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UNVEILING ETHNOMATHEMATICS: MATHEMATICAL ACTIVITIES IN THE KANDALA OF THE MARORI MEN-GEY TRIBE

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Abstract

This research explored ethnomathematics activities on intangible cultural heritage unique to the Papuan people, especially the Malind Marori Anim (Marori Men-gey) indigenous people, namely Tifa or Kandala, a traditional musical instrument. This research adopted a qualitative approach with an ethnographic design using observation, interviews, and documentation. The results revealed the present study met the criteria for ethnomathematics activities: measurement, design, and explanation. Mathematical concepts that can be explored using this musical instrument include the calculation of surface area and volume, the application of congruence, and the use of integrals to determine the volume of solids of revolution. This is because the mathematical objects present in the Kandala consist primarily of cylindrical tubes and truncated cones. The findings suggest that this study could serve as an alternative approach for teachers to integrate ethnomathematics into their lessons, providing students with a unique and culturally relevant learning experience.

Keywords: Designing, Ethnomathematics, Explaining, Kandala, Measuring.

1. Introduction

Ethnomathematics is a multidisciplinary research field on cultural anthropology, linguistics, mathematics, mathematics education, and cognitive mathematics [1-4]. Mathematical practices with cultural groups can be identified and can be considered as the study of mathematical ideas found in any culture [5, 6]. In addition, ethnomathematics can also be described as the way people belonging to a particular culture use a shared system to deal with quantitative, relational, and spatial aspects of life [7]. Ethnomathematics research in education can be used to uncover ideas in cultural activities or social groups thus they can be utilized for curriculum development [8]. Some research relating to ethnomathematics is shown in Table 1. Although many reports regarding this matter have been well-documented, not many reports examine the ethnomathematics activities based on traditional musical instrument artifacts.

The purpose of this research was to explore ethnomathematical activities and mathematical studies contained in the traditional musical instrument of the Marori Men-gey tribe, the Kandala. This research used a qualitative approach with an ethnographic design. The novelties of this research were: (i) three ethnomathematics activities contained in the Kandala musical instrument; (ii) the potential development of Kandala musical instruments as a creative mathematics learning media, especially the volume of rotating objects; and (iii) preserving the local wisdom of the Malind Marori Men-Gey indigenous people by integrating local wisdom values into the curriculum.

Table 1. Literature review.

No.	Title	Ref.
1	Diversifying our perspectives on mathematics about space and geometry: An ecocultural approach	[9]
2	Eksplorasi etnomatematika pada sero (set net): budaya masyarakat kokas Fakfak Papua Barat	[10]
3	Ethnomathematics in Ethiopia: Futile or fertile for mathematics education?	[11]
4	Eksplorasi etnomatematika pada rumah adat masyarakat Skouw Sae	[12]
5	Sundanese ethnomathematics: Mathematical activities in estimating, measuring, and making patterns	[13]

2. Literature Review

Ethnomathematics is composed of three words: ethno, mathema, and tics. Ethnomathematics refers to the techniques or ways used by members of groups with certain cultural tradition environments (including language, jargon, behavioural codes, myths, and symbols) in encoding, measuring, classifying, inferring, and modelling activities [14, 15]. Figure 1 shows that ethnomathematics is an intersection of three disciplines, namely mathematics, mathematical modelling, and cultural anthropology. There are six common activities found in cultures and societies that are an extension of the four areas of mathematical study, namely: number, measurement, geometry, and logic [16]. The ethnomathematics activities include counting, locating, measuring, designing, playing, and explaining.

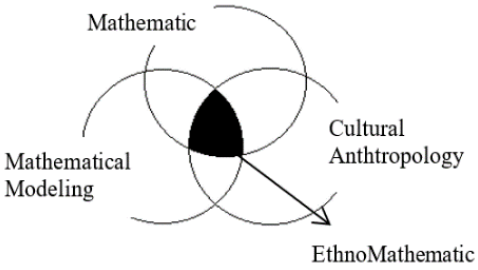

Fig. 1. Ethnomathematics is the intersection of three disciplines.

3. Methods

The method used in this research employed a qualitative approach with an ethnographic design. Ethnography was a type of qualitative research that collected observations, interviews, and documentaries to produce detailed and comprehensive reports on various social phenomena [17]. The research subjects consisted of the indigenous people of the Malind Marori Men-Gey tribe and Alil Anem (people who are experts in making Kandala).

4. Results and Discussion

The findings of ethnomathematics activities from this Kandala musical instrument included measuring, designing, and explaining activities. During the process of making the Kandala, the expert who made it did not use standard or non-standard sizes but only based on estimation. The concept of estimation was part of the mathematical context of estimation, including numerosity, measurement, and computational estimation [18]. Designing activities on the Kandala musical instrument could be seen from how Alil Anem designed the instrument thus it is making a work. Furthermore, the ability to explain was observed based on interviews with indigenous peoples and cultural observers. This research succeeded in revealing the historical, technical, and symbolic dimensions of the Kandala musical instrument. Table 2 shows the findings of ethnomathematics activities found in Kandala musical instruments.

Table 2. Measuring, designing, and explaining at Kandala.

No.	Ethnomathematical Activities	Characteristics
1	Measuring	Estimation, length, area, volume, weight, qualities
2	Designing	Design, shape, form, aesthetics, large, small, similarity, congruence, common geometry shapes, figures and solid, nets, surfaces
3	Explaining	Classification, logical connectives, story explanation, internal validation

Another finding in this study is that the mathematical objects found in Kandala musical instruments were the shapes of tubes and frustum. These mathematical objects can be used by teachers as active learning media from elementary to high school level. Figure 2 shows the Kandala musical instrument and the representation of the tube shape.

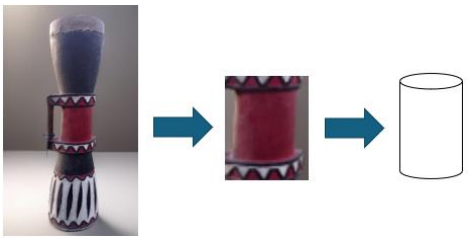

Fig. 2. Kandala and representation of the tube.

A frustum was a space formed from a cone whose apex is cut with a plane parallel to the base, resulting in two circles: one at the base and one at the apex cut, and had a sloping cone-shaped blanket side. Figure 3 shows the Kandala musical instrument and a representation of a frustum. These math objects can be used by teachers as active learning media from elementary to high school level.

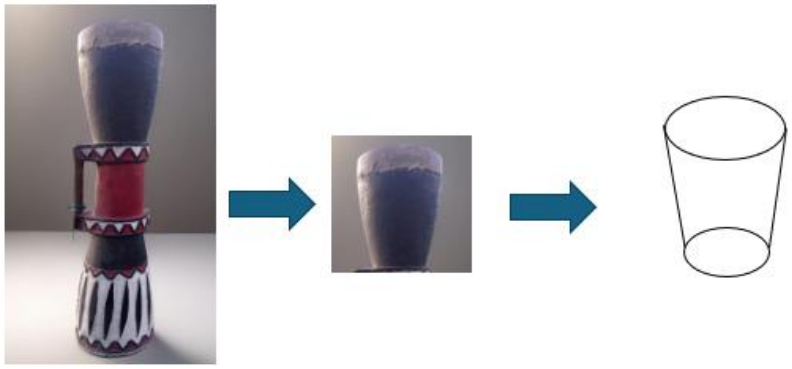

Fig. 3. Kandala and representation of a frustum.

The formula for calculating the total surface area of Kandala was described in Eq. (1).

$$[\pi a(r+R)+\pi r^2\,]+[2\pi rt\,]+[\pi a(r+R)] \quad (1)$$

The formula for calculating the total surface area of Kandala was described in Eq. (2).

$$\left[\tfrac{1}{3}\pi b(r_1R+{r_1}^2+R^2)\right]+[\pi r^2 t]+\left[\tfrac{1}{3}\pi b(r_2R+r{r_2}^2+R^2)\right] \quad (2)$$

Figure 4 shows the calculation of the volume of a frustum using the rotary body volume integral approach.

The area of the shape ($A(R)$) is obtained from Fig. 4, resulting in Eq. (3).

$$A(R)=\int_a^b f(x)dx \quad (3)$$

where $f(x)$ is the equation of the straight line through $(a, f(a))$ and $(b, f(b))$. The values of $f(a)$ and $f(b)$ can be calculated by measuring the radii at points a and b. When rotating the shape around the x-axis by 360° in Fig. 4, we could obtain as in Fig. 5.

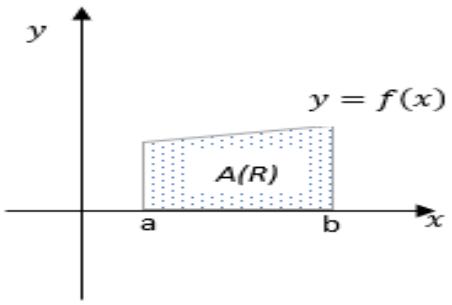

Fig. 4. The cross-section of the side of a conical cone.

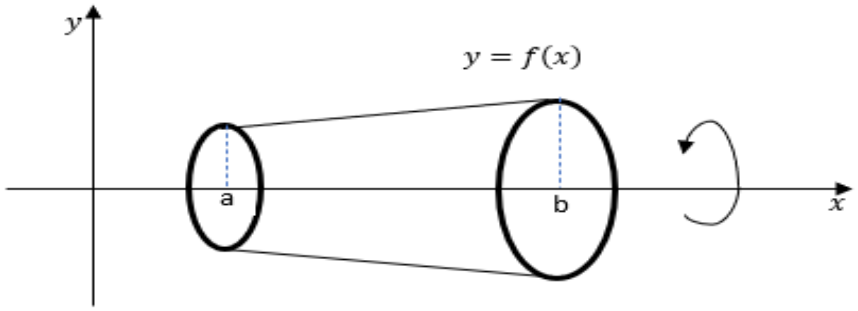

Fig. 5. A truncated cone after being rotated 360°.

The volume of the rotating body in Fig. 5 can be obtained and calculated using Eq. (4).

$$V = \pi \int_a^b [f(x)]^2 dx \quad (4)$$

The implications of the results of this study can be used as an alternative learning that could be applied by teachers in teaching students, namely by integrating ethnomathematics concepts thus students not only learned mathematical concepts in the abstract but also applied these concepts in a context close to their lives. This study can increase motivation and interest in learning. This approach also encouraged students to appreciate local wisdom and cultural diversity [9-24]. Indeed, this also adds you information in teaching and learning mathematics [25-30].

5. Conclusion

Several conclusions could be conveyed, including the indigenous people of the Marori Men-Gey tribe in carrying out mathematical activities based on practical values found in everyday life. Mathematical activities contained in the intangible cultural heritage of Kandala musical instruments are Measuring, designing, and explaining. In addition, mathematical studies that can be studied from this Kandala musical instrument include the surface area and volume of tubes and cones, that are studied using the concept of congruence and the integral approach to the volume of rotating objects.

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