Ethnomathematics: Disclosing mathematical concept in *batak toba* traditional house

E Hidayat¹, N Ratnaningsih¹, A Sunendar¹ and J S Siregar²

¹Program Studi Pendidikan Matematika, Universitas Siliwangi, Jl. Sailiwangi No.24 Kahuripan, Tawang, Kota Tasikmalaya 46115, Indonesia
²SMP BPK Penabur Jakarta, Jl. Raden Saleh Blok C No.44-45 Sukamajaya, Depok, Jakarta, Indonesia

E-mail: edihidayat@unsil.ac.id

Abstract. Ethnomathematics is mathematics that grows and develops in a particular culture. Technological advancement makes culture more forgotten, especially in traditional buildings such as traditional houses. Traditional houses contain philosophical values that are used as guidelines for the life of the surrounding community. Unconsciously in traditional house buildings have applied various mathematical concepts in the building. This study aims to reveal the mathematical concepts and philosophical values found in the traditional Toba Batak houses. The method of research conducted in the ethnographic approach. The source of research data was obtained from three speakers: customary kings, building experts, and residents (elders). The instruments in this study were researchers themselves and guidelines for semi-structured interviews—data collection techniques obtained from observation, discussions, and documentation. Testing the validity of the data is done by source triangulation. In this study, it was found that there was an application of mathematical concepts in traditional Toba Batak houses. The mathematical theory consists of a dimensional geometry concept, two-dimensional geometry, three-dimensional geometry, geometric transformation, and number patterns. Each of the forms contained in the traditional Toba Batak house contains philosophical values that are used as learning resources.

1. Introduction

Traditional houses in Indonesia are very diverse with their unique characteristics and uniqueness. One of the traditional houses that has the characteristics and uniqueness of the Batak Toba traditional house [1]. Batak Toba traditional house has different types depending on the size and type of ornaments in it. One area in North Sumatra that still has many traditional Batak Toba houses is in the area of Toba Samosir and Humbang Hasundutan. In the life of the Batak Toba people, the traditional house is considered as something sacred because in the division and function of the traditional house contains values that are used as the basis for building construction [2]. Each part of the Batak traditional house consists of different forms and each part contains different philosophical values. These philosophical values are used as a way of life for the Batak Toba people [3].

The forms of each part of the traditional house consist of forms that have unconsciously applied mathematical concepts. Mathematics and culture are something that cannot be avoided in everyday life. The relationship between mathematics and culture, especially in the traditional Batak Toba house, is called ethnomathematics. The understanding of ethnomathematics is mathematics that grows and develops in certain cultures [4]. While the cultural understanding is a collection of norms or general
rules that apply in society, beliefs, and values that are recognized in groups of people who are in the same ethnic group or nation [4]. In the field of mathematics, ethnomathematics is still a new study and has excellent potential to be developed into contextual learning innovations as well as to introduce Indonesian culture to students.

Based on the description previously explained, the researcher is interested and seeks to further study the traditional house of the Batak Toba by connecting with mathematical concepts and revealing the philosophical values contained in them in a complete and more detailed way. The researcher hopes that the ethnomathematics of the Toba Batak traditional house can be preserved and should be placed as a philosophical basis for a future view of life for future generations and can be integrated in the curriculum to plan and implement learning in the classroom so that it can be better understood by students because it is more adapted to the regional context in this case is the North Sumatra region, while helping students improve their mathematical abilities in various contexts, and can think mathematically according to their culture and traditions.

2. Method
This research belongs to the type of qualitative research with ethnographic approach [6]. Ethnography is a type of qualitative research, in which researchers conduct a study of group culture in natural conditions through observation and interviews [7]. The researcher chooses three different subjects (three sources) from which the three subjects can retrieve information as evidenced by the availability of historical archives and physical remains that can be directly observed in order to obtain accurate information. The data source in this study is from elders, customary kings, builders and local residents who know in more detail about the Toba Batak traditional house. Data collection techniques in research conducted by observation, and documentation. In this study the main instrument is the researcher himself. Researchers also used instruments in the form of semi-structured interview guidelines. In analyzing data, researchers conducted data analysis using the Miles and Huberman model with the steps of data reduction, data presentation, and drawing conclusions [8]. The researcher checks the validity of the research data by triangulation. Triangulation used is source triangulation. Source triangulation is a way to get data from different sources with the same technique. Researchers conducted in-depth interviews with three data sources, namely the king adat, elders, and experts who know more about the Toba Batak traditional house. From these different sources, researchers describe and categorize which views are the same, which are different, and which are specific from the three data sources. Data that has been analyzed by researchers is broken down to produce a conclusion.

3. Result and Discussion
Batak Toba traditional house is a traditional house originating from the North Sumatra. One area in North Sumatra that still has many traditional Batak Toba houses is in the area of Toba Samosir and Humbang Hasundutan. In the area of Toba Samosir, there is a Batak museum, namely TB Silalahi Museum which contains about the Batak Toba village in ancient times. The Toba Batak Village consists of various types of Batak Toba traditional houses and buildings that are hundreds of years old. Even the historical relics and ornaments of the Toba Batak tribe are still commonly found in this museum. In the Humbang Hasundutan district, there are also many traditional Batak Toba houses. This area has a majority population of the Toba Batak ethnic group. This area is famous as the place of origin of the national hero Sisingamangaraja XII. In Humbang Hasundutan, there is a tourist attraction called Sisingamangaraja Palace. At Sisingamangaraja Palace there are various types of Batak Toba traditional houses and historical relics of King Sisingamangaraja XII. Therefore, this research was conducted in two locations, namely in the TB Silalahi Museum and in Sisingamangaraja Palace.

Batak Toba traditional community dwellings were established in mutual cooperation, including traditional houses in accordance with traditional principles [9]. Batak Toba traditional house is usually occupied by one to four families. To set up a traditional house requires considerable energy and costs and requires a long time. So that in the past many traditional houses that should not have been completed in accordance with the norms or customary rules that apply, but the house has been used or occupied.
The Batak Toba traditional house symbolizes the macro cosmos and micro cosmos which consist of a single tri continent which is described as follows [10]:

3.1. Banua Toru (Lower Continent/Lower part)
The lower part of the Batak Toba traditional house or under the house is believed by the local community as a place of the underworld, a place for spirits and animals, so that in the past this lower part was used as a place to store livestock.

3.2. Banua Tonga (Middle Continent/Middle Part)
The middle part of the Toba Batak traditional house is used as the residence of the owner of the house. In accordance with the beliefs of the Toba Batak people that the middle world is a place for living things to carry out their lives.

3.3. Banua Ginjang (Upper/Upper Continent)
The upper part of the Toba Batak traditional house is believed by the community as a sacred place, in accordance with the belief of the Toba Batak people who assume that the upper world is a place of God or a place of the gods. This is the reason why the upper part of the Toba Batak traditional house is used as a place to store valuables from the owner of the house.

From each of the parts contained in the Batak Toba traditional house contains philosophical values used by the Batak Toba community as a way of life. These philosophical values will be explained as follows.

**Figure 1. Ulupaung**

Figure 1 shows that Ulupaung is the crown of a Batak traditional house. Ulu means head, paung means a kind of headgear, thought to be a kind of crown. The location of Ulupaung is at the top of the ridge in front of or in the symbol of the child's position. This means that children/offspring are expected to get dignity or glory (hasangapon). Ulupaung is one of the gorga in the shape of a human head that symbolizes the strength of the homeowner. Based on the geometric shape ulupaung has a shape that resembles a horned human head.

**Figure 2. Dila-dila**

Figure 2 shows that Dila-dila location is protruding/out of the front ridge. At the base is rather large and getting smaller and smaller, so that the ends share the tip of the arrow. At a glance it looks like a
tongue sticking down. That is why it is called dila-dila (tongue). The meaning of the tongue symbol is intended as a security from the house. This is reasonable because a tongue sticking out can mean scaring.

Figure 3. Singa-singa

Figure 3 shows that singa-singa (lions) are located on the left and right of the front of the house. Lions are beasts, fangs and sharp nails, and other wild roars. Scary or fearfulness that is then the ancestors carved it and poured it on a large piece of wood in order to protect the house from the front and left and right of the house, so that residents of the house feel safe and comfortable.

Figure 4. Adop-adop

Figure 4 shows that Adop-adop is an ornament carved into the shape of a woman's breasts. This ornament is between the two lions. There are eight adoptions consisting of 2 groups: four groups on the right and four groups on the left. The adoptions symbolize hamoraon (wealth).

Figure 5. Lizard Ornament

Figure 5 shows that Lizards are animals that are always everywhere, including in every home. So that the Batak people are also expected to be like lizards, can be everywhere and adapt wherever they are. Gorga Boras starch (Cecak) is also called as bujonggir which means lizard picture the two-tailed tail. The lizard sometimes gave a warning a sign of behavior and his voice can help people avoid danger or gain wealth. Therefore, gorga it has symbolic meaning will protect human wealth and expects to multiply.
Figure 6. Gorga

Figure 6 shows that gorga is carving or sculpture which is usually found on the exterior of the Batak Toba traditional house. The philosophy of gorga in the Toba Batak traditional house is to describe the social status of the owner home [11]. Because in ancient times Batak people believed that the more gorga in the house the higher the social status of the house owner. Gorga also contains messages and hopes from the homeowner to his offspring. Gorga carvings have meaning to each the shape. The meaning in gorga carving Batak shows that there is meaning symbolic contained in each element in the gorga carvings. So this shows that there are cultural values which still survives in culture Batak community. Mathematical concepts that can be found in gorga include the concepts of transformation including translation, rotation, reflection and dilation. this can be seen from various engravings and Gorga paintings.

In the Batak Toba traditional house can also be found applications of mathematical concepts. Concepts in mathematics are abstract ideas that allow us to be able to classify (group) objects or events, and explain whether the object or event is an example or not an example of the idea [12]. For example, a triangle is the name of an abstract concept, which with this concept a set of objects can be classified as examples of triangles or not triangles. Therefore, the mathematical concept is interpreted as an idea of abstraction to classify or classify objects or activities related to mathematics.

In the Batak Toba traditional house building itself has unconsciously applied mathematical concepts namely the concept of one-dimensional geometry, two-dimensional geometry, three-dimensional geometry, geometric transformation and number patterns that will be explained in Figure 7.

Figure 7. Roof Surfaces

The concepts in mathematics are abstract, but even so unconsciously mathematics provides benefits in human life and helps in the existence and progress of other sciences [13]. The concepts of mathematics itself can be found in daily life, because mathematics is a science that is almost related to all aspects of human life [14-16]. The application of mathematical concepts in daily life such as in buying and selling transactions, in traditional games such as congklak, in making building forms and others. Figure 7 shows that Roof surfaces, in the Batak Toba traditional house building itself has unconsciously applied mathematical concepts, namely the concept of one-dimensional geometry, two-dimensional geometry, three-dimensional geometry, geometrical transformation and number patterns.
4. Conclusion
The Batak Toba traditional house has a deep philosophical meaning related to the life of the Batak Toba community both the relationship with humans and the relationship with the creator. All the elements contained in the Batak Toba traditional house have philosophical meanings which can be found both in carvings, ornaments, colors, shapes, and room divisions. Broadly speaking, the philosophical meaning contained in the Batak Toba traditional house is divided into three (tri-continent) namely the lower part of the house (banua toru) which has a philosophy that is the relationship between evil spirits, the middle part (banua tonga) which has a philosophy that is the relationship between humans, and the top part (banua ginjang) which has a philosophy that is the relationship with the creator. The overall ornaments or carvings contained in the Batak Toba traditional house have a philosophical value which generally aims to protect and protect the owner of the house from danger or misfortune. The mathematical concepts contained in the Batak Toba traditional house include geometry of one dimension, namely lines and angles. Geometry of two dimensions, namely: square (window surface), rectangle (door surface), triangle (roof surface) and trapezoid (wall surface). Geometry of three dimensions, namely: Beams (poles) and cylinders/tubes (poles). Geometry transforms, namely: Reflections, translations, dilations and rotations which can be found in gorga patterns. Odd numbers that can be found in the number of steps.

Batak Toba so that knowledge about the Batak Toba traditional house is not extinct. The parts contained in the Batak Toba traditional house can be used as a source of learning mathematics that is adjusted to the K13 curriculum. In this study, researchers found the concept of lines and angles that correspond to the one-dimensional material in class VII, the concept of square, rectangular, triangular and trapezoidal in accordance with the two-dimensional material in class VII, the concept of tubes and beams which correspond to dimensional material three in class VIII, the concept of odd number patterns in accordance with the material pattern of numbers in class VIII, the concept of reflection (reflection), rotation (rotation), translation (shift), dilatation (multiplication) in accordance with the material geometry transformation in class IX.

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