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Ethnomathematics in Batik Making Activities in Saung Baswet, Banjarsari Wetan Village, Banyumas

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Abstract: Ethnomathematics is a discipline that explores the relationship between culture and mathematics. In Indonesia, one culturally rich tradition is batik. The process of creating batik involves various stages that result in diverse motifs unique to each region. This research aims to identify the ethnomathematical aspects related to the practice of batik-making, and the batik motifs, and to analyze the mathematical concepts associated with batik. The research employs a qualitative ethnographic approach. Data is collected through interviews, observations, and documentation, and is subsequently analyzed using data collection methods, data reduction, data presentation, conclusion drawing, and verification. In the process of batik-making at Saung Baswet Village, Banjarsari Wetan, Banyumas, various mathematical activities such as calculations, measurements, designing, and motif placement are discovered. Some mathematical concepts revealed in batik motifs include points, lines, angles, as well as geometric transformations such as translation, rotation, reflection, and dilation. Additionally, there are concepts related to plane figures such as right triangles, rectangles, trapezoids, circles, and polygons, as well as concepts of symmetry, similarity, and congruence.

Keywords: Batik-Making Activities; Ethnomathematics; Mathematics; Batik Motifs.

A. Introduction

Education and culture are two different aspects, but they are closely related. Both can be thought of as two elements that influence and strengthen each other. Culture provides a basis for understanding for education, while education plays an important role in maintaining and preserving culture, because education aims to shape individuals to have culture (Bakhrul Ulum, 2018). Education and culture have a key role in forming national values which influence the formation of individual character based on high cultural values.

The development and preservation of culture is part of the educational process. Mathematics is one of the scientific disciplines in the world of education. Apart from finding solutions to various problems that arise, we can also use mathematics in various aspects of life. As the central point of a learning and teaching process, mathematics lives and develops in community life in accordance with local culture.

Ernest believes that mathematics is the result of social and cultural constructions that are rooted in history and whose existence is reflected in human activities (Wara Sabon, 2017). Therefore, mathematics cannot be separated from the humanities and social sciences, or from

what is considered a part of global human culture influenced by human values, similar to other fields of knowledge. Mathematics has become an inseparable part of human life, often without realizing it, because many daily activities are closely related to mathematics. In other words, mathematics can be considered as a form of human activity.

In fact, mathematics learning in schools is usually known as formal and rigid learning, because it only focuses on what is contained in mathematics textbooks. It is rare to find schools that apply culture or make variations in the learning context. Formal and rigid mathematics learning often makes students reluctant to learn it because it seems boring and less interesting. Moreover, material that is considered difficult and complicated is foreign to everyday life. Therefore, there is a need for an approach and learning that links mathematics with the culture around them.

One way to start formal mathematics teaching that is appropriate to students' development in the concrete operational stage is to apply an ethnomathematics approach, which connects mathematics in the school context with mathematics in contexts outside of school. This is in line with the idea that mathematics which has cultural elements has a significant impact on mathematics learning in schools. This combination of mathematics, culture and education is often known as ethnothematics. The use of an ethnomathematics approach in the mathematics learning process can be a new bridge for educators, increase students' learning motivation, and enrich students' interest and interest in mathematics.

Around us there are many activities that contain mathematics, one of which is the batik activity. Batik is a legacy of Indonesia's ancestors which continues to develop and is in demand by various levels of society. Historically, batik is an icon or symbol of native Indonesian culture. However, previously batik was recognized as a cultural heritage originating from Malaysia. Through various evidence, batik was finally recognized by the United Nations agency for education, science and culture (UNESCO) as Indonesia's original world cultural heritage, precisely on October 2 2009. Based on this decision, Indonesia commemorates "Batik Day" every October 2 (Ari Wulandari, 2011). Therefore, we as Indonesian citizens have an obligation to preserve batik so that it remains sustainable and is not recognized by other nations. In the batik activity there are mathematical concepts that we can use to get to know mathematics. By making batik, people can know that there are elements of mathematics in it.

One of the batik production houses is Saung Baswet, Banjarsari Wetan Village. Saung Baswet is the only batik shop in Sumbang District which produces batik typical of various regions. Saung Baswet Banjarsari Wetan Village has produced various kinds of batik including written batik, stamped batik, natural dye batik, synthetic dye batik, batik tablecloths and even some batik with their own pattern innovations. Looking at the background and thoughts described above, researchers are interested in conducting research on batik activities in Saung Baswet, Banjarsari Wetan Village, Banyumas, which aims to explore mathematical concepts from the initial stages to producing batik cloth in Saung Baswet, Banjarsari Wetan Village, Sumbang District. So therefore,

B. Method

In carrying out this research, the researcher applied qualitative research methods. This qualitative method is based on postpositivism or interpretive philosophy, used to study natural

or natural situations of objects (Sugiyono, 2017). According to Farida, qualitative research is a type of research that produces findings without using statistical or quantitative steps to obtain them (Farida Nugrahani, 2010).

Researchers use an ethnographic approach, the results of the findings will be in natural form and not determined by numbers or statistics. Derived from Greek which consists of the word 'ethnos' which means 'people', 'cultural group', 'culture'. Where culture here is explained as everything learned, routines and values. The assumption is that humans always exist in their culture (JR. Racao, 2010).

One important factor that researchers must know is that they must master culture, because qualitative methods aim to capture meaning. Seeking understanding or insight into culture in a particular community group is the goal of ethnography (JR. Raco, 2010). This research aims to describe, describe and analyze mathematical activities in batik activities and mathematical concepts in batik motifs in Saung Baswet, Banjarsari Wetan Banyumas Village using an ethnographic approach.

This research was carried out by tracing or digging or exploring some information through observations at Saung Baswet Banyumas, interviews with resource persons, namely batik makers and the head of Saung Baswet as well as documenting it. The results obtained from this data will then be reduced to selecting and processing the data needed and eliminating data that is not needed by the researcher. Then, the researcher will present, analyze and draw conclusions based on the data.

Data analysis is carried out from the time the researcher formulates and explains the problem, before going directly to the field and continues until the process of writing up the research results (I Made Laut Mertha Jaya, 2020). Data analysis carried out before data collection aims to determine the focus of the research, but is temporary. After the researcher collects various data starting from observations, interviews, and documentation, the researcher will analyze the development of temporary data while in the field. The analysis stage includes data reduction, data presentation and data verification.

C. RESULTS AND DISCUSSION

1. Analysis of Mathematical Activities in Batik Making Activities at Saung Baswet Banyumas

Based on the introduction of batik activities in Saung Baswet by collecting data through interviews and observations, researchers found mathematical activities in batik activities. The data analysis is presented in table 1.

Table 1. Analysis of Mathematical Activities in Batik Making Activities in Saung Baswet

Batik Activities	Math Activities
Observe the process of determining the materials and tools needed to make batik	Count
Observe the process of determining the cloth to be used for batik	Measuring, Counting
Observe the processing process of the cloth that will be used for batik	Counting, Measuring
Observe the process of making batik motifs/patterns	Measuring, Designing, Placing
Observe the process of determining the wax/wax needed to make batik	Count

Batik Activities	Math Activities
Observe the process of determining the dyes needed in the coloring process	Counting, Measuring
Observe the process of determining additional medications required for the locking process	Counting, Measuring
Observe the process of determining the water needed in the process"nglorod"	Measuring, Counting
Observe the process of determining the time for making batik cloth	Count

From the data in table 1, it can be seen that in the batik activity there is a mathematical activity. Calcullating activities are found in the process of determining the materials and tools needed to make batik, which involves the process of adding up certain values to determine the number of objects, in this case the materials and tools used in making batik such as one batik stamp, one frying pan, one ruler, two canting. Second, in the process of determining the cloth that will be used for batik, which involves the process of dividing certain values to determine the quantity of an object, in this case, for example, in one roll measuring 100 meters, if you want to make 2 meters of batik cloth, it will produce 50 sheets. cloth. Third, in the process of processing the cloth that will be used for batik, which involves the process of dividing certain values to determine the quantity of an object, In this case, for example, in one roll measuring 100 meters, if you want to make 2 meters of batik cloth, you will produce 50 pieces of cloth. Fourth, in the process of determining the wax/wax needed for batik, which involves the process of adding up certain values to determine the quantity of an object, in finding out how much wax is needed, such as one cloth requires 8-10 ounces of wax. Fifth, in the process of determining the dye needed in the dyeing process, it involves an addition process, such as the blue color needed for 50 fabrics, namely 1,250 grams, 250 cc WAHS matexil, mixed with 50 liters of water, adding 100 grams of table salt and 100 grams of soda ash. . Sixth, in the process of determining additional drugs required, the locking process involves a comparison process, For example, for 1 kg of water glass we usually use a mixture of 2 liters of water, meaning the ratio between the water glass and the water used is 1:2. Apart from the comparison process, the division process is also used as previously explained, for one Aqua bottle, 500 ml of water is used. Seventh, in the process of determining the water needed in the "nglorod" process, it involves an addition process, namely 40 to 45 liters. Finally, in the process of determining the time for making batik cloth, namely in one month producing 10 batik cloth. Seventh, in the process of determining the water needed in the "nglorod" process, it involves an addition process, namely 40 to 45 liters. Finally, in the process of determining the time for making batik cloth, namely in one month producing 10 batik cloth. Seventh, in the process of determining the water needed in the "nglorod" process, it involves an addition process, namely 40 to 45 liters. Finally, in the process of determining the time for making batik cloth, namely in one month producing 10 batik cloth.

Measuring activities are contained in the process of determining the cloth that will be used for batik, namelyinvolves the concept of measurement and practicing critical mathematical thinking skills, in this case determining the size of the cloth, measuring the length and width, such as when making a robe or bottom and top, you can use a cloth size of 2 meters x 115 centimeters. Second, in the process of processing the cloth that will be used for batik, it involves the concept of measurement, in this case measuring the liquid capacity or the amount of material used, such as 90 liters of water, measuring the weight of alum as much as 625 grams

and soda ash as much as 190 grams. Third, in the process of making batik motifs/patterns, it involves measuring concepts such as measuring the length of the baking pan to be used with a size of 40 centimeters. Fourth, in the process of determining the dye needed in the coloring process, which involves the concept of measurement, in this case measuring the capacity of the liquid used, such as in a bottle of aqua containing 500 ml of water, measuring the weight for the number of colors such as 1,250 grams of blue dye. Fifth, in the process of determining additional drugs required, the locking process involves a measurement concept such as four bottles of aqua used to measure 2 liters of water. Finally, the process of determining the time for making batik cloth involves measurement concepts such as the size of the pan used, 45 cm x 30 cm and liters which indicate the size of the water used, namely 40 to 45 liters. In the process of determining additional drugs required, the locking process involves measurement concepts such as four Aqua bottles used to measure 2 liters of water. Finally, the process of determining the time for making batik cloth involves measurement concepts such as the size of the pan used, 45 cm x 30 cm and liters which indicate the size of the water used, namely 40 to 45 liters. In the process of determining additional drugs required, the locking process involves measurement concepts such as four Aqua bottles used to measure 2 liters of water. Finally, the process of determining the time for making batik cloth involves measurement concepts such as the size of the pan used, 45 cm x 30 cm and liters which indicate the size of the water used, namely 40 to 45 liters.

Design activity, in the process of making batik motifs/patterns, namely motifsUse wax in the cloth according to the pattern that has been made using a pencil. The placing activity, in the process of making batik motifs/patterns, is depicting the main pattern or motif on the main side of the cloth plus complementary motifs around the main motif. This is in line with previous research carried out by Faradita Dwi Indah Sari. That there are calculating, measuring and designing activities in batik activities. For activities, I agree with Hanifah Nur Rohma's research as well as research from Maya Modigliani Azra. The difference is that in this study, placing activities were found in batik activities.

2. Analysis of Mathematical Concepts in Batik Motifs in Saung Baswet Banyumas

Based on the introduction of batik motifs in Saung Baswet Banyumas, it shows that the batik motifs in Saung Baswet contain mathematical concepts. These include points, line segments, angles, geometric transformations (translation, rotation, reflection, dilation), flat figures (right triangle, rectangle, trapezoid, circle, polygon), symmetry, similarity and congruence. The mathematical concepts in the batik motifs in Saung Baswet are guided by groups of data formulated from data obtained from research results in the field which can be seen in table 2.

Table 2. Analysis of Mathematical Concepts in Batik Motifs

Mathematical Concepts	Batik Motif
Point	Lumbon motif, machete motif for IAI Temanggung branch administrators
Line Segments	Lumbon motif
Corner	Lumbon motif, machete motif for IAI Temanggung branch administrators

Mathematical Concepts	Batik Motif
Translation (Shift)	The parang motif of the IAI Temanggung branch administrator, the Brambang motif, the Kamaratih Kamajaya motif, the Saung Baswet motif, the leaf collection motif, and the Bodhi leaf motif.
Rotation (Spinning)	Brambang motif
Reflection (Mirror)	Kamaratih kamajaya motif, Saung Baswet motif
Dilation (Enlargement/reduction)	The machete motif of the IAI Temanggung branch administrator
Right triangle	Lumbon motif
Rectangle	Saung Baswet motif
Trapezium	Saung Baswet motif
Circle	The machete motif of the IAI Temanggung branch administrator
Polygon	The machete motif of the IAI Temanggung branch administrator
Symmetry	Baswet saung motif
Congruence	Kamaratih kamajaya motif, Saung Baswet motif
Congruence	Saung Baswet motif, leaf collection motif, and bodhi leaf motif.

Data analysis was carried out based on the documentation that researchers obtained while conducting research in the field. The results of data analysis regarding mathematical concepts in batik motifs in Saung Baswet will be explained by researchers as follows:

a. Concept of Points and Line Segments

Based on the findings of a study on batik motifs in Saung Baswet, there is a mathematical concept, namely the dot concept in the lumbon motif and parang motif of the IAI Temanggung Branch. In the batik making process, dots are an important element. Because, batik itself is a word that comes from the words amba and dot. In its development, batik is referred to as the activity of drawing on a large or wide cloth by connecting certain points (Ari Wulandari, 2011). The concept of line segments is found in the lumbon motif. The line segments in this motif are two parallel lines. The lumbon motif has two parallel lines which are components of a line whose base and end are limited by 2 points.

The following will explain the concept of points and line segments found in batik motifs:

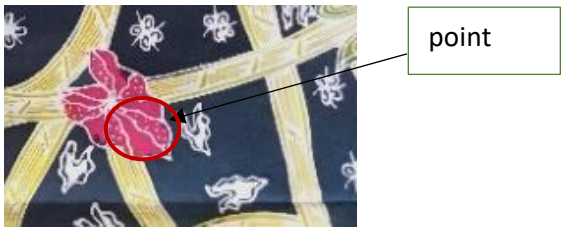

Figure 1. Point concept in the Lumbon motif

Figure 2. Point concept on the Parang Motif of IAI Temanggung Branch Management

Figure 3. The concept of line segments in the Lumbon motif

b. Corner Concept

Based on the findings of a study conducted on batik motifs in Saung Baswet, the corner concept appears in the lumbon motif and Parang motif of IAI Temanggung Branch. An angle is formed from the meeting of two lines that are not opposite and have adjacent starting points.

In the lumbon motif, the leaf buds form an acute angle, namely an angle less than 90°. Meanwhile, in the Parang IAI Temanggung Branch motif, it forms an obtuse angle whose size is more than 90°. The following will explain the concept of corners in batik motifs:

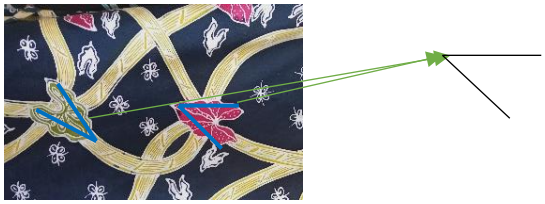

Figure 4. Corner concept in Lumbon motif

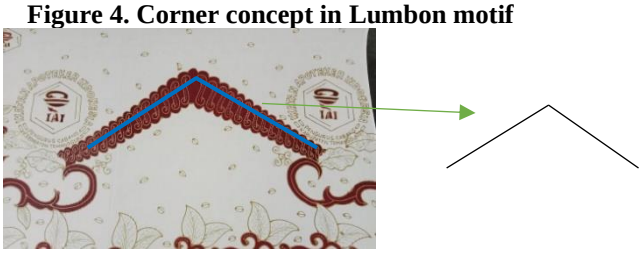

Figure 5. The concept of angles in the IAI Parang Motif, Temanggung Branch

c. Transformation Concept

Based on the findings of a study conducted on batik motifs in Saung Baswet, the concept of transformation appears in several motifs. A transformation in a plane is a bijective function (one-to-one correspondence) between two sets of points in the related plane (Antonius Cahya Prihandoko, 2005). Transformations in the plane are divided into four, namely translation (shift), rotation (rotation), reflection (mirror), and dilation (enlargement or reduction).

In the Parang IAI Temanggung Branch motif, Kamaratih Kamajaya Motif, Brambang Motif, Saung Baswet Motif, Leaf Collection Motif, and Bodhi Leaf Motif, there is a concept of translation or shift. These motifs are made by tracing the pattern on the fabric repeatedly vertically or horizontally with the same shape and size without changing the shape and size. Below we will explain the concept of translation or shift that appears in batik motifs.

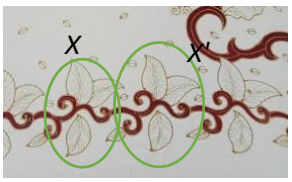

Figure 6. The concept of translation in the IAI Parang Motif, Temanggung Branch

Figure 7. The concept of translation in the Kamaratih Kamajaya motif

Figure 8. The concept of translation in the Kamaratih Kamajaya motif

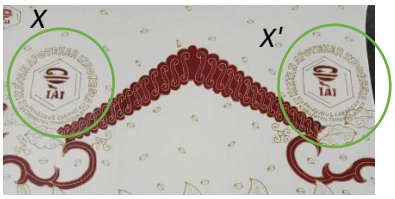

Figure 9. The concept of translation in the IAI Parang Motif, Temanggung Branch

Figure 10. The concept of translation in the Brambang motif

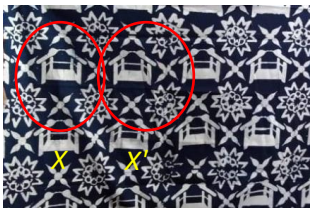

Figure 11. The concept of translation in the Saung Baswet motif

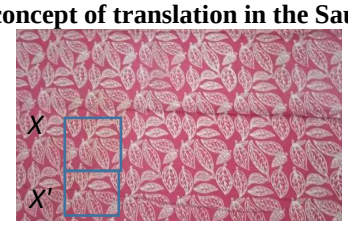

Figure 12. The concept of translation in the leaf collection motif

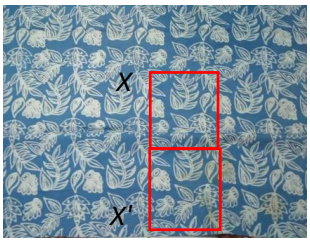

Figure 13. Concept of Translation in the Bodhi Leaf Motif

In the Brambang batik motif, the concept of rotation or rotation is found. The brambang part is rotated by 90˚ which is aligned clockwise to the center point (0,0). Rotation is negative because it is clockwise. The concept of rotation or rotation appears in the following saung brambang motif:

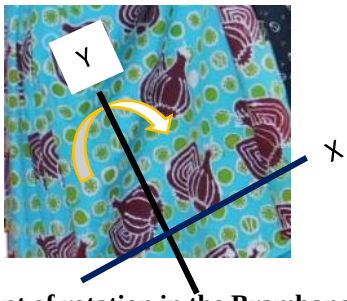

Figure 14. The concept of rotation in the Brambang motif

Displacement of plane points in mirror-like reflection. The result will be the opposite or inverted from the original point, but the size and shape will remain and be congruent. In the Kamaratih Kamajaya motif, the concept of reflection is found, where the batik maker makes a pattern on the cloth and copies the pattern horizontally. The concept of reflection or mirroring appears in the following motifs:

Figure 15. The concept of reflection in the Kamaratih Kamajaya motif

Figure 16. Reflection concept in the Saung Baswet motif

Dilation is a change in the distance of points with a certain multiplier factor to a certain point of a transformation. The size of a shape can change when it is enlarged or reduced (dilation). However, dilation does not result in a change in the shape of a shape (Istiqomah, 2020). In the Parang IAI Temanggung Branch motif, the concept of dilation, namely reduction, is found. The parang motif consists of several similar machete shapes. In the middle of the motif, there are two large machete shapes which are then reduced downwards to the bottom right and bottom left to form like mountains. If the original image has a value of 1, then the next form of motif has a value of $k<1$. The concept of dilation appears in the following motif.

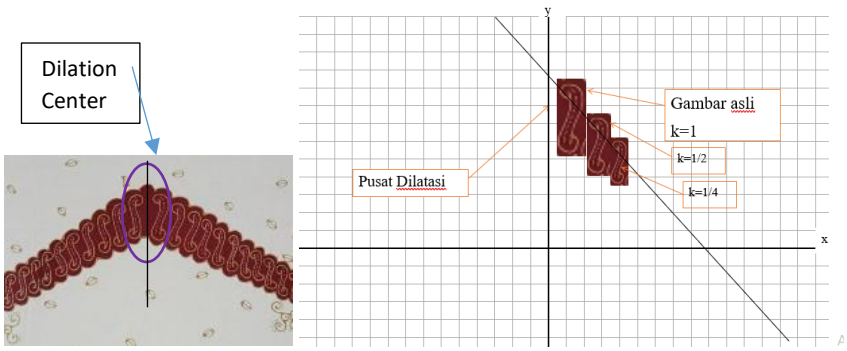

Figure 17. Dilation concept in the IAI Parang Motif, Temanggung Branch

d. Flat Build Concept

Based on the findings of a study conducted on batik motifs in Saung Baswet, the flat concept appears in several motifs. The flat shapes found are right triangles, rectangles, trapezoids, circles and polygons. A right triangle is a type of triangle whose angles are right angles with a measure of 90° and has one hypotenuse and two perpendicular sides. The next flat shape is a rectangle, where the opposite sides are the same length and the four corners are right angles. A trapezoid is a type of flat shape that has two parallel sides of different lengths and the angles do not form right angles. A circle is a flat shape where all points on the circle are the same length as the center point (P) and have a diameter and radius (A. Marini, 2013).

The concept of a right triangle is found in the lumbon motif, the concept of a rectangle is found in the Baswet saung motif, the trapezoid concept is found in the Baswet saung motif, the circle concept is found in the parang motif of the IAI Temanggung branch administrators, and the polygon concept is found in the parang motif of the IAI Temanggung branch administrators. Below we will explain the concept of flat shapes in batik motifs.

Figure 18. The concept of a right triangle in the Lumbon motif

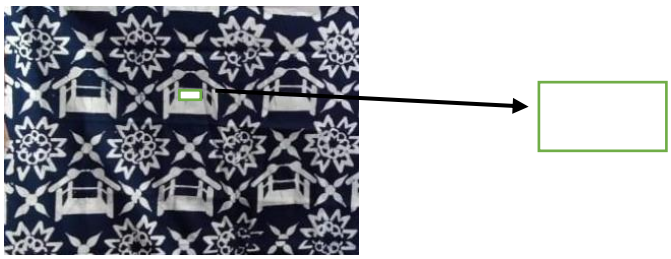

Figure 19. Rectangular concept in the Saung Baswet motif

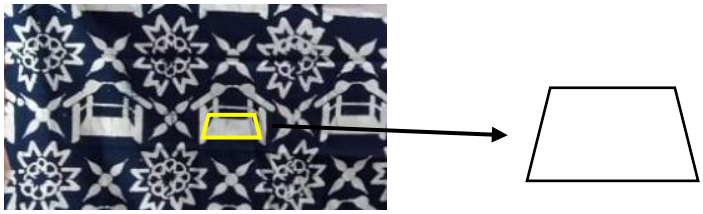

Figure 20. Trapezoid concept in the Saung Baswet motif

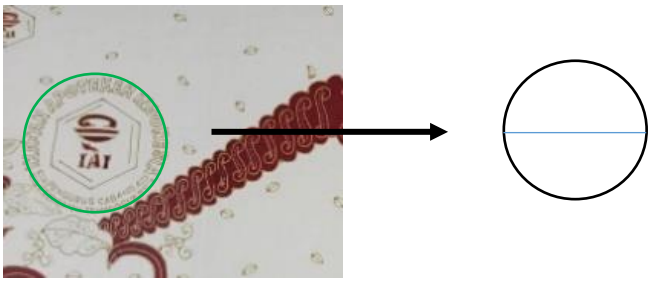

Figure 21. Circle concept in the machete motif of IAI Temanggung Branch administrators

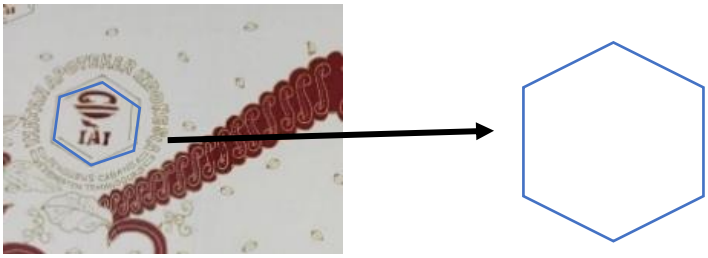

Figure 22. Polygon concept in the machete motif of IAI Temanggung Branch administrators

e. Symmetry Concept

Fold symmetry is the application of mirroring to a flat shape (Antonius Cahya Prihandoko, 2005). Based on the findings of a study conducted on batik motifs in Saung Baswet, the concept of folded symmetry appears in the saung Baswet motif.

Figure 23. The concept of folded symmetry in the Saung Baswet motif

f. Concept of Congruence and Congruence

Based on the results of research at Saung Baswet, the concept of congruence was found in the lumbon motif. In this motif there are large lumbon and small lumbon shapes. As for making small lumbon patterns, adapt them to the size of large lumbons, so that the two lumbon shapes can be said to be similar lumbons. The following is the concept of congruence in batik motifs.

Figure 24. Concept of Congruence in the Lumbon Motif

Based on the results of research at Saung Baswet, motifs were found that were the same in shape and size, namely the saung Baswet motif, the leaf collection motif, and the bodhi leaf motif. This motif is made by tracing the previous pattern, resulting in a pattern that is the same in shape and size.

Figure 25. The concept of congruence in the Saung Baswet motif

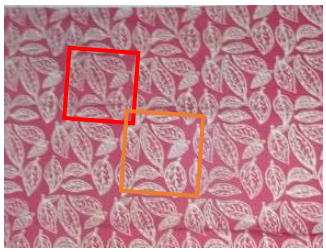

Figure 26. The concept of congruence in the leaf collection motif

Figure 27. Concept of Congruence in the Bodhi Leaf Motif

3. Discussions

Apart from being a scientific discipline in education, mathematics can be a tool for finding solutions to various problems. In addition, mathematics can be used in various aspects of life. This is in line with Ernest's statement, mathematics is a socio-cultural construction where mathematics is contained in history whose existence is in human activity (Wara Sabon, 2017).

However, in reality learning mathematics is synonymous with formal, rigid and monotonous lessons stuck to the material in textbooks. It is rare to find schools that apply culture in learning. Culturally nuanced mathematics is one variation that can play a role in

school mathematics. The combination of mathematics, culture and education is usually known as ethnomathematics. The process of learning mathematics using ethnomathematics becomes a new link for an educator, so that it will increase learning motivation for students, attracting more students' attention and interest in liking mathematics. Apart from that, ethnomathematics can provide an understanding of mathematics to the public and provide an explanation that mathematics is so close to humans.

From the results of this research, it is proven that there is mathematics in culture, namely in batik activities and batik motifs which can increase knowledge about mathematical activities and mathematical concepts, especially related to geometry.

D. Conclusion

By referring to the findings, analysis and discussion that have been described previously, it can be concluded that there is ethnomathematics in batik activities in Saung Baswet, Banjarsari Wetan Village, Banyumas, namely mathematical activities and there are mathematical concepts in the batik motifs of Saung Baswet, Banjarsari Wetan Village, Banyumas. The following is a summary of this research:

(1) Based on data identification, there are mathematical activities in batik activities in Saung Baswet, Banjarsari Wetan Banyumas Village, including calculating, measuring, designing and placing activities. (a) Counting activities involve the process of adding certain values to determine the amount of materials and tools used in making batik, the process of dividing certain values to determine the number of an object, the process of comparing certain values to determine the difference in the values of two numbers. (b) Measuring activities involve measurement concepts and practice critical mathematical thinking skills such as measuring the length and width of the tools used for batik, the capacity of liquids or the amount of materials used. (c) Design activities involve problem solving and using mathematical concepts to create something that integrates creativity, analytical thinking and understanding mathematics in the context of designing and making batik motifs. (d) Placing activities relate to determining the position or location of objects or points in a given reference frame in making batik patterns or motifs, involving the use of mathematical concepts such as coordinates, geometry and distance calculations.

(2) Mathematical concepts contained in batik motifs in Saung Baswet, Banjarsari Wetan Village, Banyumas include the concept of points and line segments, the concept of angles, the concept of geometric transformation consisting of translation/shift, rotation, reflection/reflection and dilation, the concept of flat figures. such as right triangles, rectangles, trapezoids, circles and polygons, the concept of symmetry, and the concepts of similarity and congruence.

From the results of this research, it can be concluded that mathematics does not only exist in books and learning at school, but in culture and everyday life. Ethnomathematics proves that mathematics also exists in culture, such as in batik activities in Saung Baswet, Banjarsari Wetan Village, Banyumas and mathematical concepts in the batik motifs of Saung Baswet, Banjarsari Wetan Village, Banyumas. Apart from that, the existence of ethnomathematics can be an innovation for educators in explaining mathematics learning material that is more

interesting and new for students, so that learning mathematics is more fun and can increase students' interest in studying mathematics.

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