

Ethnomathematics in Gong Musical Instruments The Relationship of Form, Size and Harmony in Local Wisdom

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Abstract: Ethnomathematics is a study that connects mathematical concepts with local culture. One of its forms can be found in traditional musical instruments, such as gongs. This article discusses the relationship between shape, size, and harmony on gongs from an ethnomathematical perspective, examining how mathematical principles, such as geometry, proportion, and vibrational patterns, play a role in their creation. The study also highlights how traditional societies intuitively apply mathematical concepts in producing and tuning gong tones to create distinctive harmony in regional music. Through a qualitative approach and literature analysis, this study reveals that local wisdom in making gongs reflects a deep understanding of the relationship between mathematics and art. The results of this research are expected to enrich insights into ethnomathematics and contribute to the preservation of local culture through a scientific approach.

Keywords: Ethnomathematics, Gong, Shape, Size, Harmony, Local Wisdom.

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A. INTRODUCTION

Indonesia is an archipelagic country with various ethnicities, races, religions, and regions. This diversity has resulted in Indonesia becoming a unique country. One of the topics that became an interesting topic was Indonesian culture. Koentjaraningrat (1974: 19) explains culture as a whole system of ideas and tastes, activities, and works produced by humans in social life, which are made their own by learning. This is the basis for the importance of culture as part of social life. Even cultural heritage is recognized by UNESCO as something that must be preserved. To overcome the crisis of cultural understanding, the Indonesian government has made efforts to cultivate cultural education through formal education. Mathematics education is a formal education that helps preserve and maintain Indonesian culture. Therefore, learning math is essential. This can be seen from including mathematics as one of the compulsory subjects at every level of education.

The National Education System Law No. 20 of 2003 Article 37 emphasizes that mathematics is one of the compulsory subjects for students in elementary and secondary schools (Ministry of National Education, 2003) (Sitanggang, 2021). This is also emphasized by (Bishop, 1994) that culture is a form and has been integrated with aspects of human life. Mathematics underlies many different fields, so science and technology cannot separate the

role from mathematics (Komarudin & Thahir, 2019; Rodiawati & Komarudin, 2018). Therefore, it is undeniable that mathematics is an important knowledge and can be the basis for studying and overcoming problems that can be studied mathematically. The same thing is implied in the National Education System Law No. 20 of 2003 Article 37 states that mathematics is one of the compulsory subjects for elementary and junior high school students. In mathematical studies, culture is one of the interesting and important exploratory studies for students to learn. One that can bridge the relationship between mathematics and culture is ethnomathematics. Zhang & Zhang (2010) consider ethnomathematics to be the study of the relationship between mathematics and sociocultural contexts, showing how mathematics is produced, transmitted, disseminated, and specialized in different cultural systems (Prastowo et al., 2022).

Ethnomathematics is a study that studies the relationship between mathematical concepts and culture through ideas, activities, and cultural objects that become the identity of a community group. According to (Budiyono & Rahtwo, 2022, ethnomathematics examines the relationship between mathematics and culture, closely related to education. Ethnomathematics was first introduced by a Brazilian mathematician named Ubiratan D'Ambrosio in 1977. D'Ambrosio's ethnomathematical goal is to recognize that there are ways of doing mathematics, considering the academic mathematical knowledge developed by different sectors of society, different modes in which different cultures practice methods of classification, calculation, measurement, designing buildings, equipment and games. In his view (1985), Ethnomathematics refers to the practice of mathematics that develops within specific cultural groups, such as ethnic communities, work environments, or age groups such as children. Thus, ethnomathematics can be understood as a bridge that connects culture and mathematics, allowing various mathematical ideas that arise in people's daily activities to be studied scientifically in the context of education

This approach emphasizes that mathematics is present in the form of numbers and symbols in the classroom and in cultural practices passed down from generation to generation. Moreover, this study was carried out by someone who has an understanding and expertise in the field of mathematics in order to be able to identify mathematical concepts in cultural practice (Fajriyah, 2018). Through ethnomathematics, mathematics learning can be directly linked to the context of students' real lives, making it more meaningful and relevant. Research (Sulfayanti et al., 2022) shows that ethnomathematics can integrate cultural values into the learning process, so that mathematics learning is not only cognitive, but also plays a role in character education that is in harmony with the values of Pancasila.

One of the forms of culture that is widespread in various regions is traditional musical instruments. Each region has its distinctive musical instruments that are often influenced by local geographical conditions, and develop along with the course of history and life of its people (Khuluq, 2016). In ethnomathematics, traditional musical instruments such as gongs store interesting mathematical values to study in terms of geometric shapes, varying sizes, and structured tone patterns and harmony. Thus, traditional musical instruments serve as a means of art and cultural communication and represent mathematical order and concepts passed down from generation to generation.

Gong is one of the traditional musical instruments that are widely found in various regions in Indonesia and has high cultural and historical value. Gongs are the main

instruments in Leku Sene's musical game. The gong is one of the traditional musical instruments of the Dawan Tribe in Palau, Timor that has existed since ancient times (Simarmata et al., 2022). From the ethnomathematical side, the structure of gong shapes reflects geometric concepts such as circles, symmetry, and size comparison. Physically, the gong has a circular shape with a convex surface in the middle called a cuc, and the size varies depending on its function in the musical ensemble. In addition, the tone patterns produced by the gong in a set of ensembles show the regularity of frequencies that can be studied through mathematical concepts such as patterns, intervals, and ratios. Thus, the gong became an aesthetic and spiritual symbol in the local culture and a representation of mathematical thinking integrated into people's lives (Haryanto, 2018).

The mathematical values contained in traditional musical instruments such as gongs are still rarely used as a learning resource in formal education. Mathematics learning in schools still tends to be abstract and less relevant to the local cultural context of students. This leads to a disconnect between what is learned in school and students' real life. Traditional societies have long applied mathematical concepts intuitively, especially in making and tuning gongs, such as setting the size, proportions of the gong parts, and harmonizing the pitch. This skill reflects a local understanding of mathematical order manifested in art and sound.

When we associate cultural sciences with mathematics education, we know them as Ethnomathematical sciences (Kumoro et al., 2022). Culture-based mathematics can be an interesting, fun, and innovative learning alternative because it allows the formation of contextual meanings that arise from students' experiences as members of the cultural community, so that students are expected to participate in and support the literacy movement (Pasaribu, 2022). Therefore, it is important to examine the relationship between mathematics and local culture more deeply through an ethnomathematical approach. This study examines how gong musical instruments' shape, size, and harmony contain mathematical principles such as geometry, comparison, and vibration patterns. Through a qualitative analysis based on literature, this paper reveals how the local wisdom of the community in producing and tuning the gong not only plays a role in preserving traditional musical arts, but also shows the natural integration between art, culture, and science. Thus, ethnomathematics can bridge cultural heritage and contextual scientific learning.

Based on the information that has been explained, the Gong musical instrument unknowingly has mathematical concepts. Thus, it is possible to conduct research with the title "Ethnomathematics in Gong Musical Instruments: Relationship of Shape, Size and Harmony in Local Wisdom" and it is hoped that it can explain the mathematical concept in the organology of Gong musical instruments which can be used as a source of student learning and can improve their culture, especially in Gong musical instruments.

B. METHODS

The research method to be carried out is exploratory with an ethnographic approach. This research used exploration, observation, documentation and literature study. To find the shape, size and harmony of the gong musical instrument, exploration, observation and documentation methods are used, then literature studies to analyze the concept of shape, size and harmony of sound results produced from the circles in the gong. The object of this study

is the traditional musical instrument of the gong. The research was conducted at the Banten State Museum on Jl. Masjid Agung Banten, Banten, Kasemen District, Serang City, Banten 42191. This study used three data collection techniques: observation, interview, and documentation. Observation is an activity that uses the five senses such as sight, smell and hearing to obtain the information needed to solve research problems. The results of the implementation of observation are in the form of specific actions, events, events, objects, conditions or atmospheres and emotional feelings that a person feels. Interview is a process in which communication is established between the researcher and the research subject to produce information by conducting questions and answers. Documentation is a step taken by researchers in collecting data in the form of notes, letters, archives, photos, meeting results, and so on. Researchers need documentation to be able to support the results of the research conducted.

C. RESULTS AND DISCUSSION

Based on the results of observations and interviews with the subject, it can be explained in the image below that the gong music instrument is one of the objects in the research, so that the researcher can see directly the form of the musical instrument that can be used as a tool in understanding the concept of circles.



Figure 1. Traditional Musical Instrument Gong

There are several parts that researchers have observed of this musical instrument, such as:

1. In a circular shape, gong has a circular shape base, one of the most perfect geometric shapes. The gong circle has a diameter, radius and circumference that can be measured and calculated.
2. The size of the circle, the gong musical instrument has a circle size of the gong can be determined mathematically.

This size can be used for:

1. Comparing the size of multiple gongs in a set.
2. Determine the proportions between the surface and circumference, which can affect the design and aesthetics of the gong.

Not only mathematical calculations, gong circles can be determined traditionally based on hereditary experience and habits. This size may not always use a standard unit such as cm, but uses a local measure such as "satu jengkal", "sebahu", atau "segenggam".

3. The connection of traditional gong musical instruments to harmony such as the resonance of sound or the tone produced by the shape of the gong circle allows for a good resonance

of sound or tone. When the gong is hit, the vibration propagates from the center to the entire surface of the circle symmetrically. The resulting vibrations create sound waves that produce a specific tone, depending on the size of the gong (radius, thickness, and material). Larger gongs (longer fingers) produce lower notes, while smaller gongs produce higher notes.

D. CONCLUSIONS

Based on the research results, it can be concluded that the traditional musical instrument gong has a strong connection between culture and mathematical concepts, especially in terms of shape, size, and harmony. The basic shape of the gong in the form of a circle contains geometric concepts such as diameter, radius, circumference, and area that can be studied mathematically. In addition, the size of the gong circle both calculated with mathematical formulas and those measured traditionally affects the tone produced. Larger gongs produce lower notes, while smaller gongs produce high notes. The harmony of sound resulting from symmetrical vibrations on the surface of a circle also reflects the principles of resonance and wave patterns in physics and mathematics. Thus, gong is an art tool and a medium representing local wisdom in intuitively understanding mathematical principles. This study shows that ethnomathematics can be a bridge that connects local culture and contextual mathematics learning.

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