Exploration of Ethnomathematics in The Traditional Houses of Tana Toraja Tongkonan in The Learning of Mathematics

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ABSTRACT

Mathematics and culture go hand in hand. One example is the tongkonan, a traditional Tana Toraja house with some mathematical components. Apart from containing a mathematical component, it also has historical roots so it is more than just mathematics. Tana Toraja's heritage is closely linked to traditional dwellings, or tongkonan. This research aims to convey mathematical concepts such as the geometry found in tongkonan traditional houses and the history they carry, as well as finding out the meaning of the carvings on Tana Toraja traditional houses. This research uses a qualitative research methodology with an ethnographic approach. Data from observations, documentation, interviews and literature reviews were used as data sources in this research. Research findings show that several mathematical concepts such as triangles, blocks and cylinders, which have never been explored but are widely known, are found in the Tana Toraja Tongkonan traditional house.

Keywords: Ethnomathematics, Tongkonan traditional house, mathematics learning

1). INTRODUCTION

Education is one of the sectors of national development in which there is an effort to enlighten the life of a nation of quality and broad vision, as well as to make a person culturally and behave according to culture. Education and culture are two mutually supportive things, where education programmes and implementation must be supported by a multitude of cultural aspects, so that efforts to advance education equal efforts to promote culture. (Lupita, Anwar, & Andriani, 2021). What supports the progress of education and culture is the study of mathematics, where it can't be separated from culture, instead it is part of human culture, where Mathematics is not only present in culture but also growing, bound, and influencing culture. (Muzakkir, 2021).

One of the purposes of learning mathematics is to create a new mindset by taking into account the mindset that exists within the individual, thus absorbing information. Therefore, in teaching mathematics at school, teachers start by exploring informal mathematical knowledge that students have acquired from everyday life in their surroundings. The use of concrete concepts related to the day-to-day experience of the student can be an interesting source of learning. One aspect that can be emphasized for learning innovation is to consider and integrate local local culture (Marsigit, Condromukti, Setiana, & Hardiarti, 2018). Innovative as well as interactive mathematical learning can be done by means of an approach to a culture known as the term ethnomatematics.

According to Soebagyo, Andriono, & Rizfy, & Arjun (2021) ethnomathematics is a form of mathematics that is influenced or based on culture. Ethnomathematics is a collaboration between cultures and mathematics. (Hartanti & Ramlah, 2021). Kurniasari (2018) states that ethnomatematics is a science that describes mathematical connections within a culture, which is also in line with Padafing's (2019) view that ethnography is a special method used by a group of cultures or societies in mathematics activity. (Muni & Patricia, 2023). D'Ambrosio, a Brazilian mathematician who introduced the word ethnomatematics in 1997, defined it as a mathematical activity found in a particular cultural group of societies (Randan, 2022), where the aim of ethnomathematics is to recognize that there are different ways of doing mathematics by considering academic mathematic knowledge developed by different sectors of society as well as by taking into account the different modes in which different cultures negotiate their mathematological practices (modes of grouping, counting, measuring, designing buildings or instruments, playing in others). (Zulaekhoh & Hakim, 2021). With this investigator can draw the conclusion that ethnomatematics is a process of learning mathematics that associates cultures.

In the study of ethnomatematics, exploratory activities are very common, where exploration is a scientific technical activity to discover an area, region, circumstance, space previously unknown to the existence of its contents, and in education, exploration is an activity to acquire new experience from a new situation. (Paris & Wahyuda, 2022). Ethnomathematics aims to demonstrate the interrelationship between mathematics and culture, especially those directly related to the culture of society. (Nurhasanah & Puspitasari, 2022). Ethnomathematics gives the contextual meaning necessary for many abstract mathematical concepts. (Ajmain, Herna, & Masrura, 2020). So from that, the

exploration of mathematical concepts of various Indonesian cultural artifacts can be done through ethnomatematics.

According to Marsigit, Condromukti, Setiana, & Hardiarti (2018), ethnomatematics is only relevant to school-level mathematical learning, where the alignment of ethnomathematics with school mathematics, i.e. 1) Mathematics as the activity of pattern searching and relationships, 2) Mathematic as creativity requiring imagination, 3) Mathematical as problem solving, and 4) Mathematica as a means of communication. The development of mathematical learning based on ethnomatematics can be done by identifying ethnomathematical objects, where one of the interesting for researchers to be identified is Tongkonan Tana Toraja Traditional house which is one of traditional houses located in Somba Opu Fortress, Gowa.

Traditional houses are one of the assets of traditional houses in which each district has its own unique characteristics. This makes every custom home unique and striking, making it a symbol of the identity of an area of varying beauty and function. Similarly, as Yuningsih, Nursuprianah, & Benefits (2021); Nurfauziah & Putra (2022) described, traditional houses are a type of traditional building that reflects the cultural wealth of the tribes and at the same time becomes the highest form of culture in a society. Traditional houses serve not only as dwellings, but also as dwelling places, as real beings of historical heritage, beliefs, and social norms. For example, the traditional house of Tongkonan Tana Toraja, which is not only unique, but also has a profound meaning. The peculiarity of this traditional house includes the ethnomathematical element in its engraving, which is the particular attraction of the traditional house.

Figure 1. Tongkonan Traditional house, Opu Somba Fortress, Gowa

In relation to ethnomatematics, several studies that highlighted the Tongkonan traditional house as the object of his research, among them are the research carried out by Jainuddin, Silalong, & Syamsuddin (2020) which argues that on the motif of the Toraja custom house engraving almost all contain the concept of geometry whose representation is inspired by things such as folk stories, sacralised animals, objects in the sky, household appliances, precious objects, and plants that are then poured out in the form of geometric buildings. The concepts of geometry found in these traditional house engravings include parallel lines, curved lines, triangles, squares, square lengths, circles, angles, and folded symmetries. As for the research conducted by Wahyuni, dkk., (2023) obtained the results of the research describing that in Tana Toraja Tongkonan traditional house there are elements of mathematics that have never been exported and known by society including the concept of triangles, tubes, squares, long squares and circles. Other research on ethnomatematics in the native Tana Toraja Tongkonan, namely by Jainuddin, Iman, & Rahim (2023).

Ethnomathematics is here to help teachers teach mathematics more realistically and help students explore and interact with their local cultures. Based on the above description, the researchers wanted to review the Ethnomathematical Exploration of the Tongkonan Tana Toraja Traditional house in Mathematical Learning. It is hoped that the results of this research can be used as a mathematical

learning material in schools and as a learning media development material on ethnomatematics for use in cultural and historical sites in Gowa.

2). RESEARCH METHODS

This research is qualitative research with an ethnographic approach. Qualitative studies are naturalistic research that uses the researcher as the main instrument and directly plunges into the field to gather data through observations and interviews what it is without manipulation. The study uses a qualitative ethnographic approach, which uses both theoretical and empirical methods to obtain a complete explanation of the Tongkonan House. In this study, the data collection techniques that will be used are observations, interviews, documentation and library studies. Research instrument, i.e. guidelines for interviews, interviews conducted to an artist or cultural artist in Somba Opu who understands the intricacies of the Tongkonan House, both architecturally and the values of its ancestors.

The research begins with the researchers determining the informants according to the criteria of the informant which is to know and understand well about the culture of Toraja in particular at the Tongkonan house and can tell with ease and understand the information required by the researcher. The research begins with the researchers determining the informants according to the criteria of the informant which is to know and understand well about the culture of Toraja in particular at the Tongkonan house and can tell with ease and understand the information required by the researcher. Then the researchers will make a taxonomic analysis by framing and grouping previously conducted domains based on the geometric concepts found in Tongkonan houses such as triangles, beams and tubes. Then the latter is the writing of ethnography, the process of translating and transmitting the meanings that exist in a culture into the form of writing.

The Tongkonan House is located in Somba Opu Fortress, Barombong, Makassar, South Sulawesi. For the Toraja people, there are two types of houses that exist in their territory, namely: 1) Barungbarung, as an ordinary household without any particular connection to custom, which is usually a theatre house as the form of a house of the Bugis tribe, and 2) Tongkonan, as a house that has a function of custom, social, and cultural, inherited successively in one generation, and is the center of traditional activities such as Rambu Tuka' (ritual of love) and Rambu Solo'(rite of mourning) (Patriani, 2019).

Figure 2. Tongkonan Traditional house in Somba Opu Fortress, Makassar

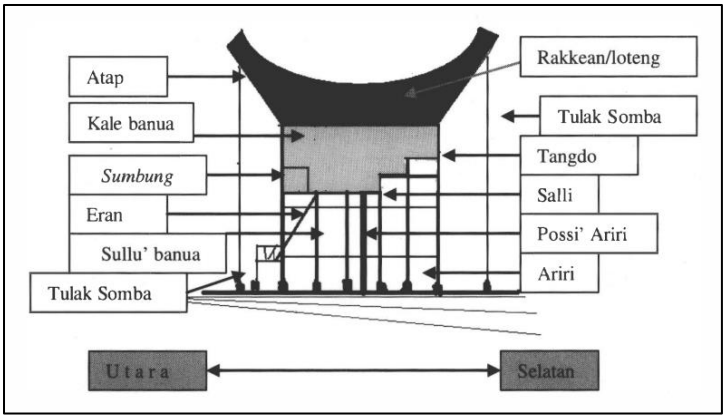

Figure 3. Vertical Visualization of Tongkonan Traditional house (Departemen Kebudayaan dan Pariwisata, 2009)

As for the mathematical concepts on the geometric material found in the traditional house of Tongkonan, along with the form of examples of matters that can be used in the learning of mathematics by integrating cultural values, in particular, the Tana Toraja Adult House, which is as follows.

Table 1. Mathematical concepts that exist in the Tongkonan Traditional house

Tongkonan House Section	**Loaded Geometry Concept**	**Questions and Answers**

<table>
<tr>
<td>Roof
  </td>
<td>Square function, trapezium</td>
<td>If the roof of the house has an equal side which is 18 m and 8 m respectively and also has a height of 6 m, Count the height of the roof of the house of Tongkonan!
Answer:

Dik : $a = 18\ m$
$b = 8\ m$
$t = 6\ m$
Dit : Roof area of traditional house (L)…?

Solution:
Because the roof of the house is trapeziuml, so:
$L = \frac{1}{2} \times (a + b) \times t$
$= \frac{1}{2} \times (18 + 8) \times 6$
$= \frac{1}{2} \times 26 \times 6$
$= \frac{1}{2} \times 156$
$L = 78\ m^2$

So, the roof area of the Tongkonan house is 78 m².</td>
</tr>
<tr>
<td>Kale banua (body of the house)
  </td>
<td>Rectangle, Cuboid</td>
<td>The body of the traditional house is cuboid. Determine the volume of the body of the traditional house if its length is 8 m, wide 4 m dan height 2,5 m!
Answer:

Dik : $p = 8\ m$
$l = 4\ m$
$t = 2{,}5\ m$
Dit : Volume of the body of the Tongkonan (V)…?

Solution:
$V = p \times l \times t$
$V = 8\ m \times 4\ m \times 2{,}5\ m$</td>
</tr>
</table>

		$V = 80\ m^3$
Tulak Somba (roof support pillar) 	Cylinder	In the Tongkonan traditional house there are roof support pillars in the shape of Cylinder. Determine the height of the pillar if its volume is $1{,}9782\ m^3$ and diameter of the base circle is 30 cm! Answer: Dik : $V = 1{,}9782\ m^3$ $r = 30\ cm$ Dit : Height of the pole (t)…? Solution: Because the pillars are tubular, then the method of finding the height of the pillar is used in the formula how to find the heights of the tubes. First of all, look for the breadth of the pipe, that is: $LA = \pi r^2 = 3{,}14 \times 30^2 =$ $2826\ cm^2 = 0{,}2826\ m^2$ So that the height of the pillar is obtained, that is: $V = LA \times t$ $t = \frac{V}{La}$ $t = \frac{1{,}9782\ m^3}{0{,}2826\ m^2}$ $t = 7\ m$ So, the height of the pillar is 7 m.

3). DISCUSSION

According to Said in Pakan, Pratiknjo, & Mamosey (2018), the word Tongkonan comes from the word "tongkon" which means sitting, and the end of "an", so the word Tongkonan or seat means "sitting together with family members, that is, a group of people who are gathered together to be an individual group that comes from one offspring." Tongkonan as a home with traditional, social, and cultural functions, used as 1) a common seat, or a place of inheritance, which is in the possession of the elders; 2) The house of the congregation of the sons of the children of the nations, even of the inhabitants of the cities, and of the families of those who are born of them, even their children, who are outside of the land of Toraja; 3) The house of a leader of the people, who governs according to

the customs and the teachings of Aluk Todolo, where the leader is called toparennge' (Departemen Kebudayaan dan Pariwisata, 2009; Pakan, Pratiknjo, & Mamosey, 2018).

The oldest of the houses of the tribe of Toraja was called Tongkonan Layuk, which means a noble house, or a house of noble inheritance, where the beginning of the existence of the tongkonan was brought by the early rulers (tomanung) whose navigation was impeded because they could no longer pass through the rocky rivers and the heavy waters, so that the early inhabitants dismantled their boats and carried them to the mountains to be used as building materials in the shape of a boat. The boat was the building material used by the early rulers to build the first traditional house on the high plains of Toraja. The Layuk Tongkonan is a tongkonan built by traditional rulers as a place to create rules, as a source of power, as the source of orders concerning the life of the Toraja people in ancient times. Therefore, the Tongkonan is a Tongkonan that remains respected and decorated by the Toraja people who have shaped the history and culture of Toraja.

As for the mathematical concept that is found in the traditional house of Tongkonan in the Fortress of Somba Opu, in the city of Makassar, it is as follows.

1. **The concept of right triangles and the Pythagorean theorem of house roofs (Rattiang Banua) in Tongkonan traditional houses**

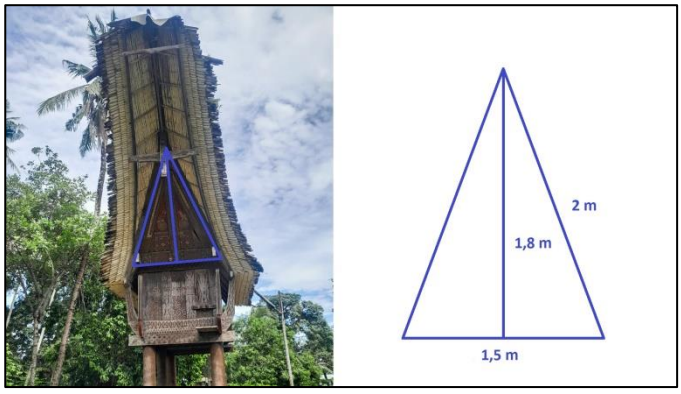

Figure 4. Triangle concept and Phytagoras theorem on Tongkonan Traditional house

In the houses of Tongkonan, the roof of the house is called a chain of pineapples, which covers the whole house, and was once made of bamboo that has a characteristic shape like a boat length and its two ends form a curve that has the same curve as the boat's length. (Pakan, Pratiknjo, & Mamosey, 2018).

Based on observations, on the front of the roof of the house there is a triangular shape of an elbow that can be attributed to the concept geometrid an teorema phytagoras. The size of the front of the roof has a height around 1,85 meter, and side bends around 2 meter, and a triangle base 1,5 m, or 0,75 m for a triangle. Based on the concept of the Phytagoras theorem, the shape of the roof can be mathematically defined as follows.

$$c^2 = a^2 + b^2$$
$$2^2 = 1{,}85^2 + 0{,}75^2$$
$$4 = 3{,}4225 + 0{,}56254 \approx 3{,}9854 = 4$$

Based on the mathematical description above, it is obtained that the roof of Tongkonan traditional house contains the concept of Phytagoras's theorem. Therefore, the roof of Tongkonan traditional houses can be a medium for learners to learn about the concept of the triangle of my elbows and the Phytagoras theorem, where this mathematical concept is very often found in everyday life, then accompanied by cultural learning about Tongkonan traditional house.

2. Concept of Building the Body of the House (Kale Banua) on the Tongkonan Traditional House

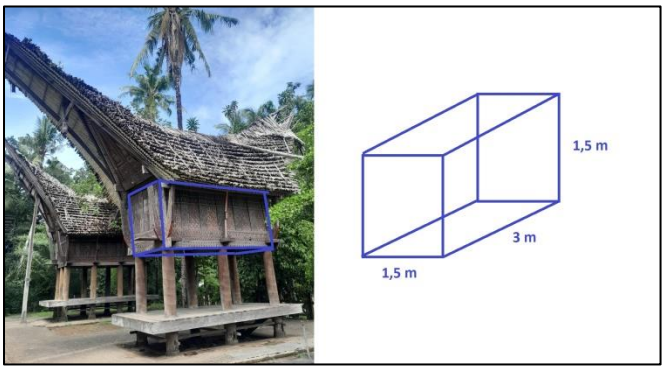

Figure 5. Concept of Building a Body Bar Space (Kale Banua) on a Tongkonan Traditional House

In the Tongkonan traditional house, the body of the house is called the banua kale. Kale banua is a place where the center of activity involves man and his connection with nature, which consists of spaces ranging from north to south. *Tangdo'* on the front, in the north, serves as a resting place and a family guest bed, as well as a place to perform the thanksgiving ceremony. The Sali on the middle, which is lower than the other rooms, served as a kitchen, dining and family meeting place, and when

there is a deceased (*tomate*) who is in the process of performing his funeral ceremony (*rambu solo'*) is usually placed in the *Sali*. As for *Sumbung* or the southern rear room used by family members as beds. According to *aluk todolo*'s belief, if there is a ritual performed by Tongkonan, then it must follow the direction East-West. In the ceremony of the *rambu solo*, the portion is served on the west side, and in the ceremonies of the rams, on the east side. (Jainuddin, Dipalaya, & Mangampang, 2022).

Based on the observations, it was obtained that the Tongkonan traditional house body contains the concept of building a beam room, with the size of the house body length is about 3 m, the width of a house about 1.5 m, as well as with a house height of about 1,5 m. As for the concept of building a balcony room that can be learned from the traditional house of tongkonan, namely:

a. Properties of cuboid
b. The surface area of the cuboid, that is, the size of the whole flat building that surrounds it or that covers it, $L = 2pl + 2pt + 2lt$.

   As for the surface area of the Tongkonan traditional house which is the object of the author's observation, with a length of 3 m, a width of 1.5 m, and a height of 1,5 m, namely:

$$L = 2(3)(1{,}5) + 2(3)(1{,}5) + 2(1{,}5)(1{,}5)$$
$$L = 9 + 9 + 4{,}5$$
$$L = 22{,}5\ m^2$$

c. Volume cuboid, that $V = p \times l \times t$

   As for the body volume of the Tongkonan traditional house which was the object of the author's observation, with a length of 3 m, a width of 1.5 m, and a height of 1,5 m, that's:

$$V = 3 \times 1{,}5 \times 1{,}5$$
$$V = 6{,}75\ m^3 = 6750\ dm^3 = 6750\ liter$$

Based on the above description, it is obtained that Tongkonan's traditional house body contains the concept of cuboid. Therefore, Tongkonan traditional home bodies can be a medium for students to learn about the concept of building a beam room, where this mathematical concept is very often found in everyday life, and then accompanied by cultural learning about Tongkonans traditional house.

3. Concept of building a tubing room in the basement of the house (*Sulluk Banua*) on the Tongkonan traditional

In Tongkonan's traditional house, the basement is called *sulluk banua. Sulluk banua* surrounded by wooden pillars for the body of the house. In the past, the *Sulluk banua* served as a cage for cattle, that is, the cattle of choice had a type that was judged by society to indicate a high degree of social status. Now Sulluk Banua Tongkonan is no longer used as a buffalo cage because the people of Toraja have understood about the hygiene of the environment due to the dirt of the buffalo so that the house cage no longer serves as a buffalo cage.

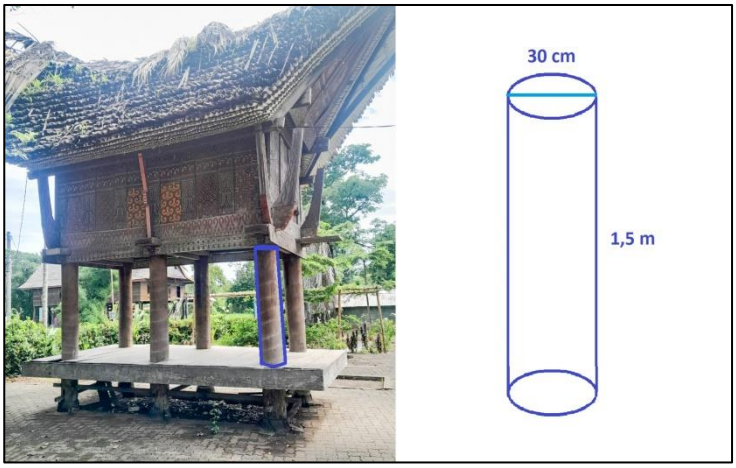

Figure 6. Concept of Building a Tubular Room of the Underground (*Sulluk Banua*) on a Tongkonan Traditional House

Based on the observations, it is obtained that one of the pillars in the traditional house of Tongkonan that exists in the Fortress of Somba Opu contains the concept of building a tube room, with the height of about 1.5 m, with a diameter of about 30 cm or 0.3 m. As for the concept of building a tubular room that can be learned from the traditional house of the Tongkonan, that:

a. Properties of cylinder
b. The surface area of the cylinder, that is, the size of the whole flat building that surrounds it or that covers it $L = 2\pi r(r + t)$.

   As for the surface area of the tube-shaped pillar in the basement of the traditional Tongkonan house which was the object of the author's observation, with a height of 1.5 m, and a diameter of 0.3 m and fingers of 0.15 m, that is:

$$L = 2\pi r(r + t)$$

$$L = 2(3{,}14)(0{,}15)(0{,}15 + 1{,}5)$$

$$L = 1{,}5543\ m^2$$

c. Volume cylinder, that $V = \pi r^2 t$

As for the volume of tube-shaped pillars in the basement of the traditional Tongkonan house which was the object of the author's observation, with a height of 1.5 m, and a diameter of 0.3 m and fingers of 0.15 m, that is:

$$V = 3{,}14(0{,}15)^2(1{,}5)$$

$$V = 0{,}105975\ m^3 = 105{,}975\ dm^3 = 105{,}975\ liter$$

Based on the above description, it is obtained that the basement of Tongkonan traditional houses is specialized in the pillar of the body of the house contains the concept of building a tubular room. Therefore, the sub-room of the traditional house of Tongkoan can be the medium of learning of the pupils about the concepts of building tubular rooms, where this mathematical concept is very often found in everyday life, then accompanied by cultural learning about the Tongkonans traditional house.

4). CONCLUSION

Based on research, students can learn mathematics from Tana Toraja's native home known as Tongkonan and can also use it as a historical resource to develop a greater appreciation for culture and math. After exploring the Tana Toraja Tongkonan Traditional house, some concepts of geometry such as triangles, beams, and tubes were discovered. The use of the environment (cultural) as an object of learning is more easily understood by students, it can also enhance the student's ability to think contextually. Ethnomatematics or the use of cultural components in mathematics, helps students understand formal ideas by starting from their personal experience.

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