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Lingko: Interweaving Manggarai Culture, and Mathematics

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Abstract. This research was conducted to explore the relationship between formal mathematics and *Lingko*, a system of traditional agricultural land distribution in Pocoleok, Manggarai-NTT Regency shaped like a spider web. *Lingko* was interesting to study concerning mathematics because of the philosophical values contained in *Lingko* and the *Lingko* sharing ceremony. This research focused on two things, namely: (1) how the distribution of ulayat land, *Lingko*, was mathematically reviewed while still paying attention to cultural values, and (2) how the community practiced mathematical concepts in the distribution of *Lingko*. The first focus of the problem was to uncover the mathematical activity of the distribution of ulayat land, *Lingko*, which was unknowingly carried out by the Pocoleok, Manggarai peoples. Knowledge gained from this first study might produce a new approach to learning mathematics, both from a mathematical or mathematical education perspective. The second focus of the problem sought to reveal the extent to which the basic concepts of Manggarai culture (following understanding) to solve mathematical problems faced in the reality of life. This second study provided more space for cultural-based mathematics learning, namely how to comprehend mathematical concepts based on contextual issues that arise in Manggarai culture.

1. Introduction

Education carries the mission as a means of transferring value and transferring knowledge [1]. This means that in the learning process, the teacher not only emphasizes the aspects of education but also the values of the students' local cultural wisdom [2]. Since mathematics is a product of culture, the development of mathematics should not be separated from the development of existing culture, and also mathematics should influence the development of culture to achieve civilization [3,4]. This is important because mathematics is inherent in the customs of the people that are applied by certain cultural groups, for example in the activities of division of traditional agricultural land, traditional games, motifs in traditional equipment, traditional woven cloth motifs, and the creation of traditional houses[5].

The approach to learning mathematics from a cultural point of view in educational process aims to build a bridge between the student background knowledge and formal mathematics [4,6]. Culture-based mathematics learning is important because learning in schools needs to emphasize the formation of positive characters that reflect the cultural values in addition to improving the cognitive aspects of students [2]. The study that links mathematics and culture is ethnomathematics [7–10]. In particular, ethnomathematics explores the interaction between mathematics and culture, so that one's understanding of mathematics becomes more precise, easier to understand, and more rooted [3,7,11,12].

This study discusses mathematical concepts that emerge and are practiced in Manggarai culture. Specifically, it was conducted to explore the relationship between mathematics and the traditional agricultural land distribution system in Pocoleok, Manggarai Regency, East Nusa Tenggara. The agricultural land in this area is divided into a number of circular units called *Lingko* which is shaped



like a spider web. *Lingko* is defined as cultivated land owned by a particular village and is an official and public (communal) garden that is shaped like a spider's web [13]. *Lingko* is a circle with its center called *lodok*, and the outer edge is called *cicing* as seen Figure 1. Each *lingko* has a name given by its predecessors which based on plants / trees that grow a lot in that area (*Lingko Waek*, *Lingko Kalo*, *Lingko Kenti*), environmental conditions (*Lingko Roga*, *Lingko Tengku*, *Lingko Rowet*). *Lingko* consists of five main parts, namely *Lodok* (as-as the center of *Lingko*), *Lander Lekong* (a small circle usually within one handspan of *Lodok*), *Langang Lekong* (the larger circle with radius 1 to 5 stretches of hand from the *Lander Lekong*), *Le'as* (sector), dan *Cicing* (outer circle). The results of the *lingko* division form a sectors which is known as *moso*.

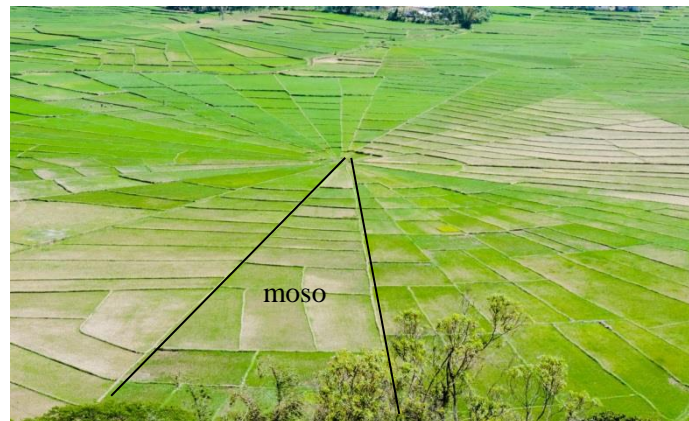


Figure 1. *Lingko* in Manggarai

Lingko is interesting to study in relation to mathematics because of the philosophical values contained in *Lingko* and the *Lingko* sharing ceremony. This research focused on two things, namely: (1) how the distribution of ulayat land, *Lingko*, was mathematically reviewed while still paying attention to cultural values, and (2) how the community practiced mathematical concepts in the distribution of *Lingko*. The first focus of the problem was to uncover the mathematical activity of the distribution of ulayat land, *Lingko*, which was unknowingly carried out by the Pocoleok, Manggarai peoples. Knowledge gained from this first study might produce new mathematical knowledge, both from a mathematical perspective or mathematical education. The second focus of the problem seeks to reveal the extent to which the basic concepts of Manggarai culture (in accordance with understanding) to solve mathematical problems faced in the reality of life. This second study was aim to provide more space for cultural based mathematics learning, namely how to comprehend mathematical concepts based on contextual phenomenon that arise in Manggarai culture.

This research is important because the mindset and cultural values are interesting to learn [1]. The hope of researchers is that multi-cultural and multi-ethnic education in Indonesia has a characteristic in which local cultural wisdom is used as a starting point in learning. By studying the subject of local wisdom, students are not only equipped with knowledge, but more than that the task is entrusted to enrich, preserve, and continue the cultural values that underlie the subject. In addition, love for culture will foster pride that forms the positive character of the younger generation.

2. Method

This research was conducted using a qualitative research approach, with ethnographic methods. Qualitative research is a social science approach that observes humans in their territory and interacts with them in their own language and terms [13], Gall, Gall, and Borg in [14] specifically states that ethnographic methods of research are qualitative research procedures to describe, analyze, and interpret patterns of behavior, beliefs, and languages of a particular cultural group that develop over time. Furthermore, ethnography involves intensive study of certain cultural features and patterns in these features. We used ethnographic methods since this research explored the connections between Manggaraian culture and mathematical concepts and ideas contained in *Lingko* Manggarai.

Data is taken from various interviews, observations, and documentation. Data was collected by semi-structured interviews because interviews were considered as one of the most effective ways in which researchers tried to understand fellow humans. And observations made in this study are honest observations, namely researchers in collecting data honestly to data sources, that researchers are conducting research. When making this observation, the researcher made a field note to write all the information. At this stage, the researcher observes and records all information related to *Lingko*. Sampling for the data source determined is a purposive sampling technique. Purposive sampling is defined as a sampling technique based on certain criteria and considerations. The consideration here is that the parties chosen are those who are considered to know to get the information needed. Informants were classified as main informants, supporting informants, and informants for triangulation. The research subject was a native Pocoleok who really understood the meaning of the *Lingko* division and philosophical meaning in the *Lingko* division. Subjects interviewed regarding *Lingko* were chosen based on certain criteria which were able to bring *torok / tudak* in traditional rites. This is the main criterion because someone who is able to bring *torok / tudak* is considered to have capable abilities in terms of customs and rites. Next, the researcher conducted in-depth interviews with the research subjects regarding what is *Lingko*, the meaning of *Lingko*, and how *Lingko* was formed in the view of the Manggarai people. Before thoroughly discussing *Lingko*, the following related matters need to be considered to get a complete understanding of the views of the Manggarai people.

Data for planning, evaluation, and development of performance are taken from the informants either from interviews, observation, or documentation. Whereas to get valid data, extend the phase of data collection, increase persistence, triangulation, use references, and examine members for data reduction and display before conclusions are obtained.

3. Result and Discussion

3.1. Distribution of *Ulayat Land, Lingko*

The study focused on the division of land in the Pocoleok area, Satar Mese District, East Nusa Tenggara Province in 2019. This research focused on two things, namely: (1) how the distribution of *ulayat land, Lingko*, was mathematically reviewed while still paying attention to cultural values, and (2) how the community practiced mathematical concepts in the distribution of *Lingko*.

Lingko (in the form of circle) with its center *lodok* (the center point of a circle) and its outer edge *cicing* (circumference of a circle) as seen in Figure 2. *Lingko* consists of five main parts, namely: *Lodok* (A), *Lander Lekong* (B), *Langang Lekong* (C), *Le'as* (D), and *Cicing* (E) as explained before. This characterizes the unity of the universe symbolized by the number 5 (five) which is believed to be a perfect and magical number for the Manggarai people.

Lodok as the center of the garden is marked with *haju teno*, *lander lekong*, and *langang lekong* on the top is carved like a top, wrapped with a rope, then plugged five times into the ground (*tente teno stage*). In the process *Lingko* distribution, from *haju teno* (as a center) made a small circle, *lander lekong*, with radius *ca pagat* (one handspan). From this *lander lekong*, *lingko* will be divided into smaller parts in the form of circle sectors, *moso*, whose area is determined by the width of the finger surface that divides *lander lekong* become circular arcs. On *lander lekong* plugged in *Lance* (look at the vertical line on *lander lekong* in Figure 2) which divides the circle into long arcs according to the desired *moso*. *Lance* are small stakes made from sticks, *haju teno* branches, or small pieces of bamboo (resembling toothpicks) that have the same size so that they do not cause differences in the size of the area due to differences in size *Lance*. Then close to *lander lekong* placed *watu lodok* (symbol G in Figure 2) which serves to put offerings and place to put animal blood when holding a traditional rite in *lodok*.

From *lander lekong* made larger circles with radius 1-5 *depa* (hand stretch) and this is called *langang lekong*. On *langang lekong* determined boundary between *moso* known as *langang* (symbol F in Figure 2). Trusted and experienced person (*ata tirik*) determine the points on *langang lekong* in line with the center of *Lodok* and *Lance*. Drawing a boundary line from *Lance* which lies in *Lander Lekong* headed *langang lekong*. This activity is often called *Wero Langang*, which is an activity to make a straight line from *lodok* to *cicing*.

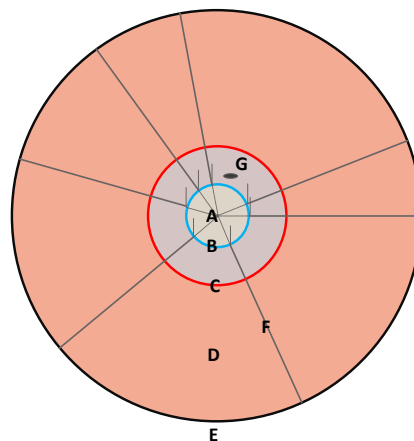


Figure 2. Illustration of *Lingko*

In the interview related to *Lingko*, researchers found that the traditional form of the Manggarai people who resembled spiderwebs was full of religious meaning. This spider web describes human relations with the universe and His creator. The Manggarai people see life and reality as a network like a spider web, where each creation (which is alive or not, visible or invisible) is interconnected and forms a system that is orderly, complicated, and perfect with *Mori Kraeng* (God) as the center of everything [15]. In relation to this, humans are seen as beings who have very high dependence on other people but have unique and irreplaceable values and roles. This is in line with the opinion written by [15] that the Manggarai community is a society that is paradigmatic of spiderwebs, namely people who see their lives and all reality as a network of interconnected relationships such as spider webs. The Manggarai people consider themselves to be only a small part of the vast world. The Manggarai people believe that their life is a network of relations where every aspect of their lives is always related to the other 4 components in the circle of life, with every element of nature, animals, plants, spirits, and God as the center of everything.

3.2. Mathematical Concepts contained in *Lingko*

Based on information obtained during interviews, analysis of mathematical material obtained mathematical concepts that can be taught contextually with *Lingko* are nonstandard unit measurement and circle.

Students should understand the process of comparing and measuring before using standard measurement units. Students are expected to be able to measure the same objects simultaneously with different non-standard units so that they are able to see the need for units that are consistent in measurement. It is known that the same object tends to have different length if it is measured by two non-standard units. The experience of students when measuring the same objects using different non-standard unit encourages discussion about how to measure the length of objects using the same unit so that there are no differences in the measurement results. To teach this non-standard unit, teachers can use a cultural approach related to *Lingko*. In addition to making students understand the material, the teacher can also instill a loving attitude towards culture and also teach the values contained in this activity. In ancient times the Manggarai people used several aids in measuring the length of the fingers with *pagat* (one handspan) and *depa* (one handstreach) units as units of length, and *moso* (circle sector) as a unit of area. These measurements are always used in the *Lingko* distribution activities. *Pagat* is used to measure the length, which is calculated from the thumb to the middle and middle fingers which are also used to measure the length, which is calculated from the tip of the middle finger of the left hand to the tip of the middle finger of the right hand. *Moso* is used to determine the area of cultivation of each farmer. The division of land using non-standard measurement units is relevant to the Principal Material of Measurement in Elementary School Grade IV. Basic competency to be achieved is to recognize the length measure with non-standard units and solve contextual problems

related to time and length. Learning through this cultural approach is expected to be effective because learning is carried out close to students' daily lives [16,17].

A circle is defined as the set of all points in the plane that have a fixed distance, called the radius, from a fixed point, and called the centre. Any line that joining a point on the circle to the centre is defined as a radius. Any two radii, by the definition of a circle, have the same length. Furthermore, Let P and Q be two distinct points on a circle with centre O . These two points split the circle into two opposite arcs. If the chord PQ is a diameter, then the two arcs are called semicircles. Otherwise, one arc is longer than the other – the longer arc is called the major arc PQ , and the shorter arc is called the minor arc PQ . Now join the radii OP and OQ .

In relation to *Lingko*, the center of the circle is marked by *haju teno*, the radius is called *langang*, and the points that are equidistant from the center of the circle form *cicing*. Also, minor sector is known as *moso*. Learning about this circle is relevant to the Main Material of the Circle in the Class VI Elementary Education Unit. Basic competency to be achieved is to explain the center, radius, diameter, arc, and sectors. In addition, it is also in accordance with the next Basic Competence, which explains the approximate circumference and area of a circle.

A pie chart is a statistical graph in the form of a circle divided into slices to describe numerical proportions. In a pie chart, the length of the arc of each slice (and consequently, the center angle and area), is proportional to the quantity it represents. *Lingko* can also be used to achieve Basic Competence in Grade VII namely Analyzing the relationship between data by means of presentation (tables, line diagrams, bar charts, and pie charts) and presenting and interpreting data in the form of tables, line diagrams, bar charts, and pie chart. Furthermore, it can be learned in grade VIII to achieve basic competencies Explaining the central angle, the circumference of the circle, the length of the arc, and the area of the circle, as well as its relationship and then explaining the tangent of external fellowship and fellowship in two circles and how to paint it.

Apart from being in school, parental participation is needed in teaching mathematics contained in everyday life. Parental involvement, through encouragement and monitoring of educational and behavioral activities, which is conducive to successful educational outcomes, is considered to be critical factors in academic success [18]. The involvement of parents in the educational process with a cultural approach feels more contextual, considering the culture is inherited from generation to generation in the family environment. Togetherness of parents and children in the learning process becomes more likely and results in rooted knowledge of children in the culture in which he grows and learns.

4. Conclusion

The results drawn from this study have implications in which ethnomathematics has a significant role in providing the necessary contextual meaning to abstract mathematical concepts. In order to accommodate the role of ethnomathematics in mathematics learning, researchers need to find the link between teaching materials and students' culture to encourage student's development of conceptual learning materials. Learning mathematics in the context of Manggarai culture is intended to instill a sense of love for culture, make the educated and the younger generation aware that they want to preserve and develop cultural values, and realize that culture is the main and first place to shape one's character and personality. One of the values that can be learned in the *Lingko* division is justice, brotherhood, and trust.

Mathematics learning material that can be learned by *Lingko* are Measurement, Circles, and Circle Charts The findings lead to the recommendation to design a new approach in mathematics educators by engaging students' culture to learn process mathematics.

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