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Ethnomathematics Study of Islands Indigenous Peoples in Maluku Province, Indonesia

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Abstract: Ethnomathematics study of islands indigenous peoples in Maluku Province, Indonesia. Objectives: The aim of this study was implementation of a mathematics study in learning related to island communities' context in Maluku. **Methods:** This study used methods of exploration, documentation and literature study. **Findings:** Many local communities in the Maluku did not realize that all selling activities, handicraft, or woven are included in mathematics in the form of fractions or geometry. **Conclusion:** This study concluded that the activities of selling, weaving and crafting in the community display fraction and geometry patterns

Keywords: Ethnomatematics, island indigenous peoples, fractions, geometry.

Abstrak: Kajian matematika pada masyarakat adat kepulauan di Provinsi Maluku, Indonesia. Tujuan: Implementasi kajian matematika dalam pembelajaran berkaitan dengan konteks masyarakat kepulauan di Maluku. ***Metode:*** Metode eksplorasi, dokumentasi dan studi literatur., ***Temuan:*** *Banyak masyarakat lokal di Maluku yang lokal yang tidak menyadari bahwa seluruh aktivitas jualan, tenunan maupun kerajinan atau anyaman masuk dalam bentuk matematik berupa pecahan maupun geometri.* ***Kesimpulan:*** *Penelitian ini menyimpulkan bahwa aktivitas jualan, tenun, dan kerajinan masyarakat menampilkan pola pecahan dan geometri.*

Keywords: *Etnomatematika, masyarakat adat kepuluan, pecahan, geometri.*

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INTRODUCTION

Mathematics and culture are something that cannot be separated from one another. Culture is a pattern of learning behavior and is a way in which a person lives and an integral part of every society, thus creating a sense of life of belonging and togetherness among citizens. Culture includes various aspects of life including communication, attitudes, ethics, beliefs, values, norms, food, and art. Every society has a different culture, which gives identity and uniqueness.

Without culture, humanity will lose its identity as a social society. The presence of mathematics that has cultural nuances contributes greatly to the learning of mathematics. It is caused formal education is a social institution that is different from the others, which allows inter-cultural socialization. Furthermore, all formal mathematics education is a process of cultural interaction and each student experiences various cultural conflicts in the process. Mathematics ideas arise naturally, through the knowledge and views of tribes or certain groups of people or certain individuals without going through a formal education.

Mathematics concepts in a cultural context have been found in several countries in the world, for example traditional stone throwing games called the Mozkat game in Israel (Fouze & Amit, 2018). Then, mathematics in the creation of patterns in Canada (Ezeife, 2011); mathematics in traditional games in Nigeria (Yusuf et al., 2010); the Indian calendar system that has mathematics knowledge similar to the Maya tribe (Sis, 2011); African mathematics that facilitates mathematics concepts (Horsthemke & Schafer, 2007); The relationship of art and geometry symmetry in Africa (Marchis, 2009); and Mathematics in the craft of muzambi baskets in South Africa (Gerdes & Mozambique, 2011).

The beauty of mathematiccs concepts can be found in the composition, patterns and aesthetics of nature, even culture. Beauty in mathematics is primary, there is no place for bad math. Beautiful mathematics can be found through cultural artifacts (Hardy, 1940). For example, geometric patterns found in architectural art (Abas, 2001), *songket* (Embong et al., 2010), and woven (Albanese et al., 2014). The connection of the beauty of geometric patterns like this with mathematics leads to the connection between mathematics and culture.

Anthropologists know mathematics as part of culture. Their findings are limited to arithmetic in primitive cultures (Wilder, 1950). To understand mathematics as part of culture, it is necessary to look at human influence on mathematics. Epistemically, there is no difference between mathematics and other sciences (Prediger, 2003). The values contained in the behavior of human culture show the power of aesthetic taste and human creative power (Noah & Dardiri, 2016). The association of mathematics with culture must be explored based on local wisdom held by the culture-holding community.

Ethnomathematics is based on a new awareness of the introduction of the potential of society in the field of mathematics. In addition, the mathematics curriculum is too euro-centric. In other words, the existing mathematics concepts are oriented towards Europe. The impact of local culture related to mathematics is increasingly marginalized. However, every local culture has a number of wisdom related to mathematics. *Ethnomathematics* can be found in various parts of the world, both from Africa, China and America. For the Asia Pacific region, it can be seen through *Ethnomathematics* study in Papua New Guinea (Owens, 2012), Kabihug tribes in the Philippines (Rubio, 2016) and Tolaki communities in Southeast Sulawesi, Indonesia (Sirate, 2011), and numerical aspects in Riau communities & Dardiri, 2016). D'Ambrosio, a Brazilian mathematician in 1977, first introduced research on *Ethnomathematics*

in 1977.

In Indonesia, studies on *ethnomathematics* have been developed in accordance with local regional superiority. Many publications related to *ethnomathematics* are research on *ethnomathematics* of the society of Sidoarjo (Rachmawati, 2012) and qualitative studies of the Tolaki community (Sirate, 2011). Therefore, ethno-mathematics exploration of indigenous peoples in Maluku becomes very important for exploration because it has unique and potential custom structures that are not owned in other regions in Indonesia or even the world.

Maluku is also divided into three cultural regions, which are distinguished from Central Maluku Culture or known as the state republican territory based on the cultural configuration of kings. Southeast Maluku culture (Malra) with the main foundation of national culture, and North Maluku culture (Malut) with the cultural orientation of the sultanate. These three divisions seem to provide definite arguments for cultural groupings in the Maluku region, which will have a significant effect on regional development if it is utilized. These debates in locality are very detrimental to the culture of Maluku. Moreover, it is supported by regional regulations that do not provide special space for cultural preservation. The gift of islands and sub-ethnicities that are rich in culture is a resource that cannot be managed for the common good.

The area of Maluku since the 14th century has become a very popular region with a number of great hopes for the development of the world. The cloves and nutmeg, as the initial commodity that gave rise to a series of history and culture in Maluku, are now no longer the *primadonna* of the Maluku culture. Osellin de Jonge in the inauguration of his Professor at Leiden University in 1935 said that Indonesia was a model of ethnographic diversity that almost perfectly transcended the Australian continent. The interesting thing that was conveyed by Joselin de Jonge was when he mentioned Seram, Central Maluku in his presentation as a home for investigating cultural diversity in Indonesia. In addition, British Naturalist Alfred Russel Walacea visited 1859-1860 in the Maluku Islands and gained a unique culture. Then, Dieter Bartels, the anthropologist at Yavapai University in US Arizona, conducted an investigation into the superiority of the *Pela* and *Gandong* culture in Central Maluku as a model of kinship between the Christian Muslim communities, which also covered lands in Central Maluku. In addition, George Everadus Rumpius who is called the Maluku scientist carried out research on species of plants and shellfish and published a fairly popular work, D'Ambonsche Rariteitkamer in 1705. The results of this study sparked interest in cultural heritage in Indonesia.

Various advantages in Maluku have become a distinctive power to be examined in a mathematics context. One of the habits of the Orang-orang Maluku in buying and selling activities is arranging their merchandise in the form of piles called one *tampa* (*sa tampa*) for one stack. Traditionally, the selling process is carried out on selling materials in the form of crops and fish catches. If it is associated with habits, then the way to trade buying and selling in general is with a pattern of piling up goods in small assemblages, such as *satampa* of *momar* fish (one *tampa* means one place), *satampa* of langsat, *satampa* of Chile, etc. The term *satampa* is related to a set of objects (langsat, or chili, or mangosteen or fish), which consists of several pieces or pieces or several fish. The habit that has been entrenched in the buying and selling transactions of the Maluku has indirectly used mathematics concepts (numbers). The use of this method can be used as one of the approaches in the presentation of material on the concepts of fractions, relations and fraction operations, which is one of the difficult material for students. One of the reasons is the

conceptual learning that is not done with a realistic or contextual approach. When the presentation is formal or symbolic, there will be a misconception in the presentation. When students learn fractions by representing the problem symbolically, they will make misconceptions and algorithmic errors. In addition, the West Southeast Maluku community group has a habit of weaving which is one of the local wisdoms. In the process of formation, they have indirectly used geometric concepts to form woven pattern decorations. The pattern formed can be implemented in the study of mirroring flat shapes or other patterns that use the concept of reflection. In addition to cultural products in the form of woven products, there are clay-processed objects in the form of cooking and drinking equipment produced by the Saparua community and some people in Southwest Maluku. It can be studied and used as a tool in learning mathematics. The typical food of the Maluku region in the form of processed sago and cassava can be used as a tool to instill the concept of fractions as part of the whole. By paying attention to the number of parts in an *embal love* or sago plate as well as bamboo pulut rice, it can be used as an ingredient in teaching mathematics concepts.

From the description above, it can be said that diverse cultural differences in Maluku can be studied and analyzed to be implemented in learning, for example by making a learning approach that can be developed in a mathematics curriculum as local content packaged in teaching materials. Thus, the purpose of research was how the implementation of mathematics studies in learning relates to the context of island communities in Maluku.

METHOD

This research was a qualitative research with exploration, documentation and literature study methods. The exploration method used for research objects is buying and selling transaction patterns, typical foods and cultural products in the form of woven products. Exploration methods were used to trace or search for information about the use of mathematics objects in the daily activities of Maluku people and what cultural products that utilize mathematics ideas or concepts. In this case, exploration methods was used to look for information about mathematics concepts behind the habit of selling, the mathematics concepts behind the process of making woven and weaving processes.

The scope of the research sample included, 1) community groups, in the form of street vendors in the Hatiwe Besar area with the custom of selling local fruits such as langsat, duku, *Gandaria*, mango and other local fruits. 2) Street vendor community groups from Southeast Maluku, Ambon Island and Leasa Island in trading enbal, pulut bamboo and sago plates, 3) Community groups of weaving workers in one of the villages in West Southeast Maluku Regency, 4) Woven mats from the Southwest community. The technique of collecting data that is included in the documentation in this study is the field notes, transcripts, images of communities' habit, special foods and cultural products in the form of woven products as well as *koli* leaves woven. After obtaining geometric shapes and mathematics concepts behind how to transact and form typical food products, a literature study was conducted to analyze geometric concepts and other related mathematics concepts. Data analysis techniques were in the form of patterns formed from daily habits found in selling, food, cloth and processed mats.

RESULTS AND DISCUSSION

Thousands of this population consists of 60% of the tribe (Alifru) who are native to Seram Island and the rest are other tribes in Indonesia who occupy the Maluku region. The spread of the population occupying thousands of islands

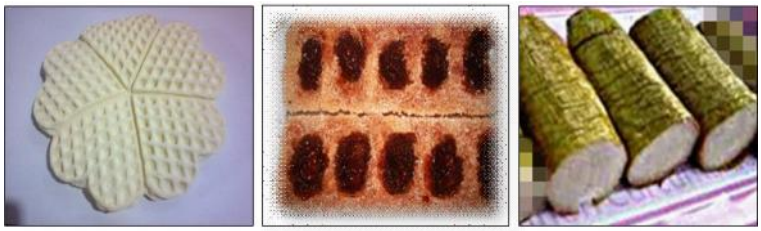
in Maluku illustrates that the socio-cultural life of the Maluku varies greatly. Each island has different customs, languages and habits. Thus in reviewing *ethnomathematics* of the Maluku, the focus of the study was limited to the communities around Ambon City and Central Maluku, West Southeast Maluku and Southwest Maluku.

The ethnomatics study was seen based on the transaction habits of Maluku people on Ambon Island, which occupied Ambon City and Central Maluku District. The general habit of Maluku people in transactions, especially in traditional markets and markets in a limited environment, is by piling up sales at the selling place either on the sales table or on the sidewalk or roadside. The goods sold in this way are local fruits such as mangosteen, duku, durian, langsat and other types of food. However, in this study, the focus was on selling methods that were associated with planting fraction concepts. The data obtained based on the results of this study is the activity of selling *Gandaria* (Maluku typical fruit) or langsat and duku, which are obtained once a year. Figures 1 show the way people in selling local fruits by stacking, which is put in a structured manner on the ground or placed in a container.

The selling way shown in the figures is almost done by people in all areas of Maluku traditionally. The process of grouping selling goods has a relationship with the price offered. If the yield of fruits is large, the price will decrease otherwise if the product is small, the price will be high. In addition, the price of goods sold also depends on the location where the community is located. This thinking process indirectly uses economic concepts and also the concept of function. Suppose x is the variable number of fruits and z is the location where you sell and y is the price variable, then y can be written as a function of the fruit products number and sales locations in which mathematically can be formulated as y = f (x, z). The stacking of rambutan, cempeda and *Gandaria*h indirectly use the set concept.

Figure 1. How to sell traditional trades

In addition to fruits, the ways in processing typical food of the Maluku people is interesting for ethnomathematical studies. The examples are *embal love* from the people of



(a) (b) (c)

Figure 2a. *Embal Love*, b). Sugar Sago, c). Bamboo pulut rice

Southeast Maluku, sago plates and *nasi bulu*, rice that are roasted by inserting rice into bamboo pieces that have several segments. These processed products can be used as a medium to embed the concept of numbers or the concept of geometry. The following are some of the processed products of the typical Maluku community, namely *embal love*, sugar sago and pulut bambu rice as shown in Figure 2.

The picture in Figure 2 is some typical Maluku food, which is processed from raw materials of cassava, sago and sticky rice. 1 *embal love* fruit, 1 porna sago and 1 bamboo of *nasi bulu* are considered as a unity. The pieces are considered as a set of parts that describe fraction parts. Habits or ways to sell by stacking or processing typical foods arranged in containers that consist of several parts can be used to teach the concept of numbers. In relation to fraction concept learning, selling methods can explain the concept of fractions. The same process can be carried out on other special foods such as *embal love*, sago plates and *nasi bulu* as the unity of the *embel*.

(a) (b)

Figure 3. (a) Woven fabric motifs, b). The suit made of original fabric Tanimbar Islands woven

In addition to the typical habits and food, there were handicrafts from the people of West Southeast Maluku and the Southwest Maluku Community who can study the mathematics concepts contained therein. Some of the typical woven handicrafts of West Southeast Maluku can be seen in Figure 3.

Figure 3 shows woven fabrics with varied motifs and their use for clothing. If examined carefully, the use of mathematics concepts by the people of West Southeast Maluku in making clothing material from yarn by means of weaving has been done since their ancestors and made as one form of local wisdom. The mathematics concept that can be studied is the way of composing the motifs and the results of the arrangement, which shows the existence of a straight-line concept, alignment and reflection in the fabric made.

The pattern of making Tanimbar community woven consists of human, plant and fish motifs that each of which has its own philosophical value (Ngilawayan, 2018). In addition to philosophical values, the patterns formed on woven fabrics are made from repetitively projected objects of the same size and different sizes. Projections made in drawing motifs on woven fabrics refer to the basic concepts of phthalic geometry, namely self-similarity and size (ion dimension). The *ethnomathematics* used is the principle of alignment and reflection as well as the concept of points and lines. In addition to culture related to habits and typical foods, woven crafts are work that is traditionally made since the ancestors of the community of Southwest Maluku. Woven crafts made using local palm-producing trees (*koli* trees) have forms that are related to the use of mathematics concepts from calculating to preparing leaves to calculating them to forming them. These woven crafts are made for their own use and can also be marketed locally. Some forms of woven can be seen in figure 4.

The *koli* woven handicrafts in figure 4a, b, c contain mathematics concepts especially geometry, namely circles for basket bases and hats, and regular hexagon concepts for *nyiru*. The basic concepts of other geometry can be seen from the woven pattern that uses the principle of tessellation or tiling.

The *Ethnomathematics* study on the habit of selling local fruits of the Maluku community can be used as a method in embedding fraction concepts. In the Indonesian school curriculum, the fraction concept was introduced since grade 3 elementary school. By studying how to sell, the embedding of the fraction concept and fraction of similar value can be taught using this pattern.

to the arrangement of *Gandaria* fruit in a row (horizontal) with the number of piles in the row is 4 stack then if you take 1 stack of 4 stacks in a row (horizontal), the fraction in question is ¼ or if calculated based on the whole fruit, 8 x 20 fruits = 160 fruits. Therefore, the *Gandaria* that has been purchased is 2 x 20 = 40 fruits. Fractions showing the number of fruits that have been sold are 40/160 or ¼ = 2/8. In here, the

(a) (b) (c)

Figure 4. (a) Basket, (b) *Nyiru*, (c) The original hat from Southwest Maluku

The following is the process of embedding fraction concepts using piles of *Gandaria* fruit. *Gandaria* is one of the local fruits of the Maluku community which is produced once a year. The marketing is done traditionally by peddling on the roadside, both on the sidewalks and on the sales tables along the road. Examining traditional sales patterns, ideas can be raised for planting mathematics concepts in them. Planting fraction concepts can be done using 3 models, namely flat wake models, fractional models and long models or number lines. Fractions are interpreted as part of the whole and are explained by flat model (region or area models), set models and length models. The overall set model it is understood as a number of objects and the set of parts forming fractional parts. For example, in each stack there are 20 *Gandaria* fruits. If a *Gandaria* is taken to eat, the amount of *Gandaria* that has been eaten is 1 fruit out of 20. If there are 8 stacks with 20 fruits each and someone buys 2 stacks of 8 stacks, then the fraction that shows the number of Gandaria that have been sold is 2/8. If you pay attention fractions concept and the fraction concept of similar value is introduced.

With activities designed in learning students can conclude that fractions are part of the whole and can find equivalent fractions, namely ¼ = 2/8 = 40/160. Planting concepts using a set model according to Van de Wall (2008) needs to be explained that what is considered is the number of objects, not their size. This is because some students will have trouble because when paying attention to its size it is not the object of the set. However, this model is widely used in everyday life and in understanding the concept of ratio.

In the West Southeast Maluku community, we can see that the use of geometric concepts has been around for a long time by the local community. The woven product made shows several geometric concepts patterned in the arrangement of motives made. The analysis of the motives made shows that the community's visual thinking process is so high that without learning the concept of space they can represent images or woven motifs. By having abstract

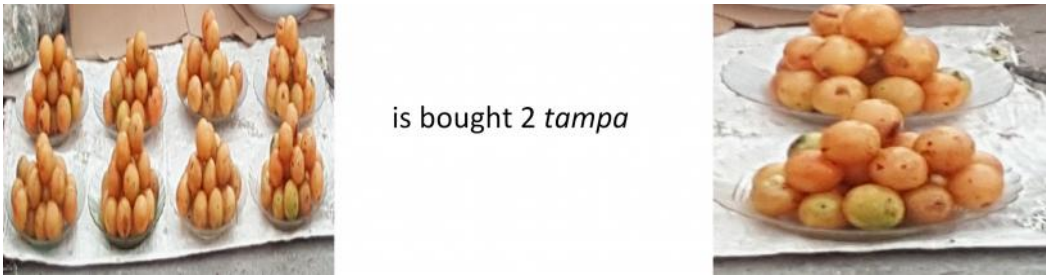
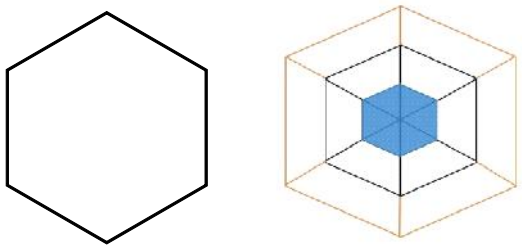


Figure 5a. Eight stacks of *Gandaria* fruit, b) Two stacks taken from eight stacks, the habits of traditional traders in Ambon Island

visualizations, weavers design motifs with regard to symmetry. According to D'Ambrosio & Acher in Sabilirosyad (2016), weaving involves the visualization of geometry. A weaver must know the symmetrical balance model in the weaving motif. Symmetry will be seen if the placement of the same decorative motif repeatedly in full on the fabric. In mathematics learning, the form of symmetry is introduced at the secondary school level in the concept of transformation geometry.

In addition to weaving culture products, there are other cultural products in the form of woven crafts from the leaves of *koli* trees. *Koli* trees by the people of West Maluku are called blessing trees because the stems, leaves and fruit and the resulting leaves can benefit their survival. Leaves of *koli* trees are made for wicker to meet their daily needs. If we pay attention to the results of webbing made, it can be seen that there are many mathematics concepts that can be studied to be used in learning. For *nyiru* webbing (totope), the mathematics concept contained in *nyiru* is to build a flat, regular hexagon that forms the basis of webbing. Hexagon angle points are the basis of development to get a larger size. The concept of dilation can be taught by using woven patterns on the *nyiru* that can be seen in figure 6.

In figure 5b, the matting is made of *koli* leaves which have 6 *susu* (= point) of weaving base. In the process of forming, 12 leaves are made to sit the base, which forms 6 vertices in the form of a hexagon star. Then weaved with a base of 6 corner points and developed according to the desired size. By noting the basic shape of the *nyiru* weaving, it can be seen that the shape of the regular hexagon plane figure can be used as a tool to introduce the concept of parallel lines, corner points, and regular hexagon in students. If a pattern in *nyiru* arrangement is observed, it can be seen that there is a process in the transformation geometry known as dilatation and the pattern of tiling



(a) (b)

Figure 6 (a) The flat hexagon, (b) Dilation results

(tessellation) that in this case called as the regular tessellation. The definition of tessellation according to O'Daffer in Purbawati (2016) is as follows: *A tessellation is a special type of pattern that consists of geometric figures that fit without gaps or overlaps to cover the plane"*. The quotation above states that the tessellation is a special pattern consisting of geometric shapes arranged without separator / distance to cover another Etnomatematic plane in a woven hat that shows the concept of a circle. By examining mathematics concepts or ideas in woven, it can be used as a tool to embed geometric concepts.

■ CONCLUSION

Maluku people with various ethnicities have a variety of cultures that can be studied to be used as a tool in learning. Learning to use local culture gives students value in recognizing and appreciating their culture. The habit of piling up fruit sales is used as one of the fraction concept learning approaches. Likewise, woven motives and woven skills can be used in geometry learning. *Ethnomathematics* implementation certainly takes into account the curriculum content in accordance with the standard content set. Thus, ethnomathematics is an innovation in mathematics learning. Ethnomathematics studies in other societal cultures can enrich the repertoire of mathematics learning.

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