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Exploration of Ethnomathematics in the Design of Mandailing Natal Traditional Houses as a Learning Resource

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ABSTRACT

Education and culture are inseparable, much like two sides of a coin. Ethnomathematics emerges to bridge the gap between education and culture, particularly in the context of mathematics learning. Surprisingly, without realizing it, the mandailing community has long been applying mathematical concepts, as can be seen in the architecture of the bagas godang in mandailing natal. The aim of this research is to explore and describe the mathematical concepts found in the structure and ornaments of the bagas godang. This study adopts a qualitative research design with an ethnographic approach. The elements of the building, such as fences, windows, roofs, roof ornaments, house structure, pillars, and stairs in the bagas godang, contain mathematical concepts, namely geometry and odd numbers, which can be utilized as a means of teaching mathematics.
Keywords: *ethnomathematics, mandailing natal traditional house, geometry, odd numbers.*

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INTRODUCTION

Fundamentally, students acquire their initial learning from their immediate environment, including mathematics education (Litiloly et al., 2020). It is crucial for Indonesian teachers to engage in innovative mathematics instruction to ensure an effective transfer of knowledge. As such, mathematics educators should explore mathematical concepts that can be linked to the students' surrounding environment. The utilization of concrete and observable phenomena facilitates students' comprehension of the learning materials. Furthermore, the incorporation of instructional aids during the learning process fosters better understanding and enhances the overall learning experience. One exemplary teaching approach that teachers can employ is integrating local culture into mathematics instruction (Nugraha & Sundayana, 2014).

In society, the importance of education and culture in carrying out daily activities is undeniable, as these two elements are inseparable (Hardiarti, 2017). Education is defined as a fundamental necessity for each individual in societal life, while culture represents the customs and way of life embraced by a group of people, passed down through generations (Mar et al., 2021). Indonesia, a country with diverse ethnic groups, utilizes culture as a symbol or distinctive feature of each region. The country showcases a wide range of cultural diversity, evident in various dance forms, architectural styles, customs, and traditional attire, each differing across different regions.

Culture and mathematics can be connected through ethnomathematics. Education and culture, especially in mathematics education, can be linked through ethnomathematics (Wahyuni et al., 2013). However, society has often overlooked the fact that many of their daily activities involve mathematical concepts. The term "ethnomathematics" was coined by D'Ambrosio with the aim of providing the community with an understanding that there are alternative ways of utilizing mathematics, particularly in cultural activities such as architectural design, measurement, calculation, and play. Ethnomathematics is a field of study that connects mathematics with the culture of a society. The use of ethnomathematics in mathematics education becomes more meaningful as students can perceive the taught material in a tangible way, relating it to their everyday activities (Izah et al., 2021).

Indonesia's diversity is evident not only in its various ethnic groups but also in the distinctive traditional houses found in each region. A notable example is the traditional house of the Mandailing tribe located in Mandailing Natal, North Sumatra. Known as Bagas Godang, which translates to "big house," it represents the cultural heritage of the Mandailing tribe. However, the presence of these traditional Mandailing Natal houses is becoming increasingly scarce (Puspita & Sari, 2022).

The Mandailing tribe is an ethnic group residing on the island of Sumatra, specifically in North Sumatra, and it represents the local culture of the region. Mandailing refers to both the tribe and the area within the Mandailing Natal regency. Similar to other tribes, the Mandailing tribe upholds traditions including ceremonial rituals that honor their customs and a clan system. The present generation plays a crucial role in preserving and conserving the customs of the Mandailing tribe, as its distinct cultural characteristics set it apart from other indigenous cultures in Indonesia.

These efforts aim to ensure the preservation and recognition of Mandailing culture as an integral part of the national heritage. Various Mandailing cultural practices endure to this day, encompassing the iconic Bagas Godang traditional houses, the Mandailing script, Ulos/abit Godang textiles, gordang sambilan musical instruments, traditional woven fabrics, and customary markobar. The steadfast adherence to Mandailing customs remains evident, particularly in the traditional houses of Mandailing Natal (Lubis et al., 2018).

Multiple research studies have shown that adopting a sociocultural approach to learning can support students in their intellectual development, emotional and social learning, and political awareness (Delviana et al., n.d.). By integrating their own cultural references, which exhibit distinct characteristics, it can lead to improved knowledge, attitudes, and skills (Zayyadi et al., n.d.).

This research aims to highlight the importance of integrating social aspects into mathematics education, moving beyond mere academic exercises. By incorporating social elements into the mathematics curriculum, the government can provide a new perspective and enrich the learning experience. Indonesia's diverse society is characterized by a wide range of ethnic and cultural groups in different regions, each with its distinct problem-solving methods, similar to various ethnic communities.

METHOD

In this research, the researcher employed a qualitative research method using an ethnographic approach. The definition of qualitative research itself, according to Sugiyono (2016), is a naturalistic research method where the research process occurs naturally. Qualitative research is characterized by the collection and analysis of qualitative data. Initially, qualitative research was primarily conducted in the field of cultural anthropology but is now widely used in various fields, including mathematics, with a focus on cultural elements.

The research was conducted starting from the end of April 2023, specifically on April 28th at 10:00 AM Western Indonesian Time. The research took place in front of Bagas Godang and Sopo Godang Mandailing Natal, located at Jl. Williem Iskandar No. 10, Pidoli Dolok, Kec. Panyabungan, Kabupaten Mandailing Natal, North Sumatra. The specific focus of this research was to examine the mathematical concepts present in the architectural design of Bagas Godang Mandailing Natal, located in Pidoli Dolok.

The data collection instrument used by the researcher was a guided interview with the caretakers or managers of Bagas Godang, also known as cultural experts, in the Mandailing Natal region. These experts have extensive knowledge about the stories and historical aspects related to the Mandailing Natal traditional house, specifically Bagas Godang located in Pidoli Dolok, with a particular focus on its architecture and ancestral values.

The first step taken by the researcher before conducting interviews with the informants was to observe the location. Then, the researcher prepared the interview guide as a reference material. The selection of informants (respondents) with a deep understanding of the history and ancestral values of Bagas Godang Mandailing Natal was carefully determined. Next, the researcher scheduled interview sessions with the

cultural experts. The last step involved data collection through direct observation of the Mandailing Natal traditional house. Interviews were conducted with the cultural experts who possessed knowledge about the history of the traditional house. Finally, during the interview process, documentation was carried out. The researcher recorded the information provided by the informants and took photographs of the structure and motifs of Bagas Godang Mandailing Natal..

RESULTS AND DISCUSSION

Results

Apart from its cultural significance, the Mandailing Natal traditional house, Bagas Godang, also incorporates mathematical concepts that can be utilized as a learning resource for students in schools. Upon direct observation of the structure of the Mandailing Natal traditional house, it becomes evident that the Mandailing Natal community has implemented mathematical principles, specifically geometry and odd numbers. The architecture of Bagas Godang encompasses various mathematical concepts, including two-dimensional shapes such as squares, rectangles, trapezoids, isosceles triangles, and rhombuses. Additionally, there are three-dimensional shapes present, such as cuboid and octagonal prisms. The concept of odd numbers is also incorporated (Rahmawati & Muchlian, 2019).

1. Plane Figure

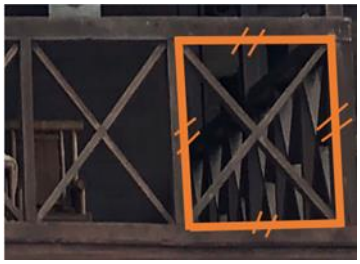


Figure 1. The fence section of Bagas Godang

The square shape can be found in the fence of Bagas Godang Mandailing Natal. A square is defined as a two-dimensional plane figure with four equal-length sides and four right angles (Utami, 2018).

Figure 2. Windows of Bagas Godang

In the windows of Bagas Godang, there is a rectangular concept. A rectangle is a quadrilateral with two pairs of parallel sides and four right angles, where the length is greater than the width.

Figure 3. Roof Ornament of Bagas Godang

Figure 3 depicts the presence of a rhombus concept in the roof ornament of Bagas Godang. According to information from the informant, the rhombus-shaped ornament in Bagas Godang is known as "Burangir" or "Aeropik," which means betel leaf. The definition of a rhombus itself is a quadrilateral shape with opposite sides parallel, four equal side lengths, and congruent opposite angles.

Here are the special properties of a rhombus:

a. It has equal side lengths.
b. A rhombus has diagonals that serve as axes of symmetry.
c. A rhombus has perpendicular diagonals, forming four right-angled triangles at their intersection points.
d. In a rhombus, all opposite angles are congruent and are bisected by the diagonals of equal length.

2. Three-dimensional Figure

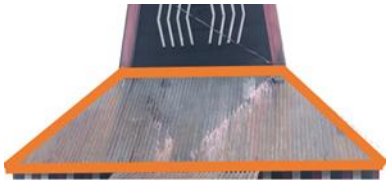


Figure 4. Roof of Bagas Godang

The isosceles trapezoid shape can be seen in the roof structure of Bagas Godang. An isosceles trapezoid is defined as a quadrilateral with one pair of parallel sides. Meanwhile, an isosceles trapezoid is a trapezoid with one pair of sides that have equal length, in addition to having one pair of parallel sides.

Figure 5. Roof of Bagas Godang

The shape of an isosceles triangle can be seen in the roof structure of Bagas Godang and also in the roof structure of Sopo Godang. An isosceles triangle is defined as a triangle that has two sides of equal length.

Isosceles triangle has the following characteristics:

a. It has two sides of equal length.
b. It has two angles of the same measure.
c. It has one line of symmetry.
d. It does not have rotational symmetry.

Figure 6. Shape of Bagas Godang

The shape of a cuboid can be seen in the interior of Bagas Godang. A cuboid itself is defined as a three-dimensional solid formed by six faces, where each face is a rectangle or a square. At least one pair of opposite faces has different dimensions (Zega, n.d.).

Figure 7. Shape of the pillars of Bagas Godang

In the shape of the pillars of Bagas Godang, there is a mathematical concept of an octagonal prism. Based on the interview with Mr. Ali Sutan, the pillars of Bagas Godang, which are in the form of an octagonal prism, symbolize the king's authority in all eight cardinal directions. An octagonal prism is defined as a three-dimensional solid with an eight-sided base and top, and its lateral sides are in the form of rectangular shapes (Wikaningtyas et al., 2022).

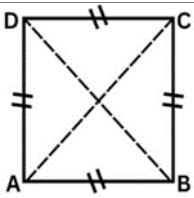
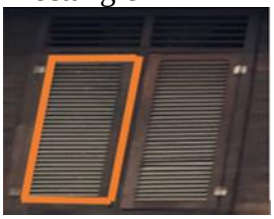
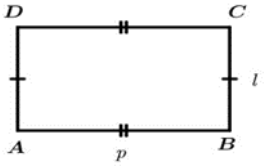
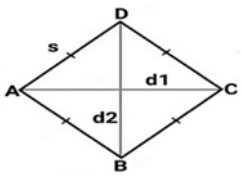
3. Odd Numbers

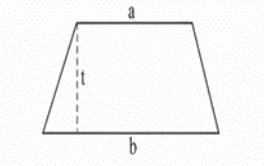
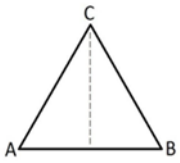
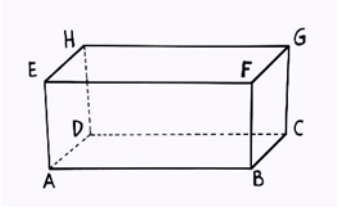
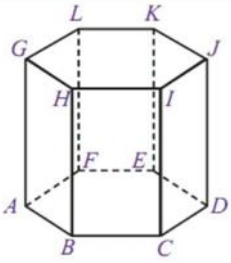
Figure 8. Pattern of arrangement of the pillars of Bagas Godang

Odd numbers are related to the arrangement and pattern of the pillars in Bagas Godang Mandailing Natal. Odd numbers are defined as numbers that are not divisible evenly by 2. Odd numbers can be observed in the pattern arrangement of the pillars in Bagas Godang, where the supporting pillars on the shorter sides are in a quantity of 5, while the pillars on the longer sides are in a quantity of 7 and 9.

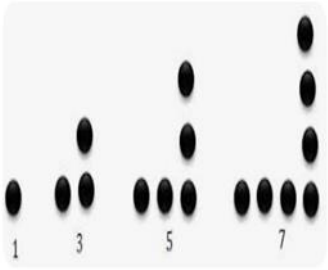
Figure 9. Stairs of Bagas Godang

The concept of odd numbers is also present in the number of steps used to ascend the Bagas Godang, which is a traditional raised house. The number of steps in Bagas Godang is 9 wooden steps. Based on the interview with the informant, this number holds sacred and magical meanings. The number 9 symbolizes two significances: firstly, the 9 customary figures who hold authority in customary matters, and secondly, each representative from the eight directions, with Bagas Godang at the center.

No	Ethnomathematics	Mathematical Concepts	Syllabus
1	Square 	 Formula: $Perimeter = s \times s$ $Area = 4 \times s$	The material is included in the mathematics syllabus for the even semester of Grade VII in junior high school (SMP/MTS) based on the K13 curriculum.
2	Rectangle 	 Formula: $Perimeter = 2(p + l)$ $Area = p \times l$	The material is included in the mathematics syllabus for the even semester of Grade VII in junior high school (SMP/MTS) based on the K13 curriculum.
3	Rhombus 	 Formula: $Perimeter = a + b + c + d$	The material is included in the mathematics syllabus for the even semester of Grade VII in junior high school (SMP/MTS)

		$Area = {}^{1}/_{2} \times d1 \times d2$	based on the K13 curriculum.
4	Isosceles trapezoid 	 Formula: $Perimeter = sum\ of\ the\ 4\ sides$ $Area = {}^{1}/_{2} \times (a + b) \times t$	The material is included in the mathematics syllabus for the even semester of Grade VII in junior high school (SMP/MTS) based on the K13 curriculum.
5	Isosceles triangle 	 Formula: $Perimeter = s + s + s$ $Area = {}^{1}/_{2} \times base \times height$	The material is included in the mathematics syllabus for the even semester of Grade VII in junior high school (SMP/MTS) based on the K13 curriculum.
6	Cuboid 	 Formula: $Volume = p \times l \times t$ $Area = 2 \times (pl + pt + lt)$	The material is included in the mathematics syllabus for the even semester of Grade VIII in junior high school (SMP/MTS) based on the K13 curriculum
7	Octagonal prism 	 Formula: $V = Area\ of\ the\ base \times height\ of\ the\ pris$	The material is included in the mathematics syllabus for the even semester of Grade VIII in junior high school (SMP/MTS) based on the K13 curriculum

$$L = (^{1}/_{2} \times (a + b) \times t)$$

8	Odd numbers   Odd numbers are: 1,3,5,7,9,11,… 		The material is included in the mathematics syllabus for the odd semester of Grade VIII in junior high school (SMP/MTS) based on the K13 curriculum.

Discussion

The Mandailing ethnic group is located in the coastal areas of West Sumatra, bordering the Indonesian Ocean, and the southern plains of North Sumatra province, which is adjacent to West Sumatra province. Geographically, it is positioned between 000°13'30"-010°20'42" N latitude and 980°50'19"-990°50'19" E longitude. The Mandailing region is an independent administrative area known as Mandailing Natal Regency. This regency, along with Toba Samosir Regency, was officially established on March 9,1999, and is the youngest autonomous region in North Sumatra province. The total area is approximately 6,620.70 km2 with a population of around 352,027 people. (Fitri, 2000).

From the interview conducted by the researcher with Mr. Ali Sutan, an informant who holds the traditional title of Sutan Batara Pidoli, it is known that the traditional house or community commonly known as Bagas Godang Mandailing Natal is located at Jl. Williem Iskandar No. 10, Pidoli Dolok, Panyabungan District, Mandailing Natal Regency, North Sumatra (Dwi Kurino, 2022).

Figure 10. Bagas Godang

Figure 11. Sopo Godang

The Pidoli Dolok kingdom was established in the 1400s by the first king named Raja Baroar, who founded the kingdom located in Panyabungan Tonga. He had a son named Sang Hyang Dipertuan, who established a kingdom in Huta Siantar. Later, the kingdom located in Pidoli Dolok was led by King Mangaraja Mandailing. The Pidoli Dolok kingdom represents the third generation of previous kings.

The traditional houses in Mandailing Natal have two important aspects in their construction: Bagas Godang and Sopo Godang. These two aspects serve different functions. Bagas Godang, in particular, serves as the residence of the king, who is the leader of the community. The traditional meaning of Bagas Godang symbolizes "Bona bulu," signifying that the village has a complete set of customs known as "dalihan natolu" in the community. This set includes Namora natoras, Datu, ulu-balang, si baso, panggora, and raja pamusuk, who serve as the adat king. The use of this architectural aspect is not only limited to that but also serves as a venue for traditional ceremonies. It provides shelter and security for the residents, which are guaranteed by the king (Dewita et al., 2019).

Sopo Godang can be utilized as a place for community deliberations. It is built in front of Bagas Godang, enclosed by a courtyard. Constructed in a rectangular shape, Sopo Godang is smaller in size compared to Bagas Godang. It is an open space without walls. It serves as a venue for deliberations, important decision-making, receptions for honored guests, and also as a place for overnight stays for travelers. Considering the functions of Sopo Godang, the king and Na Mora Na Toras figures gave it a name: "sopo sio rancang magodang inganan ni partahian paradatan parous-rosuan ni hula dohot dongan" (a grand deliberation place for conducting customary meetings and gathering esteemed figures and relatives to foster brotherhood and closeness). Sopo Godang is also commonly used for artistic performances and as a place for learning traditional customs, arts, laws, handicrafts, and other knowledge (Effendi et al., n.d.).

From the perspective of student thinking, the thinking model involving prior knowledge has a significant impact. Considering the aim of the K13 Curriculum, which is for students to construct their own thinking based on their previous experiences, ethnomathematics will greatly assist students in absorbing the learning materials. For example, in geometry lessons, students can directly observe the concepts through the forms of traditional houses, particularly the Mandailing Natal traditional houses (Suripah et al., 2021).

Based on the aforementioned points, educators can be more creative in teaching and creating mathematics

exercises by incorporating cultural elements. The advantage of using cultural contexts within the students' environment is that it enables them to understand the materials more easily. When teachers explain abstract concepts and relate them to familiar cultural contexts, students can comprehend them easily based on realistic situations they are already familiar with. By leveraging the existing cultures in each region, teachers can utilize them in the process of transferring knowledge to students, making it easier for them to understand (Lynna ALuthan et al., n.d.).

CONCLUSION

Therefore, from the results and discussions, the researcher can conclude that the Bagas Godang Mandailing Natal culture contains elements and mathematical concepts. The Mandailing community, who previously did not understand mathematical concepts, have actually applied them in the construction of Mandailing Natal traditional houses using ethnomathematics. Mathematical concepts can be directly observed in terms of the structure and ornaments of the Mandailing Natal traditional houses. In the construction of Bagas Godang Mandailing Natal, one can find mathematical concepts related to two-dimensional shapes such as squares, rectangles, rhombuses, trapezoids, and isosceles triangles. Additionally, three-dimensional shapes like cubes and the concept of odd and even numbers can be seen in the philosophy behind the construction of the steps in Bagas Godang Mandailing Natal.

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