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ETHNOMATHEMATICS: MUSICAL INSTRUMEN IN JA'I DANCES FOR CULTURALLY RESPONSIVE TEACHING IN ELEMENTARY SCHOOLS

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Abstract

In culturally responsive teaching, teachers need to have the ability to explore mathematical phenomena in cultural elements as learning content. This research is a qualitative descriptive study aimed at exploring ethnomathematics in Bajawa traditional dances, namely the Ja'i dance, its relevance to competency standards and basic mathematics competencies in elementary schools. The approach used is ethnographic. The collecting data technique used observation and study of documents and the researcher himself acts as the main instrument. Observations were made on the accompanying music devices contained mathematical concepts. Furthermore, researchers compare with the basic competencies of elementary school mathematics. The results showed mathematical material was found in the musical instrument section of Ja'i dance. The surface of the *gong* and the drum (*gendang*) are circular, the body of the large drum is frustum of a cone, and the *gendang laba kagu*, *laba bhuga* and gong are tube-shaped. In the middle of the gong there is a kind of lump which is shaped like a half ball. The implementation of this research can be applied in culturally responsive teaching in elementary schools.
Keywords: culturally responsive teaching, ethnomathematics, ja'i dance

Abstrak

Dalam pembelajaran responsif budaya, guru perlu memiliki kemampuan untuk mengeksplorasi fenomena-fenomena matematika dalam unsur budaya sebagai konten pembelajaran. Penelitian ini merupakan penelitian deskriptif kualitatif yang bertujuan mengeksplorasi etnomatematika pada tarian tradisional Bajawa yaitu tarian Ja'i, relevansinya dengan standar kompetensi dan kompetensi dasar matematika di sekolah dasar. Pendekatan yang digunakan adalah etnografi. Teknik yang digunakan adalah observasi dan studi dokumen dan peneliti sendiri berperan sebagai instrument utama. Observasi dilakukan terhadap perangkat musik pengiring yang terdapat konsep matematika. Selanjutnya, peneliti membandingkan dengan kompetensi dasar matematika sekolah dasar. Hasil penelitian menunjukkan materi matematika ditemukan pada bagian alat musik penggiring tarian Ja'i. Bagian permukaan gong dan gendang berbentuk lingkaran, tubuh gendang besar berbentuk kerucut terpancung, dan gendang *laba kagu*, *laba bhuga* dan gong berbentuk tabung. Pada bagian tengah gong terdapat semacam bonggolan yang berbentuk setengah bola. Implementasi hasi penelitian ini dapat diterapkan dalam pembelajaran responsif budaya di sekolah dasar.
Kata Kunci: etnomatematika, pembelajaran responsif budaya, tarian ja'i

INTRODUCTION

Each region has an unique communal intellectual property that must be preserved continuously. The forms of communal intellectual property rights include traditional knowledge and traditional cultural expressions. Traditional cultural expressions including traditional dances need to be protected and continue to be preserved because they have high use values in terms of economic, social, and cultural aspects including in the development of

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technology in the Industrial Revolution 4.0 era. One example of the exploration of elements of Bajawa culture in technology development is the 128-bit block cipher cryptography that uses floor patterns and Ja'i dance hand movements (Sukihana & Kurniawan, 2018). This example shows that the technology at the time of the Industrial Revolution 4.0 can now be developed starting from the exploration of phenomena that are rooted in cultural elements. One way to preserve traditional dance is through school mathematics learning, where mathematical phenomena in traditional dance are used as learning content and contexts. Mathematical pedagogy must be responsive or relevant to students' cultural references.

Culturally responsive pedagogy will provide opportunities for children to develop optimally both in terms of cognitive (intellectual), social and emotional students (Wonda, 2016). Cultural references owned by students are useful for teachers to instill students' knowledge, skills, and attitudes holistically. Ladson-Billings states that responsive or culturally relevant pedagogy is a teaching methodology that is designed to fit in with school culture created through student culture as a basis for helping them understand themselves and their peers, develop and structure social interactions, and concepts of knowledge .

Incorporating cultural elements in mathematics learning, teachers need to have the ability to explore mathematical phenomena in cultural elements as learning content. These mathematical phenomena in cultural practice are called ethnomatematics (D'Ambrosio & Rosa, 2016). Ethnomatematics can be used as a bridge between mathematics and culture (Tandililing, 2013). Ethnomatematics is a technique for explaining and understanding mathematics derived from cultural values (Fredy, Tembang, et al., 2020). While mathematics is considered a socio-cultural system (Kilpatrick, 2014), it is internally internalized in the character values of students (Tereshkina et al., 2015). Through ethnomatematics, students are expected to learn mathematics from culture through mathematical content that is explored from cultural elements. When learning mathematics derived from cultural elements and developing it, students are expected to learn culture, then love and be proud of their own cultural products.

Learning mathematics with an ethnomathematics approach, of course requires the ability of deep reflection from teachers and students about culture. Students' mathematical abilities will increase if teachers can improve their knowledge in optimizing mathematics learning (Albert & Kim, 2013). One is that teachers must have the ability to increase their knowledge to maximize cultural potential in mathematics learning. By observing mathematical phenomena rooted in Bajawa culture and using them in learning mathematics. In fact, not all teachers have the ability to reflect or explore mathematical phenomena in cultural elements

that are useful for learning mathematics in their classrooms. In fact, in the Bajawa traditional society itself, there is a hereditary spirit of "*wake wadho*" which continues to be raised so that everyone always revives intellectual and cultural wealth through the retrieval of history and local wisdom (Sudhiastiningsih, 2016).

Previous research has found a mathematical element in traditional musical instruments. The researc Destrianti (2019) found the concept of cylinders of different sizes in the Rejang Lebong musical instruments (*gong, kulintang, and redap*). Likewise, the research Afriyanty & Izzati (2019) found the concept of plan and solid geometry on the Marawis musical instruments. Research Hall & Teixeira (2018) that discovered the symmetry concept in ceramics and handicrafts in Portuguese pavements and research on ethnomathematics of the Bajawa tribe in East Nusa Tenggara was carried out, including exploring the geometric shapes of Bajawa traditional houses (Dapa, 2019). However, exploration of musical accompaniment on the Ja'i dance has never been done, even though if this is done it will be very helpful in finding mathematical concepts/materials that can be used for the development of learning mathematics based on local wisdom.

Research to explore mathematical phenomena in cultural elements is still very much needed including ethnomathematics in Bajawa culture. Mathematics is the practice of universal cultural life Bajawa community is still very much and broad and has not been explored to its full potential for learning culture-based mathematics. This study sought to explore Bajawa etnomatematika on traditional dances, its relevance to the Competency Standards, and Basic Competence School Mathematics. The mathematical elements explored in this dance are only limited to the accompanying musical instruments used in the Ja'i dance. The results are expected to be able to enrich the knowledge of mathematics education practitioners, especially teachers, to carry out learning that is responsive to culture.

METHOD

This study used descriptive qualitative method. This research was conducted for six months and used an ethnographic approach. This study seeks to explore ethno-mathematics in the music that accompanies the traditional Bajawa dance, namely Ja, i, its relevance to the competency standards and basic competences of school mathematics. The techniques used were interviews, observation to observe directly the ja'i musical accompaniment and document study. Researchers act as the main instrument. Researchers themselves make plans, analyze and draw conclusions based on field findings.

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Triangulation is used to check the validity of the data. The data collected is then reduced (inappropriate data is excluded), analyzed based on the themes and basic competences of elementary school mathematics so that the conclusion is not biased and illustrates the exploration results of the musical accompaniment ja, i as culturally responsive teaching.

RESULTS AND DISCUSSION

Results

Bajawa is one of the tribes on the central part of Flores that has a distinctive culture and has cultural elements like other ethnic groups in Indonesia. Bajawa is also the capital of the Ngada Regency and is included in the administrative territory of the Province of East Nusa Tenggara. Ja'i dance as a typical Bajawa dance is often danced as an important guest pickup, construction of traditional houses and other traditional events. The Ja'i Dance Performance was attended by 8,000 participants at PRJ Kemayoran, 16 February 2013 and broke the MURI record by the Jakarta Flobamora Community Forum.

Ja'i 'is a typical Ngada dance performed in the *Sa'o Ngaza* rite (Vianey et al., n.d.) in order to express gratitude and joy. This dance is usually performed in the middle of the village (*kisanata*), and also often danced to welcome guests of honor and at traditional ceremonies. Ja'i dance has the characteristics of movement and the use of less space in the form of lines and is repeated. As a mass dance or communal dance, the beauty and allure of Ja'i lie in the uniformity and energy of the dancers.

Bajawa distinctive clothing is also worn during the Ja'i dance. The complete traditional clothing worn by male dancers consists of broom, *lu'e, boku* (head rest), *keru* (belt), *sau* (machete), and *lega jara* (men's bag) and *degho* (bracelet). While women wear *lawo* (cloth), *keru* (belt), *kasa sese* (plain yellow sling), *marangia, lua manu* (chicken feathers), *butu* (beads), *lega kebi tuki* (women's bag), and other accessories. Bajawa people refer to this set of traditional clothing as *saboweki* (Yulianti, I., & Martyastiadi, 2020).

Ja'i is accompanied by a set of rhythmic music at gongs and drums (*go laba* or *laba go*). Go profit consists of a set of *go* (= *gong*) and *laba* (= *gendang*/drum) is struck with a certain rhythm to accompany the Ja'i dance. A set of *go laba* consists of *gendang* and *gong*. The drum (*gendang*) consists of one drum with larger but shorter surface radii (*laba dera*), and two taller drums but smaller surface radii (*laba kagu* and *laba bhuga*). The gong consists of 5 pieces, 1 *gong wela*, 1 *gong bheme*, 1 *gong ridhu*, pair *gong uto* or *uto-uto*. Each gong has a different sound.

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Keterangan:
1. Laba Dera
2. Laba Kagu
3. Laba Bhuga
4. Wela
5. Ridhu
6. Bheme
7. Uto-uto

Figure 1: A set of *gong* and *gendang*, the accompaniment of the Ja'i dance

All musical instruments accompanying the Ja'i dance are geometric. The geometrical shape of the musical instrument accompanying the dance can be used in learning mathematics based on local wisdom. The large drum (*laba dera/laba*) is frustum of a cone, while the other two drums (*laba kagu* and *laba bhuga*) are cylinder and *gong wela*, *uto, ridhu* or *bheme* is a combined cylinder and half-ball.

a. Circle

The surface of the gong and the drum are circular. If $\pi = 3.14$ or 22/7, r is the radius and d diameter (= 2xr), then the formula for area and circumference of the circle is as follows.

Circular Area $= \pi \times r^2$

Circle Circumference $= 2\pi \times d$

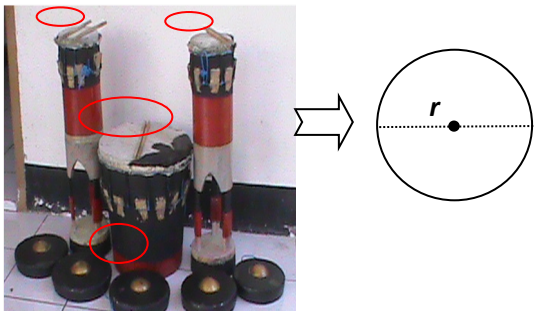

Figure 2: The concept of the circle on the Ja'i dance music instrument

b. Cone

The cone concept in the Ja'i dance is found in the big drum (*gendang*). Large drums (*laba dera*) have larger radius on the surface (R) and smaller at the bottom (r). If a large drum is turned upside down, it resembles a frustum of a cone (Figure 2).

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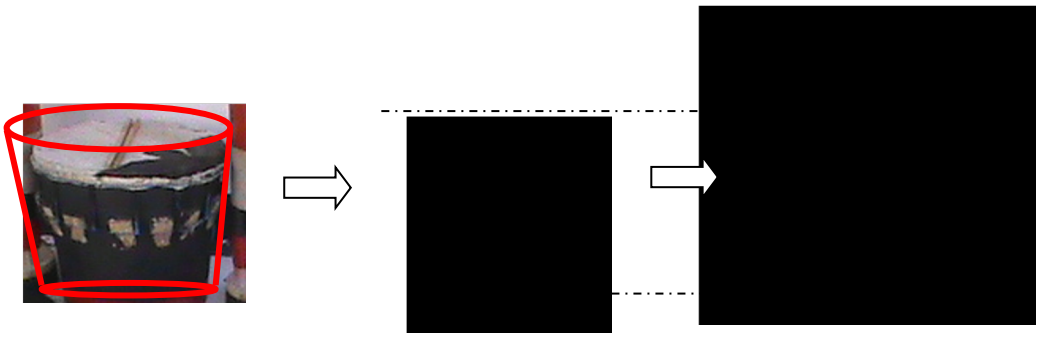

Figure 2. Drum (*laba dera*) and frustum of a cone concept

The figure above is two cones, namely a large cone and a small cone, a small cone is part/piece of a large cone, where the large cone has the radius R, length of the painter s line and height *t*. The small cone has radius *r*, length of painter s and height t_1 and R > r.

Large cone volume is V, Small cone volume is V_1, the height of a large cone is $t = t_1 + t_2$, and the height of small cone is t_1. To calculate the volume of the fustum of a cone (drum shape) (VKT) must first calculate the volume of the large cone as a whole (V) then subtract the volume of the small cone (V_1).

VKT = V- V_1

$$= \frac{1}{3}\pi R^2 t - \frac{1}{3}\pi r_1^2 t_1$$
$$= \frac{1}{3}\pi(R^2 t - r_1^2 t_1)$$
$$= \frac{1}{3}\pi\left(R^2(t_1 + t_2) - r_1^2 t_1\right)$$
$$= \frac{1}{3}\pi\left(R^2 t_1 + R^2 t_2 - r_1^2 t_1\right)$$
$$= \frac{1}{3}\pi\left(R^2 t_1 - r_1^2 t_1 + R^2 t_2\right)$$
$$= \frac{1}{3}\pi\left(t_1(R^2 - r^2) + R^2 t_2\right)$$
$$= \frac{1}{3}\pi\left(\frac{rt_2}{(R-r)}(R+r)(R-r) + R^2 t_2\right)$$
$$= \frac{1}{3}\pi\left(rt_2(R+r) + R^2 t_2\right)$$
$$= \frac{1}{3}\pi\left(Rrt_2 + r^2 t_2 + R^2 t_2\right)$$
$$= \frac{1}{3}\pi t_2\left(R^2 + Rr + r^2\right)$$

Likewise, when calculating the area of blankets in the form of drums (cone sticks). Its surface area is obtained from the area of a large cone blanket reduced by the area of a small cone blanket.

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$$= \pi\ R\ s - \pi\ r\ s_1$$
$$= \pi(Rs - rs_1)$$
$$= \pi\left(R \cdot \frac{R}{R-r}s_2 - r \cdot \frac{r}{R-r}s_2\right)$$
$$= \pi\left(\frac{R^2}{R-r}s_2 - \frac{r^2}{R-r}s_2\right)$$
$$= \pi s_2\left(\frac{R^2 - r^2}{R-r}\right)$$
$$= \pi s_2 \frac{(R+r)(R-r)}{R-r}$$
$$= \pi s_2 (R+r)$$

c. Cylinder

Based on observations, *gendang laba kagu*, *laba bhuga* and *gong* shaped cylinder.

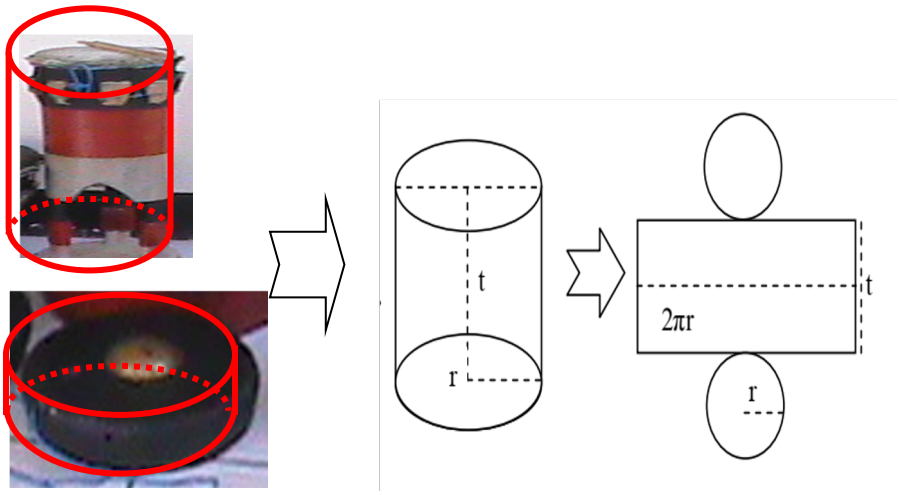

Figure 3. The concept of the cylinder on the *gendang laba kagu*, *laba bhuga* and *gong*

The volume (V) of a cylinder and the surface area of a cylinder with the radius of the base *r*, and height *t* can be calculated using the following formula.

Volume $= \pi \times r^2 \times t$

Surface area $= 2 \cdot \pi r \cdot (r + t)$

d. Ball

In the middle of the gong there is a kind of lump which is shaped like a half-ball. Volume and half-ball surface area with radius r.

Volume $= \frac{1}{2} \{4/3 \times \pi \times r3\} = 2/3 \times \pi \times r3$

Surface area $= \frac{1}{2} \{4 \times \pi \times r2\} = 2x \pi \times r2$

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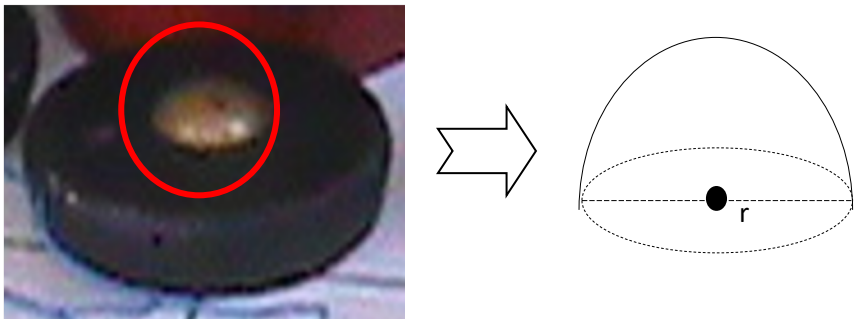

Figure 4. Concept of the ball in the middle of the *gong (go)*

Discussion

According to Piaget's learning theory, elementary school students are at the stage of concrete operational thinking so the learning given by the teacher must have a connection with the daily lives of students. The more concrete mathematics subjects are given, the more interested students are in learning mathematics. Students can understand and know real problems that can be solved by mathematics (Arisetyawan et al., 2014). One way that can be taken is to apply culturally responsive teaching. Mathematics teachers are expected to be able to realize mathematics as a science that is inherent in culture (cultural bounded) in learning (Sumiyati et al., 2018). The teacher is emphasized having knowledge about the mathematical elements obtained from the local culture and then designing and designing it in mathematics learning.

The findings of this study in the form of mathematical concepts such as circles, cylinders, cones, and balls were found in musical instruments accompanying dance Ja, i. The top has a circle-shaped. The big drum (*laba dera*/*laba*) is frustum of a cone and the two other drums (*laba kagu* dan *laba bhuga*) are cylinder while the gongs are either *wela, uto, ridhu* or *bheme* in the form of cylinders and half-balls. This finding is in line with the findings of Lubis et al. (2018) research on the sideline gardon instrument and Fredy, Halimah, et al. (2020) on the Malind tribal musical instrument. The difference is the size of each of the different musical instruments. The musical instrument accompanying the Ja'i dance consists of a set of *go* (= *gong*) and *laba* (= *gendang*/drum*)* which is struck with a certain rhythm to accompany the Ja'i dance. The drum consists of one drum with larger but shorter surface radii (*laba dera*), and two taller drums but smaller surface radii (*laba kagu* and *laba bhuga*). The gong consists of 5 pieces, 1 *gong wela*, 1 *gong bheme*, 1 *gong uto* (or *uto-uto*). Each gong has a different sound.

The implementation of the results of this study can be used as material for learning culturally responsive mathematics. Learning mathematics with culture is very helpful for students in understanding mathematical concepts in elementary schools (Supriadi, 2019). In addition, students' cultural backgrounds have contributed to effective and meaningful learning (Weldeana, 2016). It can also be designed to be an authentic (real) task so that students can not only solve mathematical problems but also understand their application (Dickman, 2020). Problems in the cultural context need to be given so that students can gain direct experience and know mathematics practices in everyday life, traditions, and culture of Bajawa (Utami et al., 2019). Moreover, it can hone a positive attitude towards mathematics and towards its own culture (Danoebroto, 2016).

As an illustration, learning ethnomathematics uses a musical instrument that accompanies the Ja'i dance, which is teaching the material of plane and solid (geometry) in elementary school. Students can find the area and circumference of the circle by measuring the top of *gong* or *gendang*. You can also find the area and volume of the cylinder or half ball on *gong* or *gendang*. Students can play this musical instrument and formulate the mathematical concepts contained therein. This research is expected to contribute to the learning of culturally responsive mathematics, especially in the Bajawa area. This research is expected to contribute to the culturally responsive teaching mathematics, especially in the Bajawa area.

CONCLUSION

In the musical instrument that accompanied the Ja'i dance, the concept of geometry consisted of a circle, a tube, a cone and a ball. The surface of the *gong* and the drum (*gendang*) are cirle, the body of the cone-shaped drum is beheaded, and *gendang laba kagu*, *laba bhuga* dan *gong* are cylinder. In the middle of the gong there is a kind of lump which is shaped like a half-ball. This research is expected to be able to enrich the knowledge of mathematics education practitioners, especially teachers, to carry out learning that is responsive to culture. In addition it is expected to be able to preserve the Bajawa culture.

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