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Ethnomathematical Study of Jepara Troso Ikat Weaving Motifs in Two-Dimensional Geometry Mathematics

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Abstract. The motifs on the typical Troso Jepara ikat weaving have unique shapes and patterns and have references in their design. Besides being designed according to beauty, the motifs on the Troso ikat also have their own philosophical and mathematical values. This research was conducted with the aim of describing the mathematical ideas contained in the troso ikat motif as well as the philosophical ones contained in the culture. The method in this study uses a qualitative research method with an ethnographic approach. Data collection techniques in the study were carried out directly in the field to find information by observation, interviews, and documentation. The informant in this study was Mr. Muhammad Habib as the owner of the Troso "Aida" Ikat Weaving business in Jepara, Central Java. The instruments in this study were observation sheets, interview sheets, and field documentation. Data analysis techniques used in this study are domain analysis and taxonomic analysis. The results of this study indicate that there are mathematical ideas with nuances of two-dimensional geometry in several Jepara Troso Ikat Weaving motifs including gill motifs, re-woven motifs, baron motifs feather motifs, and lurik motifs. The geometric concept in the troso ikat motif is in the form of a flat wake concept including rectangles, rhombuses, isosceles triangles, triangles, circles, hexagons, and parallelograms.

Keywords: Ethnomathematics, Tenun Ikat Troso, Geometry

Abstrak. *Motif pada tenun ikat khas Troso Jepara memiliki bentuk dan corak yang unik dan memiliki acuan dalam perancangannya. Selain dirancang sesuai keindahan, motif pada tenun ikat Trosojuga memiliki nilai filosofi tersendiri dan nilai matematis. Penelitian ini dilakukan dengan tujuan untuk menguraikan ide-ide matematis yang terkandung dalam motif tenun ikat troso serta filosofis yang terkandung dalam budaya. Metode pada penelitian ini mengunakan metode penelitian kualitatif dengan pendekatan etnografi. Teknik pengumpulan data pada penelitian dilakukan secara langsung di lapangan untuk mencari informasi dengan observasi, wawancara, dan dokumentasi. Informan pada penelitian ini adalah Bapak Muhammad Habib selaku pemilik usaha Tenun Ikat Troso "Aida" di Jepara, Jawa Tengah. Instrumen dalam penelitian ini adalah lembar observasi, lembar wawancara, dan dokumentasi lapangan. Teknik analisis Data yang digunakan dalam penelitian ini yaitu analisis domain dan analisis taksonomi. Hasil pada penelitian ini menunjukkan bahwa terdapat ide-ide matematis yang bernuansa geometri dua dimensi pada beberapa motif Tenun Troso Jepara meliputi motif insang, motif re-woven, motif baron, motif bulu, dan motif lurik. Konsep geometri yang ada pada motif tenun ikat troso berupa konsep bangun*

datar meliputi persegi panjang, belah ketupat, segitiga sama kaki, segitiga, lingkaran, segienam, dan jajar genjang.

Kata kunci: *Etnomatematika, Tenun Ikat Troso, Geometri*

INTRODUCTION

Indonesia is a country consisting of 37 provinces, has many islands, tribes, religions and cultures. Indonesia has a lot of local potential that comes from culture. As with the statement from Putri et al (2018) that local potential can arise from geographical conditions, natural resources, human resources, history and culture. One of the local cultural potentials that is quite famous in Indonesia is the Troso Weaving culture. Troso weaving comes from the City of Jepara, Central Java. As the name implies, Jepara woven fabric was originally made by villagers in Jepara located 15 km from the city center, namely Troso village. Troso is a village located in Pecangaan District, Jepara Regency, Central Java. The village has a distinctive culture that has been passed down from generation to generation and still exists today, namely Troso weaving, so that the village is known as the center of the Troso weaving industry or can be interpreted as a village producing woven crafts.

Troso Ikat is said to be one of Jepara's cultural heritages which has been preserved since it was first discovered in 1935. Troso Ikat was originally made only to meet the needs for clothing initiated by Mbah Senu and Nyi Senu, who served only to visit with the great scholar Mbah Datuk Gunardi Singorejo who at that time spread Islam in Troso Village (Alamsyah in (Putri et al., 2018)). Until now, Troso Weaving continues to experience development and is timeless. The development of Troso Weaving in Jepara is able to survive under any circumstances (Alamsyah in (Putri et al., 2018)). Although it originates from word of mouth, the history of the origins of Troso weaving cannot be known with certainty. However, according to Pak Habibi, the owner of the Aida Tenun industry, Troso weaving has long been cultivated by the local community and has been passed down from his grandparents. At that time, people still used simple looms or original looms called gendong looms and are now experiencing

developments using Non-Machine Weaving Tools or commonly abbreviated as ATBM, namely modern semi-machined looms but in production activities they still use manual methods and need human help.

Troso Ikat combines several forms into a motif. The motifs on Troso's woven fabrics are very interesting and unique because they use various and distinctive shapes. The distinctive feature of the troso woven motif is sometimes the result of adoption from motifs outside of Java, especially from Eastern Indonesia, namely Bali, Flores, as well a slightly modified Sumbawa (Hendro G in (Ramadhani & Subandi, 2015)). The combination of motifs from other regions makes the latest Troso Weaving motifs able to keep up with the times and can add to diversity of existing motifs. In the business history of the Troso weaving industry, there is also a history of the motifs used in making weaving. In the past, the type of cloth and woven motifs could indicate whether a person was a descendant of a king, a traditional head, or simply enthroned as an ordinary citizen. In addition, several types of motifs used are also the result of the times. The craftsmen are able to stimulate various inanimate and living objects around them to be used as unique motifs and are able to attract consumer interest. These motifs are also closely related to geometry in mathematics because the shapes that are carried apply the concept of mathematical calculations. This shows that mathematics and culture are two separate but interrelated things because humans in fulfilling life and carrying out activities require mathematics in solving various problems. Therefore, the mathematics used throughout the world tends to fall into applied mathematics. The concept of culture-based applied mathematics which later became familiar was called ethno-mathematics.

Ethnomatematics studies have been carried out in various regions around the world and are also spread over various ethnicities. Including in Indonesia, ethnomathematics studies are not foreign research studies, considering that Indonesia is a country rich in cultural diversity. According to Sumardyono in (Panjaitan et al., 2021), ethnomathematics is defined as a certain method that is often used by a cultural group in grouping, sorting (separating or dividing), counting, playing, patterning (making patterns), and explaining in their own way.

Meanwhile, according to Sarwoedi et al (2018), ethnomathematics is always synonymous with a specific set of steps used by cultural or community groups to carry out mathematical activities. When associated with the realm of education, ethnomathematics is a historical and philosophical study of mathematics which has implications for teaching (D'Ambrosio in (Panjaitan et al., 2021)). Ethnomatematics aims to explain the reality of connection between mathematics and local culture in solving everyday life problems. In addition to the cultural diversity that Indonesia has, the difficulty for someone to understand mathematics based on theory and make connections in everyday life is a major factor in studying ethnomathematics. But until now, mathematics is still considered far from human life (Prahmana and Kusumah in (Risdiyanti & Prahmana, 2018)).

In everyday life, we can find various cultures related to mathematical concepts. Based on the results of interviews with the owner of Aida Tenun (one of the woven textile industries in Jepara), the mathematical activities in making Troso woven fabrics appear naturally, through the knowledge and views of the Troso people themselves without going through formal education, in the sense that the woven motif makers have unconsciously apply math concepts. However, the results of making Troso's woven motifs have gone through a family of mathematical concepts, one of which is two-dimensional geometry. Geometry itself is defined as a branch of mathematics related to the statement of shape, size, and properties (Susanto in (Citrowati, 2019)). Some of the results of the study show that relevant research studies that find mathematical concepts in local culture are Suryawana and Maharani (2021) in research on ethnomathematics exploration of Gringsing ikat cloth in Tenganan Village obtaining the concept of mathematical transformation geometry in the motifs of dingding ai, sanan empeg, cakra, cemplong, gegongnggang, temple puppets, and others. Meanwhile Juano and Jediut (2019) in his research on ethnomathematics and its connectivity with the concept of geometry, the results obtained were geometric concepts in the form of triangles, rectangles, rhombuses, hexagons, circles, blocks, cones, and tubes.

Similar findings were found in research Firdaussa et al (2021) mathematical values and mathematical concepts were obtained in the form of geometric

transformations and two dimension shapes of rhombuses, circles and squares in typical Banten batik. Not only that, research conducted by Ulum (2018) on the exploration of Suropati's pasedahan batik motifs also obtained the results of mathematical concepts in the form of points, curved lines, triangles, rectangles, ovals, folding symmetry, and also obtained philosophical results on the batik motifs. Therefore, it is deemed necessary to carry out an ethnomathematics exploratory study on Jepara Troso Ikat Weaving motifs with the aim of seeing the existence of mathematical concepts and philosophical values contained in local culture of Indonesia.

METHOD

The research method used in this study is a qualitative research method through an ethnographic approach. Qualitative research is used as a research procedure that produces descriptive data. Meanwhile, the ethnographic approach is an empirical and theoretical approach to obtain an in-depth description analysis of culture. This study aims to describe the results of a mathematical exploration of the two-dimensional geometry material in Jepara Troso Ikat Weaving motifs. In addition, this research also aims to raise local potential advantages in Jepara which can be used as a model of character and cultured education for the nation in the era of globalization. This research was conducted April 27, 2022, at Jalan Rawa No. 1, RT 06 RW 03, Troso, Pecangaan, Jepara. Data collection techniques were carried out directly at the Aida Weaving Showroom to seek information by observation, interviews and documentation.

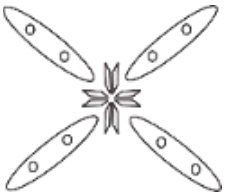
Data collection was carried out by field studies and interviews with informants, Mr. Muhammad Habibi, the owner of the Ikat Troso "Aida" Weaving industry, exploring and seeking clarity in a comprehensive manner by going directly to the factory and meeting with informants, Mr. Habibi's employee. In this study, the instruments used were observation sheets, interview sheets, and field documentation. Data analysis used in this study is domain analysis and taxonomic analysis, domain analysis is used to obtain a general description of the research object, while taxonomic analysis aims to describe in detail the mathematical ideas

and meaning or philosophy contained in Jepara Troso Ikat Weaving. Data analysis in this study also used Miles and Huberman's model analysis in the form of interviews following the guidelines that had been made.

RESULTS AND DISCUSSION

Mathematical Ideas

As stated by Koentjaraningrat in Hartoyo (2013), culture is a form of various concepts and ideas into a set of patterned human behaviors and activities. Human activities related to each other from the implementation of concrete mathematical concepts. Just as the real world is assumed to be land and mathematics is assumed to be another land separated by a river, mathematics and the real world is something different, a bridge is needed to connect the two, namely in the form of a representation that connects abstract mathematical concepts with the context of everyday life. Thus, based on the results of research on the Aida Weaving Troso industry, Jepara we obtained 5 types of motifs Troso weaving that can be studied mathematical concepts, especially in the concept of two-dimensional geometry, namely gill motifs, re-woven motifs, feather motifs, baron motifs, lurik motifs. These motifs contain mathematical concepts that are applied starting from the making of printed patterns to the finished product of the woven itself. The description of the results of the exploration of mathematical values is visualized in the table below.

No.	Type of Motif	Picture	Concept Sketch	Type of Geometry
1.	Gill			Rectangle, rhombus
2.	*Re-woven*			Isosceles triangle
3.	Feather	 	 	Rhombus, triangle, circle, hexagon and parallelogram

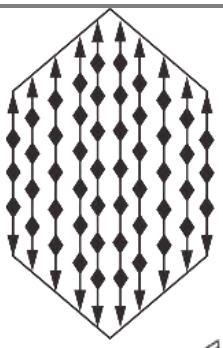
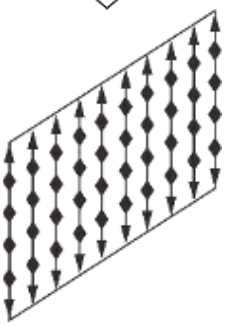
		 	 	
4.	Baron			Rhombus, hexagon, and triangle
5.	Lurik			Rectangle

Table 1. Table of Troso Weaving Motifs and Geometry

Table 1 above shows that the Troso Jepara woven motifs have a mathematical connection in each knitted motif, these motifs are also related to the concept of two-dimensional geometry in mathematics, namely the geometry of triangles, hexagons, rectangles, rhombuses, circles and parallelograms. The concept of two-dimensional geometry related to ethnomathematics in Troso Ikat Weaving motifs can be explained as follows:

1. Triangle

   The definition of a triangle is a two dimension object that is formed by connecting three points that are not on a straight line (Meilantifa & Budiarto, 2018). Triangle two-dimensional geometry has special lines, namely (1) weight line, (2) height line, (3) bisector line. Meanwhile, the angle in a flat triangular shape is 180° (Suryaningrum, 2017). There are two triangular shapes in the Troso Ikat Weaving motif, namely an isosceles triangle and an equilateral triangle. Each of these triangles has the following characteristics:

   a. An equilateral triangle
      - An equilateral triangle has three sides that are the same length
      - An equilateral triangle has three angles that are equal in measure
      - An equilateral triangle has three rotational symmetries
      - An equilateral triangle has threefold symmetry

   b. Isosceles triangle
      - Having two sides on the legs of a triangle that is the same length
      - There are two equal angles of a triangle
      - Each corner of the base is said to be opposite the same sides
      - Has one fold symmetry
      - Having rotational symmetry of one

2. Hexagon

   A hexagon or commonly referred to as a hexagon belongs to a polygon that has six corner points and six sides or planes. Hexagons have the following characteristics:

   - Has rotational symmetry and fold symmetry of six
   - All six sides or sides are the same length
   - All six angles are equal

3. Rectangle

   Rectangle is one of the two-dimensional quadrilateral geometries formed from all four sides that are equal in length and parallel, the size of each angle is (90°). Rectangle has the following properties:

- The four sides are the same length and parallel
- It has four angles, the four angles measure 90°
- Has two fold symmetries
- The two diagonals are the same length

4. Rhombus

   A rhombus is a two-dimensional quadrilateral geometry composed of two isosceles triangles. Rhombus has the following characteristics:

   - Has four sides of the same length
   - Has four angles that are equal and opposite
   - Has two diagonals that intersect perpendicularly

5. Circle

   Circles are formed from small dots that are combined into one curved line that is equidistant at a certain point so as to form a closed curve. The circle has one center point.

6. Parallelogram

   A parallelogram is a two-dimensional geometry in the form of a quadrilateral in which all four sides are parallel and opposite, and the four angles are equal and opposite. A parallelogram has the following characteristics:

   - All four sides are parallel and facing each other
   - All four corners are equal and facing each other
   - There are two rotational symmetries, and no folding symmetries

Philosophical value

Several types of motifs obtained from observations at the Jepara Weaving Aida industrial house have their own philosophies. The philosophical value contained in the Troso Ikat Weaving motif has a special positive meaning related to human life. This is because traditional cultural patterns must be protected and their philosophy must be preserved regardless of the many innovations (Kononov & Zhukov, 2020). The philosophy of the Troso woven motif can be described as follows:

1. Gill motif

The pattern on the gill motif is adopted from the traditional cultural heritage of the Pontianak Malay community. The gill motif represents the Pontianak civilization that lives on the banks of the Kapuas River and reflects the life of Pontianak which depends on the Kapuas River. This gill motif depicts breath and movement in life, and expresses love for nature and the environment.

2. Re-woven motif

The re-woven motif is one of the batik motifs adopted from a weaving craftsman in Pekalongan named Ridaka Weaving and Handicraft. There are several types of re-woven motifs, depending on the type of thread used. Some threads that are often used include: cotton, viscose, silk and others. The thread used greatly influences the final result on the fabric (Nazie in (Aghniyauddini & Telkom, 2018)).

3. Feather and Baron motif

The feather motifs on Troso's woven fabrics have several forms, namely oblique shapes, rhombus shapes, and straight line motifs, each of which has a philosophy. The straight line motif is made from a collection of threads that are aligned so as to form a straight line which is meaningful as a habit of the Javanese people who always uphold the value of gotong royong and unite under any circumstances. In addition, the straight line motif has the meaning of gender equality for Jepara men and women, just like the idea by R.A. Kartini, a fighting figure from Jepara who is fighting for gender equality.

Next is the oblique line motif or it can be called a diagonal line.This motif is a group of line shapes that give an unstable, immobile and dynamic effect. A line that slopes to the right or left is analogous to a person running, a horse jumping, and a tree leaning. The meaning of this motif signifies the dexterity and tenacity possessed by the Jepara people, never tired, and strong believe.

While the rhombus motif is interpreted as a Jepara tradition, namely "kupatan". This motif is adopted from the form of a kupat or ketupat which has a philosophy of "confessing" or admitting one's mistake and forgiving each other between humans on Eid al-Fitr.

4. Lurik Motif

Although this lurik motif looks simple, this motif has various meanings (Djoemena in (Hariyanto, 2013)). The meaning contained in this lurik motif is closely related to culture in Java. The term lurik is taken from the Javanese language, which comes from the word array which means line, line or lane. Even though the motive is striated it only consists of a collection of simple lines, but this motif has meaning, traditions, customs and beliefs, especially for the Javanese people. Lurik motifs are divided into several types. The Troso Weaving striated motif belongs to the traversal striated pattern. In Javanese, the word liwatan means to be skipped. This can be interpreted that the lurik liwatan patterned cloth is usually worn by pregnant women who are celebrating their seventh month of pregnancy, where this motif is believed to increase the authority of pregnant women.

CONCLUSIONS

Mathematics can be found in various forms of life, both in the form of ideas, daily activities, and culture. One of the cultures that can be found in Jepara City, Central Java is Troso Ikat Weaving. Ikat Troso weaving has a variety of aesthetic motifs. Apart from only being seen from the beauty side, Troso Ikat Weaving is also made using mathematical concepts and contains philosophical values. Several kinds of motifs on Jepara Troso Ikat Weaving found mathematical ideas, namely the concept of two-dimensional geometry. Geometric shapes include rectangles, rhombuses, isosceles triangles, triangles, circles, hexagons, and parallelograms. This study shows that Troso ikat weaving as an ancestral inheritance can be used as a first step in learning mathematics in real life, especially regarding the topic of two-dimensional geometry. So that the benefits of Troso Ikat Weaving can be used as a motivational tool for students learning in mathematics and building the meaning of cultural values in learning mathematics. Culture in Troso Ikat Weaving can be used as concrete mathematical objects, the context of mathematical problems, and examples of the application of mathematics in everyday life. In addition to the mathematical concept, the Ikat Troso Weaving motif also contains philosophical values related to human life in positive terms so that the meaning can be learned as learning and advice. Thus, the results of this study can be used as a reference for teachers in Java in particular and even teachers throughout Indonesia to increase students' creativity and motivation to learn mathematical concepts by integrating local culture.

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