



ETHNOMATHEMATICS IN ULOS ABIT GODANG OF SOUTH TAPANULI, NORTH SUMATRA

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ABSTRACT

This research explores ethnomathematics, particularly the relationship between geographical culture and the use of mathematics, focusing on Ulos Abit Godang from South Tapanuli, North Sumatra. As a cultural heritage object, Ulos Abit Godang provides a unique context for analyzing the correlation between mathematical principles and local culture. A qualitative descriptive methodology with ethnographic techniques was adopted to understand the interaction between mathematical concepts and cultural context. The findings reveal a connection between the ideas of set theory and geometric transformation in the Ulos Abit Godang culture. Thus, Ulos Abit Godang of South Tapanuli holds significant ethnomathematical elements, linking cultural heritage to mathematical concepts. These insights offer valuable educational contributions, enriching ethnomathematical methods in teaching mathematics to enhance student creativity and engagement. Future research is suggested to develop similar studies on other cultural artefacts in Indonesia and integrate them into the mathematics education curriculum to enrich student learning experiences.

ETNOMATEMATIKA PADA ULOS ABIT GODANG KHAS TAPANULI SELATAN SUMATERA UTARA

ABSTRAK

Penelitian ini mengeksplorasi etnomatematika, khususnya hubungan antara budaya geografis dengan penggunaan matematika, berfokus pada Ulos Abit Godang dari Tapanuli Selatan, Sumatera Utara. Sebagai objek warisan budaya, Ulos Abit Godang menyediakan konteks unik untuk menganalisis korelasi antara prinsip-prinsip matematika dan budaya lokal. Metodologi deskriptif kualitatif dengan teknik etnografi diadopsi untuk memahami interaksi antara konsep matematika dan konteks budaya. Hasil penelitian menunjukkan keterkaitan antara gagasan himpunan dan transformasi geometri dalam budaya Ulos Abit Godang. Dengan demikian, Ulos Abit Godang Tapanuli Selatan memegang unsur etnomatematika yang signifikan, menghubungkan warisan budaya dengan konsep matematika. Temuan ini menawarkan wawasan berharga untuk pendidikan, memperkaya metode etnomatematika dalam pengajaran matematika untuk meningkatkan kreativitas dan keterlibatan siswa. Saran untuk penelitian selanjutnya adalah mengembangkan studi serupa pada artefak budaya lain di Indonesia serta integrasinya dalam kurikulum pendidikan matematika untuk memperkaya pengalaman belajar siswa.

Kata Kunci:

Etnomatematika

Konsep Matematika

Ulos Godang khas Tapanuli Selatan

1. INTRODUCTION

Mathematics is widely recognized as a discipline within the exact sciences, necessitating diligent learning to achieve anticipated educational objectives [1]. It significantly influences cognitive development and logical reasoning skills [2]. Furthermore, mathematics is broadly considered the fundamental foundation of all knowledge domains due to its extensive application in daily activities. In the classroom, several issues commonly arise during the mathematics learning process. These include students' lack of initial ability and difficulties comprehending mathematical materials, often due to the ineffectiveness and monotony of teachers' instructional methods [3]. Therefore, teachers must solve these challenges in mathematics education [4]. This research, conducted at SMK Negeri 1 Portibi with 332 students, of which 32 did not experience mathematical difficulties, and 300 did, seeks to find learning solutions to make mathematics less challenging, utilizing mathematical concepts. Mathematical concepts, the basic ideas or principles underlying understanding and skills in mathematics, form the backbone for comprehending the subject. Key mathematical concepts include numbers, arithmetic operations, algebra, geometry, and statistics. These concepts enable problem-solving, calculations, and predictions, essential in daily life and science and technology fields. With mathematical concepts, we can also develop cognitive abilities, such as thinking, expanding knowledge, and systematically solving problems.

One solution to such issues is reevaluating the instructional approaches used [5]. Teaching methods encompass activities conducted by educators to determine the trajectory of the learning process [6]. To enhance student motivation in educational content delivery, it is crucial to use engaging and enjoyable pedagogical methods. The application of anthropological methodology, particularly in mathematics, commonly called ethnomathematics, is an intriguing avenue to explore. Ethnomathematics is an academic field that investigates the interaction between mathematics and culture. It examines how people in a culture utilize mathematics in activities like counting, calculating, measuring, etc., and how mathematical patterns are found in cultural elements like art, music, and architecture [7].

Ethnomathematics also explores how the use and application of mathematics in specific cultures can enrich our understanding of mathematics. Today, ethnomathematics is seen as an effort to transform how we learn mathematics from what is typically associated with formal learning and decontextualize it into a learning culture more integrated with everyday life and culture. It involves understanding information and solving problems systematically [8].

Ethnomathematics is a pedagogical technique that integrates mathematical concepts by establishing connections between the cultural context of a specific region and mathematical studies [9]. This approach recognizes that cultural factors can influence how mathematics is perceived and understood during educational activities [10]. Beyond its unique impression, the application of ethnomathematics is also considered to enhance students' learning abilities about a cultural object linked with mathematical science, offering a distinctive aspect. Mathematics and ethnomathematics are interconnected as the latter studies the use and function of mathematics in specific cultures or societies. Ethnomathematics seeks mathematical models used in particular cultures to provide a deeper understanding of mathematics [11].

For instance, mathematical operations and problem-solving have been employed in many cultures for centuries to manage land usage systems, measure livestock, and allocate crop yields, illustrating specific mathematical concepts. Additionally, ethnomathematics provides a global perspective on mathematics as a discipline, showing how mathematical

knowledge has evolved in different ways across various cultures worldwide. In this way, mathematical knowledge can be considered universal and deeply related to specific cultures and contexts. Several scientific investigations have been conducted on the principles of ethnomathematics related to Indonesian culture, a country characterized by diverse regions, each with distinct cultural traditions [12]-[14].

North Sumatra Province is renowned for its cultural, ethnic, and customary diversity [15]. Cultural differences across various districts can be observed by analyzing several small cases. The province comprises a total of 25 districts and eight municipalities. South Tapanuli stands out for its distinctive and diverse local cultural heritage among the various districts in North Sumatra Province.

South Tapanuli, geographically bordered by Central Tapanuli and North Tapanuli to the north, Padang Lawas and North Padang Lawas to the east, and Mandailing to the west and south covers an area of approximately 444,482.30 hectares, including 15 sub-districts and 503 villages [16]. Given its vast geographic spread, it is undeniable that South Tapanuli harbours diverse civilizations, tribes, and customs. The East Angkola and Mandailing tribes are widely recognized as the most influential in South Tapanuli, which is evident in the region's numerous Mandailing cultural artefacts and traditions. The area is home to various prominent artefacts related to the Batak Mandailing tribe, including historical buildings, traditional clothing, customary laws, Ulos Abit Godang, and other significant cultural objects easily found in the region.

The Ulos Abit Godang of South Tapanuli is considered an essential artefact that provides evidence of the Mandailing cultural civilization in the region. Ulos Abit Godang, one of the critical traditional weavings from the Mandailing culture, signifies the unique cultural identity of the Mandailing tribe, especially in South Tapanuli [17]. Made using coloured silk or cotton threads manually woven with traditional tools, the fabric's motifs represent various aspects of Batak Mandailing society's life and philosophy, such as beliefs and religious ceremonies, the universe, and social and life values [18], [19].

This large fabric is typically used as a shawl for customary and religious ceremonies, like weddings, funerals, and bathing rituals [20]. Its use is considered a symbol of the Batak, particularly Mandailing cultural identity, and also holds high aesthetic value due to its beautiful and attractive motifs [21].

The research findings indicate a correlation between the distinctive features of South Tapanuli's Ulos Abit Godang and various mathematical learning sources. Therefore, phenomena like this form the basis for researching to emphasize the importance of South Tapanuli's Ulos Abit Godang as a subject matter in ethnomathematics, enhancing the appeal of mathematics education.

Research related to ethnomathematics on Ulos has been extensively conducted, including ethnomathematics on Ulos mats for the concept of sets [22], ethnomathematics of Batak Toba Ulos for mathematical concepts [23], ethnomathematics of Ulos Hela of the Batak Toba tribe for plane figures [24], and ethnomathematics of Ulos Sadum for the concept of plane geometry [25]. However, no ethnomathematics research has discussed the specific Ulos Abit Godang of South Tapanuli.

The primary objective of this study is to understand the correlation between the ethnomathematics found in South Tapanuli's Ulos Abit Godang and its utilization of mathematical principles. As previously explained, prior research has not delved into the field of ethnomathematics concerning the Ulos Abit Godang found in South Tapanuli, North Sumatra. This scholarly paper serves as a valuable reference for mathematical studies, focusing specifically on its application in educational settings, particularly in the North Sumatra region.

2. METHODS

This study employed a qualitative descriptive methodology using an ethnographic approach. Scholars typically utilize ethnographic methodologies to elucidate, depict, and examine the cultural components of a specific community or ethnic collective [26]. This research aimed to explore concepts encompassed within certain cultural components. Qualitative research is a methodological approach focused on understanding phenomena experienced by individuals who are subjects of a research study [27]. Descriptive research is conveyed through verbal and visual means rather than numerical representations [28]. The primary instrument in this research was the human instrument, where the researcher played a central, irreplaceable role [29].

The research was conducted at the Gedokan weaving production facility. The main methods for data collection included observational practices and documentation. The interviewees for this research were the owners of the Gedokan weaving house, who have comprehensive knowledge of the cultural elements inherent in the Sipirok Tapanuli Selatan traditional Ulos Abit Godang weaving. The research was conducted by observing the Ulos Abit Godang weaving artefacts at the Gedokan weaving house in Sipirok Tapanuli Selatan. Indirect observations were also made by reviewing existing references, such as scientific articles on Google Scholar discussing the Ulos Abit Godang weaving artefacts. A survey was conducted on students at SMK Negeri 1 Portibi. The validation process for interview instruments and observation sheets was carried out in collaboration with research lecturers. Further data collection methods included conducting literacy studies on scientific publications featured in academic journals, seminar proceedings, and theses.

This study utilized Spradley's data analysis technique, which involves sequential processes, including the analysis of cultural domains, cultural taxonomy, cultural components, and cultural themes [2].



Figure 1. Research Flowchart

3. RESULTS AND DISCUSSION

Ulos Abit Godang is a cultural artefact used in traditional ceremonies. This fabric, a type of Sipirok weaving, is adorned with paintings in specific colour patterns. Among the Angkola tribe, Ulos Abit Godang is considered a heritage item, as it is acquired only a few times in one's life. The research on Ulos Abit Godang revealed numerous motifs. These motifs can be associated with the following concepts of sets and geometric transformations.

3.1 The Concept of Sets in Ulos Abit Godang Motifs of South Tapanuli

A set is a collection of distinct objects clearly defined [30]. In Ulos Abit Godang, several motifs are used and recognized, including rambu, beaded si mata rambu, surat, jarak, pusuk rombung, lus-lus, tutup mumbang, iran-iran mata pune, jojak mata-mata, iyok-iyok mata pune, ruang, si jobang, singap, horas tondi madingin sayur matua bulung, bunga, suri-suri, bintang, dalihan na tolu, togu. Here are some explanations of the relationship between the set concept and the motifs of Ulos Abit Godang of South Tapanuli.



Figure 2. Motifs of Ulos Abit Godang in South Tapanuli

The common weaving motifs used in South Tapanuli's Ulos Abit Godang can be associated with the concept of sets. The subset identified here includes various patterns: P (common weaving motifs) = {rambu, beaded si mata rambu, surat, jarak, pusuk rombung, lus-lus, tutup mumbang, iran-iran mata pune, jajak mata-mata, iyok-iyok mata pune, ruang, si jobang, singap, horas tondi madingin sayur matua bulung, bunga, suri-suri, bintang, dalihan na tolu, togu}. Therefore, $P(n) = 19$. Motifs depicting living beings used in Ulos Abit Godang can be related to the concept of subsets, registered as Q (motifs of living beings) = {pusuk bombing, tutup mumbang, iran-iran mata pune, iyok-iyok mata pune, sijobang, bunga}. Thus $Q(n) = 6$. Motifs of inanimate objects in Ulos Abit Godang can also be linked to subsets: R (motifs of inanimate objects) = {rambu, surat, togu, bintang}, leading to $R(n) = 4$. Similarly, motifs depicting the surrounding environment in Ulos Abit Godang are associated with subsets: S (environment-related motifs) = {jarak, jajak mata-mata, lus-lus, singap, dalihan na tolu, suri-suri, horas tondi madingin sayur matua bulung, ruang, beaded si mata rambu}, resulting in $S(n) = 9$.

In mathematical set theory, various sets exist, such as universal sets, subsets, and empty sets [20]. In Ulos Abit Godang, the universal set is P (common weaving motifs), encompassing all the subsets described. The subsets are categorized motifs like Q (living being motifs), R (inanimate object motifs), and S (environment-related motifs) [31]-[33].

3.2 Concept of Geometric Transformation in Ulos Abit Godang Motifs of South Tapanuli

The concept of geometric transformation refers to the alteration of position and scale of a point, line, plane, or curve, represented graphically or in matrix form [34]. Ulos Abit Godang of South Tapanuli displays various motifs associated with geometric transformations, including transformations, translations, and reflections. These motifs can be grouped into seven examples: floral motif, pusuk rombung, iran-iran mata pune, Ruang, Singap, and Sijobang.

All these concepts in geometric transformation relate to motifs in Ulos Abit Godang of South Tapanuli. Learners can be encouraged to identify motifs and analyze their correlation with relevant geometric transformation concepts [35]. This approach provides both cultural insight and a more profound understanding of mathematics to the learners [36], [37].

3.3 Translation

Translation can be defined as a geometric transformation involving the displacement of a specific point along a straight line, following a predetermined direction and distance [38], [39]. Subsequent comprehensive testing of mathematical principles in Ulos Abit Godang of South Tapanuli reveals practical implementations of geometric translation.



Figure 3. Geometric Transformation in the Pusuk Rombung Motif

Figure 3 includes an image of the Pusuk Rombung motif. The Pusuk Rombung motif, symbolized by the bamboo shoot known as 'robung', rapidly grows and soars skyward [40]. The research reveals that this motif incorporates principles of geometric translation. This is evident from the observed movement in the motif's plane, where the transferred motifs maintain uniformity in shape, size, direction, and distance. The gap between two shifted elements in this motif is approximately 3 cm/4 cm, equivalent to the width of two fingers. Additionally, this motif exhibits bilateral symmetry with a two-fold rotational symmetry.



Figure 4. Geometric Transformation in the Iran-Iran Simata Pune Motif

Figure 4 includes an image of the Iran-Iran Simata Pune motif. This motif, resembling a flower and embellished with brightly coloured beads, features distinct characteristics in each scattered flower. The Iran-Iran Simata Pune motif reminds the Abit owner to respect and honour the surrounding tribes and cultures [40]. The findings show that the Mata Pune Iran-Iran pattern applies geometric translation principles. This is visible in the motif's plane, showing consistent movement while maintaining uniform shape, size, direction, and distance features. The Mata Pune Iran-Iran motif exhibits a gap of about 3 cm - 4 cm, akin to the span of two fingers. It features distinctive bilateral symmetry with folds along its central axis.

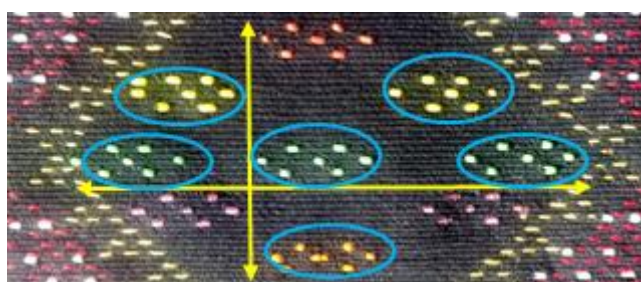


Figure 5. Geometric Transformation in the Singap Motif

Figure 5 includes an image of the Singap motif. The Singap motif resembles an ancient house with a single-roofed carriage called 'berabung satu'. The top is triangular and covered, known as 'adop-adop', which faces challenges from various weather elements. The Singap motif symbolizes 'dalihan na tolu' and represents resilience, independence, and a 'better destroyed than surrender' attitude [40]. Observations indicate that the Singap motif incorporates geometric translation principles, evident in the consistent characteristics of the motifs' shape, size, direction, and distance movement. The gap between two moving shapes in this motif ranges from 80cm to 90cm, following the size of the Abit Godang.

3.4 Reflection

Reflection is a geometric transformation involving the movement of a shape such that the distance between the point of movement and the mirror equals the distance between the origin point and the mirror [38]. In analyzing mathematical principles on the Ulos Abit Godang of Tapanuli Selatan, several observations were made about the practical application of geometric reflection concepts.

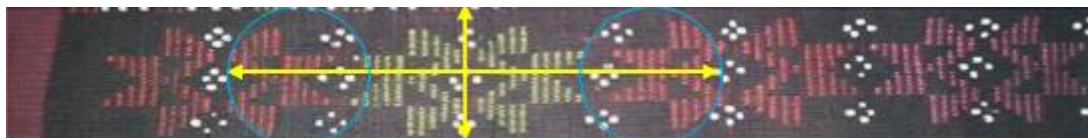


Figure 6. Geometric Transformation in the Floral Motif

Figure 6 includes an image of the floral motif, resembling a beautiful and visually appealing rose, found in the Ulos Abit Godang of South Tapanuli. In the local South Tapanuli language, the term for flower is 'jagar-jagar', which has cultural significance, denoting purity and nobility, essential virtues in life [40]. Observations suggest that this motif incorporates principles of geometric reflection, where each point on the plane reflects an object along a specific line. The length of the floral motif measures approximately 80 cm – 90 cm.



Figure 7. Geometric Transformation in the Si Jobang Motif

Figure 7 illustrates the Si Jobang motif, resembling the feathers of the exquisite Uwo bird. This motif symbolizes diligence and cleanliness in joyous and sorrowful community events [40]. The observation indicates that the Si Jobang motif adheres to geometric reflection principles. Each point on the plane reflects an object along a predetermined line. The Si Jobang motif measures approximately 80 - 90cm in length and about 7cm in height.

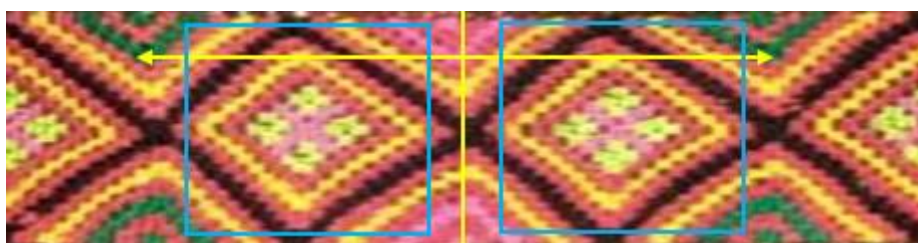


Figure 8. Geometric Transformation in the Space Motif

Figure 8 depicts a space motif with a pattern resembling snake scales. This motif serves as a reminder to be cautious in speech and actions. It signifies that one should not act recklessly and be careful in social interactions, as beauty can bring benefits and dangers. Observations reveal that this motif adheres to the principles of geometric reflection. Specifically, each point on the object's plane displays a reflection along a predetermined line. The space motif measures approximately 80cm to 90cm in length, with a height ranging from 3cm to 4cm. The findings of this study can be implemented in education to introduce students to local culture and the idea that mathematics can be learned from everyday life. Various patterns in the ulos motif hold significant meanings and mathematical elements, as previously explored in research on the ethnomathematics

of the Batak Toba ulos, which found geometric principles within [23]. These findings align with the current research that in ulos (in this study, abit godang), particularly geometric values, are present. These insights offer valuable educational contributions, enriching ethnomathematical methods in teaching mathematics to enhance student creativity and engagement. Future research is suggested to develop similar studies on other cultural artefacts in Indonesia and integrate them into the mathematics education curriculum to enrich student learning experiences.

4. CONCLUSION

The research findings on each analyzed motif aspect indicate a correlation between the ulos abit godang motifs and the concept of ethnomathematics. Identifying ethnomathematics reveals that the Ulos Abit Godang Khas Tapanuli Selatan applies mathematical concepts in its weaving motifs. Specifically, cultural practices involve using set theory and geometric transformations, such as translation and reflection. These findings can be implemented in education, especially in mathematics learning in the Padang Lawas Utara District. This research aims to inspire the development of innovative pedagogical approaches that enhance student engagement and enjoyment in the learning process. Specifically, this study seeks to introduce students to interdisciplinary learning experiences that integrate cultural studies with mathematics education. By contextualizing mathematical concepts within a cultural framework, it is hoped that students previously disinterested in mathematics will develop a new enthusiasm for the subject. Furthermore, ethnomathematics demonstrates how mathematical patterns in cloth can be applied in everyday life in the Batak society, particularly in Mandailing, such as in customary ceremony calculations and harvest distribution. This illustrates how mathematics in the Batak, especially in Mandailing culture, impacts social, cultural, and religious contexts, highlighting the importance of ethnomathematics in preserving the culture and traditions of a community.

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