of transformation, namely sliding reflection found in a triangle pattern. Triangles were reflected on the *x* and *y* axes first, then translated to vectors $\binom{a}{b}$.

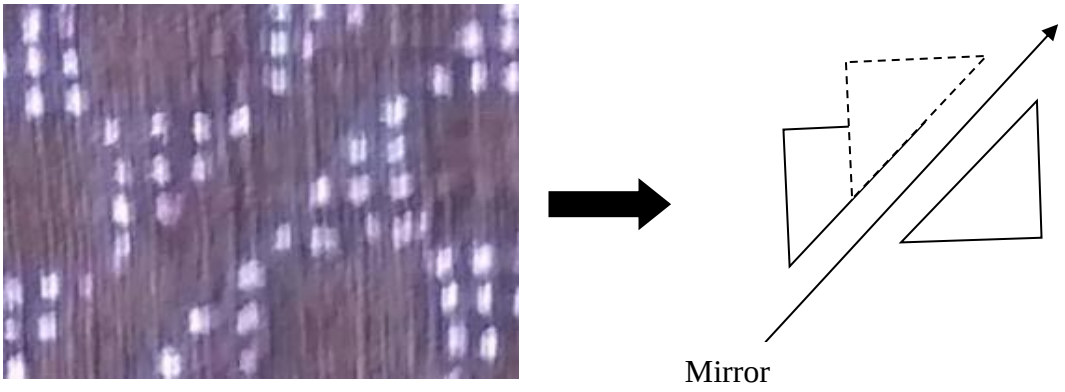


Figure 5 Sliding Reflection in Triangle Pattern

3.1.5 Congruence

In the motif of Kijing Miring, there also contained congruence concepts which was in a triangle and square pattern. The congruence concept could be demonstrated by giving the action of reflection, translation or rotation of the basic pattern in order to obtain another motif at a particular position with the same shape and size as the original pattern.

Students could show that two objects were congruent by moving one object on top of the other. In addition, students could show that an object if it is reflected or rotated or translated would get the same result as the original object.

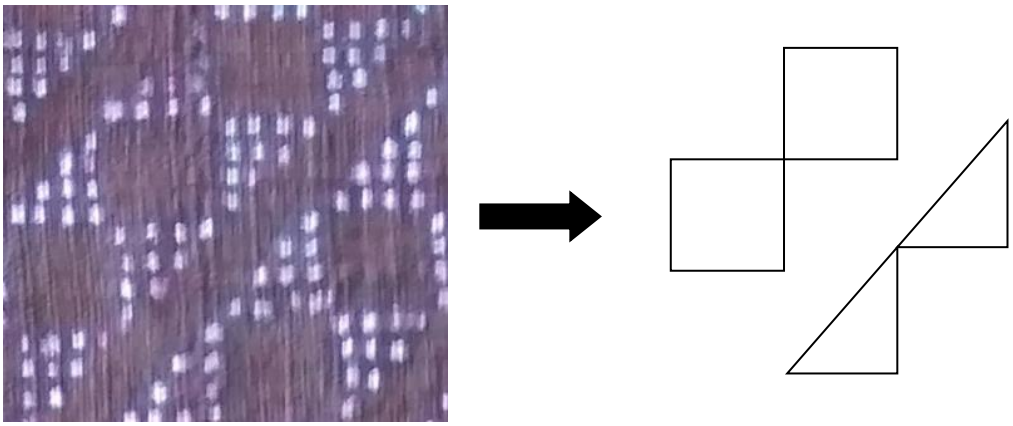


Figure 6 Congruence in Triangle and Square

3.2 Owal Awil Motif

Figure 7 Owal Awil Motif

Owal awil showed the main style of swastika or banji, this pattern was also called wal-wil, which meant continuously repeating. The main background was black with white patterns. This motif was believed by the community as a form of harmony between husband and wife; men were symbolized by the form of birds, which meant courage and willing to fly to make a living for their family while women were symbolized by the Cananga flower that illustrated that a woman had a gentle, beautiful, and fragrant nature. Usually, this motif was worn by the bride and groom. The basic motif was composed of two swastika, a symbol that resembled the letter T with a bent cross. The swastika was also a religious symbol of Hindus [30][31]. There were a number of mathematical concepts found in the Batik Gedog Owal Awil.

3.2.1 Translation

On the Owal Awil motif, there was the concept of transformation namely translation, such as translation to vector $\binom{a}{b}$ and then translated to the *x*-axis followed by the *y*-axis or on the *y*-axis first and followed by the translation of the *x*-axis. The translation result was a pattern with the same size and shape at the certain position.

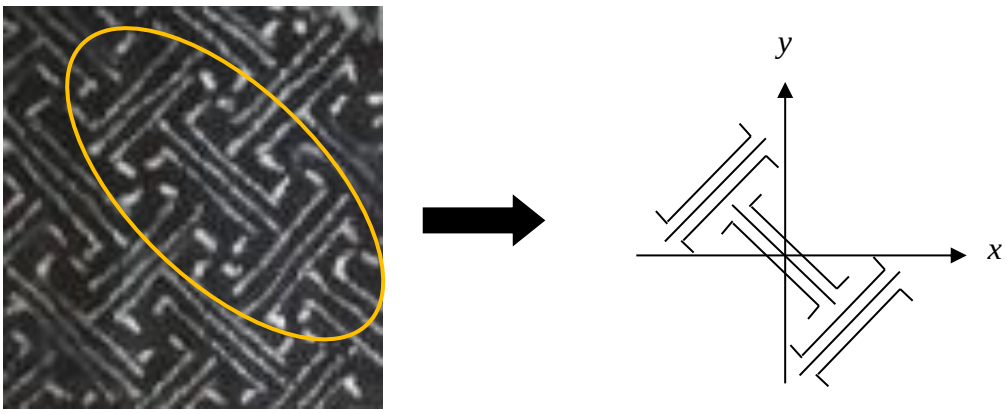


Figure 8 Translation to vector $\binom{a}{b}$. Translated to the *x*-axis and followed by the *y*-axis

3.2.2 Reflection

There was the concept of transformation, namely reflection in Owal Awil Motif. Reflection produced the same object as the original object while maintaining a fixed distance to the symmetry axis.

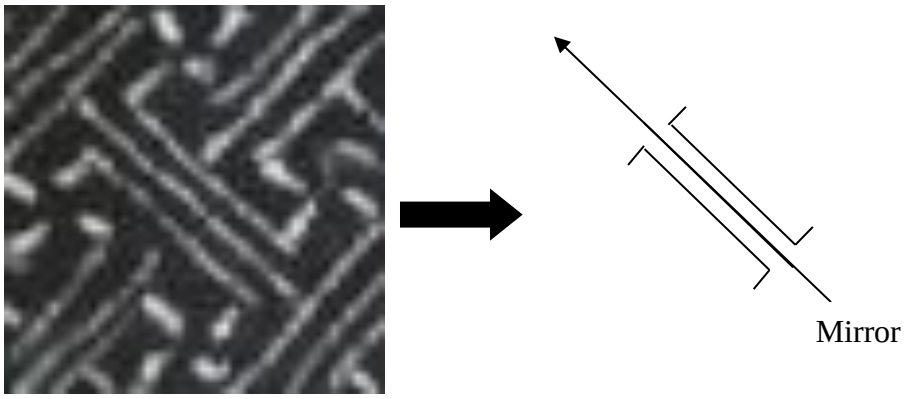


Figure 9 Reflection in Owal Awil Motif

3.2.3 Sliding Reflection

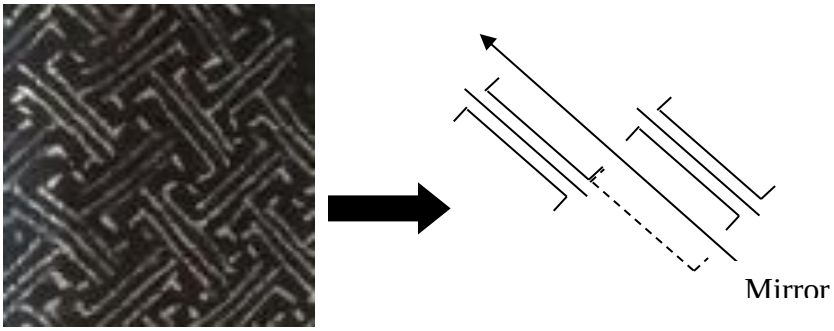


Figure 10 Sliding Reflection in Owal Awil Motif

In the Owal Awil motif, there was also the concept of transformation, namely sliding reflection. The patterns were reflected on the *x* and *y* axes first, then translated to vectors $\binom{a}{b}$

3.2.4 Congruence

In the Owal Awil motif, there was the congruence concept. The congruence concept can be demonstrated by giving the action of reflection, translation or rotation of the basic pattern in order to obtain another motif at a particular position with the same shape and size as the original pattern.

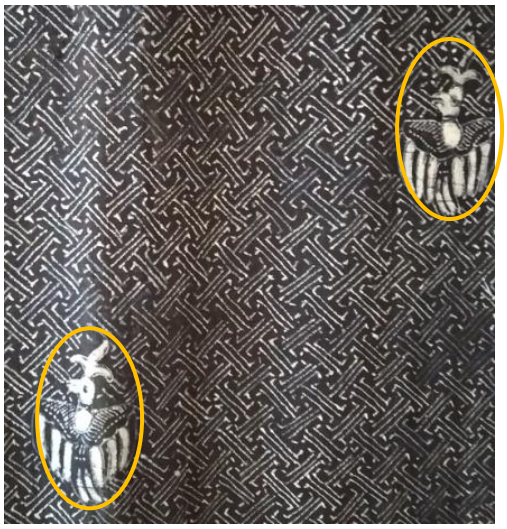


Figure 11 Congruence Concept in Owal Awil Motif

3.3 Panji Ori Motif

Figure 12 Panji Ori Motif

The *Panji Ori* motif was also believed to have existed since the days of the Majapahit kingdom. It was usually used by knights. The form of the main motif was *ren-renan* which was placed in a cage or rectangular area. *Panji Ori* was also commonly referred to as *Panji Lor* that had the meaning of *southern Panji*, or could also be interpreted with the word *banji* that was a mistake of the pronunciation and the word *wan ji* in Chinese which

usually referred to the swastika ornamental style with all its variations. The decorative style meant the wheel of Buddhist life. This *Panji Ori* motif used to be only owned by the nobility and those who used it were men or knights. However, through the development of the era, this motif could be worn by ordinary people [13]. There were a number of mathematical concepts found in the Batik Gedog Panji Ori.

3.3.1 Geometry

On the Panji Ori motif, there were geometric concepts such as points, lines, squares, and triangles.

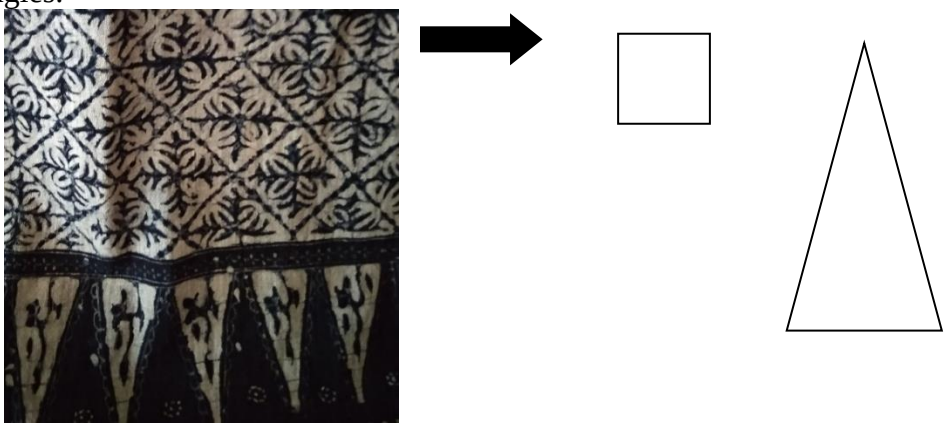


Figure 13 Square and Triangle in the Panji Ori Motif

3.3.2 Translation

On the Panji Ori motif, there was the concept of transformation namely translation such as translation to vector $\binom{a}{0}$ (Translated to the x-axis) and $\binom{0}{b}$ (Translated to the y-axis). The translation result was a pattern with the same size and shape at the certain position.

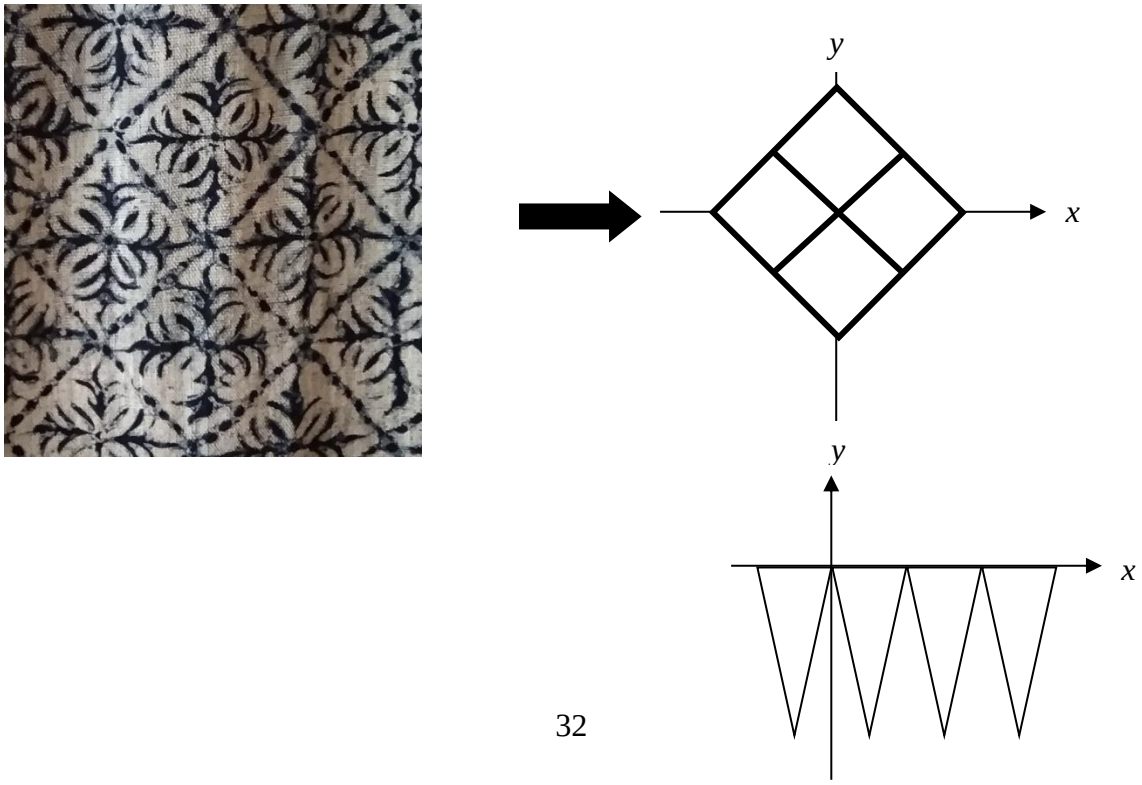
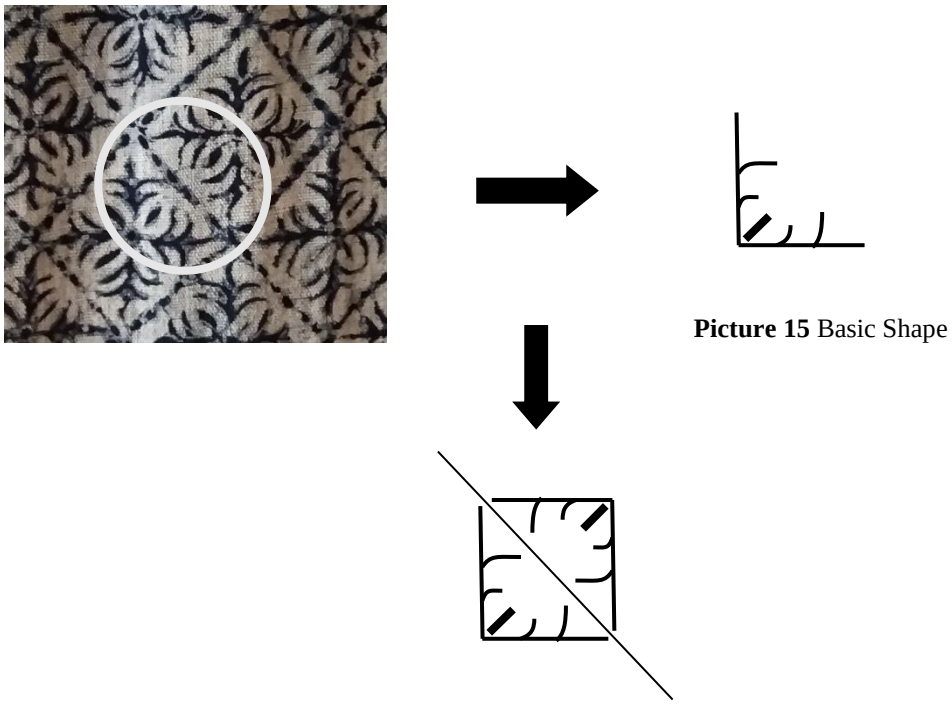


Figure 14 Translation on Panji Ori Motif

3.3.3 Reflection

On the Panji Ori motif, there was the concept of transformation namely reflection on the *x*-axis and *y*-axis. Reflection produced the same object as the original object while maintaining a fixed distance to the symmetry axis.

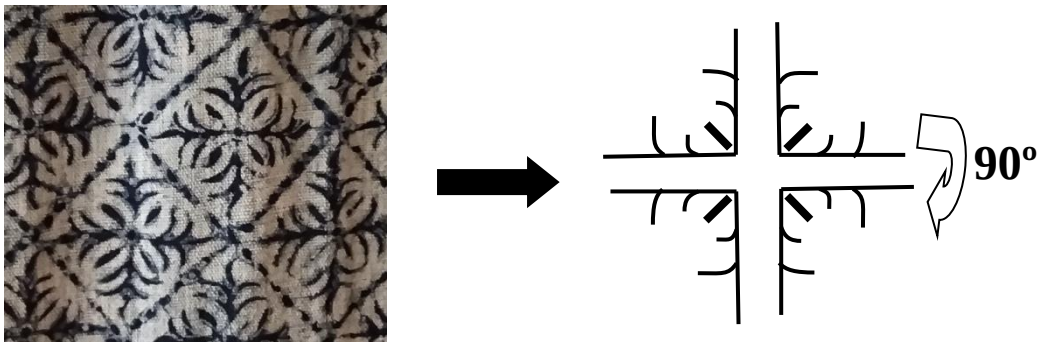


Picture 15 Basic Shape

Figure 16 Reflection on the *y*-axis and *x*-axis

3.3.4 Rotation

On the Panji Ori motif, there was also the concept of transformation, namely rotation at 90°



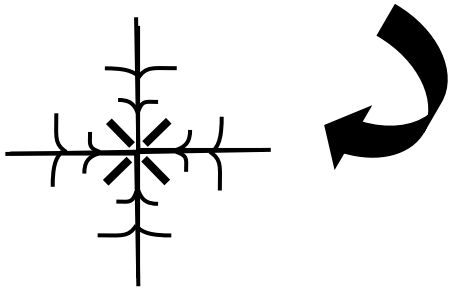


Figure 16 Rotation at 90°

3.3.5 Congruence

On the Panji Ori motif, there was the congruence concept that was in a Triangle pattern. The congruence concept was demonstrated by giving the action of reflection, translation, or rotation of the basic pattern in order to obtain another motif at a particular position with the same shape and size as the original pattern.

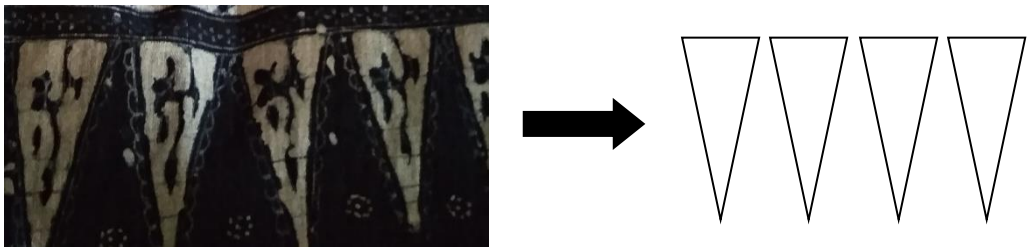


Figure 17 Congruence concept in Triangle

4. Conclusion

Batik Gedog Tuban is one of the ancestral heritages in Tuban that has been preserved with diverse and unique motifs and colors. Not only the unique motif of Batik Gedog, but the motif also contains several mathematical concepts such as geometric concepts (e.g., square, triangle, and circle), geometric transformation (e.g., translation, reflection, rotation, and sliding reflection), and congruence. Unconsciously, the people in Tuban have applied mathematical concepts in the pattern of Batik Gedog Tuban. This study can be a reference for teachers to design teaching materials based on cultural context.

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