Ethnomathematics at TIFA Yapen as A Source for Learning Mathematics

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Abstract

This study's primary objective is to investigate and elucidate the principles and regulations of ethnomathematics prevalent in the Yapen Islands of Papua, Indonesia, for application in the context of mathematics education in schools. The research methodology involves qualitative research with an ethnographic approach. Data was collected through participant observation techniques and in-depth interviews, and the subsequent data analysis followed a sequence of ethnographic data analysis, domain analysis, and taxonomic analysis. The findings of this research indicate that precise measurements of the tifa's length and width significantly affect the sound (tone) produced when the tifa is struck. The design aspect involves the ability to elucidate the steps and sequence involved in crafting a tifa, ensuring clarity and comprehensibility in the explanation. Furthermore, the ability to explain extends beyond comprehending the manufacturing process to effectively communicating it to the general public. The geometric patterns observed on the tifa include circular shapes on the lid and base, a prism shape near the tifa cover, an isosceles trapezoid shape on the tifa handle, and a parallelogram shape on the tifa handle.

Keywords: ethnomathematics, tifa yapen, learning resources

INTRODUCTION

Mathematics learning at school aims to transfer knowledge and explore new knowledge (Ruamba et al., 2022). Exploration of new knowledge is intended to develop knowledge itself in order to improve human life. This often happens in the mathematics learning process (D'Ambrosio, 2016); (Prahmana & D'Ambrosio, 2020) where mathematics learning in principle must be related to life and culture, because the

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development of mathematics learning cannot be separated from the influence of the human socio-cultural environment. This is also because humans themselves are elements of a socio-cultural environment itself.

In designing learning, it needs to be more contextual and more meaningful for the individuals who take part in the learning process so that it creates real life. A contextual approach helps link the material taught with real world situations (Sari et al., 2020). With contextual and constructive learning, students are trained to construct knowledge and trained to use mathematical concepts to solve problems in real life (Arbain & Sirad, 2023). Therefore, learning must be designed to involve culture and other things that exist in life around them, so that the concepts taught are easier for students to understand (Risdiyanti & Prahmana, 2017).

Mathematics learning is currently experiencing a change in focus on development by involving a more contextual and culturally related approach (Ruamba et al., 2022). This stems from the concept of learning mathematics using ethnomathematics which was introduced by D'Ambrosio in 2016. Ethnomathematics shows how cultural results and interactions in daily activities are analyzed and used to build mathematical concepts and mathematical ideas, so that they are in line with more contextual learning and scientific in nature.

Ethnomathematics is simply defined as a style, art, and method of understanding, managing, explaining, and relating between mathematics and the social and natural environment (Mania & Alam, 2021). D'Ambrosio states that ethnomathematics is practiced by cultural groups, including not only indigenous peoples, but also working groups, professional classes, and children of certain age groups (Lidinillah et al., 2022). Borba describes ethnomathematics as the way in which people use culture-specific mathematical concepts in dealing with the relational and spatial aspects of their lives. (Supiyati et al., 2019).

Several ethnomathematical research has been carried out, this research is related to this research, namely researching the geometric concept of transformation of weaving crafts (Puspadewi & Putra, 2014), researching the concept of symmetry and circles on the Maramis musical instrument (Marina & Izzati, 2019), researching geometry learning through batik balls (Prahmana & D'Ambrosio, 2020), researching the determination of a good day to build a house in the Cigugur community (Umbara et al., 2021). Meanwhile in

Papua specifically there are several studies that are relevant to the research, namely those that examine the ethnomathematics of the sero culture (sero net) of the Fak-fak coke community in West Papua (Ubayanti et al., 2016), researching ethnomathematics exploration of wooden paintings of the Asei community in Sentani Papua as a source of school mathematics learning (Dumatubun et al., 2021), researching ethnomathematics of the Dani tribe in the Balie Valley, Wamena, Papua (Kho & Siep, 2022), examines the exploration of geometric concepts in traditional paintings and carvings in Ampimoi Bay, Yapen Islands as a source for school mathematics learning (Ruamba et al., 2022).

Indonesia has a variety of cultural products. One of the cultural products in Indonesia is musical instruments. Tifa is a musical instrument from the province of Papua which is made from wood with layers of animal skin, and decorated with motifs according to local beliefs (S, 2020). Tifa is played by hitting the membrane on the basis of four rhythmic patterns where the Papuan people use tifa as a provider of identity, a symbol of identity, and a strengthener of social ties (S, 2020). Tifa Yapen is used and becomes the identity of the Yapen people. Yapen is a district in Papua province.

Some of the research results above show that mathematics learning continues to experience changes in context and approach by using real and more contextual problems. Furthermore, ethnomathematically, the cultural products of the tribes in the Papua region are very rich, such as paintings and carvings as well as the structure of houses. However, until now not much in-depth research has been carried out. Research focused on traditional musical instruments in the northern region of Papua has not been carried out much until published. Therefore, this research aims to explore and describe the concepts and rules of ethnomathematics found in the Yapen Islands, Papua, Indonesia.

Tifa as a cultural product that contains mathematical elements is expected to be utilized in mathematics learning. The use of cultural products in mathematics learning can be used as a context for developing student worksheets (A et al., 2020; Astuti et al., 2021; Disnawati & Nahak, 2019; Mahlina et al., 2022; Paridatunapisah et al., 2021; Puji Ariyanto et al., 2022; Silvia & Mulyani, 2019; Y.A. Talo et al., 2022), development of ethnomathematics-based questions (Astuti et al., 2023; Nuryenisa et al., 2022; Sukmawati et al., 2022), and module development (Hardiyanti, T.A., Syaf, A.H., & Widiastuti, 2022; Prihatin et al., 2022; Sintiya et al., 2021).

METHODS

This type of research is qualitative research using an ethnographic approach. This method was chosen because entomathematics research aims to analyze ideas, concepts, procedures and processes in the culture of a civilization from the perspective of its original members. (Ascher & D'Ambrosio, 1994); (D'Ambrosio, 2016). The research procedure was carried out by placing research subjects in a situation where there was no intervention or treatment. Meanwhile, the researcher only acted as a participant observer in this research.

Data collection was carried out in stages, namely field studies, observations and in-depth interviews with informants. The field study stage was used to obtain qualitative data related to the Yapen tifa as a cultural product of the people of Yapen Regency, Papua Province. During the field study, the researcher carried out a direct inspection of the location where Tifa Yapen was located. Observations were carried out by directly observing objects in the form of Yapen tifa. These observations were carried out using an observation sheet. The results of the observations are in the form of qualitative data regarding the mathematical elements found. The in-depth interviews aim to obtain data that will complement and confirm the data obtained through field studies and observations.

In interviews, the selection of subjects as informants was carried out using purposive sampling techniques. Purposive sampling technique is a technique for determining samples with certain considerations. Certain considerations in this research were selecting local community figures who were deemed to understand in depth the process of making and using the tifa musical instrument. The criteria for determining informants are in line with what was expressed by (Umbara et al., 2021), but then modified as follows: (1) The informant really understands the culture and customs of the people of the Yapen Islands; (2) The informant masters the process of making and using tifa; (3) The informant is willing to be interviewed, and (4) The informant can provide complete and complete information.

This research data was obtained from observation, documentation and in-depth interviews. Observations were carried out by observing cultural products, namely the tifa musical instrument. The aspects observed are related to the mathematical elements contained in the tifa. Observations were carried out guided by observation guidelines.

Documentation is used to obtain documents related to the musical instrument Tifa which has mathematical elements. The documentation taken in this research is in the form of photographs of Tifa and documentation of interview results. Meanwhile, in-depth interviews were conducted by researchers with informants regarding the mathematical aspects found in TIFA. The results of data analysis were carried out using the stages of ethnographic analysis, domain analysis and taxonomic analysis.

RESULTS AND DISCUSSION

Results

The population in the Yapen Regency area, Papua province consists of 7 (seven) large tribes with each tribe having a very different variety of local languages. The seven tribes are the Onate tribe (Yawah Unat), the Aruisai tribe, the Busami tribe, the Ampari tribe, the Berbai tribe, the Poombawo tribe, and the tribe called the 3W tribe, namely Wondei, Wondau and Wonawa. Even though there are various ethnicities, languages and cultures in this community group, the musical instruments used in various traditional events are always the same and relatively not much different. The research data found by researchers in this study is information regarding (1) the meaning of tifa, (2) the manufacturing process, (3) use, and (4) its form and meaning.

Ethnographic Data Analysis

The results of interviews with research subjects provide in-depth information related to Tifa from the community. This information concerns everything from the manufacturing process to how to use the Tifa musical instrument.

Tifa is a traditional musical instrument like a drum that produces sound when hit on one side. Tifa is made from a milkwood tree whose tree height reaches 15 to 50 meters, has a diameter of 25 to 50 cm, the bark is grayish brown and gummy like milk.

To make a tifa you need two types of tools, namely an iron shaped like a spear on one side and another iron shaped like a golf club, but one side is made very sharp to pick up the remains of the wood after piercing the inside of the wood. The process of making tifa is milk wood taken from the forest and then cut to the size of the tifa (uncertain size) but about 80 cm – 150 cm long and 10 – 15 cm in diameter. After cutting, the wood is cleaned from the outside and dried in the sun until the wood is completely dry. After that, using special tools, the tifa is formed until it is finished. The surface of the tifa is then painted and carved according to the user's wishes.

Domain Analysis

Based on the data obtained in this research, namely observation data, interview data and documentation data, a domain analysis was carried out which was revealed in the process of making the tifa as follows:
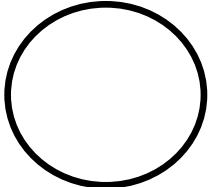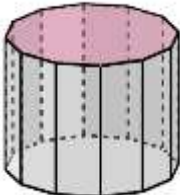
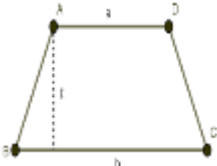Table 1. Ethnomatametics Domain Analysis on Tifa

Domain	Linkages	Ethnomathematics Activities
Measuring Activities	To answer what size (length, width) use certain measuring tools	Measuring activity can be seen when research subjects can determine the length and width of the tifa, even though they do not specifically mention the numbers but can compare, for example "the size of the tifa varies and is uncertain" and "the length of the tifa is adjusted to the user."
Designing Activities	To answer how the process of making	Design activities are seen when the research subject can explain the stages and sequence of making a tifa, the stages are explained in sequence so that they are clear and easy to understand.
Explaining activity	To answer every question	Appearing in activities, research subjects were able to answer each question clearly and easily understood.

Taxonomic Analysis

Based on the data obtained in this research, namely observation data, interview data and documentation data, a taxonomic analysis of the musical instruments contained in the tifa was carried out. The tip of the tifa on parts other than the membrane looks like a circle. A circle is a collection of points in a plane that are the same distance from a certain point (hereinafter referred to as the center). There is a part of the Tifa blanket that resembles a prism. A prism is a three-dimensional shape bounded by an identical n-shaped base and lid and square or rectangular vertical sides. There is also a part that resembles a trapezium. A trapezoid is a two-dimensional shape formed by four edges, two of which are parallel but not the same length. The rest of the tifa resembles a parallelogram. A parallelogram is a 2-dimensional flat shape formed from two pairs of edges and each side facing each other is the same length.

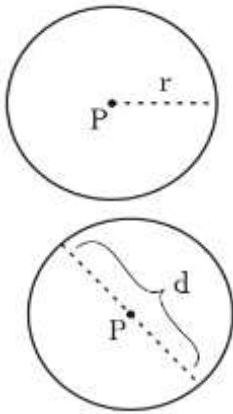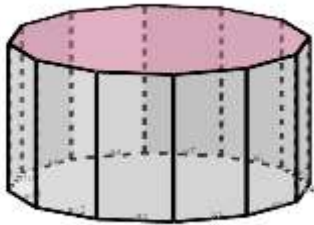The results of the analysis are presented in the following table:

Tabel 2. Analisis Taksonomi Pada TIFA

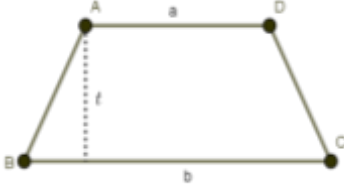| Ethnomathematics	Geometry Concept	Concepts / Mathematical Procedures
		The concept in plane geometry "circle"
		The concept of "prism"
		The concept in plane geometry "trapezoid"
		The concept in plane geometry " parallelogram"
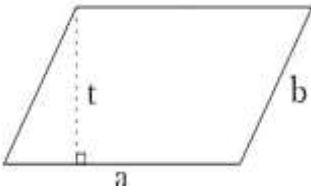
Geometry Exploration in Mathematics Learning

The results of the research show that in making tifa it is still found that local people still use non-standard measurements such as predicting, estimating and even estimating. In its manufacture, several geometric elements were found on the lid and base of the tifa, the arms of the tifa and several other parts. The following are several geometric concepts discovered and their implementation in mathematics learning as in the following table:

Table 3. Geometric Concepts in Tifa Yapen Islands

Tifa Shape Observation	Geometric Concept	Ethnomathematics
	Circle	The circle shape is found on the lid and base of the tifa. A circle is a collection of points in a plane that are the same distance from a certain point (center). The properties of circles include: • Has infinite rotational symmetry • Has one-sided symmetry • Has no corner points • Line of symmetry and infinite axes **Circle formula** **Area** = π x r x r = π x r^2 **Circumference** = π x d = 2 π r **Diameter (d)** = 2 × r **Radius (r)** = d : 2 *Notes:* $\pi = \frac{22}{7}$ or 3,14 r = radius d = diameter
	Prism	The prism is located at the top near the TIFA cover A prism is a three-dimensional shape bounded by an identical n-shaped base and lid and square or rectangular vertical sides. An n-sided prism has n + 2 sides, 3n edges and 2n vertices. Formula from Prism The surface area of the prism and the base and cover of the n-facet can be calculated using the formula: Total area = 2 x Area$_{base}$ + P$_{base}$ x h Volume = Area$_{base}$ x h Notes: Area$_{base}$ = area of base P$_{base}$ = perimeter of base h=height The area of the data base is adjusted and adjusted to the flat shape.
	Trapezoid	The isosceles trapezoid shape is found on the TIFA handle

Tifa Shape Observation	Geometric Concept	Ethnomathematics
		A trapezoid is a two-dimensional shape formed by four edges, two of which are parallel but not the same length. There are three types of trapezoids, namely: (1) Any trapezoid is a trapezoid that has four edges of unequal length; (2) Isosceles trapezoid is a trapezoid that has a pair of edges of the same length; (3) A right-angled trapezoid is a trapezoid in which two of the four angles are right angles. The properties of a trapezoid shape include: (a) It has 4 sides and 4 vertices. (b) Has a pair of sides that are parallel but not the same length. (c) Has an angle between parallel sides of 180°. Some trapezoid formulas: Perimeter $= AB + BC + CD + DA$ Area $= \dfrac{the\ sum\ of\ the\ lengths\ of\ parallel\ lines \times height}{2}$
	Parallelogram	The parallelogram shape has a TIFA handle shape A parallelogram is a 2-dimensional flat shape formed from two pairs of edges and each side facing each other is the same length. The properties of a parallelogram include: (a) Has parallel sides of the same length (b) Angles opposite each other are equal (c) Has a dividing diagonal (d) Has angles that are mutually perpendicular (e) The two diagonals intersect each other (f) Has a total of 360 degrees (g) Has no axis of symmetry Formula for parallelograms (with an example of a parallelogram in the side column): **Perimeter = a + b + a + b** **Luas** = a x t

Discussion

Based on the data analysis and results in the table above, it was found that the mathematical elements found in the shape of the Yapen Island tifa include the circle shape found on the lid and base of the tifa, the prism shape at the top near the tifa cover, the

isosceles trapezoid shape that There are parts of the tifa handle, and a parallelogram shape found in the painting of the tifa handle. The geometric shapes found are plane geometric shapes, while other geometric shapes are well identified. Apart from the geometric shapes found, there is a concept of approximation in making the Yapen Islands tifa. Therefore, if this is integrated into mathematics learning, it can provide broad impacts and benefits for preserving culture and creating positive characters for students in developing the culture of the local community.

These results are relevant to mathematics learning in SD/MI and equivalent, SMP/MTs and equivalent, SMA/SMK/MA and equivalent. At elementary school level, for example, the concepts of circles, trapezoids and parallelograms are relevant to topics related to flat shapes. Students can learn about the definition, elements, properties, perimeter and area of flat shapes. Students can also use knowledge about the concept of flat shapes to carry out problem solving related to geometric concepts. This can also be developed in mathematics learning in SMP/MTs and equivalent. As for SMA/MA/SMK and equivalent mathematics learning, you can work with geometric concepts and approximation concepts in making typas.

These results can be utilized in mathematics learning to realize contextual learning that integrates ethnomathematics. Contextual learning that integrates ethnomathematics can be used as a means of achieving students' mathematical competence as well as understanding students about local culture. Integrating local cultural insights into the mathematics learning process will make it easier for students to understand mathematical ideas, this is because students learn directly from the culture around them so that educators can easily instill noble culture which has a direct impact on character education. Integrating ethnomathematics with appropriate learning models and materials can help students improve mathematical communication skills, critical thinking skills, and mathematical literacy skills (Bakhrodin et al., 2019). In addition, ethnomathematics is mathematics applied and used by certain cultural groups.

This is consistent with (Sirate, 2012) which states that using ethnomathematics to encourage and engage students can help them overcome boredom and challenges in learning mathematics. We argue that the inclusion of ethnomathematics into the mathematics learning process will be of added benefit to students studying mathematics at all levels, from primary school to higher education.

CONCLUSION

Based on data analysis, results and discussion, the research conclusions can be stated as follows. Correctly measuring the length and width of the tifa has a significant effect on the sound (tone) produced when the tifa is hit. The design aspect involves the ability to explain the steps and sequence involved in creating a tifa, ensuring clarity and understanding in the explanation. In addition, the ability to explain goes beyond just understanding the production process to communicating it effectively to the general public. The geometric concept obtained based on the results of ethnomathematics analysis of the tifa of the Yapen Islands people is found in the tifa lid, the tifa base, the tifa arms, and the shape of the carvings on the tifa arms. The geometric shapes found include a circle shape (on the lid and base of the tifa), a prism shape (on the part near the tifa cover), a trapezoidal shape (on the tifa arm) and a parallelogram shape (on the painting of the tifa arm). The geometric shapes found are flat geometric shapes. Apart from the geometric shapes found, there is a concept of approximation or estimation also found in the process of making tifa. This can be seen from how the makers do not use measuring tools (units of length) in making the shape of the tifa frame but the makers only guess, predict, or even just estimate the scale of the size of the tifa they make. It is hoped that the results of this research can be used by educators in teaching mathematics.

Conflict of Interest: The process from start to finish of this research is free from all forms of conflict of interest.

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