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Ethnomathematic Exploration of Ulos Batak Toba on The Concept of Flat Shapes

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Abstract

Ulos is a traditional woven cloth in the Toba Batak tradition, Ulos functions as an important symbol that symbolizes love, protection and unity. Therefore, this study aims to uncover the values of these plane figures using ethnomathematics. This study employed qualitative methods. Interviewing informants and analyzing Toba Batak ulos (traditional Batak cloth) aimed to explore the cultural values of the Toba Batak people. Then the data was obtained through the interview process, observation and documentation . The data validity technique used was source triangulation. Triangulation techniques are used to test the validity of data.
Furthermore, the researcher analyzed data using Toba Batak Ulos, based not only on the researcher's interpretation but also on discussions with cultural experts, informants, and mathematics experts. This study proposes the conceptual values of plane figures found in Sadum, Holong, and Panssamot ulos. In Sadum ulos, the plane figures found are equilateral triangles, rhombuses, and circles. In Holong ulos, the plane figures found are trapezoids and rhombuses. In Panssamot ulos, the plane figures found are pentagons, rectangles, and rhombuses, which are associated with the cultural values of Toba Batak ulos.
Keywords: Culture, Ulos Batak Toba, Platforms

1. Introduction

In recent years, a lot of research has begun to be studied that links mathematics and culture. According to (Z & Muchlian, 2019) the results of the International Community of Mathematics Education meeting stated that problems related to culture will inevitably surround the mathematics learning process, even all forms of mathematics. The abstract characteristics of mathematics mean that many students are still in a state of anxiety when studying mathematics and most students have difficulty applying mathematics to real life situations. This shows that students' mathematics learning is not yet meaningful, so students' understanding of concepts is very weak. Teachers need to link the schemes that students already have and provide opportunities for students to discover and construct their own mathematical ideas. Therefore, mathematics learning is more meaningful in students' minds. This means that students do not easily forget the mathematics material they have studied because these problems are often seen in everyday life.

Regarding this, it is based on students' knowledge which cannot be focused on in the classroom, but can come from the socio-cultural life that develops in society or our own families (Aulia & Afri, 2023). According to (Murniati & Ginting, 2023) mathematics is a subject that students find difficult.

This connection between culture and mathematics applies not only to mathematics itself but also to various other disciplines.

Ethnomathematics consists of two words, namely ethno (culture) and mathematics (D. Febriyanti & Afri, 2023).. Ethnomathematics specifically deals with real content (Azizah & Ananda, 2024). This shows that mathematics originated from human activity, and gradually became daily habits, and became a cultural practice (Purba et al., 2022). Ethnomathematics is a traditional method for calculating, measuring, and understanding environmental patterns. (S. Siregar & Hasibuan, 2019).

Ethnomathematics is a forum for bridging mathematics with local cultural contexts. According to Gerdes in (Z & Muchlian, 2019) ethnomathematics is mathematics applied by certain cultural groups, groups of workers/farmers, children from certain classes of society, professional classes, and so on. Based on this definition, it is concluded that ethnomathematics has a broader meaning than just ethno (ethnicity) or tribe. Therefore, ethnomathematics experts are of the opinion that basically the development of mathematics at any time cannot be separated from the culture and values that already exist in society, so ethnomathematics research needs to have space.

Research related to ethnomathematics applied by a certain group of people in a social and cultural context (Fitriatien, 2016). Mathematical literacy is known as ethnomathematics (C. Febriyanti et al., 2019). Ethnomathematics is a branch of mathematics that is related to culture and mathematics (Zayyadi and Halim, 2020). Mathematics as culture has actually been integrated into all aspects of social life (Turmuzi et al., 2022).

This research aims to educate the public that the Toba Batak ulos motifs contain mathematical values, specifically the concept of plane figures. Interestingly, the research is based on the belief that ulos symbolizes life, birth, and death, as well as its philosophical and symbolic meaning, as well as its shared spiritual expression and spiritualization (Wahyu Darni Uli Mega Putri; Saragih Dian, Rismar; Tambunan, 2021).

. Ulos cloth provides a dialogue between culture and mathematics, while also providing a strong foundation for the study of the concept of flat shapes based on Toba Batak culture. The uniqueness of Toba Batak ulos in everyday life lies not only in its aesthetic value, but also in the symbolic meaning, social function and cultural values contained in it. This Ulos also shows our status in society (Sitohang et al., 2023). The Toba Batak ulos motif is not only beautiful but also contains flat geometric patterns such as rectangles, squares and trapezoids.

Ulos is a type of traditional woven cloth that is often used for traditional ceremonies in the Batak tribe. This cloth is one of the main requirements for carrying out traditional Batak ceremonies (Sigulang-gulang & Nainggolan, 2015). The presence of this ulos cloth in a ceremony can also be used as an identity as a way of paying respect to people who carry out customs and to invitees who attend traditional events. Batak is the name of a tribe in Indonesia. This tribe mostly lives in North Sumatra. The majority of Batak people adhere to Christianity and Islam. But there are also those who adhere to animist beliefs (called Parmalim). What is meant by Batak culture is that all the values of life of the Batak tribe in the future are a continuation of the values of past life and become a determining factor in their identity .

Ulos is a typical Batak woven cloth in the form of a shawl, which symbolizes the bond of love between parents and their children or between one person and another person, as stated in Batak philosophy which reads: Ijuk Pengihot Ni hodong "Ulos penghit ni halong, which means the fiber that binds the midrib to the stem and the ulos that binds the midrib to the stem and the ulos that binds love between parents and children or between one person and another person.

Ulos in the Toba Batak community has a very important function in every traditional event carried out by the Toba Batak community, whatever traditional ceremony is carried out, it is always marked by the giving of the ulos in the custom. Giving or receiving ulos is in accordance with existing rules in accordance with Dalihan Na Tolu, so that the custom that is being held is in line with the wishes or goals of the Batak people and can be implemented (legally) in the eyes of custom.

Ulos functions to provide heat that is healthy for the body and pleasing to the mind so that we are happy to make it. Among the Batak people you often hear 'mengulosi' which means giving ulos, or warming with ulos, the beliefs of the Batak people, if (tondi) also needs to be ulosed, so that hard-hearted men have the qualities of masculinity and heroism, and women have the qualities of resilience to resist witchcraft and infertility.

Ulos is a typical Batak cloth, not only among the Toba Batak tribe, but other Batak tribes also have types of Ulos cloth with their own characteristics. Ulos has many types (Saragih, 2022), as well as the meaning and time of use (Bahri & Agustina, 2016). Apart from that, the Ulos worn at one event can also vary depending on the meaning you want to convey (Nainggolan, 2020).

Plane shapes are a part of mathematics. Flat shapes are a field of mathematics which is part of geometry (Simbolon, & Sapri, 2022). A flat shape is a shape that is bounded by curved or straight lines (Unaenah et al., 2020) and has an area and perimeter (Saputra, Thalia, & Gustiningsi, 2020). So, flat shapes are a branch of geometric mathematics that has an area and perimeter bounded by curved or straight lines.

Flat construction becomes easy if we know the concept. (Fatqurhohman, 2016) said that understanding concepts is an indicator of success in learning mathematics. Difficulty distinguishing between types of flat shapes (Milkhaturrohman et al., 2022) and the occurrence of misunderstandings among students make flat shapes difficult (Fajari, 2020). So mastery of concepts is very important for students.

We often encounter flat shapes in the surrounding environment. Students can make observations Aprianti & Hidayat (2016) and compare their characteristics (Utomo, 2020) and group flat shapes (Pramesta, & Mariana, 2022). So students can observe the surrounding environment and group flat shapes to understand concepts.

We have encountered flat shapes since we were in elementary school. Elementary school is a phase of child development (Subkhi Mahmasani, 2020a) and so character cultivation of culture in ulos motif Batak Toba (Hardiarti, 2020) which is carried out for 6 years of research (Subkhi Mahmasani, 2020b).

Therefore, researchers are interested in focusing their research on one of the traditional clothes of the Batak tribe that developed in North Sumatra, namely "Ulos Batak Toba". Ulos Batak Toba is often used during traditional ceremonies by the Batak tribe outside North Sumatra. While in Sumatra we often find people wearing ulos at traditional events, outside Sumatra it is rare to find Toba Batak people wearing Toba Batak ulos during traditional ceremonies. Therefore, this research was conducted to explore the mathematical concepts that exist in Toba Batak ulos. The aim of this research is to make it easier for students to understand the concept of flat shapes in mathematics which is often considered abstract by students. Therefore, this research not only looks at Toba Batak ulos as cultural heritage, but also as a source of mathematical knowledge contained in these ulos. This is necessary to make a positive contribution when learning mathematics.

Ethnomathematical research on Toba Batak ulos was carried out by (Angie Desi K.Arum, Hardi Tambunan, Ruth Mayasari Tambunan et al 2024). The difference in previous research is in the motifs of each Toba Batak ulos. This limited study concerns Toba Batak ulos which is used as a learning resource for developing contextual mathematics learning based on cultural diversity. From the explanation above the aim of this research in exploring the shapes and forms of ulos Batak Toba by conducting research entitled "Ethnomathematics Exploration of Ulos Batak Toba On The Concept Of the Flat Shapes".

2.Method

The research carried out was qualitative descriptive research with an ethnographic approach. Based on the type and approach of this research, the instruments used by researchers are human instruments, namely research that is directly related to research and acts as a data collector, and its role cannot be replaced. The data in this research was obtained from observation, interviews and documentation. I have two informan. This research was conducted for 4 days, day 1-2 observation of ulos and informant interviews, day 3 focused on the socio-cultural ritual of wearing ulos, day 4 validation was carried out and analytical reflection was carried out using a qualitative semiotic and interpretative approach to reveal the cultural meaning of ulos in the context of Toba Batak Culture.Questions and answers were carried out to find out the use of ulos in Toba Batak traditional events, and documentation was carried out to find out the use of ulos in learning about the concept of flat shapes in the Toba Batak ulos weave. I recorded the interviews with the informants and asked several related questions. The informants are people who understand the Batak Toba ulos. Some of the questions were about traditional activities typically performed while wearing the ulos, the meaning of

the motifs and colors of this ulos, and what do you know about the background of these motifs and colors?.

The ulos-based ethnomathematics approach provides a new perspective on learning about plane figures, transforming them from abstract to meaningful, local culture, and enhancing students' competency in plane figure concepts and pride in their cultural heritage.

Observation of the research subjects was at the informant's location, Jalan Bandar Labuhan, Tanjung Morawa District, Deli Serdang Regency. The object of the investigation is the exploration of mathematics found in the Toba Batak ulos motif and the contribution of mathematics to mathematics learning found in the Toba Batak ulos. Interviews were conducted with the research subjects, namely one of the indigenous Batak Toba people who was the place of research observation and documentation in the form of photographs. Data validity testing through technical triangulation, namely by comparing data from interviews, observations and documents. The data analysis technique used follows Miles and Huberman in terms of data reduction, data presentation and form of conclusion drawing (Ulya & Rahayu, 2020). Data reduction is carried out to select parts in the Ulos Batak Motif related to mathematical concepts. Data presentation is carried out to see the overall picture of the results of the mathematical concepts found in the Ulos Batak Motif.. Then a conclusion is drawn regarding the exploration of ethnomathematics on the Toba Batak ulos motif and its contribution to mathematics learning, namely the concept of flat shapes.

Data Analysis

This research is limited to examining the rules that determine couple matchmaking. The data analysis technique used in this study is taxonomic analysis, which is applied to investigate both the criteria for matchmaking and the values of school mathematics that can be derived or taught from the process.

2. Results and Discussion

Ulos is an important item used during Toba Batak traditional ceremonies. In cultural studies in Toba Batak ulos cloth, researchers used several references, namely (Agustina, 2016). The use of Ulos Batak Toba is not only as an ordinary cloth that is worn at home, but Ulos Batak Toba is worn during events in the Toba Batak community where the motif contains certain symbols according to beliefs that have been passed down from generation to generation which have long been born in the Batak community. In accordance with the symbolic theory explained by George Herbert Mead that a person.

There is a lot of research on ulos one of them. Research conducted by (H. Siregar et al., 2024) found that ulos motifs are closely related to geometric principles, such as the use of triangular and rectangular patterns. Meanwhile, a study by (Sigulang-gulang & Nainggolan, 2015) emphasizes more on how ulos motifs can be analyzed using geometric transformation theories, such as translation and rotation.

Toba Batak ulos motifs display flat geometric patterns such as rectangles, squares, equilateral triangles, circles, and parallelograms (H. Siregar et al., 2024)research highlighted that the creation of ulos motifs explicitly utilizes these principles, for example through the repetition of triangles and hexagons, reflecting the application of geometric transformations in culture.

Ethnomathematical analysis also reveals the use of simple ratios, such as the length and width of ulos as a rectangle. And some modern research has used GeoGebra to model ulos patterns, demonstrating that these motifs contain elements of: Planar shapes (squares, trapezoids, triangles, and rhombuses).

Ulos Batak Toba is used for learning mathematics, the concept of flat shapes at the 4th grade elementary school level can be explained below:

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A. Ulos Sadum is clear evidence of love from upstream to children or their boru-boru, making it a symbol of love. Therefore, if a hula-hula cannot prove a person's love for their child, this is considered not good in Batak culture. Ulos Sadum depicts the most sacred and important sign of love shown by the ulos giver. Indeed, someone can be given gold and many people think that is good, but giving ulos is much more respected and respected because it involves strong Batak traditional values (Ruth et al., 2024).

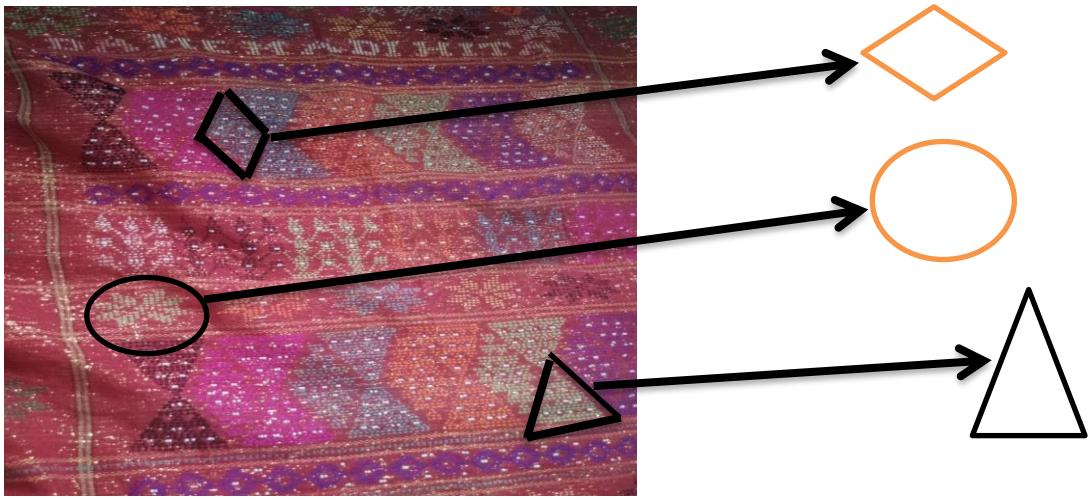

Figure 1. Ulos Sadum Fabric Motif

1). The Ulos Sadum motif forms a flat shape in the form of an equilateral triangle.

EQUILATERAL TRIANGLE

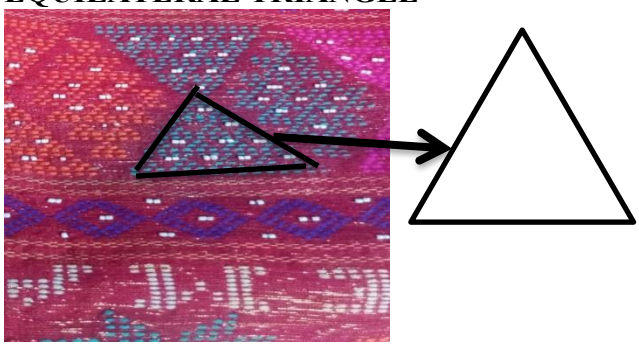

Figure 1.1 Ulos Sadum Equilateral triangle Motif

Formula:

$L=\frac{1}{2} \times a \times t$

K=3 S

Information:

L=area of the triangle
a=Base of Triangle
K=Perimeter of triangle
t=Height of the triangle

Defenition :An equilateral triangle is a triangle whose three sides have the same length. An equilateral triangle is a type of triangle that has three sides of equal length and three angles of equal size, namely 60° each.Symetry; has three axes of line symetry and three axes of rotational symetry.

b. An equilateral triangle has 3 equal angles, namely 60°.
c. An equilateral triangle has three axes of symmetry, three lines of symmetry, and three rotational symmetries.

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2). And the Sadum ulos motif also has a rhombus motif.

RHOMBUS

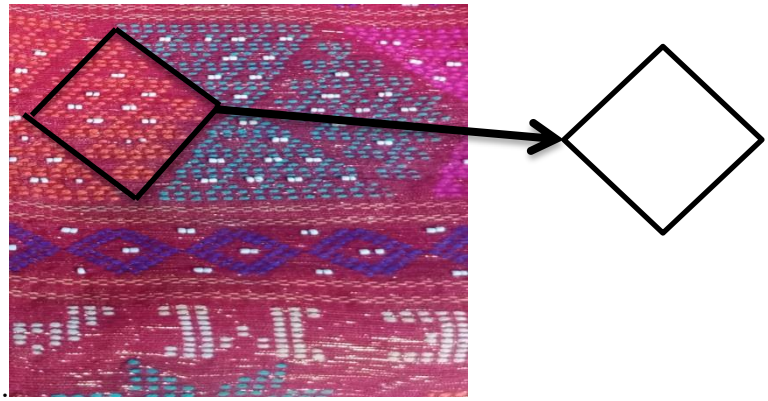

Figure 1.2 Ulos Sadum Rhombus Motif

Formula: $L = \frac{1}{2} \times d1 \times d2$

$K = 4s$

Information:
d=Diagonals of a rhombus
s=Side of rhombus

Defenition : A rhombus is a two-dimensional shape formed from four ribs of the same length, not right angles, each of which is the same size as the angle opposite it. A rhombus is also a flat shape consisting of four sides of equal length and opposite angles of equal measure.

Characteristics of Rhombus

a. Has 4 sides of the same length.
b. Has two pairs of parallel opposite sides.
c. Opposite angles are equal.
d. The diagonals of a rhombus are the axes of symmetry.
e. All the diagonals form congruent triangles.

3). And the Sadum ulos motif also has a rhombus motif circle

CIRCLE

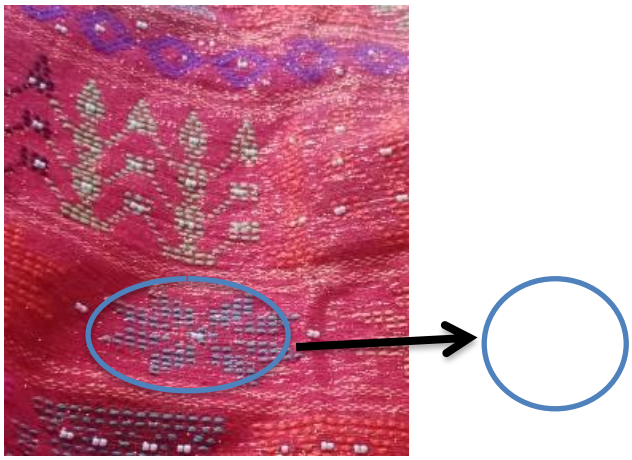

Figure 1.3 Ulos Sadum Circle Motif

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Formula :

$K = 2\pi r$

$L = \frac{1}{4} \pi d^2$

Information:
π =fingers 22/7 or 3,14
d =diameter

Defenition : A circle is a shape consisting of all points on a plane that are a certain distance from a certain point, the center. It is a closed curve that divides the circle into two parts, namely the inside and the outside of the circle.

Characteristics of circle:

a. Has one center point
b. Has a radius
c. Has a diameter
d. Has infinite lines and rotational symmetries
e. Has 360 degrees of angles
f. Has no corner points
g. Has area and circumference
h. Consists of curves and not straight lines

A. Ulos Panssamot is a symbol or symbol of the Batak community. Therefore, at every traditional event of the Toba Batak community, giving ulos should be done with full awareness and a lot of consideration, following the rules that have been set. This concept fits the Social Systems Theory proposed by Parson, which states that social systems involve interactions between individuals in situations that have environmental, physical and motivational aspects in order to maximize satisfaction related to the situation. Customs are very important for the Toba Batak community, involving traditional actors and Toba Batak people who have great motivation to maximize satisfaction in the context of the customs carried out by these parties. Toba Batak traditional tribe, Ulos is used as a symbol that is culturally structured, also from the giving of ulos we can know the position of the traditional context, where ulos is given by the girls parents give it to the grooms parents.(Sinulingga et al., 2024).

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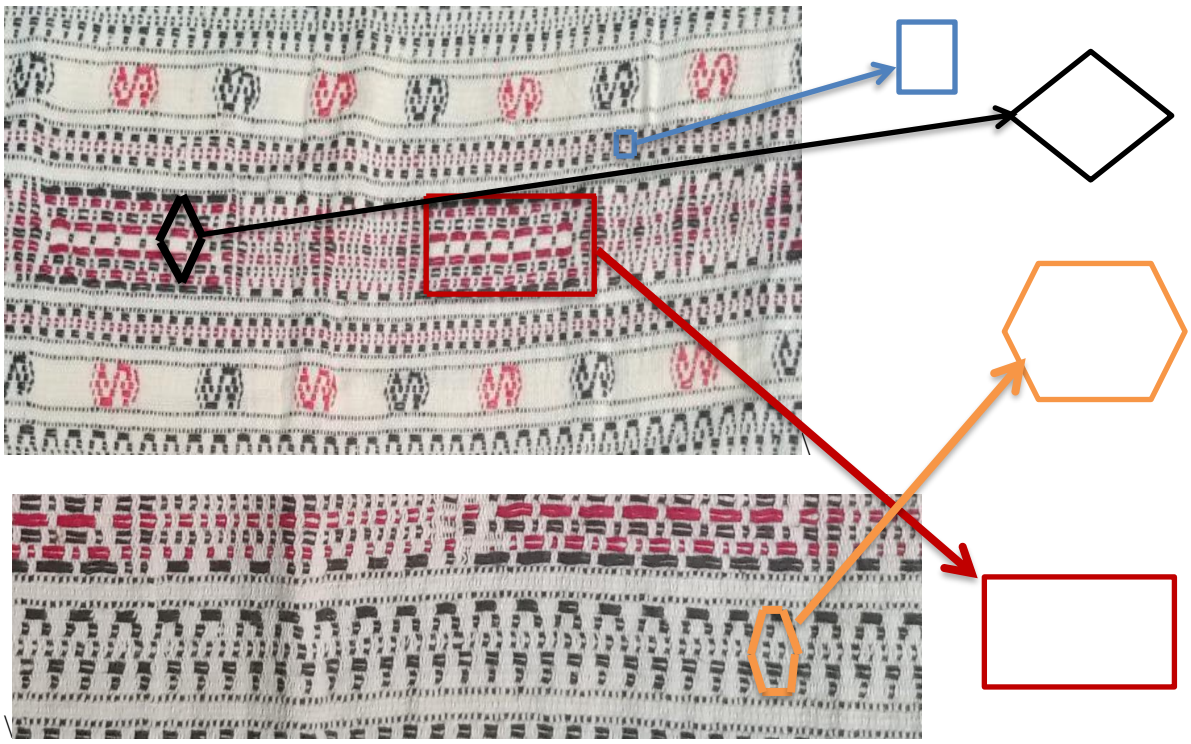

Picture 2. panssamot ulos cloth motif

1) The panssamot ulos cloth motif forms a rectangle.

RECTANGLE

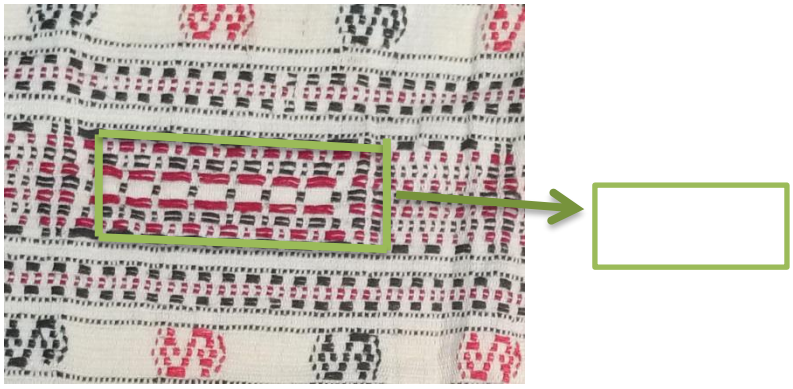

Figure 2.1 Ulos Panssamot Rectangle Motif

Formula:

$L = P \times L$

$K = 2(p + l)$

Information:
L=area of the Rectangle
P=Length of Rectangle
K=Perimeter of the Rectangle
T=Height of the Rectangle

Defenition: A rectangle is a flat shape that has 2 pairs of parallel sides of the same length and has 4 right angles. A rectangle is a flat shape that we encounter quite often. Have two angle 90 degree. In everyday life, for example, a blackboard

Characteristics of Rectangles

a. Has four sides.
b. Has two pairs of sides that are the same length and parallel.
c. It has four right angles of equal measure, namely 90 degrees.
d. It has two lines of symmetry and has two axes of symmetry.

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e. Has second degree rotational symmetry.
f. It has two diagonals of the same length and bisects two equal triangles.

2) The panssamot ulos cloth motif forms a hexagon

HEXAGON

Formula:

$L=(1/2) \times a \times P$

$K= 5 \times s$

Information:
a=Apothem
P=Around
S=Side

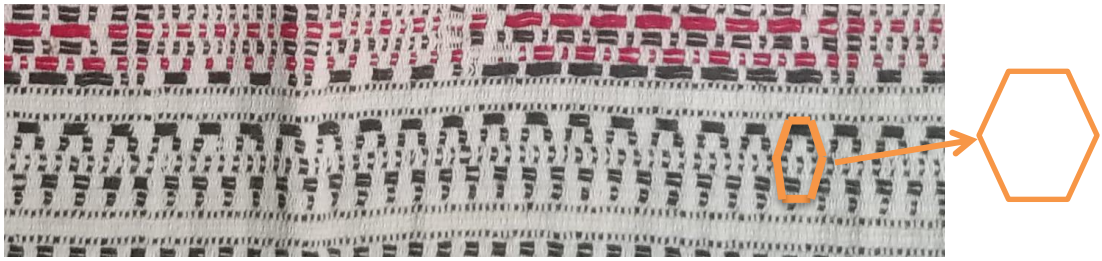

Figure 2.2 Ulos Panssamot Hexagon Motif

Defenition : Hexagon is flat shape that is bounded by straight lines that are connected to each other and form a closed curve . Polygons have sides and angles, and can be regular 9all sides and angles are the same. A regular pentagon is a polygon (two-dimensional shape) that has 5 equal sides and 5 equal angles. In other words, all sides and corners are uniform. So, if you draw a regular pentagon, each interior angle is 108 degrees, and all the sides are more or less the same length. It is also symmetrical and can be rotated 72 degrees.

Characteristics of Hexagon:

a. Has 6 sides
b. Has 6 corners
c. All sides are the same length
d. All angles are the same, namely 120°
e. The total angle is 720°
f. Has 6 axes of symmetry
g. Has 6 lines of symmetry
h. Has 6 rotational symmetries
i. Consists of 6 congruent equilateral triangles
j. The length of the diagonal is twice the length of the side

3). The panssamot ulos cloth motif forms a rhombus.

RECTANGULAR

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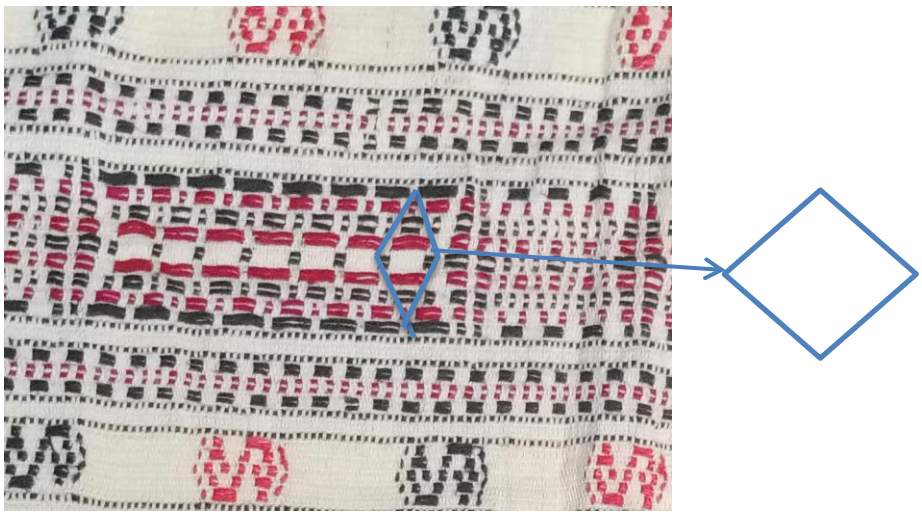

Formula:

$L = \frac{1}{2} \times d1 \times d2$

$K = 4s$

Information:

d=rhombus diagonals
s=side of the rhombus

Defenition : A rhombus is a two-dimensional flat shape formed by four right-angled triangles, each of which is the same size as the angle opposite it. A rhombus has two diagonals that are perpendicular to each other. The two diagonals are shown AC and BD.

Characteristics of rhombus

a. Has 4 sides of the same length.
b. Has two pairs of parallel opposite sides.
c. Opposite angles are equal.
d. The diagonals of a rhombus are the axes of symmetry.
e. All the diagonals form congruent triangles.

4). The panssamot ulos cloth motif forms a Square.

SQUARE

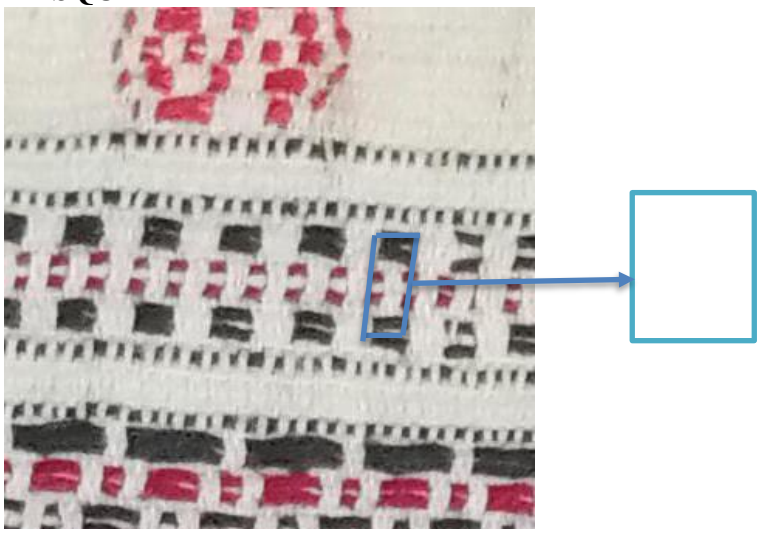

Figure 2.4 Square Ulos Panssamot

Rumus:

$L = side \times side$

$K = 4 \times side$

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Defenition : A trapezoid is a two-dimensional flat shape that has four sides and four angles, has a pair of parallel sides called bases, the lengths of the parallel sides are different, the other two sides are not parallel and are called rigid trapezoids.

Characteristics of a Square:
1. The four corners form a 90-degree angle.
2. It has 4 sides or 4 corners.
3. The sum of the four angles is 360 degrees.
4. It has four sides of equal length
5. Four right angles.
6. The diagonals are the same length
7. The diagonals intersect each other at right angles
8. The opposite sides are parallel.

B. Ulos Holong is a type of ulos that is specifically used in Toba Batak traditional weddings, as a symbol of love and giving ulos to those celebrating the wedding celebration. In the Toba Batak community, ulos are an integral part of every traditional ceremony. Therefore, at every event, wearing ulos is a necessity. The only difference is in the name and meaning of Ulos, which depends on the type of event being held by the community (Astuti, 2019).

Picture 3. Holong Ulos Cloth Motif

1) The Holong ulos cloth motif forms a rhombus.
RHOMBUS

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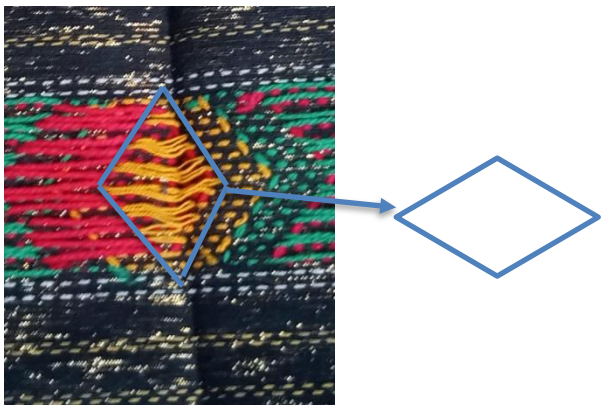

Picture 3.1 Holong Ulos Rhombus Motif

Formula:

$L = \frac{1}{2} \times d1 \times d2$

$K = 4s$

Information:

d=rhombus diagonals
s=side of the rhombus

Defenition : A rhombus is a two-dimensional flat shape formed by four right triangles, each of which is the same size as the angle opposite it. A rhombus has two diagonals that are perpendicular to each other. The two diagonals are shown AC and BD.

Characteristics of rhombus

a. Has 4 sides of the same length.
b. Has two pairs of parallel opposite sides.
c. Opposite angles are equal.
d. The diagonals of a rhombus are the axes of symmetry.
e. All the diagonals form congruent triangles.

2) The Holong ulos cloth motif forms a trapezoid

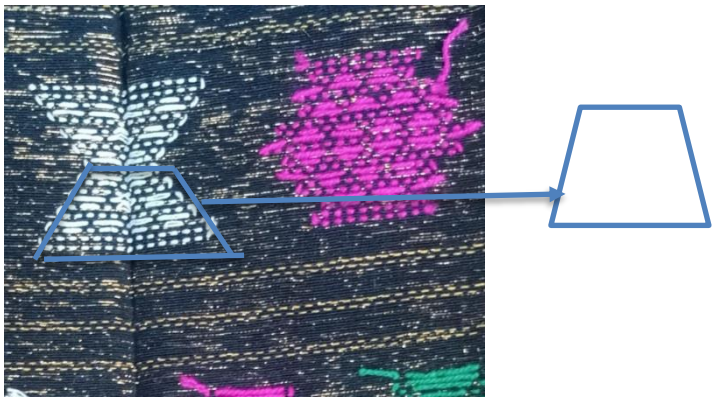

Figure 3.2 Trapezoid motif ulos Holong

TRAPEZOID

Formula:

$L = \frac{1}{2} \times$ the sum of the lengths of parallel sides × tall

$K = a + b + c + d$

Information : a,b,c,d= side of trapezoid

Defeniton : A trapezoid is a two-dimensional flat shape that has four sides and four angles, has a pair of parallel sides called bases, the lengths of the parallel sides are different, the other two sides are not parallel and are called rigid trapezoids.

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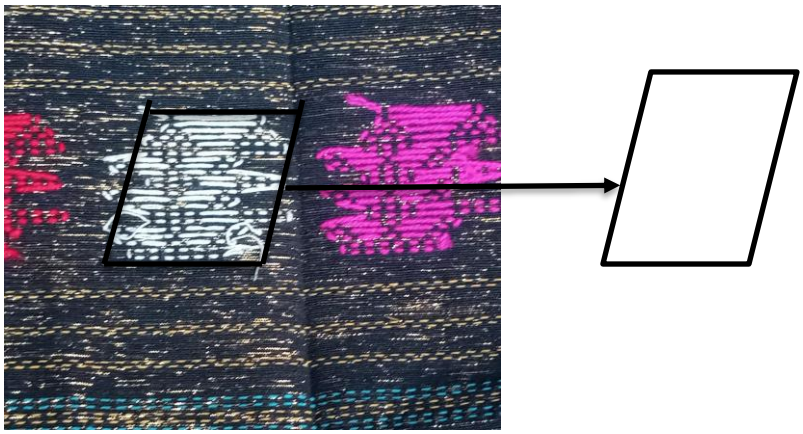
Trapezoid Characteristics:

a. Has four sides
b. Has four corners
c. Has a pair of parallel sides
d. Has two sides that are not parallel
e. The sum of all angles in a Trapezoid is 360 degrees

3). The Holong ulos cloth motif forms a Parallelogram

PARALLELOGRAM



Gambar 3.3 Ulos Holong is Parallelogram

Formula :

L=alas × $tinggi$

K=2× $a + b$

Information **:**

a.b =length of adjacent side

A parallelogram is a two-dimensional flat shape that is similar to a quadrilateral consisting of two parallel edges that face each other. This parallelogram has two pairs of angles that are the same length and parallel to their partners and has 1 pair of obtuse angles and 1 pair of acute angles and has the same angle size as the one. opposite it.

Characteristics of a Parallelogram

1. Has two pairs of parallel and equal sides
2. Has two pairs of large opposite angles
3. The diagonals bisect each other and are of equal length
4. Does not have a folding symmetry axis
5. Has two rotational symmetries

3. Conclusion

Based on the presentation of the results and discussion of data which describes the Toba Batak ulos cloth motifs, it was concluded that in the Toba Batak ulos cloth motifs that the researcher described there were three ulos cloths Toba Batak ulos are ulos panssamot, ulos holong and ulos sadum and are used for mathematics at grade 4 elementary school level on flat shapes.

On ulos holong there is trapezoidal and rhombus material, on ulos panssamot there is rectangular, hexagon and rhombus material and also on ulos sadum there is equilateral triangle and rhombus material from this study shows that using ulos in mathematics learning really helps students understand more in learning mathematics especially plane shapes because

by using ulos students can quickly imagine what plane shapes are formed so that they become critical students.

Thank You

This section is optional. Gratitude is usually given because of writing assistance that is seen as having a great influence or financial assistance to conduct research.

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