Ethno mathematics at the Traditional House
of *Mbaru Niang Wae Rebo*, Manggarai

Wara Sabon Dominikus[1], Aleksius Madu[2] , Zacharias Angelius Krisnadi Wara Sabon[3] ,
Pryscianus Lalong Jalo[4]
{dominikus@staf.undana.ac.id[1], leksi_madu@staf.undana.ac.id[2], zkrisnadi@gmail.com[3],
jalopryski@gmail.com[4]}

[1-4]University of Nusa Cendana

Abstract. This study aims to identify Ethno mathematics in the *Mbaru Niang* traditional house of the *Wae Rebo* community, describe related mathematical concepts, and develop learning tools and learning trajectories for mathematical concepts found in the culture of the *Mbaru Niang* traditional house. The research method used is descriptive qualitative research with an ethnographic approach. The researchers were the main instrument, and data was collected through observation, interviews, and documentation—the validity of the data using source triangulation techniques. Furthermore, the data were analyzed to describe the research findings. The results showed that there was a mathematical activity in the construction of the *Mbaru Niang* traditional house. This activity includes measuring with the concept of standard and non-standard units and designing activities related to the concept of geometry. Thus the mathematical concepts contained in the construction of the *Mbaru Niang* traditional house can be developed by designing a learning device and learning trajectory following school mathematics.

Keywords: ethno mathematics, Mbaru Niang, mathematics learning, traditional house

1. Introduction

Indonesia is rich in culture, and each region has its cultural diversity. Culture is one of the unique things and becomes a habit of society that exists from generation to generation in the order of social life. Ethno mathematics is a learning approach that connects mathematics with tradition or culture in the environment around students, following the needs and lives of the students. Ethno mathematics is a learning approach carried out by teaching mathematics by linking mathematics with the nation's cultural works and the needs and lives of its people [1]. Ethno mathematics is defined as the unique ways a particular cultural group or society uses mathematical activities [2]. Using Ethno mathematics in learning can be a turning point for the success of the mathematics learning process [3]. Ethno mathematics addresses mathematical knowledge, languages, values, behaviors, knowledge, and practices that cultural groups spread in particular environments [4]. Implementing learning will be meaningful for students if they can further construct the knowledge they have gained through experience with the culture into learning at school. Ethno mathematics as a learning approach will make the learning environment fun [5] because ethno mathematics-based learning makes learning mathematics fun, bringing students closer to their culture and increasing their interest and motivation in learning mathematics [6].

The house is one of the primary needs and a symbol of one's social status for every human being; therefore, everyone will try to have a decent house, more specifically, everyone who is married. The house, for society, has a significant position in terms of culture and meaning. The opinion reinforces that the house occupies a central position in the world order

and social order in the culture of the Timor region, the eastern part of Indonesia [7]. A traditional house is a gathering place for a particular family or tribe in a specific community order. The traditional house, as a form of unique architectural work that was established by the community, is a manifestation of the culture and community life system that was born and developed from the values that grew in the local community without being influenced by standard norms in the international architectural repertoire [8].

The *Mbaru Niang* traditional house, as one of the traditional houses in *Wae Rebo*, Manggarai Regency, has a very high cultural value and has been preserved to this day. *Mbaru Niang* comes from two words, namely *Mbaru*, which means house and *Niang*, which means tall and round, so *Mbaru Niang* means a conical house. *Mbaru Niang*, for the *Wae Rebo* community, is not only a place to live. *Mbaru Niang* is a part of themselves. Every corner of *Mbaru Niang* has a particular function, all of which have value and meaning [9]. The characteristics of *Mbaru Niang* are found in its conical shape with a fused roof and body. The walls of the building are composed of a bamboo frame covered with a tangle of dry weeds and palm fibers to protect the occupants from the cold temperatures typical of the mountains. Apart from being conical in shape, *Mbaru Niang* also has a circular and terraced pattern of space with different spatial functions.

The uniqueness of *Mbaru Niang*, which is enriched with mathematical concepts, can be seen from the structure of the building in the form of geometric shapes so that it can be used as a medium for researchers in learning mathematics. However, this is not realized by some *Wae Rebo* people, especially students and students who are still fixated on understanding mathematical concepts through something abstract or they have never experienced. Hence, students learn to understand mathematical concepts still patterned in books. Understanding students' mathematical concepts are still abstract because it is independent of the culture relevant to their experiences. Mathematics is a cultural phenomenon, found in every culture, embedded or hidden in every culture, shaped by every culture, influenced by culture and has a unique form according to the needs and goals of society [10]. Thus it can, and attics cannot be separated from activities. Culture exists in society, so in learning mathematics, it is necessary to involve culture in the learning process. The success of a learning process is not only realized by the achievement of student learning outcomes at school. However, a learning process is if the process has acted on students so that they can develop and apply what has been accepted in their lives.

Mathematics learning requires an approach so that in its implementation, it provides effectiveness. Mathematics learning is a learning process provided by students so that students can find relationships between concepts and mathematical structures in it and can solve problems. Cultural integration in mathematics learning following the 2013 curriculum can bring up the meaning of the material studied so that it can touch aspects of students' daily lives and local culture [11]. Integrating Ethno mathematics into the formal mathematics curriculum is one way to overcome students' difficulties learning mathematics [12].

There are several previous studies that have implemented an ethno mathematics approach to learning mathematics in schools. These studies, including [13], show that implementing an ethno mathematical approach to learning mathematics can improve student learning outcomes. Furthermore, [14] the results of his research concluded that applying Ethno mathematics as a means to motivate and stimulate students can overcome boredom and give new nuances to learning mathematics. While [15] findings showed that learners taught using an ethno mathematics approach achieved significantly higher in the test than those taught consumer arithmetic using the traditional approach and [16] use of mathematics materials-based Ethno mathematics are better than the learning that does not use mathematics materials-based ethno

mathematics. From some of these studies, the implementation of mathematics learning in the classroom with an ethno mathematics approach can improve learning outcomes. Besides, it can motivate and stimulate students to learn to eliminate boredom in learning mathematics.

This also shows that the ethno mathematics approach can be applied to all levels of education, from elementary to upper secondary level, because there are mathematical concepts at every level in culturally based mathematics learning. So the role of the teacher must adjust between the material topics to be presented with an ethno mathematics approach. Which culture will be integrated into learning and is directly related to mathematical concepts that can improve student learning activities.

Learning mathematics will be more fun if it provides opportunities for students to be creative following their actual experiences in everyday life following their socio-cultural life. Mathematics can be successful if various components are considered in the pedagogical aspect, including the student [17]. Ethno mathematics is closely related to mathematics education and socio-cultural backgrounds [18]. Students already have a cultural background that they have implemented daily based on real life. If integrated into mathematics learning, this cultural background will give students a good meaning of learning, where students will more quickly understand mathematical concepts. This has become one of the strengths of Ethno mathematics in learning mathematics in schools.

The unique habits of counting activities and the shape of the space used in building or constructing the *Mbaru Niang* traditional house can be predicted. Why is it unique? Because *Mbaru Niang* is known not only by the people of *Wae Rebo* or Manggarai but also the entire *Mbaru Niang* has become a tourist attraction. So this is the advantage of this research. Based on this, the research aims to find out what mathematical concepts the *Wae Rebo* indigenous people use in counting activities in establishing the *Mbaru Niang* traditional house in the form of geometric shapes that can be adopted into mathematics learning at school. The researchers' success in conducting research activities with an ethno mathematics approach to strengthen the development of the school mathematics learning curriculum. The practical application of ethno mathematical-based learning can be used to re-contextualize learning approaches that focus on culture-based learning.

2. Method and Materials

This article results from research conducted at the *Mbaru Niang, Wae Rebo* traditional house, Manggarai Regency, East Nusa Tenggara. This research was conducted in Wae Rebo, Satar Lenda, West Satar Mese District, Manggarai Regency, East Nusa Tenggara. This research was conducted for three days (27 - 29 September 2022). The method implemented in this study is a qualitative descriptive research method. The qualitative descriptive method is a research method to describe the background, ongoing processes, properties and relationships between phenomena to be investigated [19]. The choice of descriptive research method is because the researchers want to describe and describe in detail the ethno mathematical aspects that exist in the culture of the *Wae Rebo* community, especially regarding *Mbaru Niang* (a roundhouse shaped like a cone) and want to know the relationship between *Mbaru Niang* and mathematics from a cultural perspective and from a mathematical perspective as a science. Subjects in this study are; 1) the indigenous people of *Wae Rebo* and living in *Wae Rebo*, 2) the subject concerned is able to explain, 3) has a broad understanding of the *Mbaru Niang*

traditional house, 4) is mature and physically and mentally healthy. Thus, the research subjects who meet these requirements are two people (1 male and one female). See Table 1.

Table1. *Research Subject*

Subject	Gender	Age	Academic qualifications	Occupation
A	Male	72 years old	Primary school	Community Deputy Chief of Mbaru Niang
B	Female	76 years old	No school	Farmer at Wae Rebo

At the time of this research, the chief of the *Mbaru Niang* traditional house was sick and not in *Wae Rebo*, so the researchers chose the deputy chief of the tribe, where the deputy chief of this tribe is the sibling of the chief of the tribe. Researchers only chose these two people because they are direct descendants of the founders of the *Mbaru Niang* traditional house who know the origin and the process of establishing the *Mbaru Niang* traditional house.

The main instrument in this study was the researchers, with the support of supporting instruments in the form of interview guidelines, observation and documentation sheets, and field notes. This research procedure (1) determines the informant (data source). In determining the informant must meet several criteria set; (2) prepare interview guidelines used in collecting data related to *Mbaru Niang* and the mathematics contained therein; (3) conduct the process of collecting data from informants through the interview and observation process. Then the researchers made notes from the results of interviews and observations; (4) tested the validity of the data by using triangulation techniques, namely researchers comparing data from observations/observations directly with data from interviews and comparing with data from documentation; (5) perform data analysis; (6) obtaining ethno mathematical findings in the culture of the *Mbaru Niang, Wae Rebo* traditional house; (7) designing learning tools based on Ethno mathematics in the *Mbaru Niang* traditional house as integration in learning mathematics.

3. Result and Discussions
3.1 Result
Description of the culture of the *Mbaru niang* traditional house of the *Wae Rebo* community

Wae Rebo is a traditional village that has a unique culture. This research was conducted in the village of Wae Rebo, Manggarai. *Wae Rebo* is a traditional village located in the highlands of Manggarai. *Mbaru Niang* comes from two words: "*Mbaru*", which means house, and "*Niang*" which means cone-shaped. Thus *Mbaru Niang* is a conical house. Furthermore, there are seven *Mbaru Niang* in Wae Rebo Village, one of which is a traditional house in the local language called *Mbaru Tembong/Mbaru Gendang* because, in this house, there are stored heirloom objects such as gongs, drums and other objects used at the time of the ceremony. Traditional ceremonies.

In contrast, the other six *Mbaru Niang* are called *Niang Gena* (ordinary houses). The residents of *Mbaru Gendang* are representatives of each of the descendants of Wae Rebo's ancestors, totaling eight families. Furthermore, six *Niang Gena* is inhabited by six to seven families. In addition, *Niang Gena* is also used as a lodging house for guests and tourists visiting Wae Rebo.

Figure 1. *Mbaru Niang* traditional house and its name

Wae Rebo's traditional house has nine main pillars, which means that after nine months, a mother is pregnant with her child.
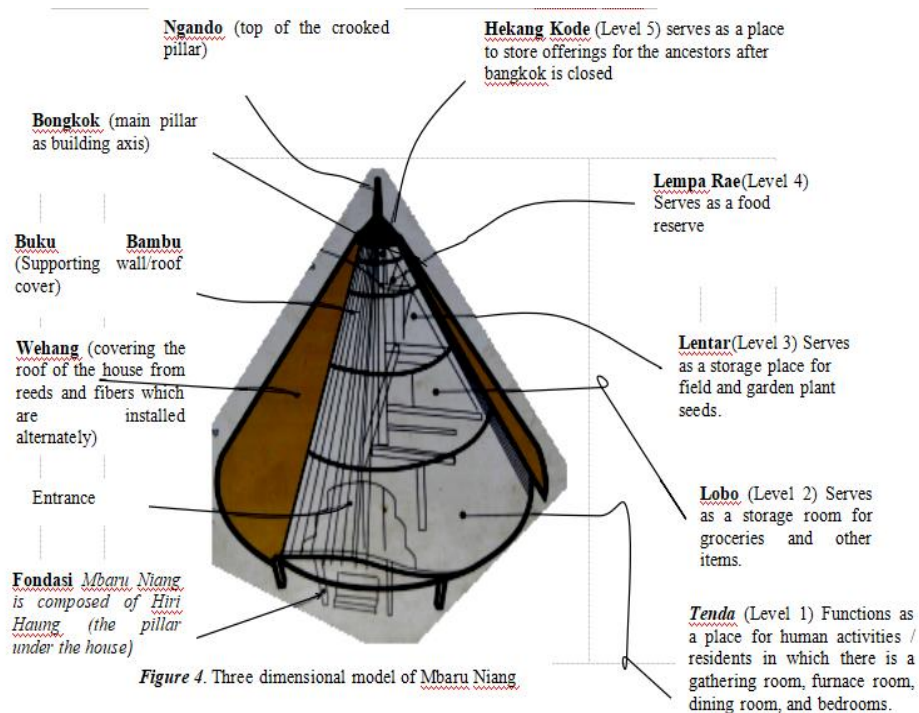

Figure 2. The pillars of the *Mbaru Niang* and *Siri Bongkok* traditional houses

(middle pillar)

Mbaru Niang's foundation is composed of *Hiri Haung* (pillars under the house) using *Worok* wood (one of the hardwoods that grow in the forest around *Wae Rebo*).

Figure 3. Pole under *Mbaru Niang*

Mbaru Niang has five levels in each house. The five levels have their own names and their respective functions. The first level is called *Tenda*, the second level is called *Lobo*, the third level is called *Lentar*, the fourth level is called *Lempa Rae*, and the fifth level is called *Hekang Kode.*

Ngando (top of the crooked pillar)

Hekang Kode (Level 5) serves as a place to store offerings for the ancestors after bangkok is closed

Bongkok (main pillar as building axis)

Lempa Rae (Level 4) Serves as a food reserve

Buku (Supporting cover) **Bambu** wall/roof

Wehang (covering the roof of the house from reeds and fibers which are installed alternately)

Lentar (Level 3) Serves as a storage place for field and garden plant seeds.

Entrance

Lobo (Level 2) Serves as a storage room for groceries and other items.

Fondasi *Mbaru Niang* is composed of Hiri Haung (the pillar under the house)

Tenda (Level 1) Functions as a place for human activities / residents in which there is a gathering room, furnace room, dining room, and bedrooms.

Figure 4. Three dimensional model of Mbaru Niang

Lutur (first level) functions as a place for daily activities such as eating, cooking, receiving guests, sleeping, etc. This floor is divided into two parts, namely *Molang and Lutur*. *Molang* is a private area or place for household activities, such as cooking and resting. This area has booths (rooms) where people rest and stoves for cooking. At the same time, *Lutur* (public area) is a place for guests to be active and rest. The division of the area *(Molang and Lutur)* on the first floor shows mutual respect between local residents and immigrants. *Lobo*

(second level), which functions as a place to store food ingredients and various items of daily necessities for the residents of the house, such as *latung* (corn), *woja* (rice), and others. *Lentar* (third level) serves as a place to store seeds, such as corn, beans, and rice. *Lempa Rae* (fourth level) serves as a place to store food reserves in the event of crop failure or drought. *Hekang Kode* (fifth level) serves as a place to store *Langkar* (square-shaped woven bamboo to store offerings to ancestors).

Ethno mathematics at the *Mbaru Niang* Traditional House

If you pay close attention, there are various mathematical activities in the culture of the *Mbaru Niang* traditional house, the *Wae Rebo* community.

They are counting activities. The activity calculates the length of time for making *Mbaru Niang*. In the culture of the *Mbaru Niang* traditional house, what the Wae Rebo community does is the process of calculating the length of time for the construction of a traditional house. Based on interviews conducted with informants, the construction of *Mbaru Niang* takes seven days or one week. It takes two years or 730 days to collect the materials used before building *Mbaru Niang*, such as wood, reeds, palm fibre and bamboo—counting the number of the bamboo trunk. Counting activities in the culture of the *Mbaru Niang* traditional house are found in counting the number of bamboo books used in a *Mbaru Niang*. The number of bamboo trunks used in *Mbaru Niang* is 100 for *Niang Gena* or the six smaller houses, then for *Niang Gendang*, the number of bamboo trunks used is 150 because *Niang Gendang* is larger than the other six houses. The activity counts the number of *Wehang* weaves prepared for the *Mbaru Niang* roof. For the number of *Wehangs* used to make a *Mbaru Niang*, there are 250 weaves for a *Niang Gena*, while for *Niang Gendang*, the number of *Wehang* mats used is more than 400, because the size of the *Niang Gendang* is more significant than that of *Niang Gena*.

They are measuring activity. There are several measuring activities carried out by the *Wae Rebo* community in the *Mbaru Niang* development process: First, *Depa*. *Depa* is one of the traditional measurement techniques carried out by the ancestors of the *Wae Rebo* community. *Depa* is a unit of length carried out by certain adults (traditional elders or artisans of the *Wae Rebo* community) by stretching their hands. Wae Rebo's ancestors used the length of Depa as a measuring tool in building the *Mbaru Niang* traditional house. Second, *Baka*. *Baka* is one of the traditional measurements used by the Wae Rebo community in the *Mbaru Niang* development process. *Baka* is a unit of distance measurement used during the installation process of *Wehang* (roof made of reeds and fibers). *Baka* measuring instrument results from using a trusted person's palm by using the distance from the ring finger to the closed index finger.

Figure 5*. Baka*

We were designing activity. The activity of designing relates to making patterns for objects or cultural artefacts used at home, in trade, decoration, warfare, games, and religious purposes. In the culture of the *Mbaru Niang* traditional house, the *Wae Rebo* community, the design activity is shown in the form of the *Mbaru Niang*. The level of the house depends on the size of the house. If the house is large, then the *Ngando* is also long, at least 1.50 m outside, including the one wrapped around it, so it does not look too long at the top. Then the height of the traditional house is 12 meters, so the diameter of the floor of the traditional house must also be 12 meters with the aim that the traditional house is harmonious. So, so that the round shape of the traditional house is balanced, we first build *Siri Ngando* or the middle pole, which is tied to 4 supporting ropes. The established *Ngando* series was firmly tied. After establishing the *Ngando* series, the second, third, fourth, and fifth floors were made from bottom to top. Before the second, third, fourth, and fifth floors are made, the first four supporting poles are tied to *Siri Ngando* so that the round shape will be balanced and conical.) The *Wae Rebo* community designed a house shaped like a cone, using several beams as tools tied to *Siri Ngando* after *Siri ngando* was established to balance the house and form a house that resembles a cone.

They explain the activity. The activity of explaining the culture of the *Mbaru Niang* traditional house can be seen in why the floors of *Mbaru Niang* are divided into five floors. The number of floors in *Mbaru Niang*, which is five pieces, are made based on their purpose. The five floors in *Mbaru Niang* are made based on their respective functions. The 1st floor is for daily activities and a place to sleep, while the second to 4th floors are a place to store long-term food reserves and seeds, and the fifth floor is a place to store offerings for the ancestors of the *Wae Rebo* community.
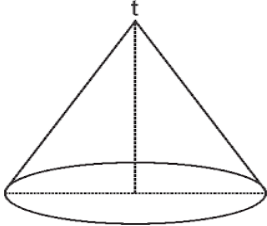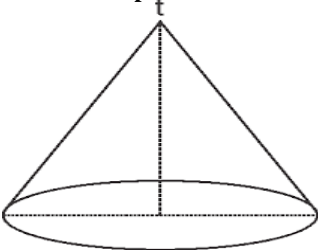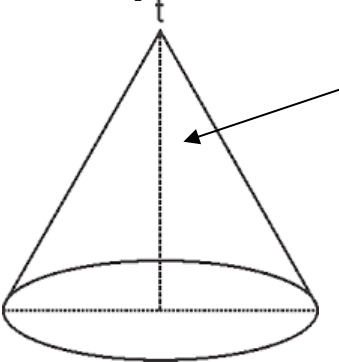
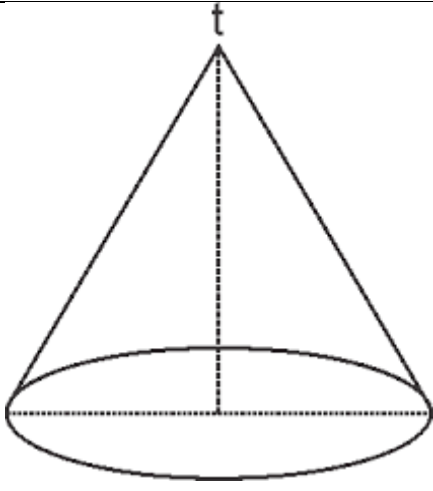**Mathematical Concepts Related to Ethno mathematics in the *Mbaru Niang* Traditional House Culture**
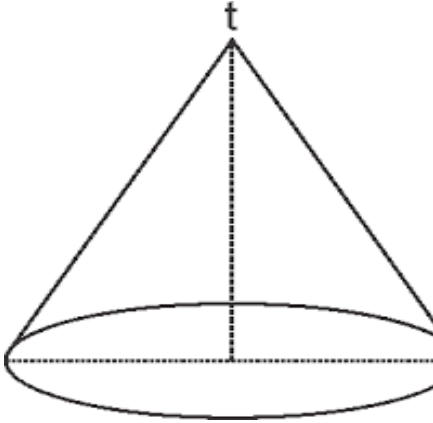
There are several mathematical concepts based on the description of Ethnomathematics in the culture of the *Mbaru Niang* traditional house, including measuring activities and designing or designing activities.
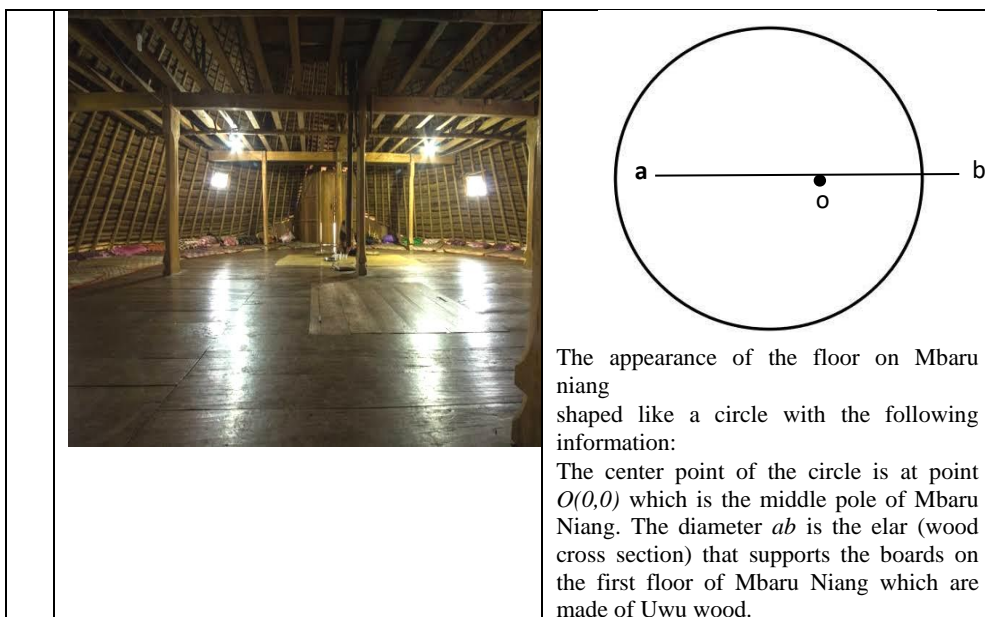
Concept of Geometry (Cones).
For the concept of geometry can be seen in table 2.

Table 2. The concept of geometry in the *Mbaru Niang* traditional house

No	*Mbaru Niang*	Cone
1	**Niang (shaped like a cone)**	**cone**
2	**Buffalo horns on *Ngando***	**Cone top** **Point *t* is the top of the cone**
3	***Hiri bongkok*** (middle pillar of Mbaru Niang)	**Point *t* is the top of the cone**
4	***Wehang*** (Mbaru Niang roof made of reeds and fibers)	Cone blanket

When the cone above is defended along the line td it will form the following conical nets |
| 5 | *Buku* is the roof frame of Mbaru Niang where reeds and fibers are tied as a roof.

 | Painter's line is a line that paints a part of the cone.

In the picture above, the painter's lines are *ta*, *tb*, *tc*, *td*, *te*, and *tf* lines. |
| 6 | *Lutur* cross section of Mbaru Niang which is shaped like a circle | **Circle** |

The appearance of the floor on Mbaru niang
shaped like a circle with the following information:
The center point of the circle is at point *O(0,0)* which is the middle pole of Mbaru Niang. The diameter *ab* is the elar (wood cross section) that supports the boards on the first floor of Mbaru Niang which are made of Uwu wood.

Measurement concept

The concept of mathematics in the culture of the *Wae Rebo* community related to measuring activities is measurement using non-standard units, namely *Depa* and *Baka*. *Depa* is used to measure an object's length with a measurement of 1 fathom ± 2 m. Furthermore, the mathematical concept in other measuring activities is *Baka*, where *Baka* is a non-standard unit of measurement used in building traditional houses and installing *Wehang* or *Mbaru Niang* roofs made of reeds and fibres. *Baka* is used to measuring the distance between one *Wehang* (at the bottom) and another *Wehang* (at the top), where 1 *Baka* is ± 10 cm. Non-standard units are only recognized in the local environment, even different for each individual. Likewise, the non-standard measuring tools used by the *Wae Rebo* community. Conversion of non-standard measurements into standard units used by the *Wae Rebo* community. 1 fathom = ± 1.60 m; 1 Baka = ± 10 cm

Ethno mathematical integration-integration in the *Mbaru Niang* Traditional House of the *Wae Rebo* Community

The *Mbaru Niang* traditional house is one of the traditional houses in the Manggarai area, which has been preserved until now. In order to preserve the culture of the *Mbaru Niang* traditional house, it is necessary to pass it down to the next generations by teaching it at school with the mathematical concepts contained in it. The mathematical concepts contained in the *Mbaru Niang* traditional house can be a bridge to understanding mathematical concepts in schools. The following describes the mathematical concepts contained in the *Mbaru Niang* traditional house that can be applied to learning at school.

Table 3. Mathematical concepts in the *Mbaru Niang* traditional house.

No	The ethnomathematics of the *Mbaru Niang* traditional house	School math concept	Basic competencies		Tier
1	*Measuring activity*	Measurement	3.8	Recognize and determine length and weight with non-standard units using concrete objects/situations.	elementary school (first grade)
			4.8	Measure length and weight in non-standard units using concrete objects/situations.	
2	*Designing activity*	Geometry (Cones)	3.7.	Generalize the surface area and volume of various curved side shapes (Tube, Cone, and Sphere)	Junior High School (Ninth grade)

3.2 Discussions

The culture of the *Mbaru Niang* traditional house of the *Wae Rebo* community contains mathematical meanings and concepts that can be integrated into mathematics learning. Thus, the mathematical knowledge contained in the culture of the *Mbaru Niang* traditional house of the *Wae Rebo* community, which contains mathematical concepts, can be applied in learning at school following the essential competencies and levels or levels of education. The integration of Ethno mathematics into the culture of the *Wae Rebo* community is applied in learning at school by selecting several mathematical concepts and then creating learning tools and trajectories. Such learning trajectories provide multiple educational advantages and a core around which varied educational activities can be structured [20]. Mathematics learning really needs to provide content/bridging between mathematics in the everyday world based on local culture and school mathematics [21]. Teaching mathematics without cultural context on the pretext that it is abstract and universal is the reason for the failure of students in this subject. On the other hand, when students are exposed to various cultural links and reflect upon them together, they develop a desire to learn, and their self-confidence grows [22].

Implementing ethno mathematical-based learning is very helpful for students to know how they think mathematically according to their culture and traditions. In addition, students are expected to be able to help students improve their ability to count and think in various life contexts. Developing knowledge through local values and culture can be designed to be further developed and integrated into learning is excellent. This is intended so that students and learners can raise local values, which are a nation's wealth. View that Ethno mathematics aims to draw from the cultural experience and practices of the individual learners, the communities, and the society at large, in using them as vehicles to not only make mathematics learning more meaningful but, more importantly, to provide learners with insights of mathematical knowledge as embedded in their social and cultural environment [23].

The culture of the *Mbaru Niang* traditional house contains mathematical activities related to learning at school. The mathematical activities include measuring and designing activities. The measuring activity is seen in the process of measuring the distance between *Wehang* (roof cover) and measuring the length of an object with non-standard units. Then the activity of designing is found in the form of *Mbaru Niang*, which is designed in such a way according to the cultural meaning and value of its function so that the shape of the house resembles a cone. Ethno mathematics believe that if we examine how mathematics arises and its uses in different

cultures, we may gain a better and deeper understanding of mathematics, thereby bringing about an improvement in the teaching of mathematics and the performance of students in mathematics [24]. In Ethno mathematics, the focus lies on recognizing the mathematical actions and knowledge of people, resulting from the needs and experiences these people have. Using people's activities and knowledge in pedagogical practices may best contribute to the student's learning process since they may interact with problems and solutions and experience the culture [25]. Mathematical concepts related to Ethno mathematics in the culture of the *Mbaru Niang* traditional house of the *Wae Rebo* community, namely the concept of geometry and the concept of measurement. These concepts can be integrated into learning in schools. The integration of culture in the learning activity has also been introducing the modern science aspect as it allows the interaction of the formation of the student in the relationship within themselves, others, the environment, and the world [26]. Ethno mathematics can enrich the mathematics commonly known and studied in formal educational institutions, ultimately affecting mathematics education [27].

Research [13,14,15,16] shows that, in general, implementing an ethno mathematical approach to learning mathematics can improve student learning outcomes. Application of Ethno mathematics as a means to motivate, and stimulate students, can overcome boredom and give new nuances to learning mathematics. Learners taught using an ethno mathematics approach achieved significantly higher in the test than those taught consumer arithmetic using the traditional approach and use of mathematics materials-based Ethno mathematics is better than the learning that does not use mathematics materials-based ethno mathematics.

4. Conclusion

Effective and efficient mathematics learning is applied to students facing real situations in their environment. Learning with cultural concepts is expected to be developed in schools. In the past, there was much information about knowledge born from the concept of culture. However, changes in knowledge that impact shifting cultural values and even culture are abandoned because culture is considered a substance attached to particular groups, old, reversed and different from Science. Cultural integration in learning activities that aim to introduce culture, introduce education through its cultural values, and cultural linkages with mathematics learning is essential to encourage future generations to continue to preserve the existing culture. The culture of the *Mbaru Niang* traditional house is a source of learning mathematics that can be presented according to various contexts in learning mathematics. The study's findings contained several mathematical aspects of the culture of the *Mbaru Niang* traditional house. These aspects were the concept of geometry (in the form of a conical shape) and the concept of measurement (using non-standard measurements). The measurement concept can be applied to elementary school students, and cone geometry can be applied to junior high school. Thus, identifying and exploring Ethno mathematics in the *Mbaru Niang* culture provides an opportunity to find other aspects of mathematics that can be raised in learning activities. Cultural integration in learning activities is done by identifying and exploring culture to find mathematical concepts and presenting cultural aspects as an introduction to mathematics learning.

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