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AN ETHNOMATHEMATICAL EXPLORATION OF LAMPUNG TAPIS FABRIC

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Abstract

Indonesia has a very large and diverse range of cultural diversity. Ethnomathematics has a very important role in introducing culture to students by studying the mathematical elements contained therein. The purpose of this research is to explore the mathematical elements contained in Lampung tapis cloth. The method used in this research is literature review and descriptive analysis. The data analysis technique used is descriptive data analysis technique. Based on the results of the study it was found that Lampung tapis fabric contains mathematical elements in which students can learn mathematical materials such as flat shapes, geometric transformations and in this study examples of problems related to geometric shapes found in tapis fabric are presented.

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INTRODUCTION

Indonesia is an archipelago that has a variety of cultural diversity. Indonesia has many provinces in which there are tribes, and diverse cultures, differences in ethnic groups with other tribes in each region make Indonesia have diverse languages, customs, traditional houses, traditional ceremonies, dances, songs, music, traditional clothing to traditional crafts. This cultural diversity is proof that Indonesia is a country rich in culture (Rahmawati & Marsigit, 2017). One of the regions that has diverse traditional crafts is Lampung province. Lampung province was born on March 18, 1964, Lampung province is located in the southernmost part of the island of Sumatra and borders Bengkulu and South Sumatra to the north. Lampung Province has a variety of traditional regional handicrafts that have penetrated the national and international markets, one of which is tapis cloth (Dewi et al., 2019).

Tapis cloth is a Lampung tribal women's clothing in the form of a sarong made of woven cotton yarn with motifs or decorations of sugi material, silver thread or gold thread with an embroidery system (Isbandiyah & Supriyanto, 2019). Lampung tapis cloth has a diversity of motifs related to the concept of mathematics. The decorative variety can be divided into three according to its nature, namely geometric decorative variety, naturalistic decorative variety, as well as several decorative varieties that are not included

in the geometric and naturalistic groups. One of the decorations that are rich in mathematical concepts is geometric decoration. Geometric ornamental varieties have shapes that generally have firm contours, the same measurements from various directions mathematically, using a variety of line elements, such as straight lines, curves, zigzags, spirals, and various fields such as triangles, rectangles, rectangles, circles, rhombuses, and angles, from the three ornamental varieties there are number patterns, regular polygons and geometric transformations (Avelia et al., 2020). Without realizing it, the people of Lampung have successfully applied mathematical concepts to everyday life. The use of mathematical concepts in a culture or customs by certain communities or tribes is called ethnomathematics (Aditya, 2017).

Ethnomathematics is a solution to link mathematics learning with students' cultural background (Hasan & Budiarto, 2022). Several studies have been conducted related to the application of ethnomathematics, including research (Kusaeri & Pardi, 2019) showing that the cultural products found are cultural products that have mathematical objects in the form of flat and spatial shapes. (Huda, 2018) in his research identified geometric shapes in various market snacks, as well as related mathematical elements. And research by (Yanti & Haji, 2019) shows that the besurek bengkulu cloth has the concept of geometric transformation. From some of the research results that have been conducted by these researchers, it can be concluded that ethnomathematics is very important to study because it can be an interesting and fun alternative and allows for contextual understanding based on students' experiences as members of a cultural community. Therefore, this research utilizes tapis cloth as an alternative to learning mathematics in the classroom that can attract students' interest in learning. By linking the material of flat buildings and geometry transformations on tapis cloth can make the material delivered inductively, stimulate creativity and student thinking and foster open thinking in students.

Thus, through the study of ethnomathematics, mathematics can be rediscovered by people from different cultural roots, so that it can connect and revive students' critical reasoning and dialogue and can foster students' democratic and tolerant character by embracing cultural differences and seeing them as opportunities for mathematics education (Prahmana & D'Ambrosio, 2020).

THEORETICAL STUDIES

1. Ethnomathematics

   Ethnomathematics was first introduced by D'Ambrosio in 1978, who is a mathematician from Brazil (Mania & Samsu Alam, 2021). Linguistically, the word "ethno" means something very broad and refers to the socio-cultural context, including language, jargon, behavioral codes, myths, and symbols. Then the word "mathema" can be interpreted as explaining, knowing, understanding, and doing activities such as coding, measuring, classifying, inferring, and also modeling. The suffix "tics" comes from the word technique which means technique (Pratiwi & Pujiastuti, 2020). So that in language ethnomathematics can be interpreted as a technique in combining, collecting and knowing the relationship between socio-culture and developing science and technology. Ethnomathematics in Indonesia is actually not a new science but has

been known since the introduction of mathematics itself. Since it was widely recognized, ethnomathematics began to be developed through the study of various scientists. Therefore, ethnomathematics began to develop, especially in learning applications in schools (L. I. Putri, 2017).

Based on the description above, ethnomathematics is a technique that combines socio-cultural science and mathematics so that it can motivate students and provide new nuances in learning mathematics. Ethnomathematics using Lampung culture is expected to be able to make math learning more interesting and is expected to be able to introduce more deeply to culture, especially Lampung culture which is starting to be forgotten by the development of increasingly modern times.

2. Tapis Fabric

   Lampung Province is part of the Unitary State of the Republic of Indonesia, which has a variety of arts, cultures and languages. One of Lampung's artistic and cultural heritages is Lampung tapis (Y. M. Putri et al., 2022). Lampung tapis is a type of cloth or clothing commonly used by Lampung people, especially the girls and women of Lampung tribe (Damayanti et al., 2019; Nugroho et al., 2021). Lampung tapis fabric has several patterns that contain mathematical elements, patterns in Lampung tapis motifs and patterns can be used as ideas for mathematics learning. Mathematics learning can be carried out both inside and outside the classroom and can be used as a reference in mathematics material other than flat buildings (Putra & Indriani, 2017). Lampung people have successfully applied mathematical concepts to everyday life by using ethnomathematics without learning mathematics. This can be proven by the results of mathematical activities owned and developed in Lampung society in the form of tapis cloth, traditional houses, local units of Lampung people, and traditional Lampung games showing mathematical concepts (Rakhmawati, 2016).

METHODS

The method used in this research is literature review and descriptive analysis. The aim is to explore ethnomathematics in Lampung tapis fabric. Data sources were obtained through search engines such as science direct, scopus and google scholar which focused on the topic of exploring the mathematical elements contained in Lampung tapis fabrics. The data analysis technique used is descriptive data analysis technique (Fauzi et al., 2022). The research stages are: (1) collecting and studying several articles and reference books, (2) processing and exploring geometry content in Lampung tapis fabric, (3) analysing geometry topics and related theories, (4) making sample questions about related materials, (5) presenting data descriptively.

RESULTS AND DISCUSSION

Results

After the analysis was carried out to find the relationship between the motifs and patterns on the tapis cloth with one of the mathematics subject matter, it was found that the variety of woven ornamental patterns found on the Lampung traditional tapis cloth has a shape and pattern. Here are some types of Lampung tapis cloth, including:

1. Tapis Gajah Meghem (originating from Abung Siwo Mego)

2. Tapis Kaca (originating from Kota Bumi, North Lampung)
   Tapis Kaca is usually worn by women when attending traditional ceremonies or accompanying brides and worn by men to attend traditional ceremonies.

3. Tapis Jung Sarat (originating from the Pepadun Tribe)
   Tapis jung sarat is worn by brides at traditional marriage ceremonies.

4. Tapis Raja Tunggal (originated from Pepadun Tribe)
   Tapis raja tunggal is worn by the wife of the oldest relative (tuho penyimbang) at traditional marriage ceremonies and taking titles, both princely and sultan titles.

Then the motif of tapis cloth, the motif in tapis cloth is also often referred to as decorative variety. The creation of this decorative variety is based on human knowledge of the

environment that can inspire to create various decorative varieties. Here are some of the decorations found in tapis weaving:

1. Geometric Decorative Variety
   a. Decorative Motif Tumpal /ajuk

Motif Lereng-Lereng

Motif Pucung Rebung

Decorative motifs of tumpal or header or tapis pucuk rebung, this motif has existed since the perundagian era (influence of Dongson culture). The slopes motif is the most popular type of motif among the people of Lampung even in Indonesia. The color on the back of this motif is red, and the color of the triangle that resembles the shape of the slopes is gold to make it look more harmonious and beautiful.

   b. Siasab Decorative Motif

Mountain Motif

Hill Motif

Motifs in the form of embroidery with a width ranging from 2-10 cm. This decorative Sasab motif is used in almost all types of tapis. If you pay attention to the patterns of penyawat / binding threads, they will form like a rhombus or rectangle. Other geometric shapes that are also used as decoration are square and diamond shapes. The mountain motif has a shape in the form of a slightly large triangle that looks like a picture of a mountain motif. The hill motif, the motif is called the hill motif because the shape of this motif looks like a hill. This motif is often made a motif of creation by the people of Lampung, the shape of this motif that resembles a hill is transformed into the shape of a siger crown that looks very beautiful.

   c. Naturalist Decorative Variety
   There are various naturalist decorative fabrics such as human motifs,
   animal motifs such as riding animals (horses, elephants, buffaloes, winged horses, birds, garuda, dragons) and floral motifs such as flowers and channels.



d. Decorative Varieties that are not Geometric and Naturalistic
Tapis fabrics that do not include geometric and naturalist decoration include: star and moon motifs and boat motifs.



Discussion

Mathematical Elements contained in Lampung Tapis Fabric

The mathematical elements contained in one tapis cloth vary. So that in one tapis cloth there are several mathematical elements in it. Here are some mathematical elements contained in Lampung tapis cloth.

Flat Buildings

A flat shape is a two-dimensional object that is bounded by straight lines or straight lines. Because flat shapes are two-dimensional shapes, they only have length and width, therefore flat shapes only have area and perimeter. Some concepts of flat shapes can be seen in the following figure:

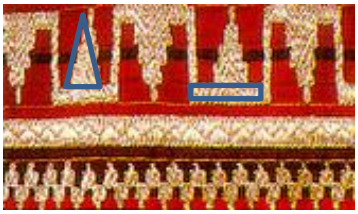


Figure 1. Motif of Lereng-lereng

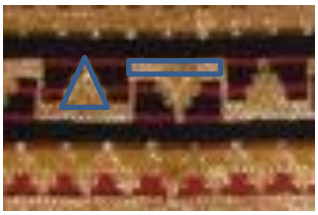
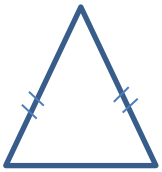


Figure 2. Motif of Pucung Rebung

Figures 1 and 2 are the most popular types of motifs in the lampung community. Based on the picture, this motif is called the motif of slopes and shoots of bamboo shoots, because in the tapis cloth there is a mathematical concept of geometry, namely triangular and rectangular flat shapes. The triangle shape is a flat shape bounded by three line segments whose ends meet each other and form an angle. In the picture the tapis fabric motif is an isosceles triangle (equilateral triangle). An isosceles triangle has properties, namely two facing sides, two equal angles and has one folding symmetry and one rotary symmetry. In addition to the triangle there is a rectangle in the motif, a rectangle is a two-dimensional flat shape formed by two pairs of ribs, each of which is equal in length and parallel to its partner, has two diagonals that intersect each other and equal angles.

Here's an example of application to a math problem:

Look at the picture of the tapis cloth on the side!
Inside the tapis cloth there is a shape if it is described as a triangle shape as illustrated below:



If the triangle has a base of $2cm$ with a height of $5cm$. What is the area of the triangle!

Answer:
To find the area of the triangle above can use the formula:
Area $(L) = \frac{a \times t}{2}$
Unknown:
If the base $(a) = 2cm$
and height $(t) = 5cm$
Ask: What is the area of the triangle?
Then
$(L) = \frac{a \times t}{2}$
$= \frac{2cm \times 5cm}{2} = 5cm^2$
So that the area obtained in the triangle is $5cm^2$

Then there is also a building other than a triangle, the building is in the form of a rectangle as illustrated in the picture below

Known in the picture the length of the rectangle is $6cm$ with a width of $4cm$. Determine the perimeter of the tapis fabric!

Answer:
To find the perimeter of a rectangle, you can use the formula:
Perimeter $(K) = 2 \times (p + l)$
Unknown: If length $(p) = 6cm$
and area $(l) = 4cm$
Ask: What is the perimeter of the rectangle?
Then
$(K) = 2 \times (p + l)$
$= 2 \times (6cm + 4cm) = 20cm$
So that the perimeter of the rectangle is $20cm$.

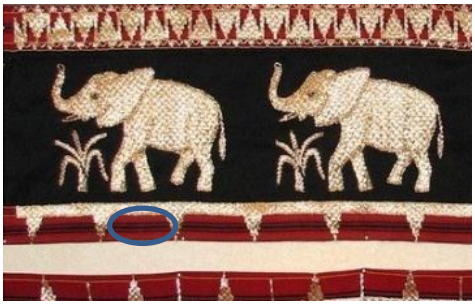


Figure 3 Animal Motif

Based on Figure 3, the mathematical elements contained in the tapis cloth motif are trapezoids. A trapezoid is a quadrilateral that has a pair of parallel sides. The type of trapezoid drawn on the tapis cloth motif is included in the isosceles trapezoid. An isosceles trapezoid is a trapezoid that has four sides, two of which are parallel and the other two are not parallel. Here's an example of application to a math problem:

Look at the picture of the tapis cloth on the side!

Inside the tapis cloth there is a shape if it is described as a trapezoid shape like the illustration beside.

If a trapezoid is known to have parallel side lengths of $6cm$ and $8cm$ and $2cm$. And if the height of the trapezoid is $4cm$. What is the area of the trapezoid!

Answer:

To find the area of a trapezoid, you can use the formula:

$$\text{Area } (L) = \frac{1}{2} \times (a + b) \times t$$
$$= \frac{(a+b)}{2} \times t$$

Unknown: If the length of parallel sides $(a) = 6cm$ and $(b) = 8cm$
and height $(t) = 4cm$

Ask: What is the area of the trapezoid?

Then

$$(L) = \frac{(a+b)}{2} \times t$$
$$= \frac{6cm+8cm}{2} \times 4cm$$
$$= 10cm \times 4cm = 40cm^2$$

So that the area obtained in the trapezoidal shape is $40cm^2$

Figure 4. Hill Motif

Based on Figure 4 the mathematical elements contained in the hill motif are rhombuses. Rhombus is a special parallelogram whose four sides are equal in length, has two folding symmetries, two rotary symmetries and two symmetry axes with diagonals intersecting perpendicularly and the angles facing each other have the same magnitude. Here's an example of its application to a math problem:

Look at the picture of the tapis cloth on the side!

Inside the tapis cloth there is a flat shape which if described is a rhombus shape like the illustration beside. If a rhombus is known to have a side length of $5cm$. What is the perimeter of the rhombus!

Answer:
To find the perimeter of a rhombus, you can use the formula:
Perimeter $(K) = 4 \times s$
Unknown: If the side length $(s) = 5cm$
Ask: What is the perimeter of the rhombus?
Then
$(K) = 4 \times s$
$= 4 \times 5cm$
$= 20cm$
So we get the perimeter of the rhombus is $20cm$.

Figure 5 Elephant Motif

Based on Figure 5 the mathematical elements contained in the tapis cloth motif are ellipses. The tapis symbolizes the motif of riding animals, namely elephants, motifs that symbolize prosperity. An ellipse is an image that resembles a circle that has been

extended in one direction. An ellipse is one example of a conic wedge and can be defined as the locus of all points, in one plane, that have the same amount of distance from two predetermined fixed points (called foci).

Here is the standard equation of an ellipse:

$$\frac{(x-p)^2}{a^2}+\frac{(y-q)^2}{b^2}=1$$

If $\neq$ q, the equation represents the graph of an ellipse with center point (a,b). The value |p| is the horizontal distance of the center point to the graph, while $|q|$ is the vertical distance of the center point to the graph.

Here's an example of its application to a math problem:

Find the equation of an ellipse that has a vertex at $(\pm 6,0)$ and a minor axis of 10.

Answer:

Given:

Minor axis length $2b = 10$ or $b = 5$

The coordinates of the vertex of the ellipse are expressed by $(x_p \pm a, y_p)$ and $(x_p, y_p \pm b)$ with (x_p, y_p) being the coordinates of the vertex of the ellipse.

It is known that the vertex of the ellipse is at $(\pm 6,0)$. From this, we get the center point at $(0,0)$ and $a = 6$.

Therefore, the equation of the ellipse is:

$$\frac{(x-x_p)^2}{a^2}+\frac{(y-y_p)^2}{b^2}=1$$

$$\frac{x^2}{36}+\frac{y^2}{25}=1$$

Geometry Transformation

Geometry transformation is one of the basic competencies that can be done through independent learning activities (Agusta, 2021). Geometry transformation is defined as a mapping of points on a plane to a set of points on the same plane. The types of transformations that can be done include: Reflection, Translation, Rotation and Dilation.

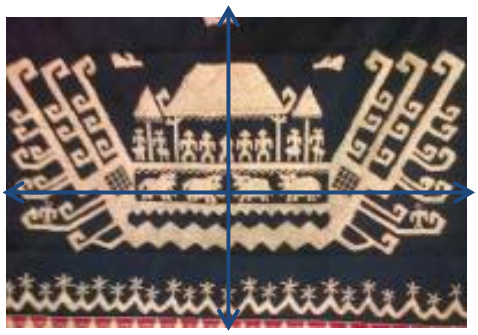


Figure 6 Ship Motif

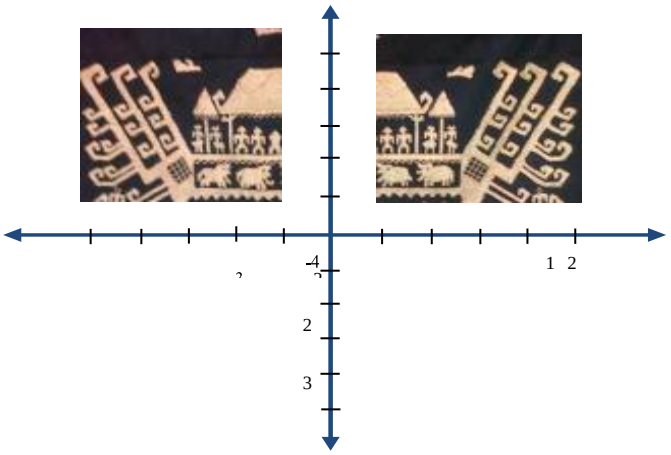
Based on Figure 6 the mathematical element contained in the ship motif is reflection. Reflection is a transfer or shift in all points on an object or wake towards a line/ mirror with the same distance. The image below shows a motif that is cut using the Y axis. the reflection properties applied to the ship motif are reflection of the Y axis.

Mirroring of the Y axis

$$P(x, y) \rightarrow p'(-x, y)$$

With mirroring matrix

$$P_y \begin{bmatrix} -1 & 0 \\ 0 & 1 \end{bmatrix} \text{ so } p'_y = \begin{bmatrix} -1 & 0 \\ 0 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix}$$



It is known that the ship motif above has a point R $(5,5)$ mirroring the Y axis so that the p' obtained is:

$$p'_y = \begin{bmatrix} -1 & 0 \\ 0 & 1 \end{bmatrix} \begin{bmatrix} 5 \\ 5 \end{bmatrix}$$

$$p'_y = \begin{bmatrix} -5 \\ 5 \end{bmatrix}$$

The result is $p'_y = (-5,5)$

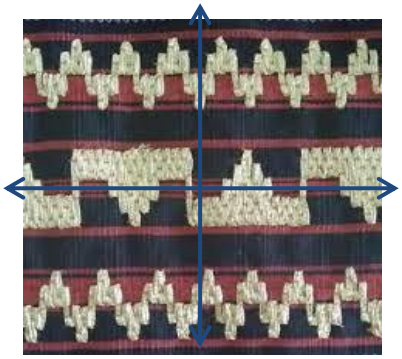
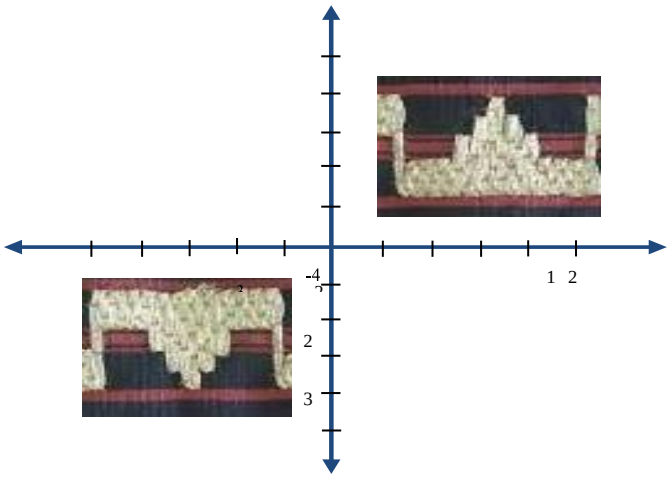


Figure 7. Pucuk Rebung Motif

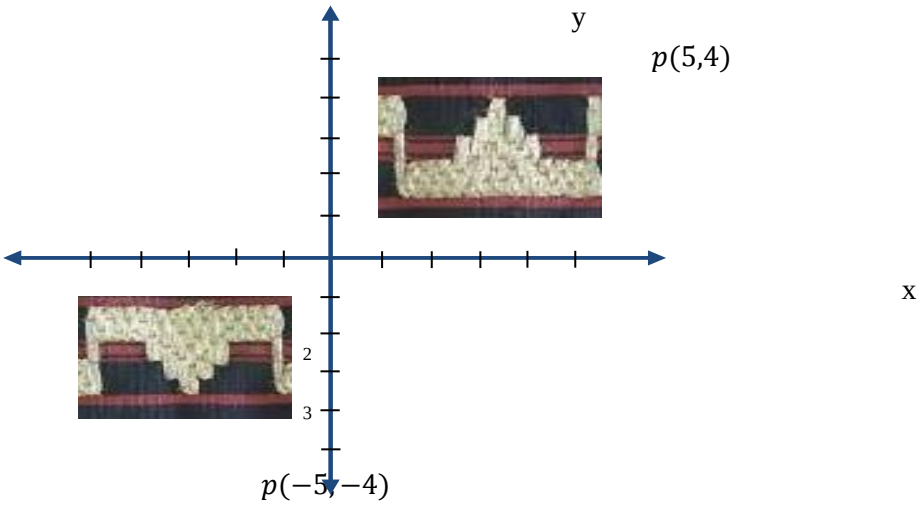
Based on Figure 7, the mathematical element contained in the pucuk rebung motif is rotation. Rotation is to rotate a point on each plane using a certain center point that has the same distance as each rotated point (radius). Rotation is also applied to the pucuk rebung motif which is described as follows:



In the picture, the pucung rebung motif is rotated by 180° with the center of rotation at point $O(0,0)$ on the cartesian coordinate.
Formulation of rotation with center $O(0,0)$:

$$P(x,y) \xrightarrow{R(0,90°)} p'(-y,x)$$
$$P(x,y) \xrightarrow{R(0,-90°)} p'(y,-x)$$
$$P(x,y) \xrightarrow{R(0,180°)} p'(-x,-y)$$

The picture below is a bamboo shoot motif that is rotated by 180°, so the following results are obtained:



Mirroring to point $O(0,0)$ of the bamboo shoot motif
Proven by the following formula:

$$\begin{bmatrix} x' \\ y' \end{bmatrix} = \begin{bmatrix} x\cos\theta & -y\sin\theta \\ x\sin\theta & y\cos\theta \end{bmatrix}$$

$$\begin{bmatrix} x' \\ y' \end{bmatrix} = \begin{bmatrix} x\cos 180° & -y\sin 180° \\ x\sin 180° & y\cos 180° \end{bmatrix}$$

$$\begin{bmatrix} x' \\ y' \end{bmatrix} = \begin{bmatrix} 5\cos 180° & -4\sin 180° \\ 5\sin 180° & 4\cos 180° \end{bmatrix}$$

$$\begin{bmatrix} x' \\ y' \end{bmatrix} = \begin{bmatrix} 5(-1) & -4(0) \\ 5(0) & 4(-1) \end{bmatrix}$$

$$\begin{bmatrix} x' \\ y' \end{bmatrix} = \begin{bmatrix} -5 \\ -4 \end{bmatrix}$$

Figure 8. Boat Motif

Based on Figure 8 the mathematical element contained in the boat motif is dilation. Dilation is a transformation that changes the distance of points with a certain scale factor at the center of a particular dilation. Dilation is a form of enlargement or reduction in transformation.

Figure 9. Single King Motif

Based on Figure 9, the mathematical element contained in the motif of the single king is translation. Translation or shift is a transformation that moves points with a certain

distance and direction. Translations only move without changing size without rotating. The motif of the riding animal on the single king tapis applies the concept of translation.

CONCLUSIONS

Based on the analysis and discussion that has been described, it can be concluded that Lampung has a large variety of cultures and customs. One of them is Lampung tapis cloth, in tapis cloth contains mathematical and cultural elements called ethnomathematics. The mathematical elements contained in the fabric motifs of Lampung tapis cloth include: triangles, rectangles, trapezoids, rhombuses, ellipses, reflections, rotations, translations and dilations. The mathematical elements contained in Lampung tapis fabric can be utilized by teachers to introduce mathematics to students through local culture. Thus, learning math in the classroom becomes more meaningful and fun. Mathematics that is considered abstract will become concrete if students have known the mathematical elements contained in the Lampung tapis cloth motif. In this case students can learn flat shapes and geometry transformations.

CONFLICT OF INTEREST

The authors of this manuscript declare that we are free from conflicts of interest regarding the publication of this manuscript. In addition, matters relating to violations of plagiarism, falsification of data and/or, duplication of publications, as well as matters relating to ethical issues of publication have been fully resolved and held accountable by the authors.

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