Analysis of Mathematical Concepts in the Angkar Motif of Sipirok Woven Fabric: an Ethnomathematical Study

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Abstract

Mathematics is a fundamental science that plays an important role in education and technological development. It covers a wide range of abstract material using symbols and variables, which often causes students to have difficulty understanding it. The purpose of this study is to identify mathematical concepts found in the angkar motifs of Sipirok woven fabrics. This study uses a descriptive qualitative research method with an ethnographic approach to interpret the mathematical concepts of sipirok weaving in angkar motifs. This study was conducted in Pangurabaan Village, Sipirok Subdistrict, South Tapanuli Regency, North Sumatra. The research subject was a weaver, and the research object was the angkar motif on Sipirok woven fabric. Data were collected through observation, interviews, and documentation. Data analysis used Miles & Huberman's data analysis, including data collection, data reduction, data presentation, and data verification decision making. The results of the study show that there are mathematical concepts in the motifs of Sipirok woven fabrics, such as the concepts of flat geometry (such as rectangles, squares, triangles, and rhombuses) and the concepts of geometric transformation (such as reflection and translation). Based on these findings, educators can consider developing teaching materials based on local culture and strengthen the role of ethnomathematics in enriching contextual learning that values Indonesian regional culture. In addition, future researchers can explore ethnomathematics in other cultures that have not yet been explored.

Keywords: *Ethnomathematics; Angkar Motifs; Sipirok Weaving; Mathematics.*

Abstrak

Matematika sebagai ilmu dasar yang berperan penting dalam dunia pendidikan dan perkembangan teknologi yang memiliki cakupan materi yang luas serta bersifat abstrak karena menggunakan simbol dan variabel, sehingga sering kali menimbulkan kesulitan pemahaman bagi siswa. Tujuan penelitian ini untuk mengidentifikasi konsep-konsep matematika yang terdapat pada motif angkar kain tenun sipirok. Penelitian menggunakan metode penelitian kualitatif deskriptif dengan pendekatan etnografi untuk menafsirkan konsep matematika tenun sipirok pada motif angkar. Penelitian ini dilaksanakan di Desa Pangurabaan, Kecamatan Sipirok, Kabupaten Tapanuli Selatan, Sumatera Utara. Subjek penelitian adalah seorang pengrajin tenun, dan objek penelitian ini yaitu motif angkar pada kain tenun sipirok. Data dikumpulkan melalui observasi, wawancara, dan dokumentasi. Analisis data menggunakan analisis data Miles & Huberman diantaranya adalah pengumpulkan data, mereduksi data, penyajian data, dan pengambilan keputusan data verifikasi. Hasil Penelitian menunjukkan adanya konsep matematika pada motif angkar tenun sipirok seperti konsep

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geometri bangun datar (seperti persegi panjang, persegi, segitiga, dan belah ketupat); dan konsep geometri transformasi (seperti refleksi dan translasi). Berdasarkan temuan ini, dapat memberikan para pendidik dalam mempertimbangkan dalam mengembangkan bahan ajar berbasis budaya lokal, serta memperkuat peran etnomatematika dalam memperkaya pembelajaran yang kontekstual dan bernilai budaya daerah Indonesia. Selain itu, untuk peneliti selanjutnya dapat mengekplorasi etnomatematika pada budaya lain yang belum ditelusuri.

Kata Kunci: Etnomatematika; Motif Angkar; Tenun Sipirok; Matematika.

INTRODUCTION

Every formal school will teach mathematics starting from the lowest level, namely kindergarten, such as learning numbers and simple arithmetic operations, and the levels above it, from elementary school to high school and beyond to higher education, will continue to teach mathematics in accordance with the needs of each level of formal schooling. Mathematics is a basic science that plays an important role in education and technological development. It has a broad scope of material and is abstract in nature because it uses symbols and variables, which often causes difficulties in understanding for students. Mathematics is a compulsory subject in school(Lubis et al., 2023; Septiana et al., 2023).

Mathematics is a basic science that has objective truths and functions as a symbol and deductive discipline that is systematically arranged through elements, axioms, and principles, so mastery of its basic concepts is very important in the learning process because it plays a role in training and developing students' critical thinking skills gradually to solve various mathematical problems (Rahmaini & Ogylva Chandra, 2024; Safari & Nurhida, 2024; Siswanto & Meiliasari, 2024). Learning that is oriented towards numbers, formulas, and procedures will cause students to lose the meaning of what they are learning. In fact, mathematical concepts are easy to find in various daily activities, especially in cultural activities and products such as traditional dances, traditional buildings, traditional clothing, and many more.

One application of mathematical concepts in our daily lives is the value of mathematics in society's culture. Culture-based mathematics learning is an

innovative, interesting, and meaningful learning alternative because it links mathematical concepts to students' contextual experiences as part of a cultural society, thereby encouraging students' active involvement in supporting the educational process (Dinarti et al., 2023). Without us realizing it, we have applied mathematical concepts to the culture of our society. The approach that has been created from linking culture with mathematics in everyday life is ethnomathematics.

Ethnomathematics is a concept derived from the terms (Ethno, Mathema, and Tics) introduced by D'Ambrosio in 1977, which refers to the study of mathematics as knowledge that develops and is practiced in specific cultural contexts such as tribes/community groups that reflect the ideas, procedures, activities, and mathematical technologies used in the cultural life of these communities (Hepy et al., 2025; Kapitan & Liliana, 2025; Rahayu et al., 2020). Ethnomathematics is a study that examines how people in a particular culture understand, articulate, and use concepts and practices that describe something mathematical (Merdja & Restianim, 2022). Ethnomathematics studies how communities apply mathematical concepts in cultural activities, traditions, and cultural works. With the ethnomathematics approach, mathematics learning will become more contextual and meaningful because students learn from their surroundings and the culture they already know. In line with this, the ethnomathematics approach is able to create an interactive and enjoyable learning environment that has a positive impact on student learning outcomes (Khaerani et al., 2024).

Indonesia has many cultures, such as Javanese, Malay, Minang, and many more. Each culture has its own cultural treasures, such as woven fabrics, batik, carvings, and textiles. Behind all of these are mathematical concepts that we need to explore. One of them is sipirok woven fabric, a cultural heritage of the Angkola people in South Tapanuli. Sipirok woven fabric has attractive motifs that showcase its beauty. In addition, there are mathematical elements that are arranged in an orderly manner, but the mathematical values contained in the woven fabric motifs have not been studied in depth.

The study (Fahrezi & Ginting, 2023) discusses ethnomathematics to explore mathematical concepts in Sipirok weaving motifs (typical of Angkola), including rose motifs, circular rose motifs, singap motifs, hiok-hiok motifs, pusuk robung motifs, and space motifs. In addition, the study (Siregar & Rakhmawati, 2023) also discusses the same thing, but the motifs discussed are only angkar motifs, and the researchers only discuss mathematical concepts in the form of geometry, namely rhombuses. Thus, this study aims to fill this gap in analyzing the mathematical concepts found in angkar motif sipirok woven fabrics through ethnomathematics studies. The purpose of this study is to identify the mathematical concepts found in the angkar motif of sipirok woven fabric. The results of this analysis are expected to become the basis for developing locally-based mathematics teaching materials and strengthening the role of ethnomathematics in enriching contextual learning that has cultural value for the regions of Indonesia.

RESEARCH METHODS

The research used a descriptive qualitative research method with an ethnographic approach to interpret the mathematical concept of Sipirok weaving in angkar motifs. Ethnography is a term derived from the words Ethnos (nation) and graphy (writing), which can be interpreted as a scientific approach in cultural studies conducted through systematic data collection to describe and analyze the way of life, social activities, and artifacts/cultural objects of a community (Sumartono, 2022). This research was conducted in Pangurabaan Village, Sipirok Subdistrict, South Tapanuli Regency, North Sumatra. The research subject was a weaver, and the research object was the angkar motif on Sipirok woven fabric. Data was collected through observation, interviews, and documentation. The collected data were analyzed using Miles & Huberman's data analysis (Merdja & Restianim, 2022), including data collection, data reduction, data presentation, and data verification decision making.

RESULTS AND DISCUSSION

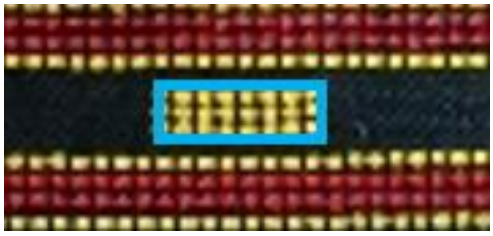
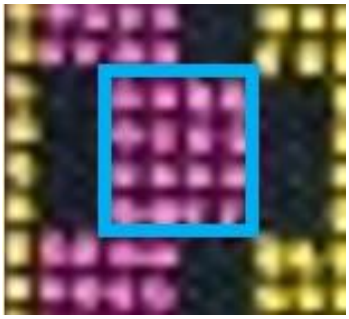
RESULTS

The researcher visited a weaving workshop in the village of Pangurabaan, Sipirok subdistrict, South Tapanuli regency, North Sumatra. These weavers have been weaving there for generations, as was the case with the weavers the researcher encountered. The weavers use non-mechanical looms to make and produce woven fabrics. Based on observations and interviews with the weavers, it was found that there are many woven fabrics produced with various weaving motifs, one of which is the angkar motif as shown in Figure 1, which contains mathematical elements.

Figure 1. Angkar Motifs in Sipirok Weaving

After data collection and reduction, mathematical elements that can be analyzed were found in angkar motifs, such as plane geometry and 2-dimensional transformation geometry. Plane geometry is a shape that has length and width, is bounded by lines or curves, and has properties such as sides, angles, area, and perimeter, without volume. The types of plane geometry found in angkar motifs are rectangles, squares, triangles, and rhombuses, as shown in Table 1.

Table 1. Images and Types of Flat Geometric Shapes

Flat Geometric Shapes	Types of Flat Geometric Shapes
	Rectangle
	Square
	Triangle
	Rhombus

Two-dimensional transformation geometry is the change in position, size, or shape of a geometric object (point, line, plane) to a new position using certain rules. The types of two-dimensional transformation geometry found in angkar motifs, namely reflection and translation, can be seen in Table 2.

Table 2. Images and Types of 2-Dimensional Geometric Transformations

2-Dimensional Geometric Transformation Images	Types of 2-Dimensional Geometric Transformations
	Reflection
	Translation

DISCUSSION

The results of this study indicate the presence of mathematical concepts in the angkar motifs on Sipirok woven fabrics, including the concepts of flat geometry and 2-dimensional transformation geometry. Based on the results of the study, the concept of flat geometry discusses types of flat shapes such as rectangles, squares, triangles, and rhombuses.

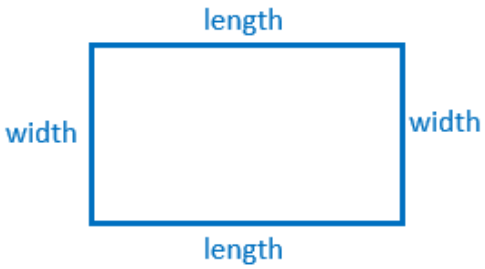


Figure 2. Rectangle

A rectangle (figure 2) has two pairs of parallel sides of equal length and four right angles. We can find rectangles around us, such as on blackboards, doors, and so on. To find the area and perimeter of a rectangle, we need to use the formulas Area = length × width and Perimeter = 2(length × width).

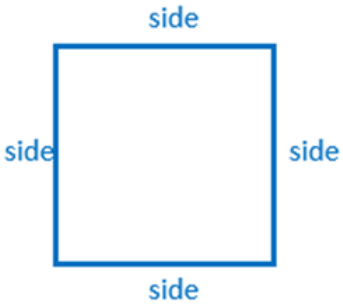


Figure 3. Square

A square (figure 3) has four sides of equal length and four right angles. We can find squares around us, such as in a 3x3 Rubik's cube, a chessboard, and so on. Similar to a rectangle, a square also has formulas for its area and perimeter, where area = side × side and perimeter = 4 × side.

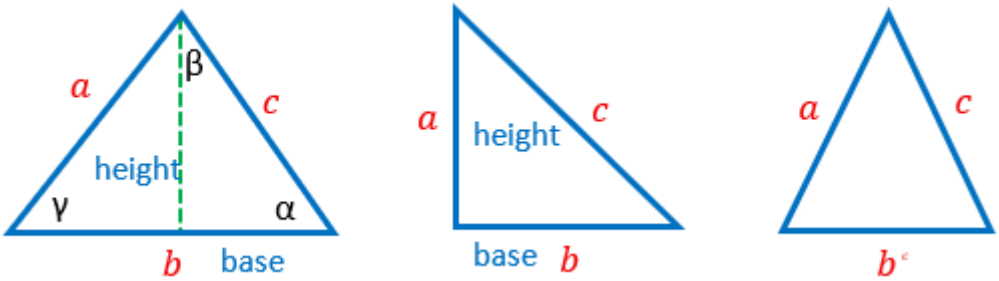


Figure 4. Equilateral Triangle (Left); Right-Angled Triangle (Center); Isosceles Triangle (Right)

Furthermore, a triangle (figure 4) also has three sides and three angles. There are many types of triangles, such as: 1) equilateral triangles, which have sides of equal length and therefore have angles of equal size; 2) isosceles triangles, which have two sides of equal length; 3) right-angled triangles, which have an angle forming a right angle, where the angle size is 90°. We often encounter triangles around us, such as on warning signs, symbols, and so on. Triangles have a base and height, so to find the area $= \frac{1}{2} \times (\text{base} \times \text{height})$ and the perimeter = the sum of all sides of the triangle. To find the length of the sides and angles, as shown in Figure 2 of an equilateral triangle, we can use the formula

$\frac{a}{sin\ \alpha} = \frac{b}{\sin\beta} = \frac{c}{\sin\gamma}$. The Pythagorean theorem only applies to right triangles, and the equations are $c = \sqrt{a^2 + b^2}$; $a = \sqrt{c^2 - b^2}$; and $b = \sqrt{c^2 - a^2}$.

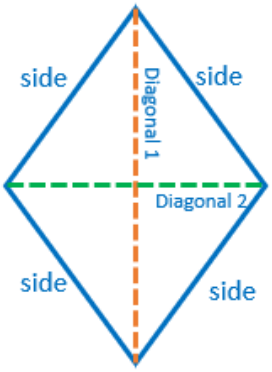


Figure 5. Rhombus

Finally, a rhombus (figure 5) has four sides of equal length, two diagonals that intersect at equal lengths, and angles that are not right angles. Rhombuses are also often found in ornamental motifs, etc. The formulas for calculating its area and perimeter are: Area $= \frac{1}{2} \times (diagonal\ 1 \times diagonal\ 2)$ and Perimeter = 4 × side.

The concept of 2-dimensional geometric transformations based on research results discusses types of geometric transformations such as reflections and translations. Reflection is a geometric transformation that moves each point of an object to a new position at a certain distance and direction relative to a line or reference point, resulting in a symmetrical image like a mirror, as shown in Figure 6.

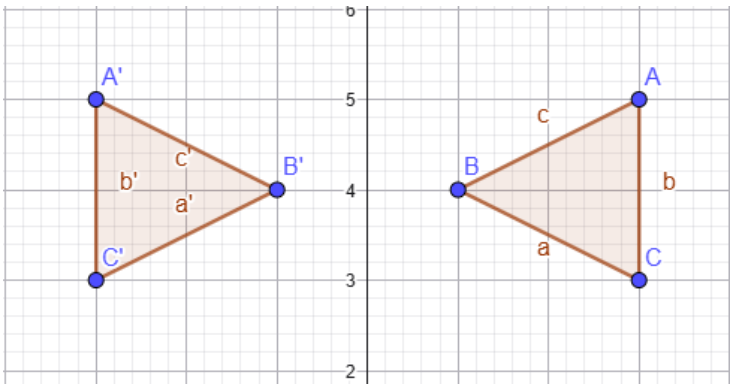


Figure 6. Reflection

Translation is a geometric transformation in the form of shifting an object, which is expressed as the displacement of each coordinate point of the object in a certain direction and distance without changing the shape and size of the object, as shown in Figure 7.

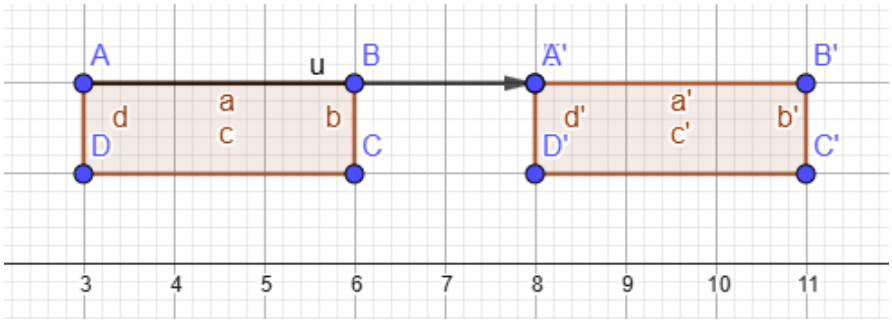


Figure 7. Translation

In this independent curriculum, the concept of flat geometry is studied from elementary school to high school, and each level has a different focus. Meanwhile, the concept of transformational geometry is introduced in junior high school to high school. The concepts of 2-dimensional geometry and transformational geometry are better linked to the surrounding culture in order to encourage students to understand the material being taught. In line with the research (Yusminah et al., 2025), it states that there is an increase in students' creativity with the use of ethnomathematics using sipirok woven fabric patterns. Thus, learning mathematics using ethnomathematics on woven fabrics can support better learning.

CONCLUSION

Based on these results and discussions, researchers can conclude that, as per the research objective to identify mathematical concepts found in Sipirok woven fabric motifs, flat geometry concepts (such as rectangles, squares, triangles, and rhombuses) and 2-dimensional transformation geometry concepts (reflection and translation) were found in Sipirok woven fabric motifs. From this study, it was found that Sipirok weavers always apply mathematical concepts in creating accurate Sipirok woven fabric motifs, making these fabrics attractive to

many people. Thus, the ethnomathematics approach can encourage us to continue learning mathematics from our surroundings, such as the angkar motifs on Sipirok woven fabrics.

Based on these findings, educators can consider developing teaching materials based on local culture and strengthening the role of ethnomathematics in enriching contextual learning that reflects the cultural values of Indonesia. In addition, future researchers can explore ethnomathematics in other cultures that have not yet been studied.

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