Ethnomathematical review of Toraja’s typical carving design in geometry transformation learning

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Abstract. Toraja’s typical carving as one of the nation’s culture wealth does not only have a philosophical meaning, but also contains mathematical elements in relation to the concept of geometry transformation. Ethnomathematics is a process of presenting the mathematical ideas possessed by traditional societies on various socio-cultural activities that can be observed as a mathematical activity. The mathematical exploration of Toraja's typical carving design such as Pa'tedong, Pa'barre Allo, Pa'manuk Londong, Pa' Sussu', and other developmental designs is an alternative learning model that can be applied in school. This is an important effort to preserve the national culture and as a cultural education to the younger generation. This is a qualitative research with ethnography approach to reveal philosophy and mathematical concept which is found on Toraja’s typical carving design.

1. Introduction
Indonesia is a big country. It has more than 17,000 islands, 1,300 ethnicities, with a population of 230 million spread from Sabang to Merauke. That’s why, Indonesia has a high level of diversity according to a cultural view that each region has its own uniqueness and distinctive characteristics. It is no exaggeration if Indonesia is dubbed as "The Country of a Million Culture", because there is no doubt about the cultural wealth of this country. The government has also consistently made the cultural power as the strength of Indonesia's development, so that all sectors of physical and mental development are colored by the values and cultural nuances.

Sociologists and anthropologists have different views about the meaning of culture. Etymologically, culture means fertilizing in relation to cultivation. This term was also rife used by the Europeans in the 15th century, until finally changed of developing human socially and politically [1]. Culture is defined as an instrument of community control and a solution to the complex problems faced [2]. According Koentjaraningrat, culture is the whole system of ideas that include actions, deeds, behaviors, and the results of human work obtained by learning. This definition conforms to J. J. Honigman's view of the cultural phenomenon in the form of ideas, patterns of action, and objects [3]. Parsons defines culture as a unique aspect of symbols, ideas, and beliefs [4]. Simply, culture means human inventions, senses, and intentions, including the work of art and intellectual [5].

As a result of the geographical and historical journey of Indonesia, cultural diversity is a necessity. This does not mean that Indonesia does not have a clear identity, but as a proof that Indonesian people have a great cultural product [6]. This enormous cultural product in quantity should be viewed as a wealth, not poverty. History proves that until today Indonesia can survive in the middle of the difference.
People can live side by side, in harmony and peace, holding the principle of Bhinneka Tunggal Ika, which means unity in diversity. However, the cultural wealth also faces challenges. Maintaining a nation's culture is not like turning a palm. The Indonesian people is required to be a cultural preservation agent, so the culture’s not to be lost in time, eroded by the current of globalization, and claimed as a culture by other nations.

One form of Indonesian cultural wealth is a variety of ornamental carving designs such as in Toraja. Toraja is an ethnic family that is administratively settled in Tana Toraja and North Toraja regencies of South Sulawesi Province. Toraja's typical carving design is one of the traditional arts which is usually found on the wall decoration in the homes of residents, traditional home of Tongkonan, and Toraja batik cloth. It must be preserved as an ancestral heritage that cannot be separated from the influence of customs, culture, beliefs, and religious rituals [7]. The design contains symbols that are made with meaning as norms and guides to the path of goodness for the generation.

One of the efforts in preserving the nation's culture is through education. Culture can be taught and passed on to generation through the learning process undertaken in school. Curriculum 2013 which is being enforced in the national education system at this time strongly supports the existence of culture-based learning because of the thematic and integrated pattern. Culture-based learning is divided into three kinds, namely learning about culture, learning with culture, and learning through culture. The learning is certainly based on the importance of culture to be preserved and cultural interconnections in the educational process [8].

In this paper, the author intends to explore Toraja’s typical carving design philosophically and geometrically. Philosophical aspects closely related to cultural elements, while the geometric aspect is part of the mathematical concept. The review of a culture from a mathematical view is known as ethnomathematics. The term was introduced by D'Ambrosio which is defined as mathematics practiced in cultural groups such as national societies, tribes, labor groups, children in certain age groups, and professional classes [9]. Ethnomathematics is the process of presenting the mathematical notion of traditional society [10], which refers to various social activities within a cultural group and can be observed as a form of mathematical activity [11]. The ethnomathematics research aims to make mathematics not an integral part of people's life, as an effort to preserve the culture, as well as preventive forms of multiethnic nation disintegration opportunities [12]. In Indonesia, cultural-based learning for mathematics has been done and studied by researchers in the field of mathematics education.

2. Methods
This research is a qualitative research with ethnography approach. Qualitative research is a natural phenomenon-oriented research to interpret the actual phenomena that occur in the observation environment [13]. While the ethnographic approach is an approach that explores the history and culture of the community observed [14]. The research focus is the exploration of Toraja’s typical carving design ethnomathematically. The review is more specific in revealing the philosophical meaning of Toraja's typical carving design and the concept of mathematical geometry contained. Generally, the steps taken in this study as follows: 1) formulating the focus of research problems: At this step, the researcher limits the scope of the problems chosen for research. This is especially important in the effectiveness of the research that will be conducted; 2) collecting the data (literature study): After determining the research focus, the researcher selects and sorts the data that is truly functional. Data that is not related to the focus of the problem can be temporarily ignored, while relevant data can be collected as study material. In collecting the data, researcher conducted literature studies related to the topic of the problem under study; 3) data analysis: The collected data is then analyzed descriptively according to the objectives to be achieved. In this case, the author looked for geometric patterns that exist in each model of a Toraja’s typical carving design; 4) preparing the reports: At this step, the author prepares a research report according to the format specified.

3. Result and Discussion
The various tribes in Indonesia still preserve their customs and culture. It becomes one of the attractions of Indonesian tourism in the eyes of the world. Toraja’s culture is one of the cultural wealth that is still
preserved in Indonesia. Since long ago, the culture has been passed down from generation to generation so it still survives in the community even famous to abroad.

One form of Toraja’s culture is traditional carving art which has various design with certain meaning, which is usually used as wall decoration at home and Tongkonan traditional house, coffin carving, and Toraja’s typical cloth. The art of carving is known as passura’ (writing) which has a flat, decorative, colorful characters (black, white, red, and yellow) and has a symbolic meaning in the context of Aluk Todolo (Torajanese’s belief).

If these typical Toraja carving motifs are carefully considered, then there can be found some mathematical concepts contained in them. The concept is closely related to learning of geometry transformation, such as reflection, translation, dilatation, and rotation. The current education curriculum that emphasizes learning in contextual aspects is very relevant to cultural-based mathematics learning. This is because students can feel for themselves the essence of mathematics they are learning. In the subject of Geometry Transformation, some basic transformations such as translation, reflection, dilatation, and rotation can be introduced to students through Toraja’s carving designs, as one form of local culture in South Sulawesi. This cultural-based learning can be used as an alternative in the mathematics learning model at school. The study of ethnomathematics on some Toraja’s typical carving designs is described as follows:

3.1. Design of Pa’tedong
Pa’tedong is carved with a design that resembles the face of a buffalo. Buffalo has a very high value for Toraja’s community so as a standard of richness. Buffalo has a various function in the life of Torajanese, namely as a tool of transactions and offerings to the ancestors. Philosophically, Pa’tedong carving means a symbol of prosperity, wealth, and nobility. This carving design applies the concept of reflection and folded symmetry, with the folded symmetry axis as the mirror. Notice the following Figure 1:

![Figure 1. Pa’tedong Carving Design](image)

3.2. Design of Pa’barre Allo
Pa’barre Allo is carved with a design that resembles the sun that shine brightly and give life to all beings in the universe. Philosophically, this carving means a form of Torajanese’s belief in the existence of God as the source of life in the universe. Geometrically, design of Pa’barre Allo is formed of the circles, stars, and astroids. On the design, applied the concept of reflection and folded symmetry with two axes of symmetry. Notice the following Figure 2:

![Figure 2. Pa’barre Allo Carving Design](image)
3.3. Design of Pa’manuk Londong

In Toraja, Pa’manuk Londong means rooster. This carving design has the connotation meaning of being a noble man who is the hope of society, the image of a wise, trustful, honest, and wise leader. On this design, applied the concept of reflection. Notice the following Figure 3:

![Figure 3. Pa’manuk Londong Carving Design](image)

3.4. Design of Pa’sussu’

Pa’sussu’ is a parallel-shaped carving with no variation and no color. Philosophically, it symbolizes the form of unity, togetherness, and mutual cooperation in community. Geometrically, Pa’sussu carving design applies the concept of translation. Notice the following Figure 4:

![Figure 4. Pa’sussu’ Carving Design](image)

3.5. Design of Pa’kapu’ Baka

Pa’kapu’ Baka is carved with a design that resembles a braid string closure that is used to store treasures and valuables. The philosophical meaning of this carving is a manifestation of the hope of harmony, peace, prosperity, and unity in the family. Mathematically, it applies the concept of 90º rotation on its vertices. Notice the following Figure 5:

![Figure 5. Pa’kapu’ Baka’ Carving Design](image)

3.6. Design of Pa’salaqbi Dibungai

Salaqbi means fence or barrier. In Torajanese, it is used to protect their families from negative things. This carving is a form of hope that humans can maintain and defend itself in living the process of life in the world. Geometrically, this design applies the concept of rotation. Notice the following Figure 6:
3.7. Design of Pa’dadu
In ancient times, dice game is a kind of gambling favored by some of Torajanese. Pa’dadu carving design is a warning to the younger generation to avoid the game dice (gambling) because it has a tremendous negative impact. Geometrically, this carving is very simple by applying the concept of translation. Notice the following Figure 7:

![Figure 7. Pa’dadu Carving Design](image)

3.8. Design of Pa’lamban Lalan
Pa’lamban Lalan consists of two words, lamban means crossing and lalan means street. This carving design means an advice to not interfere the affairs of others. Geometrically, it applies the concept of translation and reflection. Notice the following Figure 8:

![Figure 8. Pa’lamban Lalan Carving Design](image)

3.9. Design of Pa’ara’ Dena’ I
Pa’ara’ Dena’ I is carved resemble feathers on sparrows, which in Torajenese’s belief are regarded as dishonest animals and destroyers of plants. It has a meaning that people must live in honesty and truth. Geometrically, this design applies the concept of translation. Notice the following Figure 9:

![Figure 9. Pa’ara’ Dena’ I Carving Design](image)
3.10. Design of Pa’kangkung
Pa’kangkung is carved resemble the shoot of “kangkung” that grow in watery and fertile areas. It has a philosophical meaning of welfare, so that people are always given the ease of sustenance and good health. Mathematically, this design applies the concept of rotation, translation, reflection, and dilatation (magnification). Notice the following Figure 10:

![Figure 10. Pa’kangkung Carving Design](image)

3.11. Design of Pa’barana’ I
This carving means banyan tree. Philosophically, it has a meaning that the descendants of Torajanese can grow and earn sustenance that is always growing and bushy like a banyan tree. In addition, this carving as a symbol of hope that can emerge a descendant who can become a leader and protect the people. On this design, applied the concept of reflection and rotation. Notice the following Figure 11:

![Figure 11. Pa’barana’ I Carving Design](image)

3.12. Design of Ne’ Limbongan
In Torajanese, Limbongan means a source of springs that never dry to become a source of life. This design has a form of water flow that rotate and arrow in the four directions of the wind. Its philosophical meaning is the sustenance will come from the four directions like a spring united in the lake and give happiness. Geometrically, the carving design applies the dilatation (magnification) concept on the circles and rotation on the triangle. Notice the following Figure 12:

![Figure 12. Ne’ Limbongan Carving Design](image)
3.13. Design of Pa’tanduk Re’pe
Pa’tanduk Re’pe design is resemble buffalo horn, one of the Pa’tedong design development. This carving means a sign of life struggle to gain peace to the results of the effort that is done. Geometrically, it applies the concept of reflection and folded symmetry. Notice the following Figure 13:

![Figure 13. Pa’tanduk Re’pe Carving Design](image)

Based on the concept of geometry transformation contained in Toraja’s typical carving designs above, the learning of geometry transformation in junior and senior high school can use culture-based learning as one of the alternative learning model. Through this learning, students can be introduced to the basic concepts of reflection, translation, rotation, and dilatation to continue on more complex topic. Therefore, it should be there a policy about complementary learning resources based on local wisdom with the aim of bringing the concept of culture to the younger generation, so that the preservation of local culture is maintained.

4. Conclusion
Based on the results and discussion above, it can be concluded that in addition to having philosophical meaning, Toraja’s typical carving design also contains mathematical elements, especially in the basic concept of geometry transformation. Generally, the concept of reflection is seen in every design of Toraja's carvings such as Pa'tedong, Pa'barre Allo, Pa'manuk Londong, Pa'lamban Lalan, Pa'kangkung, Pa'barana 'I, and Pa'tanduk Re'pe. The concept of translation can be seen in Pa'sussu ', Pa'dadu, Pa'lamban Lalan, Pa'ara' Dena I, and Pa'kangkung design. Rotation concept can be seen on Pa'kapu 'Baka, Pa'salaqbi Dibungai, Pa'kangkung, and Ne' Limbongan design, while the concept of dilatation is seen on design of Pa'kangkung, Pa'barana 'I, and Ne'Limbongan.

Therefore, culture-based learning can be used as an alternative model of geometry transformation learning in school, as an effort to preserve national culture and cultural education to the younger generation. This research focuses only on one subcategory of the object so that it can be developed in other forms of culture according to the condition, local wisdom, and student’s environment.

5. References
[1] Schoenmakers H 2012 The Power of Culture: A Short History of Anthropological Theory about Culture and Power (Groningen: Globalisation Studies) 9-10
[2] Baecker D 1997 The Meaning of Culture (Thesis Eleven) 51 37-51
[3] Koentjaraningrat 2005 Pengantar Antropologi I (Jakarta: Rineka Cipta) 72
[4] Parsons T 1977 Social Systems and The Evolution of Action Theory (New York: Free Pr.)
[5] Jenks C 1993 Culture: Studi Kebudayaan (Terjemahan) (Yogyakarta: Pustaka Pelajar)
[6] Moeis S 2009 Pembentukan Kebudayaan Nasional Indonesia (Presented in Discussion Forum of History Education Department FFIPPS UPI Bandung)
[7] Parmono K 2013 Nilai Kearifan Lokal dalam Batik Tradisional Kawung Jurnal Filsafat 23 2 134-46
[8] Putri L I 2017 Eksplorasi Etnomatematika Kesenian Rebana sebagai Sumber Belajar Matematika pada Jenjang MI Jurnal Ilmiah Pendidikan Dasar 4 1 21-31
[9] D’Ambrosio U 2006 Ethnomathematics: Link between Tradition and Modernity ZDM 40 6 1033-34
[10] Ascher M 1991 Ethnomathematics: A Multicultural View of Mathematical Ideas (New York: Chapman and Hall)
[11] Presmeg N C 1998 Ethnomathematics in Teacher Education Journal of Mathematics Teacher Education 1 317-39
[12] Devkota S P 2013 Ethnomathematics and Multiculturalism Open Science Repository Mathematics Online(open-access)
[13] Walidin 2015 Metode Penelitian Kualitatif & Grounded Theory (Aceh: Ar-Raniry Press) 75
[14] Windiani Nurul F 2016 Menggunakan Metode Etnografi dalam Penelitian Sosial Jurnal Dimensi 9 2 87-92