Mathematics and the Art of Carving Toraja Tribe

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Abstract: *Integrating culture into mathematics learning is not impossible. Nowadays, science has been developed to explain how mathematics and culture can be integrated. The concept of the program is known as Ethnomathematics (Ethnomathematics). This research was conducted to identify mathematical concepts contained in the carvings of the Toraja tribe, South Sulawesi. This research is an ethnographic study. Data were obtained through direct observation, interviews, and documentation analysis. Data analysis will be carried out in four stages: data reduction, data presentation, drawing conclusions and checking data validity with method triangulation techniques. The results showed a mathematical concept in the carving of the Toraja tribe. Eight carvings are explored, namely Ne' Limbongan, Pa' Ambollong, Pa' Barre Allo, Pa' Bombo Uai, Pa'ara' Dena', Pa' Kangkung, Pa'lamban Lalan, and Passora Siluang. In the carving of Ne' Limbongan, there is geometry and translation, Pa' Ambollong there is rotation, Pa' Barre Allo there is rotation, Pa' Bombo Uai reflection and circle, Pa'ara' Dena' there is congruency, similarity, reflection, and translation, Pa' Kale there is reflection, Pa'lamban Lalan there is congruency, parallel lines, and translation, and Passora Siluang there is circle and Combined Geometry.*

Keywords: *Ethnomathematics; Toraja tribe*

1. Introduction

Mathematics and culture are two interrelated things. Culture teaches the noble values of the ancestors about how to behave and interact well with others. Culture includes knowledge, skills, rules, norms, traditions, languages, arts, literature, folklore, and artifacts as guides that shape beliefs and behaviors in certain groups of people [1]. Meanwhile, mathematics is a science concept and process with a logical pattern and command [2]

The interrelationship of the two is expressed by Bishop [3] , who states that mathematics is cultural knowledge derived from six human activities carried out consciously and sustainably. The activities in question are counting, locating, measuring, designing, playing, and explaining. The interrelationship of culture and mathematics is also supported by Ernest [4] who states that mathematics, as the main element of art, culture, and life (present and past), underlies science, technology, and all aspects of human culture. The interrelationship of mathematics and culture is also a concern in the world of education.

Nowadays, science has been developed to explain how mathematics and culture can be integrated. The concept of the program is known as Ethnomathematics. *Ethnomathematics* is a science used to understand mathematics adapted from a culture [5] Ethnomathematics recognizes that there are many ways to do mathematics developed by different cultures [6] Ethnomathematics emerged as a wedge of culture, mathematics, and mathematical modeling [7]. The study of ethnomathematics later became the basis for integrating culture in mathematics learning in schools.

In addition, the integration of mathematics and cultural learning also refers to the philosophical foundation of the 2013 curriculum, namely education rooted in the nation's culture and students are inheritors of the nation's culture (Regulation of the Minister of Education and Culture Number 35 of 2018 concerning the 2013 curriculum of the First Menegah School / Tsanawiyah Madrasah). The preservation and promotion of culture are also one of the goals of the Ministry of Education and Culture in 2020-2024. Hence, the presence of culture in mathematics learning is one way to realize this goal.

Ethnomathematics can help teachers understand mathematics using a cultural context that will eventually encourage students' academic mathematical understanding in schools. Ethnomathematics reinforces students' academic knowledge when they understand the ideas, methods, and practices of

mathematics that exist in everyday life [8] Combining mathematics and culture in ethnomathematics will have a dual function in its application in learning, in addition to making it easier for students to understand the subject matter students can also examine the values contained in their culture.

Applying ethnomathematics in mathematics learning has quite significant consequences for the teacher. One of them is that teachers are challenged to have extensive knowledge of mathematics and the surrounding culture to help students conduct critical and reflective testing of mathematical knowledge. There needs to be a study of the surrounding culture that can support the learning process of mathematics.

Various ethnomathematics studies have been carried out previously to study and develop teaching media/materials that can support cultural-based mathematics learning. The interrelationship of mathematics and culture can be viewed from various aspects. One of the studies on making Barongko (a typical cake of the Bugis tribe) shows that the manufacturing process involves mathematical concepts, including division, congruence, revival, and triangular and half-spherical prisms [9]

Then, studies on regional fabrics or batik also show that mathematical concepts are found in tapis fabrics, namely geometry, including transformation (the concept of reflection, dilatation, and rotation) [10]–[13] . In addition, ethnomathematics is also found in community activities and beliefs. For example, ethnomathematics in Javanese primbon [14] and Javanese calendar [15] The design of different traditional houses from each region also has the potential to be studied. The architectural study of the building has been carried out by Supiyati et al. [16] showing that the Sasak community accidentally practiced mathematics in the construction and ornamentation of the building.

It can also be found in the Toraja Tribe. The Toraja tribe is a tribe that settles in the mountains of the northern part of South Sulawesi, Indonesia. The word Toraja comes from the Bugis language, To Riaja, which means "one who dwells in the upper land." The Dutch colonial government named this tribe Toraja in 1909. The Toraja tribe is famous for its funeral rituals, tongkonan traditional houses, and wood carvings. There are various carving motifs, such as animals, plants, geometric shapes, objects in the sky, folklore, and others. J.S. Sande found there were at least 67 Toraja carving motifs.

These carvings contain meanings and values of life that are closely related to the philosophy of life of the Toraja people. Among them is advice to live life well and correctly, always work hard, respect each other, and always maintain unity, kinship, and piety to God. This Toraja carving is usually found on *tongkonan* (Toraja traditional house), *alang* (rice granary), and *erong* (coffin). The Toraja carving motif contains a variety of unique and exciting motifs found in *tongkonan* and granary (*alang*), which are contained in geometric concepts including parallel lines, curved lines, triangles, squares, rectangles, rhombuses, circles, angles, and folding symmetry, where the typical Toraja carving art motifs are inspired from various things such as folklore, sacred animals, objects in the sky, household appliances, and vegetation are following the religious teaching beliefs held by the ancestors of the Toraja people, namely the old animist belief (Aluk Todolo) which means ancestral religion. According to [17], *"Aluk Todolo"* was handed down by the Supreme Creator, Puang Matua, to the first human grandmother named Datu La Ukku, who settled in the sky.

2. Research Methods

This research is an ethnographic study. Ethnography is qualitative research to describe, analyze, and interpret patterns of behavior, beliefs, and language in a cultural group[18]. However, in this study, researchers will focus on analyzing and describing mathematical concepts in the carving of the Toraja Tribe in Toraja, South Sulawesi.

To obtain valid data related to ethnomathematics on carvings contained in traditional houses (tongkonan) and granaries (alang) of the Toraja Tribe, observations, interviews, and documentation analysis will be carried out. First, the researcher will determine the informant with the criteria that the informant must know and understand well about Toraja culture, especially in Toraja carvings. The main instrument in this study is the researcher, who is directly related to the research and acts as a data collector. Observation sheets, interview guidelines, and documentation are used as supporting instruments.

Data analysis in this study was carried out in steps: (1) Data reduction; at this stage, data in the form of recordings (audio documentation) or images were converted into written form and selected the necessary data. The selected data is adjusted to the mathematics material contained in the 2013 curriculum; (2) Presentation of data, at this stage, the reduced data is presented in the form of narrative texts and tables to describe mathematical concepts contained in the carving of the Toraja Tribe; (3) Drawing conclusions, at this stage conclusions, are drawn regarding mathematical competencies identified in carving of the Toraja Tribe and can be used in mathematics learning; (4) Checking the validity of the data, to check the validity of the data, repeated observations and triangulation of methods are carried out.

3. Results And Discussion

The Toraja people often call carvings *Passura' Toraya*. Toraja carvings are one of the attractions in the eyes of local and foreign tourists. *Passura' Toraya* has various types of designs with their respective meanings and will usually be found on the walls of *tongkonan* and *alang*. However, with the development of the times, passura' can also be found in the traditional batik of the Toraja tribe. On this engraving can be found mathematical concepts in it. The most commonly found mathematical concept is geometry. Based on the data collection results, the Toraja carvings analyzed were the carvings of *Ne' Limbongan, Pa' Ambollong, Pa' Barre Allo, Pa' Bombo Uai, Pa'ara' Dena', Pa' Kangkung, Pa'lamban Lalan, and Passora Siluang.*

3.1 Ne' Limbongan

Fig.1. Ne' Limbongan

The meaning of this carving is to show that the Toraja tribe is a persistent and determined people in obtaining sustenance from the four directions of the cardinal and like a spring united in a lake that provides happiness for their descendants. This carving is biased to be depicted on the side wall of the house. Limbongan is a spring water source that never dries and can provide the surrounding natural life. The mathematical concept in this carving is combined geometry and translation (Figure 2).
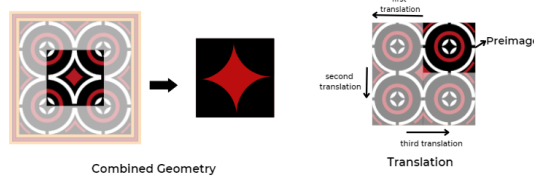

Fig. 2. Combined geometry and translation concept at Ne' Limbongan

3.2 Pa' Ambollong

Fig. 3. Pa' Ambollong

This carving comes from the word *ambollong*, which is a type of plant that is a type of taro and usually grows in rice fields. The meaning of this carving is intended so that residents and homeowners can have gifts in their livelihoods. So this engraving symbolizes wealth and well-being. The mathematical concept in this carving is rotation (Figure 4).
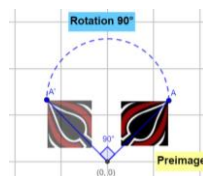

Fig. 4 Rotation concept at Pa' Ambollong

3.3 Pa' Barre Allo

Fig. 5 Pa' Barre Allo

Pa 'barre allo comes from *barre* (rise/round*)* and *allo* (sun). The shape is like a sun circle. This carving symbolizes the belief that the source of life and everything in the world comes from *Puang Matua* (God Almighty) and the owner of the highest and noblest *tongkonan*. The mathematical concept in this engraving is a circle (Figure 6).
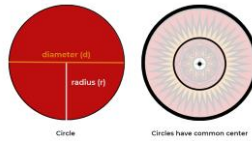

Fig. 6 Circle at *Pa' barre allo*

3.4 Pa' Bombo Uai

Fig. 7 Pa' Bombo Uai

The shape of the carving is like a geridae that can walk on water very quickly. This carving means humans must have sufficient abilities and skills to carry out their duties and responsibilities. The mathematical concepts in this engraving are reflection and circle.
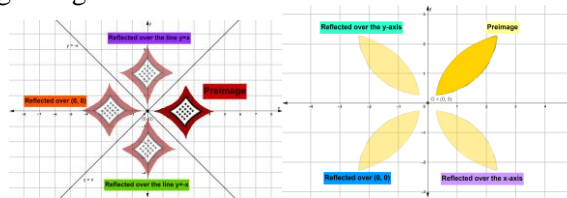

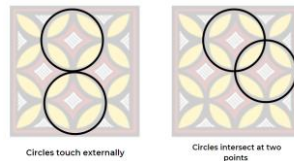Fig. 8 Reflection concept at *Pa' Bombo Uai*

Fig. 9 Relative position of two circle at *Pa' Bombo Uai*

3.5 Pa'ara' Dena'

Fig. 10 Pa'ara' Dena'

The naming of this carving comes from the word *ara'* which means chest and *dena'*, which means sparrow. According to the Toraja people, sparrows are pests that damage rice plants. In the Toraja myth, the bird is considered a dishonest bird. The Toraja expression "dena'ko angku laparebang" means "you always eat but don't want to try and work." As for which of these engravings is that in living our lives we must have a firm, firm and honest stance and work hard. The mathematical concepts in this engraving are congruency, similarity, reflection, and translation.
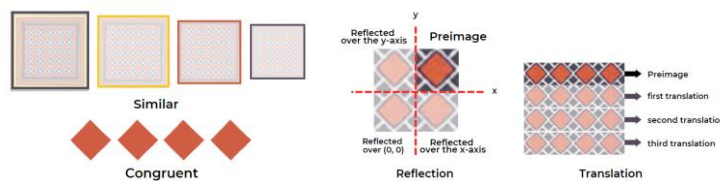

Fig. 11 Mathematics concept at *Pa'ara' Dena'*

3.6 Pa' Kangkung

Fig. 12 Pa' Kangkung

The naming of this carving comes from the word kale which means buffalo wrapped in its head. It can also be interpreted as a kale plant. Kale is a plant that has functions and benefits for the Toraja people. This plant, in addition to being cooked and used as a vegetable, is also helpful for animal feed. This carving is a carving in the form of a buffalo head wrapped from the bark. The meaning of this carving is to symbolize obedience to the creator of the universe, symbolize gratitude to the creator for blessings and sustenance, and symbolize nobility and the highest caste. The mathematical concepts in this engraving is reflection.

Fig. 13 Reflection concept at *Pa' Kangkung*

3.7 Pa'lamban Lalan

Fig. 14 Pa' Lamban Lalan

This engraving comes from the words sluggish, which means stifling, and lalan, which means street. This carving resembles grass that branches like sweet potato and usually grows on the side of the road. The meaning of carving is not to interfere in the affairs or things of others when it is not needed or has nothing to do with us and to remind posterity not to do things that can harm oneself. The mathematical concepts in this engraving are congruency, parallel lines, and translation.
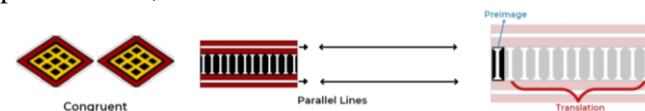

Fig. 15 Mathematics concept at *Pa'lamban Lalan*

3.8 Passora Siluang

Fig. 16 Passora Siluang

This engraving symbolizes a person who always gives enlightenment to difficult situations. It is usually depicted on the front wall of the tongkonan / house and reeds.
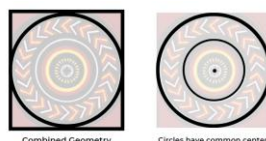

Fig. 17 Mathematics concept at *Passora Siluang*

4. Conclusion

Based on the study's results, it can be implied that there is a mathematical concept in the carving of Toraja (Passura' Toraya). The concept can be used in mathematics learning. Eight carvings are explored, namely Ne' Limbongan, Pa' Ambollong, Pa' Barre Allo, Pa' Bombo Uai, Pa'ara' Dena', Pa' Kangkung, Pa'lamban Lalan, and Passora Siluang. In the carving of Ne' Limbongan, there is geometry and translation, Pa' Ambollong there is rotation, Pa' Barre Allo there is rotation, Pa' Bombo Uai reflection and circle, Pa'ara' Dena' there is congruency, similarity, reflection, and translation, Pa' Kale there is reflection, Pa'lamban Lalan there is congruency, parallel lines, and translation, and Passora Siluang there is the circle and Combined Geometry.

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