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Ethnomatematics and Its' Relationship with the Concepts of Geometry at Elementary School Mathematics Based on Manggaraian Culture

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Abstract: ***This study aims to describe the results of the exploration of ethnomatematics forms and their relationship with geometric concepts at elementary mathematics in the culture of the Manggarai community, Flores, East of Nusa Tenggara. This study uses a qualitative approach. Researched data was obtained from community activities and artifacts. Data collection techniques are observation and interviews. The data was analyzed by the technique proposed by Miles and Huberman. The results of the study show that the shapes of ethnomatatics in the culture of the Manggarai community are explored in weaving activities, traditional ceremonies, webbing, household equipment, buildings, farming activities, and traditional musical instruments. The various ethnomatematics forms relate to geometric concepts at elementary mathematics which include concepts of triangles, rectangles, rhombus, hexagons, circles, beams, cones, and tubes.***

Keywords: culture, ethnomatematics, geometry

1. Introduction

Mathematics learning in each education unit is expected to be able to equip each student with skills and abilities to deal with various mathematical problems as well as in everyday life. This ability is called mathematical aptitude. Therefore, the implementation of mathematics learning should be able to develop students' mathematical ability. This mathematical ability is stated in the wide-ranging goal of mathematics learning formulated by the National Council of Teachers of Mathematics [1], which includes: 1) problem solving; 2) reasoning; 3) communication; 4) connection; and 5) representation.

The success of the learning process is the main thing that is coveted in carrying out education in school. As an effort to an augment accomplishment in learning mathematics in the present, many student-centered learning methods have been developed, such as student active learning, quantum learning, quantum teaching, and accelerated learning. All of these methods are used in the framework of a learning revolution which involves teachers and students as a unit that has a reciprocal relationship. The role of the teacher is as a lecturer or facilitator, while students are individuals as learners, because an effective learning will come about if a teacher can manage the learning process effectively [2].

But in reality, mathematics learning is not as expected. Learning mathematics is considered a scourge that is very frightening for most of the students. Even mathematics learning is always considered as the most difficult subject by some people, parents, and students. The causes low mathematics learning outcomes. In fact, every day students or society are always in touch with mathematics. This is because, in learning mathematics, there is the lacking of association between students' life and culture with mathematics.

Cultural nuances of learning will contribute greatly to school mathematics because school is a social institution which is different from the others, allowing socialization between several cultures [3]. This shows that mathematics is a form of culture. Mathematics as a form of culture has actually been integrated in all aspects of people's lives wherever they are. Mathematics that develops in a community environment is called ethnomatematics.

Ethnomatematics was introduced by D'Ambrosio, a Brazilian mathematician in 1977 [4]. D'Ambrosio says ethnomatematics is a study that investigates the ways in which different cultural groups understand, articulate, and apply concepts and practices that can be identified as mathematical practices [5]. Thus, the idea of ethnomatematics will be able to enrich existed mathematical knowledge. Furthermore Sardjiyo [6], said that in ethnomatematic-based learning, the learning environment will turn out to be a pleasant environment for teachers and students, allowing teachers and students to actively participate based on the culture that they already be acquainted with, so that optimal learning outcomes can be obtained. For this reason ethnomatematics is needed to be integrated into the curriculum.

Based on observations that have been made, one of the Manggarai community plait was found named *cecer*. *Cecer* is a place for storing the harvested rice of the community and was made from woven bamboo. The *cecer* resembles a tube in geometrics; hence it can be associated with the concept of tubes in mathematics learning. Based on this, it is believed that there are still many tools or cultural rudiments of the Manggaraians that resemble geometry or have something to do with geometric concepts in mathematics. Therefore, in this study ethnomatematics forms of the culture possessed by the Manggarai people and their relations to geometric concepts in mathematics learning in elementary schools will be explored.

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2. Methods of Data Collection

The type of research used in this study is qualitative which aims to explore the ethnomatematics forms in the culture of the Manggarai society. The results of the exploration are linked to geometric concepts in elementary school. Data collection techniques used were observation and interviews, so the data sources were community activities and artifacts owned by the Manggarai community. The data in this study were analyzed using techniques proposed by Miles and Huberman, namely data reduction, data presentation, and conclusion and verification.

3. Results and Discussion

The results of the study show that the Manggarai community has applied mathematics in various activities and artifacts included in weaving activities, traditional ceremonial equipment, plaits, household appliances, buildings, farming activities, and traditional musical instruments. The form of ethnomatematics in various activities and artifacts can be seen in table 1.

Table 1: Ethnomatatics Shapes of the Manggarai Society

No	Community Activities and Artifacts	Ethnomatatics Shapes of the Manggarai Society
1	Weave How to weave Woven fabric motif Weaving equipment	 *Dedang Towe Songke* *Cuwi Libong* and *Cuwi Ntala* *Kropong* and *Jangka*
2	Traditional Ceremony Equipment	Shape of *Langkar*
3	Woven: *Loce Peta* *Tange Balo* *Doku*	 Shape and motif of *Loce Peta* Shape and motif of *Tange Balo* Shape of *Doku*
4	Household equipment *Gelo* *Peti* *Langkok* *Gugu*	 Shape of the base of *Gelo* Shape of *Peti* Shape of *Langkok* Shape of *Gugu*
5	Building Traditional house roof Custom house floor	 Roof shape of *Mbaru Niang* Shape of the floor of *Mbaru Niang*
6	Farming activities Agricultural area Mousetrap	 Shaape of *Lingko* Shape of *Nggepit*
7	Traditional musical instruments *Gendang* *Nggong* *Buka*	 Surface shape of *Gendang* Shape of *Nggong* Shape of *Buka*

Based on the results of the exploration of ethnomatematic shapes in the culture of the Manggarai community, found a relationship between ethnomatematics forms with geometric concepts in elementary mathematics, namely the concept of circles, rhombus, triangles, rectangles, hexagons, beams, tubes and cones.

a. Concept of Circles

Circle is the position of points that are equidistant from a particular point, namely the center point on a flat plane [7]. This can be seen in the forms of Nggong, Nggiling, Langkar, Gelo, Buka, Gendang, and Doku.

Figure 1: Circle

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The objects in Figure 1 relate to the concept of a circle because the shapes resemble a circle. From the objects in the pictures, circle elements can be determined, such as the center point, diameter of the radius, bowstring, earthenware, and circle segment. Some forms of ethnomatematics resemble a circle can also be used to prove the value of π by measuring the circumference of these objects divided by the diameter of the object, so that =K/d .

b. The concept of Rhombus

Rhombus is a parallelogram that has the same side length and the opposite angles are equal [8]. The concept of rhombus is related to the motifs on the *Loce Peta*, *Tange Balo*, and *Cuwi /Libong* motif on *Songke* cloth.

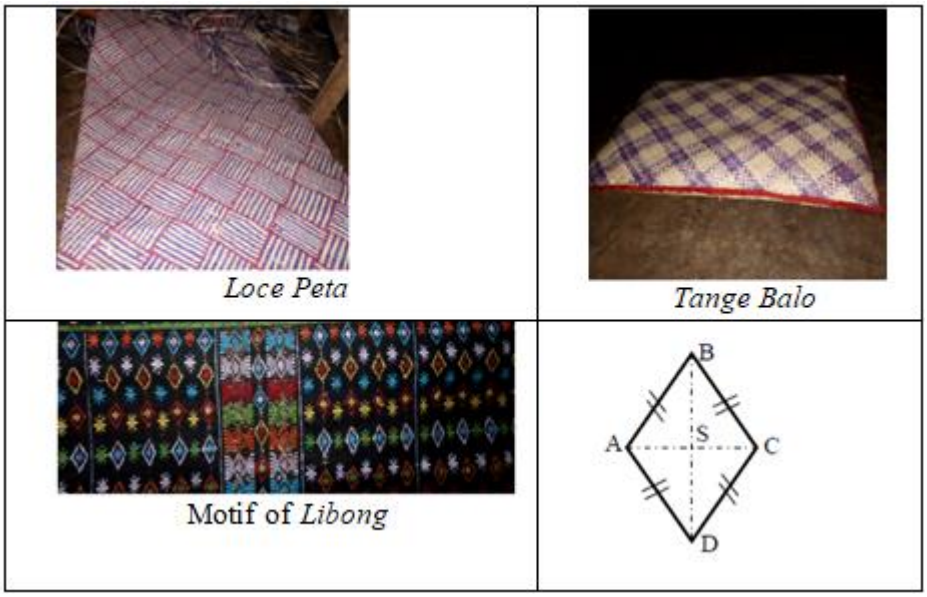

Figure 2: Rhombus Concept

The motives of objects in Figure 2 relate to the concept of rhombus because the shapes resemble rhombus. This can be seen in accordance with rhombic properties, which have two pairs of parallel sides, all sides are equal in length, have two diagonals perpendicular to each other, and the opposite angles are equal.

c. Triangle Concept

Triangles are flat shapes which are limited by three segments. Based on this, the triangle concept is related to the *Lingko*, *Cuwi Ntala*, *Mbaru Niang*, and *Nggepit* models because the shapes resemble triangles.

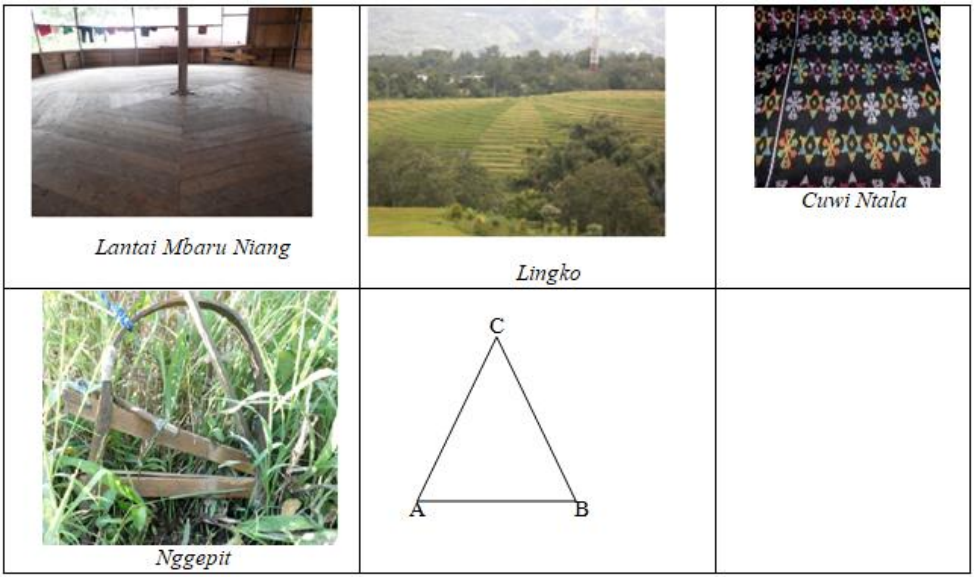

Figure 3: Triangle Concept

Based on the ethnomatematics forms, it can be seen the elements of a triangle building including sides, vertices, and peaks. Thus, the properties of a triangle are three sides, have a cusp, and have three vertices.

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d. The Concept of Rectangles

The rectangle is a parallelogram that has four angles which are equal and right-angled. The concept of rectangles relates to *Dedang Kain Songke*, *Langkar*, *bentuk Loce Peta*, *and Jangka*. Look at figure 4 below.

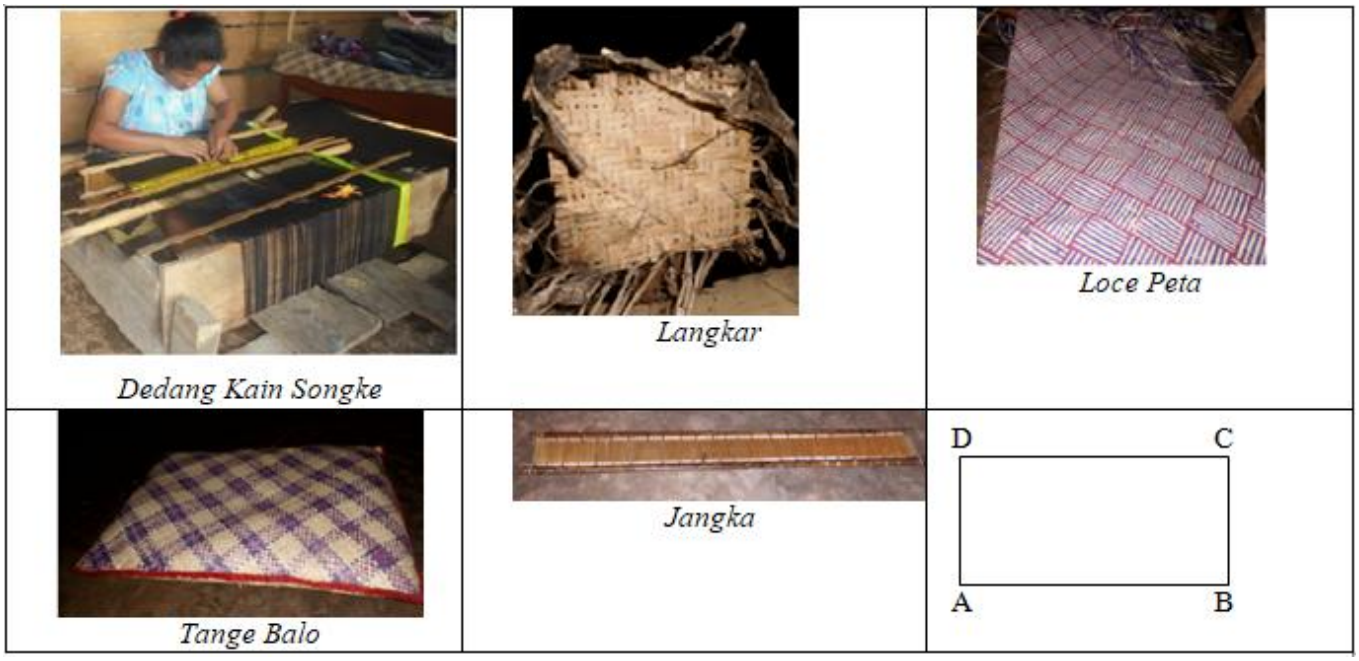

Figure 4: Rectangle Concept

The shape of the rectangle is formed from the way we started the weaving activities starting from preparing yarn until finishing the weaving. On *Loce Peta*, *Tange Balo*, and shape of *jangka*, the shape resembles a rectangle.

e. Parallelogram Concept

Parallelogram is a rectangular geometry with both sides is in line and in an equal length. This shows a parallelogram related to the *Cuwi Ntala* motif on *Songke* cloth (see Figure 5).

Figure 5: Parallelogram Concept

Based on Figure 5 above the parallelogram has the properties wherein the sides are facing parallel and in an equal length, has two sides which are facing each other, and the angles have an equal size.

f. Tube Concept

Tubes are geometrics which are limited by two sides in the form of a circle, congruent, and parallel and one side upright in the form of an arch [9]. Based on this concept the tube is related to *Langkok*, *kropong*, and *Gugu*. *Langkok* and *Gugu* are related to tubes because they resemble tubes.

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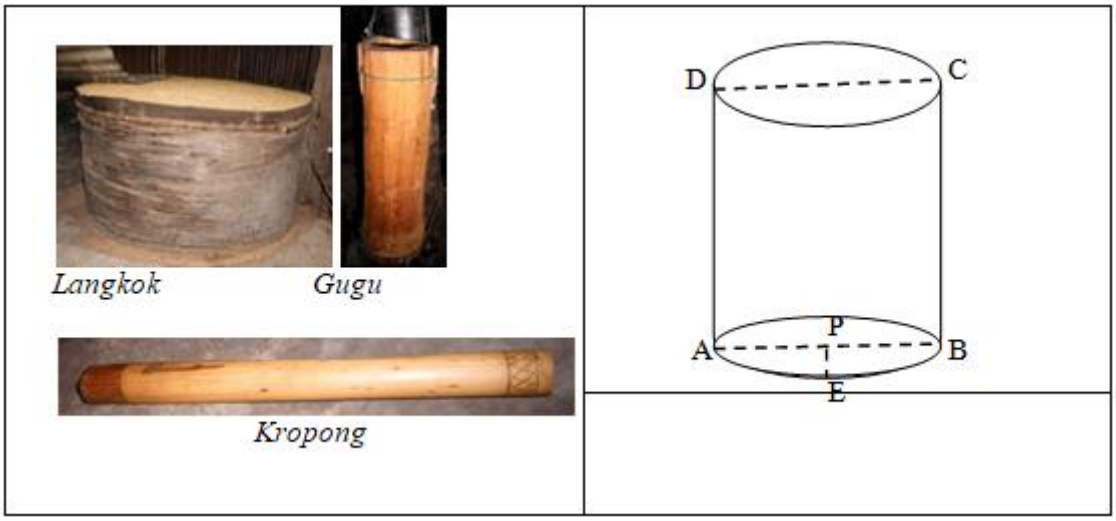

Figure 6: Tube Concept

Based on Figure 6, it can be seen that the tube elements are the upper side (lid) and the bottom side (base) in the form of a congruent circle, the tube base diameter indicated by line AB, the tube base radius indicated by PE, PA, and PB, the height of the tube indicated by lines BC and AD, the curved side called the blanket tube, and the surface of the tube, namely the plane covering the upper side, bottom side and tube blanket.

g. Cone Concept

The cone is a geometry curved side space whose base is a circle with the radius of r and the blanket in the form of a circle. The cone concept is related to *Mbaru Niang*'s roof (see Figure 7) because of its shape resembling a cone.

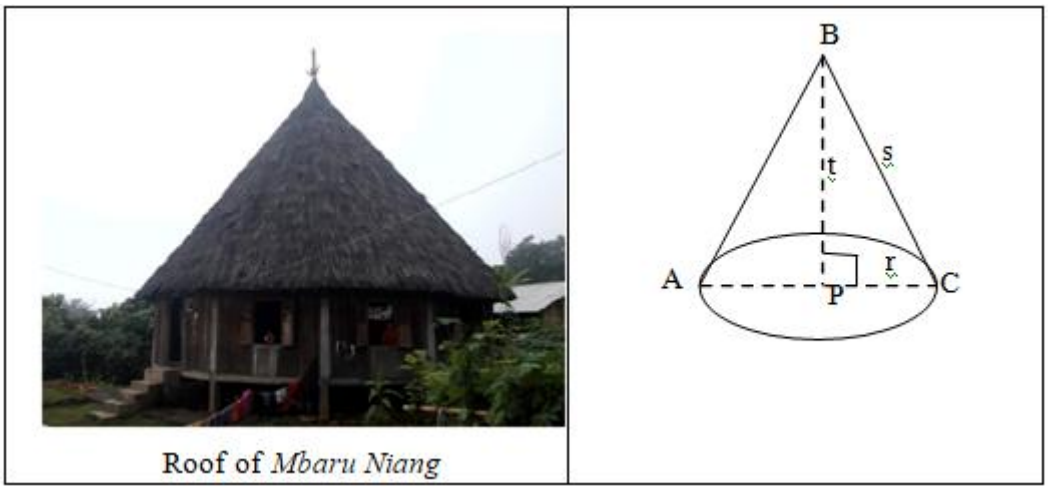

Figure 7: Cone Concept

The cone has elements including the curved side called the cone blanket and the bottom (base) in the form of a circle, the base radius indicated by the PA and PC lines, the cone height indicated by the BP line, and the cone painter line shown BA and BC lines that is the line which unite the cone peak with the point at the circle of the base.

h. Concept of Beams

Beams are geometrics bounded by six rectangles with parallel pairs [10]. Based on this concept the beam is related to *peti* (see Figure 8) because the shape resembles a beam.

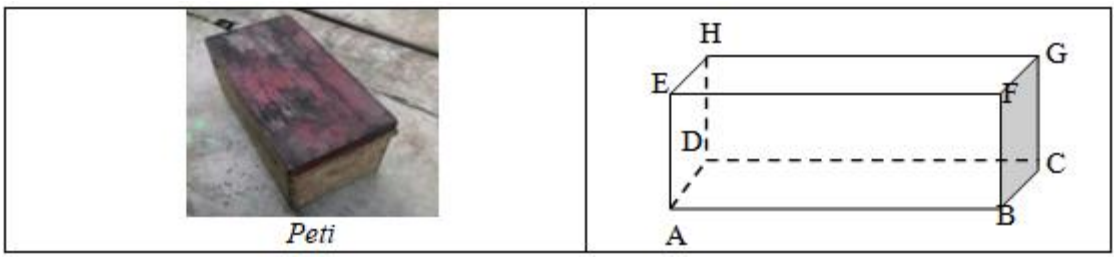

Figure 8: Concept of Beams

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Beams have elements, namely sides, ribs, and vertices. The side is a part that limits the beam. Beams have 6 sides, namely the sides of ABEF, BCFG, EFHG, DCHG, ADBC, and ADEH. Ribs are line segments which are the intersections of two sides. The beam has 12 ribs, which is indicated by the lines AB, BC, CD, AD, EF, FG, GH, EH, CG, BF, AE, and DH. The corner point is a meeting between three pieces of ribs. Beams have 8 vertices, namely points A, B, C, D, E, F, G, and H.

i. Hexagon Concept

Hexagons are many facets which are limited by six sides. This shows the hexagon concept related to *Cuwi Ntala* (see Figure 9) because its shape resembles a hexagon.

Figure 9: Hexagon Concept

The results of the research show that the Manggarai people have used mathematics since ancient times. Bishop (Orton, 2004: 130) says that in each nation's culture there are six mathematical activities in general, namely (1) counting; (2) determine the location or location; (3) measure; (4) designing; (5) playing; (6) explain. These activities were also carried out by the Manggarai people contained in traditional games, namely: *Caci*, *Kuti Welu* and *Banga Welu*; woven cloth from *Songke* and *Todo*; implementation and equipment of traditional ceremonies; woven *Loce*, *Tange*, and *Doku*; home appliances *Gelo*, *Peti*, *Langkok*, and *Gugu*; traditional house building, farming and raising activities, *Nggong*, *Gendang*, dan *Buka*

The results of the exploration of ethnomatematic forms in the culture of the Manggarai community, found the relationship between ethnomatematics forms with geometric concepts, arithmetic operations, and mea surements in elementary mathematics. Calculating operations that have a relationship with the form of ethnomatematics are the concepts of addition and subtraction. Measurements include measurements of weight, quantity, length, and time, while geometric concepts that have relations with other forms of ethnomtematics include triangles, rectangles, parallelograms, rhombus, hexagons, circles, beams, tubes and cones.

4. Conclusions and Recomendations

Based on the results of the study it was concluded that the Manggarai community applied mathematical concepts in their daily lives. This is evidenced by the discovery of ethnomatematics in the activities and artifacts of the community in the form of woven cloth from Songke and weaving equipment (*Jangka* and *Kropong*); traditional ceremonial equipment; woven *Loce*, *Tange*, and *Doku*; home appliances *Gelo*, *Peti*, *Langkok*, and Gugu; traditional house building, farming and raising activities, *Nggong*, drum and open musical instruments. The forms of ethnomatematics have relations with geometric concepts in elementary mathematics which include the concepts of triangles, rectangles, rhombus, hexagons, circles, beams, tubes and cones.

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