EDUMATSAINS
JURNAL PENDIDIKAN MATEMATIKA DAN SAINS
E-ISSN:2527-7235
Volume 10 Issue. 1, July 2025, pp 126-138
http://ejournal.uki.ac.id/index.php/edumatsains

Mathematical Knowledge of *Fala Foka* by The Takpala Indigenous People

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Article Info

Article history:
Received : July 5th 2025
Revised : July 24th 2025
Accepted : July 25th 2025
Available online : July 31st 2025

https://doi.org/10.33541/edumatsains.v10i1.7159

Abstract

Fala foka is a warehouse and dwelling house of the Abui tribe who live in Takpala Traditional Village. In the construction of this house there is mathematical knowledge. This mathematical knowledge in the construction of *fala foka* can also be called ethnomathematics. This study aims to explore the mathematical knowledge contained in the construction of *fala foka*. Data collection methods include documentation, observation and interviews with indigenous people and teachers. The sources were obtained using snowball sampling. The results of this study are in the form of base 25 numbers in reed ties, geometry in the form of triangles and lines on the vertices, geometry in the form of rectangular pyramids on the roof of *fala foka*, geometry in the form of triangles on the roof shape, rectangles on the pelupu and dilation knowledge on the floor of each level of *fala foka*, the concept of rectangular area on the pelupu.

Keywords: ethnomathematics, *fala foka*, snowball sampling, takpala traditional village

1. Introduction

The rapid development of technology today has an influence on cultural preservation. This is in line with the opinion of Nay & Lalang (2024) that on the one hand, technological developments have a negative influence on the culture of Indonesian society. If this cultural shift is left unchecked, it will be a threat to cultural preservation in the future.

Efforts to preserve culture can be done in various ways. The most important thing to have is awareness and a sense of belonging to one's own culture so that people will be motivated to study culture and culture will remain because there are people who continue to study culture (Lalang et al., 2023; Nay et al., 2023). This awareness of cultural preservation must be owned by all levels of society by supporting creative communities and helping the availability of infrastructure (Tarakanita et al., 2017). Formal education has an important role in preserving culture. Its role in preserving culture is to instill values through knowledge, attitudes and skills (Zafi, 2017). In this context, the preservation of cultural values can be given to students through extracurricular activities in order to make students more creative and take initiative (Juanda, 2010; Sularso & Maria, 2017). In addition, materials or subjects related to culture and heritage are included in learning by not eliminating the original culture (İslamoğlu, 2018). For this reason, cultural studies from the aspect of mathematics are needed because mathematics is a construction of the culture itself (Nay et al., 2023; Nay & Lalang, 2024). Cultural studies from the aspect of mathematics are then referred to as ethnomathematics.

Today ethnomathematics is a field of research on the relationship between culture and mathematics. Ethnomathematics helps build awareness about the role of mathematical knowledge in society and the cultural context of mathematics (Rosa et al., 2017; Rosa & Gavarrete, 2017). The goal of ethnomathematics is to use a variety of examples to solve problems from different cultures, and recognize that learning mathematics is a unique process for each individual (Arifin & Fortuna, 2021; Madu, 2024). This means that in the environment of each culture, the ethnomathematics will be different. For example, we can see in some research on the use of language in counting activities, which found that by using the Abui language, the Takpala indigenous village community uses base 5 numbers while the Adonara language uses base 10 numbers (Dominikus, 2017; Lalang & Parta, 2023).

A number of studies related to the application of ethnomathematics have been conducted in multicultural education and mathematics education (Disnawati & Nahak, 2019; Nurbaeti et al., 2019; Pathuddin & Raehana, 2019). The result is that the mathematical elements obtained can be compared and incorporated into the mathematics curriculum (Amit & Qouder, 2017; Samo et al., 2017). Orey & Rosa (2006) noted that one of the challenges faced in the introduction of ethnomathematics in schools is that many teachers are not allowed to teach away from the required curriculum, due to the lack of support and cooperation needed to make significant changes to the content they teach. Based on these challenges, culturally specific content should be designed to complement and support the standard curriculum and make the material more accessible and relevant to students. It is therefore important to find ways of applying ethnomathematics to classroom learning activities, not just collecting mathematical concepts from existing cultures (Amit & Qouder, 2017).

One way to do this is to show that mathematical knowledge can be acquired and used outside of school, therefore it can become part of students' culture even though their culture does not have a history of formal schooling (Rosa & Orey, 2011). In line with the research results of Orey & Rosa (2006) students did not expect that their illiterate grandmothers who could not write their own names were able to calculate and convert math. By presenting students with a wealth of mathematical concepts and uses that encompass their own culture, ethnomathematics can transform conceptions of poverty into conceptual wealth by showing that mathematics is not the only area in the school world but also has a strong presence in students' daily lives (Amit & Qouder, 2017).

In mathematics learning activities, the woven motifs of the Dawan tribe have a relationship with learning geometry concepts learned in primary and secondary schools such as the introduction of the concept of rectangles, straight lines, and the concept of mirroring (Deda & Disnawati, 2017; Disnawati & Nahak, 2019). In addition, in the Takpala community culture there is also mathematical knowledge applied to learning activities such as performing calculations by paying attention to place value, introducing rhombic flat shapes in elementary school math learning, teaching the concept of multiplication of 5 and the concept of multiplication of 100 (Lalang, 2022; Lalang et al., 2021, 2023).

In their daily lives, the people of Takpala indigenous village are inseparable from mathematical activities. This can be seen in the use of language where there are base 5 numbers, besides that the community also uses limbs in counting, in the sale of typical weavings of the takpala traditional village also uses mathematical logic in determining the selling price (Lalang et al., 2021, 2023; Lalang & Parta, 2023; Novandini et al., 2025).. Some previous research that has been done before is in line with what Fouze & Amit (2017) said that mathematics is found in cultural elements and values from everyday life including games and props.

The Takpala Traditional Village Community is a group of people who live together in the Takpala Traditional Village located on Alor Island in East Nusa Tenggara Province. The tribe that inhabits this traditional village is the Abui tribe who still maintains cultural elements such as: livelihoods, local languages, arts, social culture and belief systems or religion (Kusmayadi & Vindianingsih, 2018).

So far, Takpala Traditional Village has 14 traditional houses consisting of *Kolwati, Kanurwati*, and *Fala Foka* (Warehouse & Living House). All Abui houses in Takpala Traditional Village are made of bamboo and wood. *Kolwati* and *Kanurwati* are sacred houses of ancestral heritage, in which there are sacred objects of royal heritage such as *moko* and other valuable items (Lalang, 2022). This house can only be opened once a year by the customary leader and selected people during the planting season.

Fala Foka is a warehouse and dwelling house of the Abui tribe who settled in Takpala Traditional Village. *Fala foka* consists of four levels (Rozari et al., 2024). The top (fourth) level of this house is a place to store *moko* or valuables belonging to the family because it is considered safe from theft. The third level is a place to store crops such as rice and corn so that they can be easily taken for cooking. The second level is used as a place to sleep and cook, the place is slightly wider than the place above and away from the wind so that the furnace flame lasts longer. The first level is used as a place to welcome guests.

Research on traditional houses has been done a lot, but related to fala foka is still rarely done, the novelty in this study is that researchers explore the flow of thinking of indigenous peoples in building fala foka. Based on the results of several previous studies, cultural elements that are still preserved and preliminary research conducted by reviewing documents, researchers will conduct research describing the ethnomathematics of Takpala Traditional Village which is focused on the construction of traditional houses and their relationship to school mathematics.

2. Methods

This study uses ethnographic methods, where researchers explore in depth the construction of *fala foka* carried out by the people of Takpala Traditional Village. Cases are bounded by time and activity, and researchers collect detailed information using a variety of data collection procedures over a sustained period of time.

In this research, there are three data collection techniques, namely making observations, conducting interviews, and reviewing documents (Creswell, 2012, 2013; Manan, 2021; Pratiwi & Heni, 2020). In this research, data collection in the field will be carried out by means of: participatory observation, semi-structured interviews, photographs, sound/video recordings, document studies and artifacts.

Data collection in the field begins with participatory observation to enter the community to be studied, take part in appropriate community activities and determine research subjects. Where the subjects in this study are the cultural actors of the Takpala Traditional Village community.

Furthermore, the researcher conducted interviews with the subjects, then by snowballing the researcher obtained subjects to be interviewed in relation to other themes in the research. In this study, data was obtained by interviewing 2 teachers and 2 indigenous people. In the interviewed community, the author interviewed related to mathematical knowledge on the construction of *fala foka*. Meanwhile, the interviewed teachers were interviewed about the use of mathematical knowledge in the construction of *fala foka* in learning activities.

In addition to conducting interviews, researchers also made video recordings and took photos to make field notes. The last stage of data collection is data storage. Data that has been obtained in the form of observation notes, interview transcripts or other notes is stored properly so that it can be easily accessed for further data processing and analysis.

Briefly, the data collection process can be described as a data collection circle consisting of several previous activities. The data collection circle used in this research is a modification of the one proposed by Creswell (2013) as in the following figure

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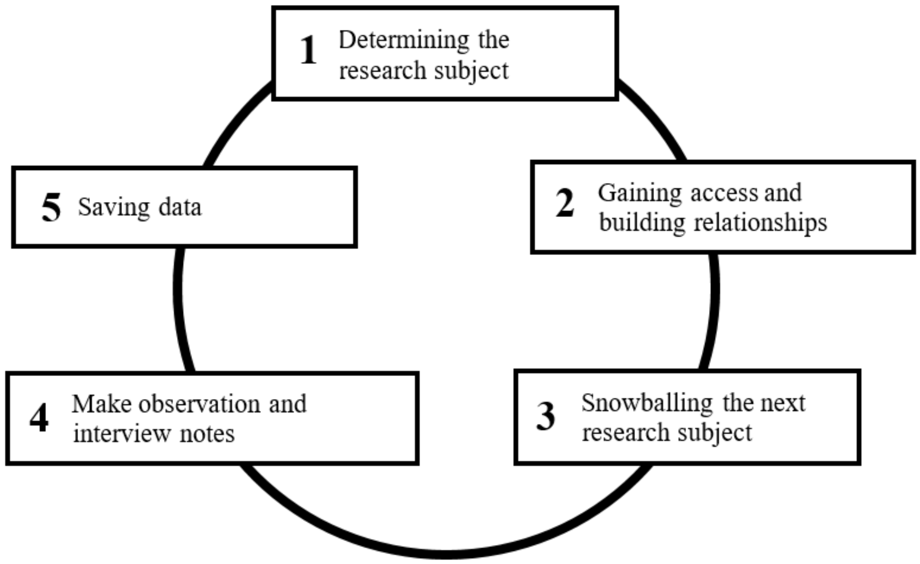
Figure 1
Data collection cycle



This research will obtain three types of data, namely the results of documentation, interviews and document reviews. Data analysis is carried out since before going to the research location, during data collection and after data collection. The current research focus is still temporary and will continue to develop during the research. Data analysis techniques are carried out continuously until completion (Sugiyono, 2013). In other words, data analysis in qualitative research may involve the process of data collection, data interpretation and reporting results (Creswell, 2013).

In general, data analysis is carried out in three stages starting from organizing and preparing the data (text data in the form of interview results and observation photos) being analyzed, then the data is reduced to themes through the process of coding and summarizing codes and finally the data is presented in the form of charts, tables and discussions (Creswell, 2013). This data analysis procedure is a modification of Creswell (2013) as in the following figure

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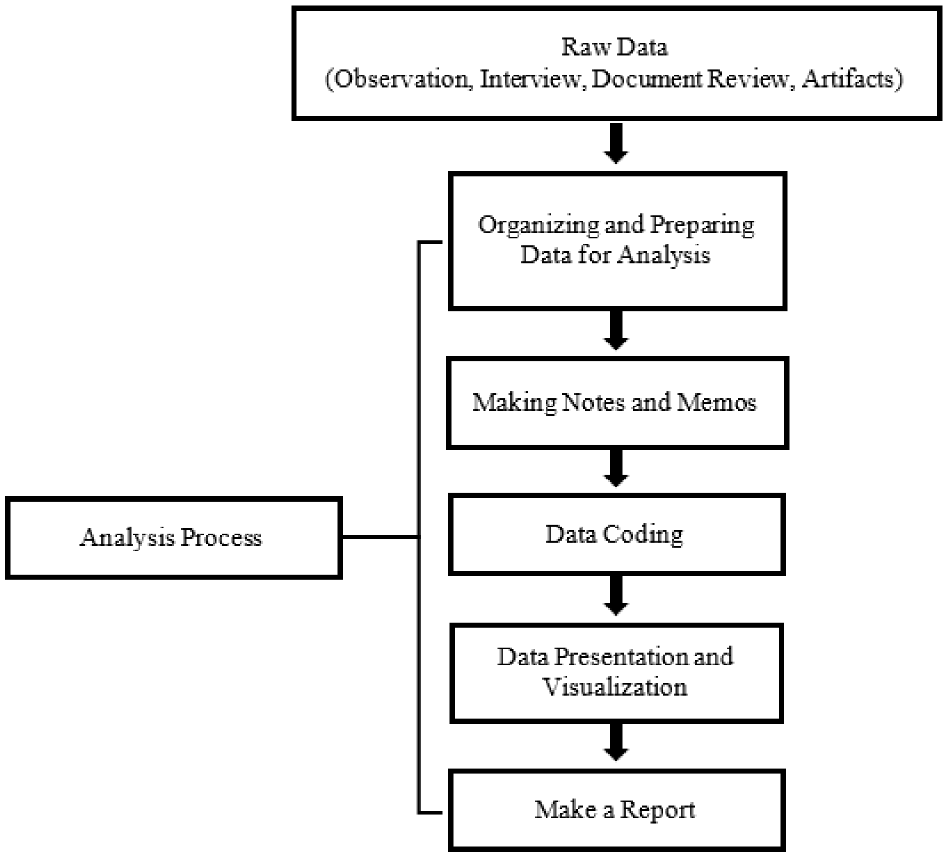
Figure 2
Procedure of Data Analysis



3. Result and Discussion

In the activity of building a traditional house, there is overall mathematical knowledge based on counting activities carried out by the community. The counting activity carried out in the activity of building a traditional house is in the activity of tying reeds as a roof on a traditional house. The term in question is *"tell nuku"* which means 1 bundle in which there are 25 kebats of reeds which has the term *ameng kolang karayouku wal yeting*. Then there is the term 1 bundle of more than 1 kebat which means *tell nuku paka ameng kolang nuku*. This way of calculating indicates that there is a base number of 25 which makes it easier for the community to know how much reeds are used in building traditional houses. For more details, see the following table:

Table 1.

Terms for the use of reeds in the construction of traditional houses

Abui Language	Many Bonds	Many Kebats
tell nuku	1 bond	25 kebats
tell nuku paka ameng kolang nuku	1 bond more 1 kebat	26 kebats
tell ayouku	2 bonds	50 kebats
tell ayouku paka ameng kolang nuku	2 bonds more 1 kebat	51 kebats
tell sua	3 bonds	75 kebats
tell buti	4 bonds	100 kebats
tell yeting	5 bonds	125 kebats
tell talama	6 bonds	150 kebats
tell yeting ayouku	7 bonds	175 kebats
tell yetisua	8 bonds	200 kebats
tell yeting buti	9 bonds	225 kebats
tell karnuku	10 bonds	250 kebats
tell karayouku	20 bonds	500 kebats
tell karsua	30 bonds	750 kebats
tell karbuti	40 bonds	1000 kebats
tell karyeting	50 bonds	1250 kebats

The way of calculating the number of reed bundles in the explanation above, indicates that there is also a base number of 25 used by the Takpala indigenous village community in making it easier to calculate the amount of reed use. The calculation method used is the same as the findings obtained by Lalang (2022) in the calculation of corn yields, where a base number of 100 is obtained which is used by indigenous people in calculating the amount of corn yields. The following table shows the construction of base 25 numbers in the use of reeds for *fala foka* roofing.

Table 2.

Construction of base 25 numbers in reed calculations

Abui Language	Many Bonds	Many Kebats	Model Illustrations
tell nuku	1 bond	25 kebats	a
tell nuku paka ameng kolang nuku	1 bundle more 1 kebat	26 kebats	$a+1$
tell nuku paka ameng kolang ayouku	1 bunch more 2 kebats	27 kebats	$a+2$
tell nuku paka ameng kolang yeting	1 bunch more 5 kebats	30 kebats	$a+5$

Abui Language	Many Bonds	Many Kebats	Model Illustrations
tell nuku paka ameng kolang karnuku	1 bunch more 10 kebats	35 kebats	$a+10$
tell nuku paka ameng kolang karnuku wal nuku	1 bunch more 11 kebats	36 kebats	$a+11$
tell nuku paka ameng kolang karnuku wal yeting buti	1 bunch more 19 kebats	44 kebats	$a+19$
tell nuku paka ameng kolang karayouku	1 bunch more 20 kebats	45 kebats	$a+20$
tell nuku paka ameng kolang karayouku wal buti	1 bunch more 24 kebats	49 kebats	$a+24$
tell ayouku	2 bonds	50 kebats	b

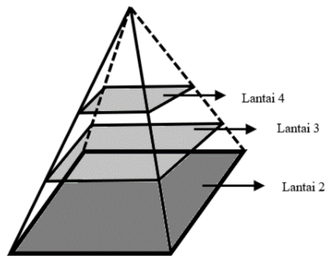
The terms *tell nuku* and *tell ayouku* in the table above, which mean that one bunch of reeds and two bunches of reeds are given the symbols *a* and *b*. Furthermore, the word *"paka"* in the use of abui language can be interpreted as "more" which is given the symbol of addition (+). This symbol is made to illustrate the model of the use of abui language in seeing the bases of numbers contained in the use of abui language and is not a base number (Lalang, 2022). Based on interviews in making the roof, approximately 5000 kebats of reeds or as many as 200 bundles (*tell aisahaayouku*) are used for making large traditional houses. As for the size of a small traditional house, it uses 4000 kebats of reeds or 160 bundles (*tell aisahanuku kartalama*).

Furthermore, based on the table above, the number of kebats of reeds from 26 kebats to 49 kebats is a repetition of one to twenty-four. *Tell nuku paka ameng kolang nuku* comes from the words *"tell nuku"* meaning one bundle of reeds and *"paka ameng kolang nuku"* which means more than one kebat of reeds. The term *tell nuku paka ameng kolang nuku* means one bunch of reeds over one kebat and is symbolized by $a + 1$. Likewise, more than two to more than twenty-four always begin with *tell nuku paka* and end with *ameng kolang ayouku* until *ameng kolang karayouku wal buti*. Therefore, the numbers formed in the table above are base 25 numbers.

In the calculation of reeds for the *fala foka* roof, there is also a multiplication of 25 that can be taught in learning activities. For example, *tell yeting* means 3 big bundles of reeds where each bundle has 25 small bundles (*kebat*) of reeds. So *tell yeting* = 25 + 25 + 25 = 3 × 25.

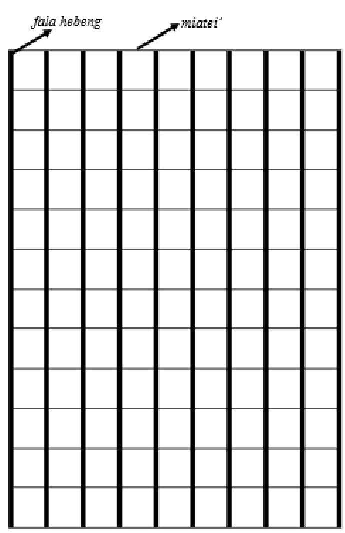
In addition to counting activities, there is also mathematical knowledge in terms of geometry knowledge in the construction of *fala foka*, namely on the roof of a traditional house in the form of a rectangular pyramid, congruence at the *fala foka* level, triangular shape on the roof side and rectangular shape on the floor of a traditional house. This can be seen in the following figure.

Figure 3
Consonance at the fala foka level



It can be seen that in the picture above, there is congruence between levels in the *fala foka* which is in the form of a rectangular pyramid. Furthermore, from the shape of the floor *(pelupu)* at each level of the *fala foka*, there is the concept of dilation. Which, if you pay attention, there is a reduction in the size of the floor *(pelupu)* from level 2 to level 4.

On the floor of the house there is a rectangular area concept where there are 10 small round *(fala hebeng)* and above that there are 25 round bamboo (*miatei'*) for the fourth level which serves as the basis for making the floor or *pelupu* on the *fala foka*. For more details can be seen in the following figure.
Figure 4
Illustration of pelupu



Based on the picture above, mathematical knowledge can be obtained where the Takpala Traditional Village community has unwittingly applied the concepts of multiplication and rectangular area in making the floor of the house (*pelupu*) at each level of the traditional house based on the number of round bamboo (*miatei'*). In the concept of multiplication in making *pelupu*, it can be seen in the number of knots resulting from the number of *fala hebeng* and *miatei* used in making the *pelupu* frame.

At the fourth level, the number of *fala hebeng* is 10 and *miatei'* is 25. The meeting of *fala hebeng* and *miatei'* is 250. If each meeting of *fala hebeng* and *miatei'* is tied with *lawai'* (rope made from tree bark), the number of *lawai'* needed is 250 *lawai'*. So the number of *lawai'* is equal to the multiplication of the number of *fala hebeng* and *miatei'*. The following equation is derived from this multiplication by assuming the number of *fala hebeng* (a), the number of *miatei'* (b) and the number of vertices (c).

$$a \times b = c$$

Furthermore, the same illustration as in Figure 4 can also be used to find the area. Where the area of a flat area as above is the number of unit squares that cover the shape (Harnas & Hidayati, 2021; Yuza, 2018). By calculating the number of unit squares, the area of the flat plane in question is obtained so that the area of the rectangle above is 216 square units at the fourth level of the cousin. Which is obtained from the product of 9 units and 24 units.

Figure 6
Knots between lata and reeds and their geometric shapes

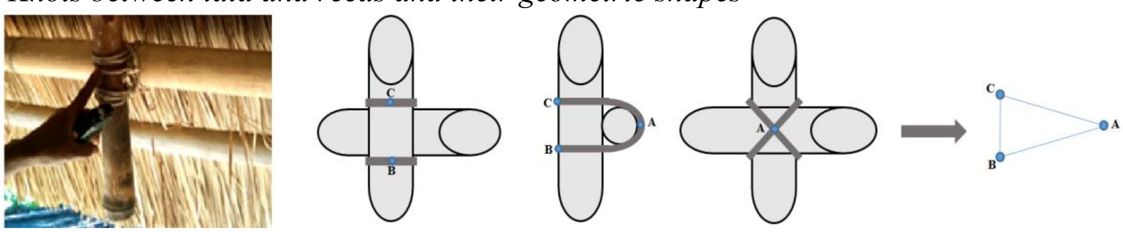
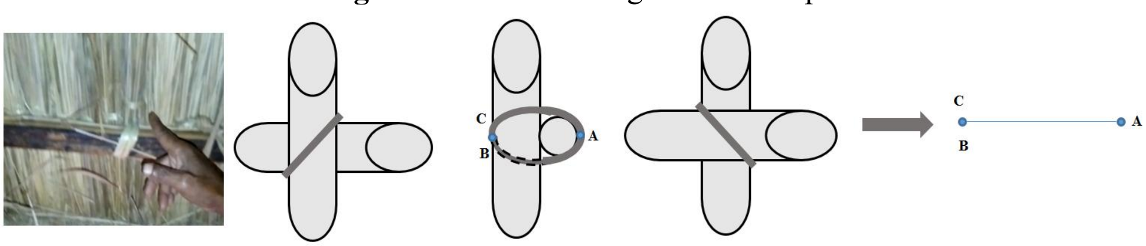


Figure 5. *lawai* and its geometric shape



The *lawai* on the *pelupu* frame is in the form of a cross knot as seen in Figure 5, where this knot ties two pieces of wood that are perpendicular to each other (Ardiyanti et al., 2024; Nuruddin et al., 2023). This knot serves to straighten and strengthen the floor frame *(pelupu)* on the fala foka which will later be placed with bamboo splits to tidy up the floor *(pelupu)*. Where the knot pattern forms a triangular flat shape.

In Figure 6, the knot formed is a secondary knot that serves to strengthen the reeds on the lata of *fala foka* to form the roof. Where the knot pattern will form a straight line.

4. Conclusion

Based on the results of the research, mathematical knowledge was found in the construction of *fala foka*. The mathematical knowledge in question includes base number 25 and multiplication of 25 on reed ties, geometry in the form of triangles and lines on the vertices, geometry in the form of rectangular pyramids on the roof of the *fala foka*, geometry in the form of triangles on the roof shape, rectangles on the pelupu and dilation knowledge on the floor of each level of the *fala foka*, the concept of rectangular area on the *pelupu*.

It is hoped that in the future ethnomathematics research on Takpala Traditional Village can be carried out on other universal elements in cultural studies to enrich the ethnomathematics knowledge contained in the daily life of indigenous peoples. The results of this study can also be used as one of the learning resources in the introduction of spatial shapes, as well as flat shapes in the learning process.

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