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EXPLORATION OF ETHNOMATHEMATICS ON THE WOODEN KELINTANG MUSICAL INSTRUMENT

Rajwa Mayyaza[1], Rima Meslita[2], Tia Agnesa[3]
Program Studi Tadris Matematika, Universitas Islam Negeri Sulthan Thaha Saifuddin Jambi,
Jl. Jambi-Muara Bulian No.KM.16, Simpang Sungai Duren, Kec. Jambi Luar Kota, Kabupaten Muaro Jambi, Jambi 36361
e-mail: [1]rajwamayyaza@gmail.com, [2]rima.meslita@uinjambi.ac.id, [3]tiaagnesa@uinjambi.ac.id

Abstract

This study aims to explore the ethnomathematics found in traditional Jambi musical instruments, especially wooden kelintang musical instruments. This type of research is a descriptive qualitative research using an ethnographic approach (socio-cultural) with data sources obtained from observation, interview, and documentation methods. Data analysis in this study uses the Spradley model analysis in Lexy J. Maleong including domain analysis, taxonomy analysis, component analysis, theme analysis. To check the validity of the data uses the triangulation technique. This research was conducted at the Mindulahin Studio in Jambi City. The results of the study can be concluded that: 1) The mathematical concepts found in wooden kelintang musical instruments include: Flat shapes in the form of rectangles, circles, and trapezoids. Space shapes in the form of blocks, cylinders, angles in the form of 90 °, relations and functions, and arithmetic. 2) Ethnomathematic activities in wooden kelintang include activities of calculating, measuring, determining locations, making designs, playing, and explaining. These activities reflect that the wooden kelintang embodies various mathematical concepts which can be integrated into mathematics learning and serve to preserve local cultural values.

Keywords: *ethnomathematics, function relation, geometry, wooden cross section*

1. INTRODUCTION

Education is the formation of human thought based on knowledge, skills, and characteristics expressed in various ways. such as formal and informal education. Formal education includes activities in schools that cover many subjects, one of which is mathematics, while non-formal education includes the family environment and social activities [1]. Culture is a habit that carries noble values, is close to human life, and is passed down from generation to generation [2]. Culture can be used as a learning tool for school students as well as learning about culture itself.

Each region has its own style and culture with its own characteristics such as traditional clothing, house style, art, language and other customs. Jambi regional culture is very diverse, one of which is in the field of musical instrument art. Jambi has a variety of regional musical instruments, including percussion, plucked, and wind. There are three types of intercultural learning: learning about culture, learning with culture, and learning through culture. Learning and culture are methods of creating learning arrangements and learning designs that integrate culture into learning activities [3].

Knowledge and culture are important in everyday life, especially if culture is a view of life for each individual or group of people that is passed down from generation to generation, knowledge is also a personal need for each person develop their abilities in facing their lives. One of the things that is done is organizing national and cultural development for students in the field of education [4]. Teaching mathematics as part of formal education contributes to developing culture and instilling cultural values and developing national values. For this reason, it is very important to study mathematics with culture in it, because mathematics is a social structure, a cultural product, and exists in culture [5].

Similar studies have been conducted in other cultural contexts. For instance, Maseleno, Susilowati, and Chauhan (2024) explored the ethnomathematical concepts found in the architecture of Wat Hua Lamphong Temple in Thailand. Their findings revealed various mathematical elements such as triangles, trapezoids, prisms, circles, and geometric transformations like reflection, translation, and dilation [6]. This demonstrates that cultural heritage can serve as a meaningful context for teaching and learning mathematical concepts [7].

Mathematics is one of the fields of science taught in schools, from elementary school to high school. Mathematics is one of the fields of education that plays an important role. Mathematics is a method, a way of thinking and reasoning. Mathematics can be used to calculate probability [8]. Mathematics education in the 21st century will move towards mathematical literacy, namely the ability of people to understand and understand how mathematics works in the world, so that they can make the right decisions and use mathematics in everyday life [9].

Ethnomathematics is said to be a particular method used by a particular cultural group or society in doing mathematics. This definition means that the results of ethnographic mathematics learning can be collected and used in various situations and conditions, one of which is mathematics learning in schools [10]. The importance of understanding regional cultural values so that students are able to become a generation with character that can maintain and preserve culture as the foundation of the national situation [11].

The importance of instilling cultural values in everyone since childhood so that everyone can understand, interpret and better understand the importance of cultural values in everyday life. Cultural practices also allow the instillation of mathematical concepts and mathematical activities called ethnomathematics in a

series of actions, customs, traditions, and activities carried out by individuals or groups in society that reflect their values, norms, beliefs, and way of life [12]. By providing a comprehensive understanding of the science being studied.

Previous studies in ethnomathematics have primarily focused on traditional fabrics, house architecture, or cultural rituals, while limited attention has been given to traditional musical instruments [13]. Although some research has demonstrated the presence of mathematical elements in various cultural artifacts, there is still a lack of in-depth exploration of geometry and arithmetic concepts in musical instruments such as the wooden kelintang.

This study aims to fill this gap by exploring the mathematical concepts embedded in the design and use of the wooden kelintang, a traditional musical instrument from Jambi. The novelty of this research lies in combining cultural arts and mathematics education through an ethnographic approach, specifically focusing on a less-studied cultural object [14].

Therefore, the main objective of this study is to explore the ethnomathematical concepts contained in the wooden kelintang and to analyze their potential in supporting mathematics learning rooted in cultural values. Consequently, this research is expected to provide practical contributions to the development of more contextual and culturally relevant mathematics teaching methods, as well as to offer opportunities for students to act independently based on scientific principles to solve problems they face in the context of cultural society and encourage students to be creative and continue to seek and find ideas based on scientific concepts and principles [15].

In this traditional musical instrument, many mathematical works are found, both in form, pattern, playing style and many musicians are involved in mathematical concepts that can be classified into the type of ethnomathematics. The results of mathematical research on this culture are integrated into

mathematics learning as a systematic effort through education to develop and pass on culture. In this case, mathematics can be used to preserve culture and advance culture [16].

2. RESEARCH METHODS

This study uses a qualitative research type with an ethnographic research design. Where this study aims to understand the problem as a whole, carried out naturally and asking directly to the data source or informant. This research is descriptive. Data obtained from the study can be in the form of words or images. The approach used is ethnography, namely empirical and theoretical, which aims to describe and analyze in depth the art of traditional musical instruments in the Jambi region based on field research. The setting in question is the place and time of the study [17].

In this study, the place used to conduct the research was at the Mindulahin Jambi studio. In this study, two data sources were used. The data sources used were primary data sources and secondary data sources. Primary data sources are data obtained directly from sources through interviews with informants, observations and notes [18]. While secondary data sources are additional types of data obtained indirectly through the subject matter, through articles, books, articles, and newspapers related to the subject matter being studied. These secondary data sources make it easier for researchers to collect data and analyze the results of this study, which will ultimately produce stronger conclusions and greater influence on the research [19].

Data were obtained from various sources using various data collection methods and continued until the required data were obtained. In accordance with the nature of the data needed in this

study, the data collection methods are observation, interviews, and documentation. Data analysis is the process of systematically searching and collecting data obtained from interviews, observations, and others. This study uses an interactive analysis model that refers to the Spradly model. The Spradly model explains that the research process follows a circle and is better known as the cyclical research process.

The steps of data analysis as stated by Spradly in Lexy J. Maleong 2007 include domain analysis, taxonomy, components, and theme analysis activities. Data validation techniques are used to minimize errors in the data collected. To obtain valid data in this qualitative research, the validity of the data is maintained to avoid errors. There are several validation methods to determine the reliability of the data. According to (Sugiyono, 2018), including: broadening perspective, increasing stability and triangulation.

3. RESULTS AND DISCUSSION

Wooden kelintang is a musical instrument originating from Jambi, almost all areas in Jambi Province have this musical instrument. This wooden kelintang has been known since the time of our ancestors where this musical instrument was used in various religious ceremonies and cultural activities. Performing traditional arts to support social collectives through preserved traditions [20]. Wooden kelintang is often played in traditional ceremonies such as weddings, circumcisions, and religious ceremonies. People in several areas of Jambi still believe that the music produced is considered to have magical powers that can bring good luck and ward off evil spirits.

In addition to being used for traditional ceremonies, the Wooden Kelintang is also played as entertainment in traditional art

performances, such as dance and folk theater. This musical instrument is part of the traditional orchestra that accompanies various forms of performing arts. The Wooden Kelintang also plays an important role in cultural and musical education.

The traditional art form has undergone acculturation, especially after being influenced by Islamic culture such as kompangan and hadroh. This can be seen from the lyrics and musical instruments. The lyrics used are prayers taken from the book of covenants, while the musical instrument is a type of drum that comes from Arabic. The community uses this art as a form of gratitude for all the grace and gifts that have been bestowed, as well as an expression of the community's love and eternal memory of the god [20]

The younger generation today is not only taught how to play musical instruments but also how to make them, this is an effort to preserve cultural heritage so that it is not forgotten. Until now, the wooden kelintang can still be recognized by many young generations through the appearance of theatrical art performances and in art studios. Many of the younger generation are interested in playing it.

The wood used to make wooden kelintang usually comes from mahang wood. Not just any wood can be used to make a kelintang musical instrument, because the influence of the basic wood material will affect the sound. Not all types of wood can produce good sound. These woods are chosen because of their ability to produce distinctive sound resonance. The process of making wooden kelintang involves several stages, including selecting and drying wood, cutting wood into slats of a certain size, smoothing the surface, and tuning the tone. Each slat must be cut and tuned carefully to produce the desired tone. Each slat has the same difference, which is 2 cm. Specifically for the slats

themselves, there are 15 slats for standard wooden kelintang and 5 slats for small wooden kelintang/jolo kelintang.

Tuning is done by measuring the length, width, and thickness of each wooden blade. Knowledge of traditional mathematics and physics is often applied in this process to ensure that each blade can produce the right tone. As is known, the length of the wooden blade has different sizes, where the resulting tone will be different. Based on the type of kelintang, for the jolo kelintang the tone produced is more limited compared to the wooden kelintang.

The standard wooden kelintang musical instrument has a frame under the wooden blade. The frame itself is trapezoidal and above it there are 15 wooden blades with a complete scale. In the form of this musical instrument there is a concept of flat geometry, spatial geometry, angles, rows and arithmetic series.

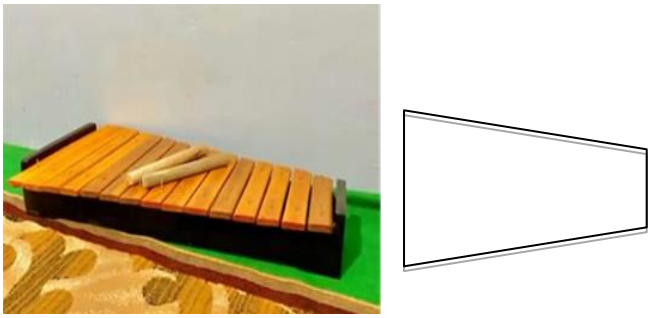


Image 1. Wooden Kelintang

Kelintang jolo is a wooden kelintang musical instrument with the same shape but has a different size and how to play it is also different and the number of blades on the kelintang jolo is only 5 wooden blades so that the tones produced are limited. Kelintang jolo does not have a frame under the wooden blades but there is a rope that connects one blade to another. In the shape of the kelintang jolo there is the same mathematical concept as the wooden kelintang. Playing the wooden kelintang or kelintang jolo requires a tool for the beater made of wood. This beater is 20 cm

long. The mathematical concept contained in this beater is a cylindrical solid shape and a circular flat shape.

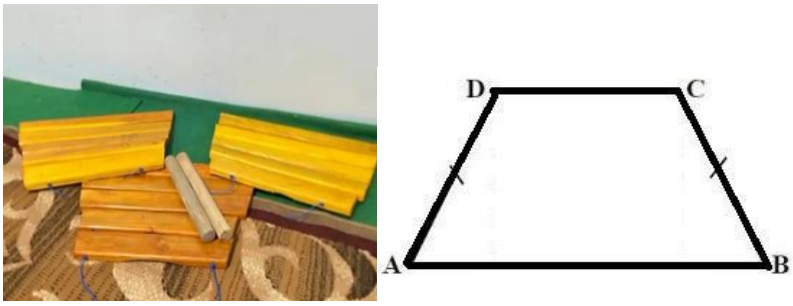


Image 2. Kelintang Jolo

Each wooden blade on the kelintang jolo is rectangular. Where starting from the length of the 1st wooden blade measuring 28 cm, the 2nd wooden blade measuring 26 cm, the 3rd wooden blade measuring 24 cm, the 4th wooden blade measuring 22 cm, and the 5th wooden blade measuring 20 cm. And the width of each blade is 5 cm. For each wooden blade on a rectangular wooden kelintang, unlike a jolo kelintang which only has 5 wooden blades, the wooden kelintang has 15 blades.

Where starting from the length of the 1st wooden blade measuring 42 cm, the 2nd wooden blade measuring 40 cm, the 3rd wooden blade measuring 38 cm, the 4th wooden blade measuring 36 cm, the 5th wooden blade measuring 34 cm, the 6th wooden blade measuring 32 cm, the 7th wooden blade measuring 30 cm, the 8th wooden blade measuring 28 cm, the 9th wooden blade measuring 26 cm, the 10th wooden blade measuring 24 cm, the 11th wooden blade measuring 22 cm, the 12th wooden blade measuring 20 cm, the 13th wooden blade measuring 18 cm, the 14th wooden blade measuring 16 cm, and the 15th wooden blade measuring 14 cm. And the width of each blade is 5 cm.

There is a mathematical concept of trapezoid in the shape of the kelintang musical instrument. A trapezoid is a flat shape formed by a pair of equal sides and a pair of parallel sides. The

kelintang is shaped like a trapezoid because this design provides acoustic and functional advantages. The trapezoid shape helps in a more even distribution of sound, the sound produced can be heard clearly and balanced. In addition, the trapezoid shape allows the placement of wooden bars of different lengths, thus the player can produce notes with only one instrument.

The kelintang percussion instrument is shaped like a tube because this design has several important advantages such as, the tube-like shape is easy to grip and comfortable to hold by the player. With this design allows better control when hitting the wooden bar to produce the right tone. The tube-shaped percussion instrument has an even weight distribution, so it is more balanced when used by the player in controlling the strength and speed of the blow and producing a consistent sound. This shape also minimizes the risk of breaking or cracking when used repeatedly.

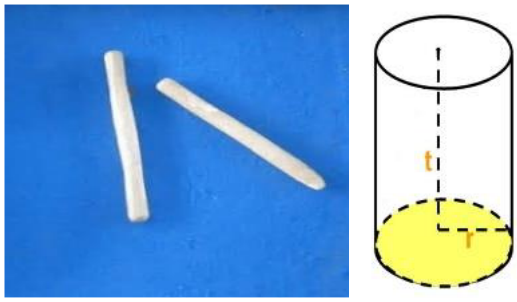


Image 3. Kelintang Percussion Instrument

The wooden slats are block shaped for several reasons related to acoustics, construction, and functionality. The block shape provides a large surface area for the sound vibrations to reflect and direct. This results in a clearer tone and good resonance for the sound quality produced by the kelintang. The block shaped slats provide enough structural strength to withstand repeated blows without easily cracking or breaking, and this shape is also stable when placed on the kelintang frame.

In playing the kelintang jolo, the player's position is by sitting with the legs stretched forward, so that from the sitting position it can be seen that a 90° right angle is formed. In addition, the position of the hands ready to play the kelintang musical instrument, both wooden kelintang and jolo kelintang, forms the same angle, namely a 90° right angle.



Image 4. Playing The Wooder Kelintang

Five wooden slats with lengths of 28 cm, 26 cm, 24 cm, 22 cm, and 20 cm, can be said to be set A. Then the tones produced on the wooden kelintang, namely C, D, E, F, G, can be said to be set B. This contains the mathematical concept of relations and functions. In the concept of rows and series, it can be seen from the length of the wooden slats on the kelintang musical instrument, which have lengths of 14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 34, 36, 38, 40, and 42. If you pay attention, the difference between the numbers is always the same, which is 2. The difference in an arithmetic sequence is said to be a difference or expressed mathematically as b or difference.

Jambi kelintang musical instruments involve several ethnomathematic activities. First, determining the location. Second, measuring activities are an important part of making wooden kelintang, accuracy in measuring the length, width, and thickness of the wood ensures the achievement of the desired musical notation.

Third, counting is also important, especially for beginners, who practice by counting from one to eight while hitting the wooden bars, making it easier to memorize which bars to play. In addition, observations and interviews revealed activities explaining the history of the instrument, design, and playing techniques. Finally, design activities are clearly visible in making kelintang, which show expertise in forming stable and aesthetic structures. The different sizes of each wooden bar produce different musical tones. These findings show that the ethnomathematical concepts in the wooden kelintang differ from previous studies by emphasizing the integration of measurement, counting, and geometric design in traditional musical practices. This supports D'Ambrosio's theory that ethnomathematics connects cultural expression and mathematical thinking, highlighting local arts as real contexts for learning mathematics.[21][22], [23]

4. CONCLUSION AND SUGGESTIONS

The results of this research indicate that ethnomathematics serves as a bridge connecting mathematics and culture through the traditional Jambi musical instrument, the wooden kelintang. Several mathematical concepts are identified, including spatial and flat shapes, geometric transformations, angles, arithmetic sequences, and number patterns. These concepts are reflected in the structure of the instrument, such as the shape of the kelintang beater, the wooden bars, and the instrument frame, each representing spatial geometry and transformation principles.

Furthermore, the process of making and playing the kelintang demonstrates mathematical reasoning in daily practice. Measuring and determining the appropriate size of each wooden bar requires precision in measurement and proportion, while counting and

arranging tones from one to eight illustrates arithmetic sequences and number patterns. The relationships between tone intervals and pitch also represent the concepts of relations and functions in mathematics.

Overall, the ethnomathematical aspects discovered in the wooden kelintang highlight that mathematical ideas are inherently embedded in traditional cultural activities. These findings reveal how ethnomathematics not only strengthens the connection between mathematics and local culture but also provides meaningful and contextual learning experiences for students through cultural-based mathematical exploration.

Based on the ethnomathematics findings on wooden kelintang, it is suggested that ethnomathematics integration be carried out in the school mathematics curriculum, especially in Jambi, to make learning more relevant and interesting for students, while fostering an appreciation for local culture. In addition, the development of innovative learning media that explicitly explain mathematical concepts in wooden kelintang will greatly help students understand the material visually and independently.

It is also important to facilitate collaboration between kelintang artists/craftsmen and educators to produce workshops or joint projects that document and transfer this ethnomathematics knowledge between generations. Furthermore, these ethnomathematics findings should be used as a tool for cultural preservation and promotion, highlighting the intellectual value inherent in wooden kelintang so as to increase community support for this artistic heritage. Finally, further research needs to be encouraged to explore ethnomathematics in musical instruments or other traditional arts in Indonesia, enriching the treasury of knowledge and demonstrating the richness of culture connected to mathematical concepts.

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