Ethnomathematics in Sidomukti Solo Batik Motifs as A Media For Learning Realistic Mathematics

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ABSTRACT

Ethnomathematics explores the relationship between mathematics and culture. One aspect of Indonesian culture that showcases this connection is Batik. Despite this, many educators struggle to incorporate local culture into math education. For instance, Sidomukti batik could serve as a practical tool for teaching mathematics in a way that relates to local culture. By studying the geometric patterns and structures found in Sidomukti Batik, students can grasp mathematical concepts in a manner that is more meaningful and relevant to their everyday lives. This research aims to investigate ethnomathematics in the Solo Sidomukti Batik motif as a medium for practical mathematics learning. The study is based on literature reviews and uses exploratory techniques with an ethnographic approach. The findings reveal several insights: 1) The main motif of Sidomukti Batik can be considered an element of a set; 2) Certain elements in Sidomukti Batik represent flat figures; 3) Data on the appearance of each Sidomukti Batik motif can lead to statistical concepts such as average (mean), median, and mode; 4) Sidomukti Batik does not feature rotation, reflection, or sliding reflection, but exhibits symmetrical patterns; 5) The creation of the batik motif "Sido Mukti" incorporates elements of measuring and calculating the cultural value of Solo.
Keywords: ethnomathematics, batik motif, sidomukti solo

1) INTRODUCTION

Mathematics is a universal science and is useful in every aspect of human life. This is knowledge that cannot be separated from every human activity, even if we do not realize that many human activities depend on mathematics. In other words, mathematics is a part of culture that has existed for a long time (Rudyanto et al., 2019).

Batik is one of the many characteristics of Indonesian culture. Batik is highly valued for its intricate processing and beautiful motifs and colors, which are full of symbolic meaning. Each batik motif has a magical symbolic meaning which is intended to convey trust and has aesthetic value to be used as decoration (Irawan et al., 2022).

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Ethnomathematics helps explain the relationship between mathematics and culture. However, the goal of ethnomathematics is to understand how mathematics relates to culture, so that students and the general public can gain a better understanding of the subject and improve their ability to comprehend it. This shows that ethnomathematics research is very important for studying mathematics itself, mathematical modeling, and cultural anthropology (ethnography) (Rudyanto et al., 2019).

The reality in schools is that most educators still fail to relate mathematics to local culture (Suwito & Trapsilasiwi, 2016). This relates to the ability of teachers and their learning processes to provide lessons that link mathematics to students' daily lives so that students do not just learn concepts (Irawan et al., 2022). Realistic mathematics learning views mathematics as a human activity. According to this approach, students should benefit from learning mathematics in the classroom by providing real examples from everyday life.

Learning media is an educational tool that can help teachers expand students' knowledge. By using learning media, teachers can foster students' interest in learning new things and make lesson material easy to understand. To achieve school teaching goals, teachers must be able to choose the most appropriate and appropriate learning media (Nurrita, 2018).

Solo is a cultural city which is famous for its batik industry (Sulistyo & Pratiwi, 2013). Various batik motifs have been produced in Solo, including Sekar Jagad batik, Cuwiri Batik, Wahyu Tumurun Batik, and Sidomukti Batik (Jordy et al., 2018). The Batik Sekar Jagad motif has a philosophical meaning that symbolizes love and has elements to maintain peace. The Cuwiri Batik motif itself has a philosophical meaning which means "hoping for prosperity and goodness in life and being respected by others" (Trixie, 2020). The motif of Wahyu Tumurun batik contains philosophical meaning namely the hope or request to receive revelation (gift), guidance, and direction from God Almighty (Muhadiyatiningsih & Hikmawati, 2018). Furthermore, the Sidomukti Batik motif philosophically has the meaning of nobility and glory (Ishartono & Ningtyas, 2021).

The Sidomukti Batik motif is one of the most popular Solo batik motifs in Solo society. This motif is widely used in traditional Central Javanese bridal clothing. Sidomukti batik comes from the words "sido", which means "so", which means "continue", and "mukti", which means "a life that is sufficient, prosperous, or prosperous." By wearing the Sidomukti batik motif, the bride and groom

hope that they will always be happy and blessed with good fortune while living their married life without forgetting God the Creator. (Meindrasari & Nurhayati, 2019).

Sidomukti batik as a concrete medium for realistic mathematics learning is interrelated because it is considered to make it easier for students to understand mathematical representation skills and allows them to research, study and express their own opinions during the learning process (Salsabila & Suparni, 2022). The geometric concept in the Sidomukti Batik motif can represent real geometric objects that exist in the student's environment. This makes it easier for students to imagine real concepts or situations regarding geometric figures (Kusumaningrum & Nuriadin, 2022).

Research on ethnomathematics has begun to be developed by researchers. (Sariningtias et al., 2020)conducting an ethnomathematical analysis of Ngawen Temple. The results of his research concluded that the shape of Ngawen Temple has the geometric shape of a cube, a rectangular pyramid frustum, and a rectangular pyramid. Another research was conducted (Prastika et al., 2021)on the mathematical elements found in rattan craft products from the Lhoknga community. The research results show that there are several mathematical objects such as serving lids, yellow pumpkins, parcel baskets, fruit and onions. These various shapes are geometric concepts consisting of lines and angles, circles, transformations, and curved side geometry. Next, the research (Ishartono & Ningtyas, 2021)conducted ethnomathematics research on Sidoluhur batik and found various geometric elements in it. Research on ethnomathematics, especially batik, has begun to be carried out. However, Sidomukti Batik has not been explored much regarding the ethnomathematics patterns and concepts contained in it and its use as a learning medium. Based on these several things, researchers are interested in exploring realistic mathematics learning media using Sidomukti Solo batik motifs. This was done as an effort to provide something new to the world of education, especially mathematics, that there is an integration of batik art and culture with mathematics which cannot be separated from life. daily.

2) METHODS

This research method uses a library research approach. Library research namely research originating from ingredients bibliography. Because of That, What is being done is an exploration of some data It is good data primary as well as data secondary with l steps concrete as follows: read and study carefully in-depth primary data such as journals which constitute results study, thesis or dissertation related to form Sidomukti Solo batik motif. Meanwhile, for data secondary, elite pens read and study journals

that are relevant to this research, then analyze What mathematics material can use Sidomukti Solo batik as a learning medium.

3) RESULTS AND DISCUSSION

a. Solo Batik Motif

Sidomukti Batik is one of the easiest to find. Solo, Central Java brides often wear Sidomukti motifs. Sidomukti batik comes from the words "sido", which means "so", which means "continue", and "mukti", which means "a life that is sufficient, prosperous, or prosperous." By wearing the Sidomukti batik motif, the bride and groom hope that they will always be happy and blessed with good fortune while living their domestic life without forgetting God the Creator. (Meindrasari & Nurhayati, 2019).

After the Giyanti Agreement in 1755, the Mataram kingdom was divided into two palaces, namely Yogyakarta and Solo. All equipment, equipment such as gamelan, clothing and batik, including Sidomukti batik, were brought to Yogyakarta. Then, the Solo Palace remade all the equipment and equipment including the Sidomukti batik but in a different style. The basic geometric pattern of Solo style Sidomukti batik consists of square areas, also known as rhombus areas. Basic pattern, this pattern represents a symbol of power. The Sidomukti Solo batik motif can be seen in Figure 1 below.

Figure 1. Structure of the Sidomukti Batik Finger Pattern

The Sidomukti batik motif consists of the main components in the form of the tree of life, garuda wings, butterflies, buildings, thrones and mountains. Apart from that, there are also complementary

components in the form of plants and flowers. An explanation of each component of Sidomukti Batik is as follows.

1) Main Elements

The main elements and symbolic meanings of the Sidomukti batik motif include the following:

a) Hayat Tree

Figure 2. Visual Form of Hayat Tree from Sidomukti Batik

The Hayat tree is called the tree of heaven, the tree of life, and the Tree of hope, and has a symbolic meaning of the belief that God has the power to give hope to humans.

b) Garuda wings

Figure 3. Visual Form of Guruda Wings from Sidomukti Batik

The shape of the Garuda's wings shows that humans can control their desires and achieve perfection in life. There is a connection between the symbol of the Garuda wings on the jarik cloth worn by the prospective bride and groom and their lives because the Garuda wings symbolize strength, fortitude, protection, wisdom, and courage. This ornament also symbolizes a husband who is depicted with wings flying everywhere to get kamukten (mukti), so the husband has to work to earn his fortune for his family.

c) Butterfly

Figure 4. Visual Form of Butterflies from Sidomukti Batik

Butterflies represent ideals, beauty and hope. Newlyweds definitely have big hopes for building a household, such as having children, getting money, and experiencing unprecedented happiness. Butterflies are also symbolized as prospective brides and grooms (men and women) who are required to fly, try, get maximum results, and then enjoy the results. This is the same as the process of forming a caterpillar into a butterfly. The butterfly symbolizes a husband who works, but not necessarily the work he does is close to where he lives, so it requires the husband to work outside the city, in a place far from his wife and children.

d) Building

Figure 5. Visual Forms of Buildings from Sidomukti Batik

In Sidomukti batik, the building shows the house where the bride and groom will live. describes the best place to live if you want to raise a wealthy family. The elements in the building show the hope that humans must reflect the nature of a sturdy house, which can accommodate all the problems faced in life, especially those related to the household, so that humans can also maintain and manage everything more wisely. The building is symbolized as a throne which has a symbolic meaning, namely depicting a husband who will later have a high position and throne as a symbol of hope for a high, noble position and rank and being respected by his wife and children and the community. (Anggraini & Affanti, 2020).

e) Throne

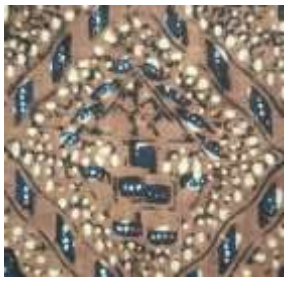

Figure 6. Visual Form of the Throne from Sidomukti Batik

The throne ornament depicts a high position and status. This throne is a symbol of hope for high, noble status and dignity, and is respected by many people, such as a leader or king (Jumariah, 2019). The way to arrange and arrange the shapes as the main ornament of the throne produces a beautiful image because the shape of the roof and foundation of the house matches the shape of the original building. An image corresponding to the original object is created when the observed object is matched to the image created in the main ornament of the throne. The comparison between the shapes that are the object of the image model in the main ornament of the throne produces ideal and harmonious shapes between the side shapes, so that the shapes that are arranged with each other have the impression of space and support each other (Aflaha & Suparman, 2022).

f) Meru

Figure 7. Visual form of Meru from Sidomukti Batik

The main Meru-shaped ornament is a symbol of mountains, land, and earth. Mountain ornaments symbolize grandeur and majesty, like a big mountain that looks mighty from a distance. This comes from the teachings about the four elements of life known as sanging paraning ngatta or the origin of life, in addition to fire, water, and air. In Javanese Hindu culture, "meru" describes a high mountain peak where the gods reside. The color black represents "meru", which if not controlled will produce anger, but if controlled will produce eternal prosperity (Jumariah, 2019).

2) Complementary / Supporting Elements

a) Plants

Picture 8. Visual Forms of Plants from Sidomukti Batik

The plant ornaments themselves have elements of shoots (buds), twigs containing leaves and sometimes flowers are also found. The plant ornaments on Sidomukti batik are in the form of lunges which contain no floral elements, only leaves and stems. In Sidomukti batik, plants have a symbolic meaning, namely depicting enough food. They also depict plants that are bowed, such as rice, which the more it bows, the fuller it becomes .

b) Flower

Figure 9. Visual Form of Flowers from Sidomukti Batik

Floral ornaments are described as flowers that have fully bloomed. Flowers themselves represent an element of beauty and beauty for Javanese people. In Sidomukti batik, flowers are placed at each corner of the rhombus because it depicts the Qibla of Papat Limo Pancer, which is depicted on the border between the four main motifs: Qibla of Papat, buildings, butterflies, and the tree of life, which depicts the journey of the bride and groom at home. Pencer and the five are ourselves. Drops of white blood and clots of red blood are represented by flowers in Sidomukti batik motifs as the standard Qibla of Papat Limo Pancer. All the red and white blood will melt and give birth to a baby in the household life. The circular dots represent the fetus in a woman's womb. (Anggraini & Affanti, 2020).

b. Ethnomathematics on Solo Sidomukti Batik Motifs

1) Analysis of the Collection of Sidomukti Batik Ornament Patterns

Based on Figure 1, it can be seen that the main ornamental motif in Sidomukti Batik consists of 6 main images, namely the hayat tree, garuda wings, butterflies, buildings, thrones and meru. This pattern is depicted in Figure 10.

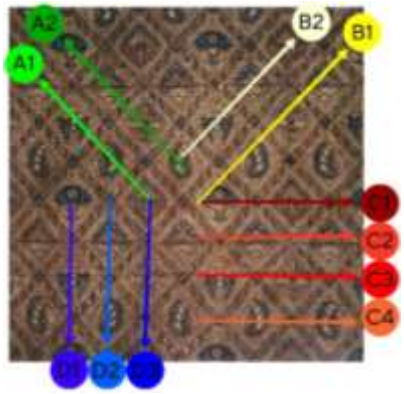

Figure 10. Collection of Sidomukti Batik Ornament Patterns

Based on the picture above, we can see that the members of each set are as follows. The set A_1 and $A_2$is a set of Sidomukti Batik motif elements towards the top left. The set B_1 and $B_2$is a set of Sidomukti Batik motif elements towards the top right. The set C_1, C_2, C_3 and $C_4$is a collection of elements of the Sidomukti Batik motif horizontally. The set D_1, D_2 and $D_3$is a collection of elements of the Sidomukti Batik motif vertically.

$A_1 = \{meru, garuda\ wings, butterfly, building\ \}$

$A_2 = \{garuda\ wings, throne, building\ , hayat\ tree\}$

$B_1 = \{hayat\ tree, garuda\ wings, throne, building\}$

$B_2 = \{garuda\ wings, butterfly, building, meru\}$

$C_1 = \{hayat\ tree, meru\}$

$C_2 = \{building\}$

$C_3 = \{butterfly, throne\}$

$C_4 = \{garuda\ wings\}$

$D_1 = \{butterfly, hayat\ tree\}$

$D_2 = \{garuda\ wings, building\}$

$D_3 = \{butterfly, hayat\ tree\}$

Based on the analysis of the set members in each element vertically, horizontally, or obliquely to the right and left, it is obtained that:

$A_1 \cup A_2 = B_1 \cup B_2 = C_1 \cup C_2 \cup C_3 \cup C_4 = D_1 \cup D_2 \cup D_3 =$

$\{garuda\ wings, hayat\ tree, butterfly, building, throne, meru\}$

2) Geometry

There are several geometric concepts contained in the Sidomukti Batik motif , as follows :

a) Circle

A circle is the set of all points on a plane that are the same distance from a fixed point on that plane. The fixed point of the circle is called the center of the circle, while the distance from a point on the circle to the center point is called the radius of the circle. Many of the Sidomukti Batik motifs have geometry in the shape of a circle.

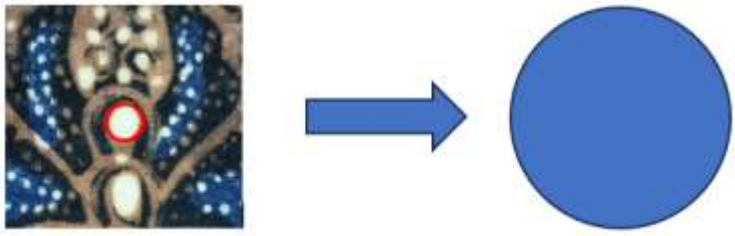

Figure 11. Circle Pattern in Sidomukti Batik

b) Triangle

A triangle is three different segments where the end point of one line segment coincides with the starting point of another line segment.

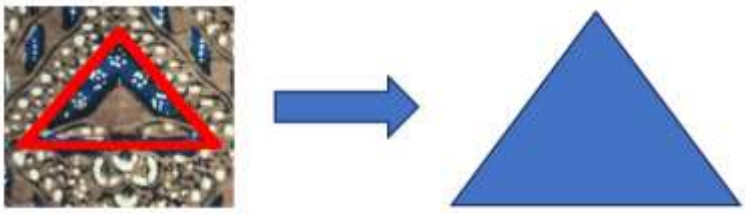

Figure 12. Triangle Pattern in Sidomukti Batik

c) Rhombus

A rhombus is a quadrilateral that has two pairs of parallel sides whose side lengths are all the same.

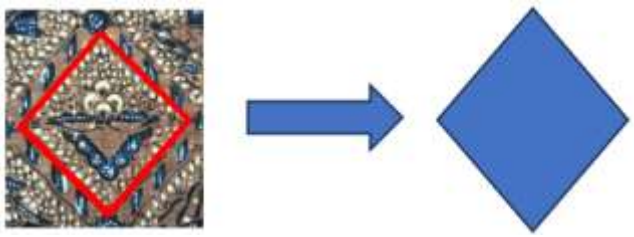

Figure 13. Rhombus pattern on Sidomukti Batik

d) Parallelogram

A parallelogram is a flat shape that has four sides with opposite sides parallel and the same length and opposite angles the same size.

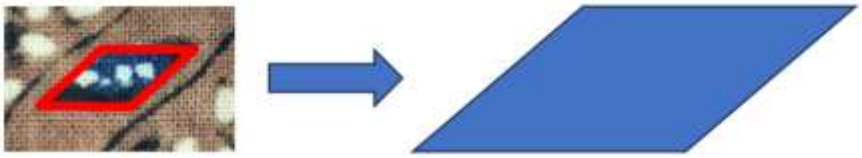

Figure 14. Parallelogram pattern At Sidomukti Batik

3) Algebra and Statistics

The concept of algebra includes the activities of calculating, measuring and counting. The counting activity occurs when the batik maker determines the number of motifs on one piece of cloth. Measuring activities arise when batik makers measure the fabric requirements for several motifs in the manufacturing process. The counting activity appears when the batik maker mentions something numbers and units for certain measurements. Counting activities relate to one bucket, one scoop, five minutes and two hours. The units often used are centimeters (cm), meters (m), liters (l), ounces (hg), and grams (gr).

In making Sidomukti Batik there are 6 main motifs on one piece of cloth, one of the motifs is a building motif and between the first building motif and the next building motif in the vertical direction there is one pausing motif, namely the Garuda wings motif. It can be seen in Figure 15. One building motif is 8.5 cm high and 8 cm wide. A batik cloth measuring 40 cm × 40 cm can only contain 2 horizontal rows with each row containing 5 building motifs as in Figure 16.

Figure 15. Size of building motifs

Figure 16. Sidomukti Batik 40 cm × 40 cm

Statistical concepts include average (mean), middle value (median), and frequently occurring values (mode). The concept of mean can be found when we calculate the average appearance of various motifs on a Sidomukti Batik cloth. The concept of median and mode can be seen when we have data on the appearance of various motifs on Sidomukti Batik. Statistics also includes the concept of data presentation, which can be seen in table 1, which is a presentation of data regarding the number of occurrences of each Sidomukti Batik motif in Figure 16.

Table 1. Sidomukti Batik Motif Data

NO	Motif Name	Emergence
1.	Hayat Tree	4

NO	Motif Name	Emergence
2.	Garuda Wings	10
3.	Butterfly	4
4.	Building	10
5.	Throne	4
6.	Meru	4
	Amount	36

From Table 1. the mean, median and mode can be calculated. The mean of this data is that the total appearance of all motifs is 36 with a total of 6 motifs, so the mean of the data is 6. If we look at the sequence of motifs as in the table, the median of the data is in the 18th motif, namely the butterfly motif and the -19 building motifs. Judging from this data, there are 2 modes (bimodus), namely the Garuda wings motif and 10 buildings.

4) Symmetry Analysis

The symmetrical pattern in Sidomukti Batik does not have a sliding, reflection or rotation pattern, but is a translation of the basic motif (Astriandini & Kristanto, 2021). Displacement is the shifting of a plane, line, or point in a certain direction and distance. Rotation itself means shifting from one point to another in the geometric plane by rotating at the center of the point (Yanti & Haji, 2019). Meanwhile, reflection means that the shadows do not differ in size, but they move in opposite directions (Albab et al., 2014). Figure 9. The following shows the symmetrical pattern of Sidomukti batik. The basic pattern, represented by the green rectangle, is changed repeatedly to produce the motif. Two translation vectors are used, the first in blue and the second in yellow (Astriandini & Kristanto, 2021).

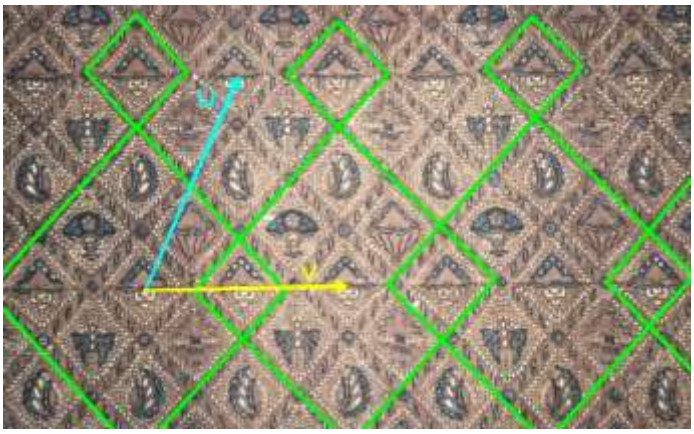

Figure 17. Sid o Mukti Batik Symmetry Pattern Analysis

5) Measurements and Calculations

The making of the "Sido Mukti" batik motif is a clear example of measuring and calculating Solo's cultural values. The following are some examples of the relationship between mathematics and mathematics:

a) Measurement of proportions.

Proportion measurement is a measurement using absolute distance compared to the length of the class where the data is located . (Kurniati & Rahardjo, 2014). To arrange each element of the Sidomukti motif correctly, batik craftsmen must measure the proportions of the hayat tree, buildings, butterflies, garuda wings, throne and meru correctly. This creates a balanced and aesthetic look.

b) Distance and Space Calculations

When making the Sido Mukti motif, craftsmen must also take into account the distance and space between each element. This helps create a harmonious and orderly appearance, with uniform spacing between each element.

c. Using Siomukti Solo Batik Motifs as a Mathematics Learning Media

1) Technology can be used to provide students with a better cultural context for learning mathematics. Technologies such as Desmos were initially used as a graphing calculator can read various Graph equations, display tables and provide the desired information about graph functions (Montijo, 2017). But now D esmos can also facilitate presentation of material and test form. Features is presented in a visual presentation interactive. This technology can offer a creative social learning environment for students to learn mathematics through culture.

2) By using measurements and calculations in making Sido Mukti motifs, Solo batik craftsmen demonstrate understanding and skills in applying mathematical concepts in art and design. The use of precise measurements and calculations produces Sido Mukti batik which is beautiful and has high artistic value. The use of the Sido Mukti motif as a real example of measurement and calculation in Solo culture can be used to teach students mathematics. By making Sido Mukti batik, students can learn concepts such as measurement, proportion, calculations and symmetry. Therefore, using the Sido Mukti motif as an example of the Solo culture of measurement and calculation can help improve students' understanding of relevant and practical mathematics.

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