An Exploration of Ethnomathematics in The Gandrang Bulo Dance of the Makassar Tribe

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ABSTRACT

Gandrang Bulo dance is a dance originating from Makassar that has a meaning of resistance to the colonizers. The purpose of this research is to explore mathematical concepts found in Gandrang Bulo dance. The type of research used in this study is descriptive qualitative research with an ethnographic approach. The subject of this research is the head of the Independent Art studio by the name of Alam. This art studio is located at Jalan Buludua Stp 3 No. 3A Lariang Banggi, Makassar. The data collection technique in this research consists of two parts, namely library data collection and field data collection which consists of three parts, namely observation, interview, and documentation. The research instrument used is a human instrument, namely the researcher acts as the main instrument which cannot be replaced by other people who act as data collectors. In addition, supporting instruments in the form of structured interviews were also used. Data analysis techniques used in this study with data reduction, data presentation, and conclusion drawing. Based on the results of Gandrang Bulo dance exploration, there are movements, floor patterns, and musical instruments used that contain mathematical elements.

Keywords: Ethnomathematics, Gandrang Bulo Dance

1). INTRODUCTION

Education is very important to form a quality generation and be able to adapt to the times. Educational progress is the best way to see the progress of a country (Lewar et al., 2022). Education contributes to the formation of quality human resources (Angel & Saija, 2023). In addition, education is a process that encourages individuals to acquire new knowledge, skills, values, ethics, beliefs, and habits (Nurina & Indrawati, 2021). Education also plays a role in shaping personality and opening up opportunities for self-potential development, so that individuals can actively participate in society with positive contributions. In Indonesian education various learning models have been created and there have been many changes in strategies, methods, and design or implementation of learning (Jemamun et al., 2023). These various models are expected to improve the abilities of students, especially in

mathematics learning. However, it should be noted that education and mathematics have a relationship.

Education and mathematics have a very close and complementary relationship. Mathematics is one of the most fundamental fields of science in education, because the ability to think logically, reason, and solve problems taught in mathematics is needed in the learning process of all other subjects. Understanding mathematical concepts from an early age can help hone the ability to think critically, analytically, and systematically in students (Destrianti et al., 2019). In addition, mathematics also equips learners with counting, measuring, and data processing skills that are very useful in everyday life. On the other hand, education also plays an important role in developing effective ways of learning and teaching mathematics, so that this lesson can be well understood and applied by students. The education curriculum is designed to include mathematics as one of the compulsory subjects, showing how important mastery of mathematics is for all learners in achieving broader educational goals.

Mathematics is a field of science that studies and uses concepts such as measurement, geometry, comparison, patterns, and numbers. Mathematics is a science that is the basis for the development of modern science and technology, and has an important role in the development of various scientific fields and human thought (Fitriyanah et al., 2021). Mathematics best supports humans in solving every problem they face (Rahmadani & Wahyuni, 2023). Therefore, mathematics has a very important role.

It cannot be denied that mathematics has a very important role. In almost every aspect of life, mathematics is applied (Jalil, 2018). Therefore, math is the key to learning because humans need it as a tool to meet their daily needs (Tampubolon et al., 2019). With mastery of mathematics, individuals are not only able to solve practical problems, but can also optimize decision-making in everyday situations as well as strengthen their scientific foundation.

But in reality, math is still a subject that is less favored by students. Most students in schools dislike math because it has abstract concepts and is difficult to understand. In addition, it is not uncommon for students to say the word "ouch" when listening to math lessons, especially during exams. Many of them are annoyed, lazy and do not like math lessons at all (Rahardian, 2022). This is in line with research conducted by Yuniyanto, Syamsuri, Hendrayana, & Anwar (2022) which states that Mathematics is also one of the most hated subjects by students because it is considered difficult.

This belief is what makes students reluctant or less enthusiastic in learning math. So in particular, there are still students who are relatively uninterested in learning mathematics. As a result, they face many difficulties when learning math, which results in poor learning outcomes (Fitriani, 2022). This can be caused by several factors, one of which is an ineffective teaching model.

Therefore, based on some of the opinions above, the researcher concludes that one of the causes of the low mathematics learning achievement of students is the inappropriate model or approach given. This is in line with the opinion of Astiati & Ilham (2023) which states that the fact that students' learning achievement is still very low is influenced by learning materials that are too abstract and less interesting, teacher teaching methods that are always teacher-centered so that students tend to be passive and students do not have the opportunity to think mathematically. Therefore, a model or approach is needed that is expected to improve students' mathematics learning achievement, namely ethnomathematics. Ethnomathematics is considered as one of the right models to use because the learning process starts from mathematical knowledge that is as easy as possible to be accepted by students and then able to develop students' insights into local culture (Sulasteri et al., 2020). Ethnomathematics integrates mathematics into the culture of the community.

Culture itself is the values, beliefs, practices and traditions that are passed down from generation to generation. When linking math learning with culture, it will be called ethnomathematics. "Ethnomathematics" can be defined as learning about the customs, habits, or even ways of life of a society that have a connection to mathematics, but which are not known to the general public (Helan et al., 2023). Ethnomathematics is the study of mathematics that considers the culture in which mathematics arises to understand the reasoning and mathematical systems used by an ethnicity (Darmayanthi et al., 2020). The things studied in ethnomathematics include symbols, concepts, principles and mathematical abilities that exist in national, ethnic or other community groups related to various mathematical activities such as counting, measuring, explaining and so on (Sa'adah et al., 2021). The existence of ethnomathematics stimulates individuals to obtain something culturally relevant learning (Naja et al., 2021). Learning mathematics with an ethnomathematics approach can be useful because it provides a new nuance in learning, so that learning mathematics can not only be done indoors but also outdoors by visiting historical places or interacting with surrounding cultures. One of the countries that has a diverse culture is Indonesia.

Indonesia is an archipelago that has many diverse tribes and races. With its diverse tribes, there are many cultures, one of which is traditional dance. Traditional dance is one of the cultures that is very close to the community (Jemamun et al., 2023). Dance is a form of art in the performing arts that is applied through the expression of emotions and expressions (Habibah et al., 2022). One of the regions that is also rich in the cultural diversity of its people is South Sulawesi Province. South Sulawesi is a province in Indonesia which is located in the southern part of Sulawesi Island. South Sulawesi also has a variety of dances, one of which is Gandrang Bulo dance in Makassar.

Based on observation, Gandrang Bulo Dance is a traditional dance originating from South Sulawesi, precisely in Makassar. Gandrang Bulo dance is usually performed as a performance dance, welcoming dance. This dance emerged during the Dutch colonial era, where this dance was an indirect form of rebellion. This dance contains the meaning of movements that make fun of Dutch colonization accompanied by the rhythm of songs that use the Gowa language with harsh words. During the Dutch colonization, Gandrang Bulo dance was played by the elderly, but now it is passed down to children. Gandrang Bulo dance is a dance that uses bamboo, but now changes are made. Classical Gandrang Bulo during the Gowa Kingdom functions as an entertainment art for the community. Gandrang Bulo as a medium to raise people's awareness of the bad colonialism functioned as a propaganda tool for artists against the colonizers and a means of entertainment for the natives when it was time to take a break from forced labor.

Based on the description above, the researcher wants to explore the mathematical concepts found in Gandrang Bulo dance. Therefore, researchers are interested in conducting research on "Exploration of Ethnomathematics in the Makassar Tribe Gandrang Bulo Dance". By doing this, it is hoped that it will be able to become a consideration for teachers or schools so that in the existing learning process it will be more easily accepted by students and able to understand mathematics well.

2). METHODS

The type of research used in this study is descriptive qualitative research with an ethnographic approach. Qualitative research is a research method in which the researcher wants to explore extensively about causes and effects or things that affect the occurrence of something (Ratuanik et al., 2022). Descriptive qualitative research is a type of research that aims to describe or describe existing

phenomena, both natural and human-made. Ethnographic approach, an empirical and theoretical approach that aims to describe and analyze culture comprehensively (Maryati & Pratiwi, 2019).

The subject of this research is the head of the Independent Art studio by the name of Alam. This art studio is located on Jalan Buludua Stp 3 No. 3A Lariang Banggi, Makassar. The data collection technique in this study consists of two parts, namely library data collection and field data collection which consists of three parts, namely observation, interview, and documentation. The research instrument used is a human instrument, namely the researcher acts as the main instrument which cannot be replaced by other people who act as data collectors. In addition, supporting instruments in the form of structured interviews were also used.

Data analysis techniques used in this study with data reduction, data presentation, and conclusion drawing (Fitriani, 2022). According to Ratuanik, Batfin, Urath & Nay (2022) 1) data reduction, namely selecting and organizing data that is considered important or appropriate for research purposes, making summaries, and creating indexes. 2) data presentation (data display), namely data refers to dividing data during data reduction and displaying it in such a way that makes it easy to see, find patterns and trends, and make comparisons. 3) conclusion drawing is reviewing the data presented and drawing conclusions.

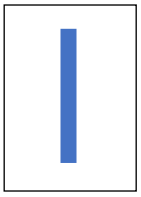
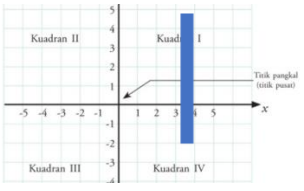
3) RESULTS AND DISCUSSION

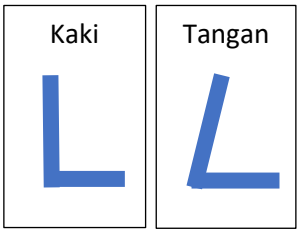
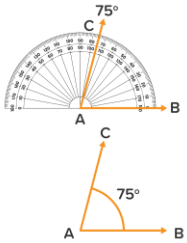
Ganrang Bulo dance is a mesmerizing artistic expression and full of cultural meaning originating from Bugis Makassar. In the performance, the dancers present graceful and dynamic movements, accompanied by Makassarese music. The costumes used by the dancers are also an important part of this performance, with bright colors and traditional motifs that reflect the rich cultural heritage of the region. The forms of ethnomathematics used in Ganrang Bulo Dance include the use of geometric patterns in the dancers' costumes, which provide artistic and symbolic dimensions. In addition, the arrangement of dancer formations and the calculation of musical rhythms that accompany the performance also reflect the mathematical understanding contained in the choreographic aspects of this dance. Thus, Ganrang Bulo Dance not only illustrates the beauty of local culture, but also integrates elements of ethnomathematics and mathematics in the expression of this traditional art.

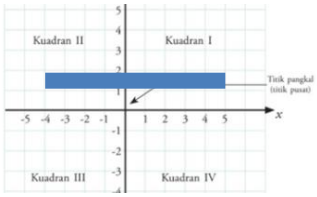
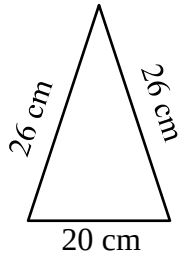
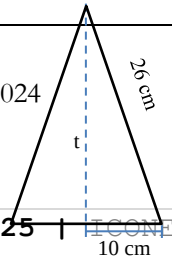
In understanding Ganrang Bulo Dance, we can see how local wisdom is not only reflected in the beautiful movements and costumes, but also in the mathematical complexity contained in it. Through every movement decorated with mathematical symbols, Ganrang Bulo Dance shows the harmony

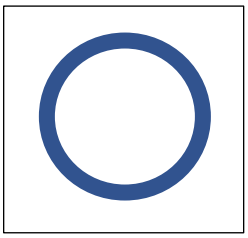
between art and science. presenting a stunning harmony between cultural expression and mathematical creativity. From the results of observations that have been made at the Independent Art Makassar art studio. Gandrang Bulo dance is usually performed as a performance dance, welcoming dance.dance

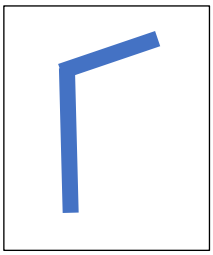
The following are the research results obtained from Gandrang Bulo Dance of the Makassar tribe.

No.	Movement and Musical instruments	Ethnomathematics Concept	Questions and answers
1	 Picture 1 Entry starting position Source: Personal documentation at Independent Art Studio	 In the picture, it can be seen that when the performance is about to begin, the initial position of the dancer forms a vertical line that can be interpreted as a representation of mathematical concepts, especially in the context of the X axis in the coordinate system. Vertical line A vertical line on the coordinate grid is depicted by a line that is parallel to or coincides with the y-axis (abscissa). 	Three dancers are known to stand in a vertical line. Draw on cartesian coordinates an illustration of the dancers with a distance of one unit between them! Answer: In order for the dancers to form a vertical line, suppose dancer A is at point (1, 2), dancer B is at point (1, 3) and dancer C is at point (1, 4). Then the location of the three points on the cartesian coordinates is as follows: 

22	 picture 1 Dance movements when giving greetings Source: Personal documentation at Independent Art Studio	 In the image, there is an interesting visual combination where the hand forms an acute angle, while the foot gives a right angle shape. In appearance, a right angle is larger than an acute angle. • Acute angle Angles that have values less than 90° to 0° are expressed as 0° < x < 90° (Mahfudz, 2020). • Right angle An angle that has a value of 90° or a full quarter turn (Mahfudz, 2020).	A dancer moves her hand so that it is at 75°. What angle is 75°? Include a picture of the angle! Answer:  Based on the picture, an angle of 75° is an acute angle because it is less than 90°.
3	 Picture 2 Row position		There are three dancers, Andi, Surya and Ari. If Andi's position is at point A (1,2), while Surya is at point B which is 3 units towards the x-axis and Ari is at point C which is 6 units towards the x-axis.

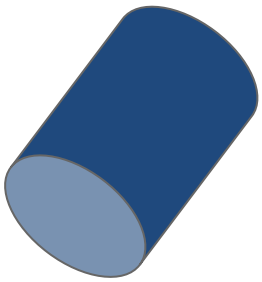
	Source: Personal documentation at Independent Art Studio	A When observed from the front, there is a horizontal line that is closely related to the concept of coordinate system.  A horizontal line is a line that is parallel to the X-axis... All points are on the same line as the y-coordinate.	Where is Ari's position when viewed from the cartesian coordinates? If the positions of Andi, Surya and Ari are connected, does it form a vertical or horizontal line? Answer:  Ari's position is at point (7,2). If a line is drawn from point A to point C, it will form a horizontal line.
4	 Picture 3 Footwork in Gandrang Bulo dance Source: Personal documentation at Independent Art Studio	 In the image, the intersecting legs form an interesting pattern, creating a geometric structure that has relevance to the mathematical concept of a triangle. An isosceles triangle, the two sides of which have the same length.	Based on the movement of the dancer's feet, the flat shape formed is an isosceles triangle. If given the following picture:  What is the height of the isosceles triangle? 

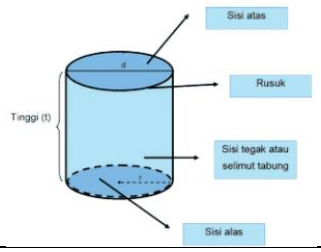
		While the height can be found with the Pythagorean formula. Formula for finding the area of an isosceles triangle $Luas = \frac{1}{2} \times a \times t$ While the perimeter of an isosceles triangle. $Keliling = sisi\,1 + sisi\,2 + sisi\,3$ $Keliling = AB + AC + BC$	Answer: $t^2 = sisi^2 - \frac{1}{2}a^2$ $t^2 = 26^2 - \left(\frac{1}{2}20\right)^2$ $t^2 = 676 - 100$ $t^2 = 576$ $t = \sqrt{576}$ $t = 24$ The height of the isosceles triangle is 24 cm.
5	 Pictire 4 Circular floor pattern in Gandrang Bulo Dance Source: Personal documentation at Independent Art Studio	`  In the picture it can be seen that when rotating it can form a circle so that the relevance to mathematics The elements of a circle consist of: Center Point (P), Radius (r), Diameter (d), Arc of the circle	Suppose a group of dancers form a circular floor pattern with a circumference of 276 cm. Calculate the diameter of the circle! Answer: Unknown: circumference of the circle = 276 cm. Therefore, $d = \frac{K}{\pi} = \frac{276}{3{,}14} = 88$

		Bowstring, Juring of a circle, Corners, Apothema, Circumference of a circle Keliling lingkaran $K = 2 \times \pi \times r$ $K = \pi \times d$	So, the diameter of the circle is 88 cm
6	 Picture 5 Gandrang Bulo Dance hand movements Source: Personal documentation at Independent Art Studio	 It can be seen that the hands form an obtuse angle when the dancers hold on to each other, which has relevance to mathematical concepts. The togetherness of these shapes creates geometric symbolism An obtuse angle is an angle that is greater than 90° but less than 180° expressed as $90° < x < 180°$.	A group of dancers were directed to move their hands to follow 13.50. From the movement of the hands, what angle is formed? Answer:  If the dancers move their hands to follow 13:50, it will form an obtuse angle as shown in the clock picture above.

7	 Pucture 6 Harp instrument that accompanies Gandrang Bulo Dance Source: Personal documentation at Independent Art Studio	 The musical instrument used in Gandrang Bulo dance is the harp, which has mathematical elements, namely the shape of the beam. Beam characteristics Has 6 sides, 12 ribs, 8 corner points, 12 diagonal planes, 4 diagonal spaces, and 6 diagonal planes. Properties of Beams • The sides of the block are rectangular • The parallel ribs have the same length • Each diagonal plane on the opposite side has the same length • Each diagonal space on the beam has the same length • Each diagonal plane on the beam has a rectangular shape Beam formula • Volume $V\ balok = p \times l \times t$	In the traditional dance of the Makassar tribe in South Sulawesi, dancers are accompanied by music in the form of a harp, one of whose elements has a block shape. If the length of the block is 87 cm, the width is 5 cm, and the height is 3 cm, calculate the area of the block! Answer: $L = 2\{(p \times l) + (p \times t) + (l \times t)\}$ $L = 2\{(87 \times 5) + (87 \times 3) + (5 \times 3)\}$ $L = 2\{435 + 261 + 15\}$ $L = 2\{711\}$ $L = 1422$ So, the area of the block is 1422 cm²

		• Area $Luas\ permukaan\ balok = 2\{(p \times l) + (p \times t) + (l \times t)\}$ cm² • Perimeter of the beam $keliling\ balok = 4\ (p + l + t)\ atau\ (4 \times p) + (4 \times l) + (4 \times t)$ • Diagonal of a beam The formula for the space diagonal of a beam: $d = \sqrt{(p^2 + l^2 + t^2)}$ Formula for the length of the front side diagonal of a beam $d = \sqrt{(p^2 + t^2)}$ Formulas for the length of the side diagonals of a beam $d = \sqrt{(l^2 + t^2)}$ Formulas for the length of the side diagonals of the base of a beam $d = \sqrt{(p^2 + l^2)}$	

8	 Picture 7 Drum instrument that accompanies Gandrang Bulo Dance Source: Personal documentation at Independent Art Studio	 The musical instrument used in Gandrang Bulo dance is a drum that has mathematical elements, namely the shape of a tube. Characteristics: • Has 3 sides • Has 2 ribs • There is a circle at the base and lid of the tube Types of tubes • Open tube An open tube is a type of tube in which one side of the lid or the base side is open or the base side and the lid side are both open. • Closed tube A closed tube is a type of tube in which all of its parts and sides are all closed. Volume of a tube $V = luas\ alas \times tinggi$ $V = \pi \times r^2 \times t$ Surface area of the tube	Alat musik yang mengiringi tari The musical instrument that accompanies Gandrang Bulo dance is a tubular drum. If the drum has a diameter of 33 cm and a height of 66 cm. Then, calculate the volume of the drum! Answer: Unknown: Drum diameter = 33 cm Drum height = 66 cm since d =33 cm, then r (radius) = $\frac{1}{2} \times d = \frac{1}{2} \times 33 = 16{,}5cm$ $V = \pi \times r^2 \times t$ $V = 3{,}14 \times 16{,}5^2 \times 66$ $V = 56421{,}09cm^3$ So, the volume of the drum is $56421{,}09\ cm^3$

		V $= luas\ alas + luas\ tutup$ $+ luas\ seilmut\ tabung$ $luas\ alas = \pi \times r^2$ $luas\ tutup = \pi \times r^2$ $luas\ tutup = 2 \times \pi \times r \times t$ $luas\ selimu\ tabung$ $= 2\pi \cdot r(r + t)$ Perimeter of the base or lid of the tube $K = 2\pi R$ Elements of a tube 	

Ganrang Bulo dance is a traditional dance originating from Makassar, which combines elements of music, dance and dialog that are jokes so that the audience sometimes laughs in watching the performance. Around the 1960s, Gandrang Bulo dance began to be popular among the public and was performed in ceremonial events and often performed at weddings, government and political parties (Syair, 2014). From the origin of the word, Ganrang Bulo comes from the Makassar language Ganrang is interpreted in Indonesian as hit, and Bulo is interpreted as bamboo. The performance of Ganrang Bulo Dance is accompanied by traditional music consisting of bamboo pieces, drums, and flutes or traditional Makassar stringed instruments. The Ganrang Bulo dancers wear traditional Makassar traditional clothes. Dancers bring funny characters or innocent villagers to face officials or powerful people who are arrogant. So funny are the movement patterns of the players that the people who are criticized laugh too. The type of movement reveals the form of a game played by boys is very

interesting and is typical of the folk games of the Makassar region (Yatim & Jamilah, 2023). Gandrang Bulo dance also has the meaning of every movement they play and there are also song verses or song themes that they perform every time they perform on stage and the song verses played also have their own meaning. So every movement they play is accompanied by drum music and the music must have a meaning in each verse or verse of the song according to the theme raised in the art performance and Gandrang Bulo Dance also has 5 to 15 players and each has a function in accompanying the music (Sidin, n.d.).

The ethnomathematics concept contained in Gandrang Bulo dance comes from foot movements, hand movements, floor patterns and musical instruments that accompany it. As in hand and foot movements, it can produce mathematical concepts, namely angles, which consist of right angles, acute angles and obtuse angles. According to Renali & Astuti (2023) angles can be formed from the dancer's own body parts or in pairs. Dancers can create acute angles, right angles, obtuse angles and straight angles using their hands or feet. This is in line with the research of Zulianti, Hidayat, & Meifiani (2021) which states that the main movements are formed by the dancer's hand movements and body movements and each movement forms an acute angle, obtuse angle and right angle. In addition, the foot movement also produces a mathematical concept, namely a flat shape, precisely an isosceles triangle. According to Nurhayati, Busnawir, & Misu (2021) in Lumense dances dancers exchange places and make triangular foot movement patterns. Thus, it is clear that traditional dances are rich in mathematical concepts implied in the hand and foot movements of the dancers, ranging from angles to flat shapes such as isosceles triangles.

The floor pattern produces mathematical concepts, namely lines, especially straight lines and circles. The straight line consists of vertical and horizontal lines. According to Nabila (2021) the straight line floor pattern is a one-dimensional geometry concept. In addition, according to Sa'o, Mei, Bito, & Mei (2022)) the floor pattern in Tea Eku dance also contains straight lines, especially horizontal lines and contains the concept of a circle. The circle has a strong symbolic meaning (Melinda & Septianawati, 2023) According to Desmawati (2018) in the lipetto motion, the circle floor pattern is formed with the feet turning fully to the original place where the feet started moving. This is in line with Mangkin, Agustina, & Huriaty (2021) who revealed that Dadas Bawo dance also has a circle concept. So based on some of the research mentioned, mathematical concepts such as straight

lines (vertical and horizontal) and circles are often found in traditional dance floor patterns from various regions in Indonesia.

Meanwhile, the musical instruments used produce mathematical concepts, namely blocks and tubes. According to Prasasti & Budiyono (2022) the tube space can be seen from the shape of the drum used as musical accompaniment. As in the musical instrument accompanying the Pencak Macan Gresik dance, one of them contains the concept of tube space. This is in line with research conducted by Sipahutar & Reflina (2023) which reveals that in prehistoric spaces there are traditional musical instruments found in the form of tube spaces. Thus, it can be concluded that the shape of traditional musical instruments used in dance performances or certain cultures often reflects the mathematical concept of spatial shapes such as tubes and blocks.

4). CONCLUSIONS

Based on the exploration of Gandrang Bulo dance, there are movements, floor patterns, and musical instruments used that contain elements of mathematics. As in the hand movements contain angle material, namely acute angles, obtuse angles. While the foot movements contain angular material, namely right angles and contain isosceles triangle material. The floor pattern used contains line material, namely vertical and horizontal lines such as coordinate points. In addition, it also uses a circular floor pattern. Meanwhile, the musical instruments that accompany it form blocks and form tubes.

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