Exploration of Ethnomathematics on the Traditional Musical Instrument Serunai in Bengkulu

Wahyu Setyo Utomo[1], Kashardi[2], Selvi Riwayati[3]
[1,2,3]Universitas Muhammadiyah Bengkulu, Bengkulu, Indonesia

Article Info

Article history:

Received 2026-01-04
Revised 2026-01-22
Accepted 2026-01-24

Keywords:

Ethnomathematics
Geometry
Learning
Serunai
Symmetry

ABSTRACT

This study aims to explore the ethnomathematical concept embedded in the traditional musical instrument Serunai Bengkulu, with a focus on its geometric and symmetrical elements. Serunai, a local cultural heritage, has a physical form that reflects mathematical concepts, such as a cylinder, a truncated cone, and a circle. Using a descriptive qualitative approach with ethnographic methods, data were collected through direct observation, interviews with cultural experts, and visual documentation. The results show that parts of the Serunai, such as the funnel, stem, and ornaments, exhibit vertical and rotational symmetry, as well as geometric shapes consistent with mathematics learning materials at the Junior High School (SMP) level. Integrating local cultural elements into mathematics learning can provide a contextual learning experience, increase student interest, and bring mathematics closer to everyday life. These findings support the importance of implementing ethnomathematics in education, particularly in efforts to preserve local culture and to strengthen understanding of mathematical concepts in more meaningful ways. This study also recommends using cultural objects, such as musical instruments. traditional in learning as a contextual medium to introduce the concepts of geometry and symmetry to students.

Corresponding Author:

Wahyu Setyo Utomo
Faculty of Teacher Training and Education, Muhammadiyah University of Bengkulu
Email: wahyuu075@gmail.com

1. INTRODUCTION

Education plays a strategic role in cultural preservation efforts, while culture itself is important to integrate into the learning process. One area of learning with great potential for developing culture-based learning is mathematics [1]. Mathematics learning in schools is still often perceived by students as abstract, difficult, and disconnected from real-life experiences. This condition leads to low learning motivation and superficial understanding of mathematical concepts, especially geometry, which is commonly taught through formulas without meaningful context [2]. One of the main problems in mathematics education is the limited use of contextual and culturally relevant learning resources that can bridge formal mathematical concepts with students' everyday experiences [3]. As a result, students tend to memorise procedures rather than understand concepts. Integrating cultural elements into mathematics instruction creates more engaging, meaningful, and context-rich learning experiences. Culture can serve as a learning resource for students, especially in mathematics education in schools, and it is hoped that it can encourage creativity and shape students' mindsets for understanding and solving problems [4]. One approach that connects education and culture, especially in mathematics learning, is ethnomathematics [5], [6].

One promising approach to addressing this problem is integrating culture into mathematics learning. Culture plays a strategic role in education, not only as a medium for preserving local heritage but also as a contextual learning resource that can make abstract concepts more meaningful [7]. Culture cannot be separated from a person's life in society, because culture is a system that regulates how humans behave in accordance with their environment [8]. Education is one aspect of life that cannot be separated from culture. Culture and education are two things that always go hand in hand and complement each other in everyday life [9]. One example of an education that cannot be separated is the concept of culture. Mathematics is inseparable from culture [10]. In cultural life, many mathematical values and elements are unconsciously embedded.

Mathematics is a form of culture and is well-connected or integrated with all aspects of human life in society everywhere. However, mathematics learning in schools is not directly related to real-life experiences or a student's life because it remains abstract. Mathematics learning also has an impact, providing a foundation that links mathematics to local culture and school activities. Therefore, integrating local culture intoathematics learning is essential to create contextual, relevant, and meaningful learning for students [11]. In this case, Ethnomathematics is present and plays a role in connecting the world of education and culture, particularly in the context of mathematics learning.

Furthermore, the field of ethnomathematics studies mathematics within the context of phenomenal culture [12]. Ethnomathematics is a mathematical method specifically designed for a particular society or community. It reflects their way of understanding and solving problems related to their environment, traditions, and daily needs [13]. However, ethnomathematics is not about a particular race or community; it is mathematics created by agricultural workers, social groups, students from certain sections, and others [14].

In recent decades, ethnomathematics has developed rapidly, with an increasing depth of research into the role of mathematics across cultures and societies [15]. Recent research shows that ethnomathematics not only improves mathematical understanding but also enhances creativity and critical thinking [16]. Ethnomathematics refers to the mathematical knowledge within a culture that a particular group uses. The ethnomathematics method in mathematics learning makes learning more meaningful [17]. Ethnomathematics aims to identify aspects of mathematics embedded in culture, using a different approach, and can introduce mathematical concepts to solve everyday problems [18]. Ethnomathematics comes from the words "ethno," which means "culture," and "mathematics." In other words, ethnomathematics is mathematics that exists in culture. Brazilian mathematician D'Ambrosio first used the term "ethnomathematics" In 1977. D'Ambrosio defined ethnomathematics as a field that connects mathematics with sociocultural contexts, encompassing elements such as language, symbols, and behavior within a society. This involves activities such as calculation, measurement, classification, and modeling that describe how individuals and groups understand and use mathematics in their everyday lives.

Ethnomathematics is part of realistic mathematics learning. In realistic learning activities, the presentation of mathematical problems is tied to the local culture of students' environments. Realistic learning has received widespread attention recently. One reason that can be put forward is that mathematics instruction in schools is too formal. So far, the problems students encounter in everyday life have been used only to apply concepts, not as a resource for students to discover solutions. new concepts based on the problems experienced. Therefore, if the development of ethnomathematics has been studied extensively, it is not impossible that mathematics can be taught optimally.

Bengkulu is a province rich in cultural diversity, including traditional musical instruments that have been preserved for generations [19]. Its distinctive cultural forms are incredibly diverse, spanning language, traditions, textiles, dances, musical instruments, cuisine, and more. These cultural forms indeed incorporate mathematical concepts, as mathematics originated within the culture that developed in society since the time of our ancestors. However, at that time, the community was unaware of the theories underlying the applied thematic patterns. One such instrument is the serunai, a tradition. These traditional musical instruments are characteristic of a region in Indonesia, and are well-maintained and preserved [20].

Based on these considerations, this study aims to explore the ethnomathematical concepts embedded in the traditional Bengkulu musical instrument Serunai, with a focus on geometric shapes and symmetry. Specifically, this research seeks to identify geometric concepts such as cylinders, truncated cones, and circles, as well as types of symmetry present in the Serunai, and to examine their relevance to junior.

The findings of this study are expected to contribute both theoretically and practically. Theoretically, this research enriches the body of knowledge on ethnomathematics by expanding its application to traditional musical instruments, particularly those from Bengkulu. Practically, the results are expected to provide mathematics teachers with alternative contextual learning resources that integrate local culture into classroom instruction. By utilizing cultural artifacts such as the Serunai, mathematics learning can become more meaningful, engaging, and relevant, while simultaneously supporting efforts to presser.

2. METHOD

This research uses a qualitative descriptive field research approach. using ethnographic methods to explore the ethnomathematical aspects of traditional Bengkulu musical instruments. Ethnography is the study of a group of people to describe their activities and social patterns [21]. One of the hallmarks of ethnography is its in-depth focus on complex social and cultural contexts [22].

This research was conducted at two locations: the Gentar Alam Art and Tradition Studio and the Serunai Drum Studio. The object of this study was the traditional Bengkulu musical instrument, the Serunai. The study employed various data collection techniques, including direct observation, in-depth interviews, field notes, and documentation, to obtain accurate and comprehensive data.

Observations were conducted by directly observing the shape and characteristics of the Serunai musical instrument. Furthermore, an interview was conducted with Mr. Roni Gentar Alam, a cultural expert with in-depth knowledge of the Serunai musical instrument, who is expected to provide comprehensive information about the relationship between the Serunai musical instrument and the Serunai musical instrument. Meanwhile, direct observations were conducted to examine the Serunai musical instrument. Interview data were transcribed, and observation data were documented in photographs. The interview transcripts and observation data were analyzed and elaborated to explain the mathematical concepts they contained.

The collected data was then analyzed using an ethnographic approach according to Spradley et al. [23] which consists of the stages of (1) determining informants, (2) conducting interviews with informants, (3) making ethnographic notes, (4) asking descriptive questions, (5) analyzing the results of ethnographic interviews, (6) making domain analysis, (7) asking structural questions, (8) conducting taxonomic analysis, and (9) writing ethnography.

3. RESULTS AND DISCUSSION

3.1. Results

According to an interview with the source, Mr. Roni, Serunai is a wind instrument commonly used in various traditional ceremonies. The Bengkulu Serunai has a distinctive, high-pitched sound and is often played to accompany traditional dances. The Serunai is not just a musical instrument, but also a symbol of pride for the people of Bengkulu. The Serunai has existed since the time of our ancestors. It bears silent witness to Bengkulu's history and culture. "We strive to preserve it so that it does not disappear over time." The Serunai is made from natural materials, including wood, bamboo, and coconut leaves. It is played alongside drums.

Figure 1. Serunai Musical Instrument

Researcher : Good afternoon, Sir. With permission, sir, I am researching ethnomathematics and would like to delve deeper into the traditional serunai musical instrument in Bengkulu. Can you explain the horn itself?

Respondent : Good afternoon. Of course, the Serunai is a traditional wind instrument commonly used in Bengkulu traditional ceremonies, such as the Tabot procession. It is elongated, like a trumpet, and made of wood or bamboo, with a widened end, usually made of metal or buffalo horn. The sound is loud and distinctive, used to accompany dances or religious ceremonies.

Researcher : Is the serunai only used in Bengkulu, Sir?

Respondent : The serunai is also known in other regions, such as the Minangkabau and Malay regions, but each region has its own distinct version. The Bengkulu serunai has its own distinctive sound and shape. Its construction, carving patterns, and playing style reflect the distinctive cultural characteristics of the Bengkulu people.

Researcher : So, what materials are used to make Bengkulu hornets?

Respondent : Serunai are generally made from hardwood or old bamboo, both of which are quite strong and durable. For the part of the funnel at the bottom end that widens the sound

Researcher : OK, thank you very much, sir. Your explanation really helped me understand the serunai from various aspects.

Respondent : You are welcome. I am happy if students want to learn about their own culture. I hope this information is helpful. This is useful.

Figure 2. Interview with Cultural Figures

Researcher : Good afternoon, sir. With permission, sir, I am researching ethnomathematics in traditional musical instruments, especially the Bengkulu Serunai. Previously, I had also interviewed Serunai. Can I ask a few more questions about this serunai, sir?

Respondent	:	Good afternoon. Please go ahead; I will do my best to help.
Researcher	:	According to you, what is the shape or structure of the Serunai musical instrument that you know? What was learned?
Respondent	:	The Serunai musical instrument generally consists of a main body, tone holes, and, sometimes, a decorative top. The shape is indeed attractive, giving the impression of symmetry and neatness.
Researcher	:	In terms of production or design, is there an element of order, sir?
Respondent	:	Yes, there is a certain pattern, especially in the position of the tone holes and the arrangement of the decorations, but that is all...
Researcher	:	Thank you very much for your time, sir.

Figure 3. Interview With Cultural Figures

Based on the results of visual observations and documentation of the Serunai musical instrument, several geometric and symmetrical concepts can be clearly identified :

a. Geometry

One branch of mathematics is geometry. Geometry comes from the Greek words geo, meaning earth, and metro, meaning to measure. Geometry is a branch of mathematics first introduced by Thales (624-547 BC), which concerns spatial relations.

There are several definitions of geometry; for example, Alders [23] states that geometry is a branch of mathematics that studies points, lines, planes, and spatial objects, along with their properties, measurements, and relationships with one another. Furthermore, Aulia (2007) states that geometry in the basic sense is a branch of science that studies the measurement of the earth and its projection in a two-dimensional plane, and Sondang (2007) states that geometry is one of the mathematical sciences applied in the world of architecture, it is also a branch of science related to form, composition, and proportion.

From the several definitions of geometry above, it can be concluded that geometry is a branch of mathematics that studies shapes, space, composition, and their properties, measurements, and relationships.

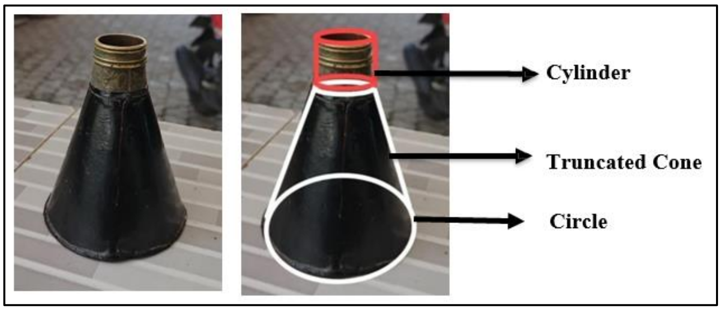

Figure 4. Geometry on the Serunai

1) Definition of a Cylinder

A cylinder is a form of space that we often encounter in everyday life. One of them is the traditional Serunai musical instrument. The tube has two caps at both ends and curved walls to form flat side surfaces. This tube consists of three main parts, namely the two caps at the ends and the curved side surfaces. The side surfaces of this tube are similar to its high, curved walls, along all sides.

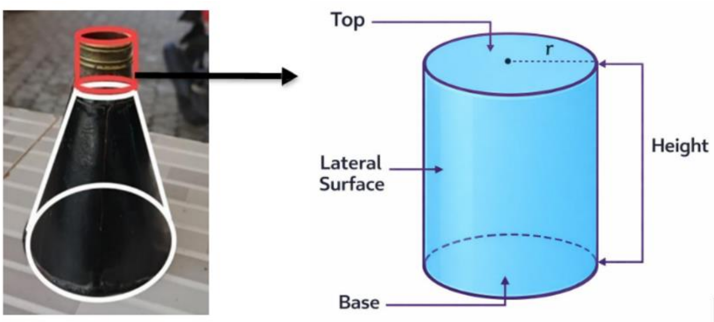

Figure 5. Cylinder

a. Cylinder volume

Formula : $V = \pi r^2 t$

where :

V = Tube Volume

π (phi) = 3.14 or 22/7 (depending on the quastion)

r = Radius of the base of the cylinder

t = Height of the cylinder

b. Formula for the total area of a cylinder

The total area of the cylinder = the area of the base + the area of the top + the surface area of the cylinder

$$\text{Total Area} = \pi r^2 + \pi r + 2\pi rt$$

$$\text{Total Area} = 2\pi r^2 + 2\pi rt$$

$$\text{Total Area} = 2\pi r\,(r + t)$$

c. Surface area of the cylinder

Surface area of a cylinder	=	area of a rectangle
	=	length x width
	=	circumference x height of cylinder
	=	2πrt

2) Truncated Cone

A truncated cone is a geometric shape that has a shape similar to a cone. Nevertheless, the top is cut off. Usually, truncated cones are used for several purposes, such as buildings, objects, and Serunai musical instruments that require top shape adjustments. In mathematics, the volume and surface area of a truncated cone can be calculated.

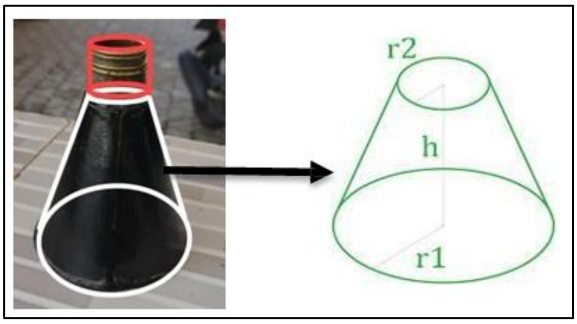

Figure 6. Truncated Cone

To calculate the volume of a truncated cone, some information is needed, such as the height of the truncated cone (h), the radius of the larger base circle of the truncated cone (r1), and the radius of the smaller base circle of the truncated cone (r2). The formula for calculating the volume of a truncated cone is:

$$V = \frac{1}{3} * \pi * h * (r_1^2 + r_2^2 + r_1 * r_2)$$

Meanwhile, to calculate the surface area of a truncated cone, the height of the truncated cone (h) is required. The radius of the base circle of the larger truncated cone (r1), and the radius of the base of the smaller truncated cone (r2). The formula for calculating the surface area of a truncated cone is:

$$L = \pi * (r_1 + r_2) * s$$

In the formula above, s is the painter's line, which can be calculated using the Pythagorean formula with the leg (a) and height (h) as input, namely:

$$s = \sqrt{a^2 + h^2}$$

3) Circle

A circle is the set of all points that are the same distance from its center. This center point is the center of the circle, and the distance from the center to the edge of the circle is called the radius.

A circle can also be defined as a flat shape in the form of a curve or curved line. The main elements of a circle include:

i. Center of circle: The center point of the circle, which is usually symbolized by the letter O.
ii. Radius: The distance from the center of the circle to the edge of the circle. Usually denoted by the letter r.
iii. Diameter: A straight line that passes through the center of a circle and has both ends on the edge of the circle. The length of the diameter is twice the length of the radius. The letter d often symbolizes diameter.

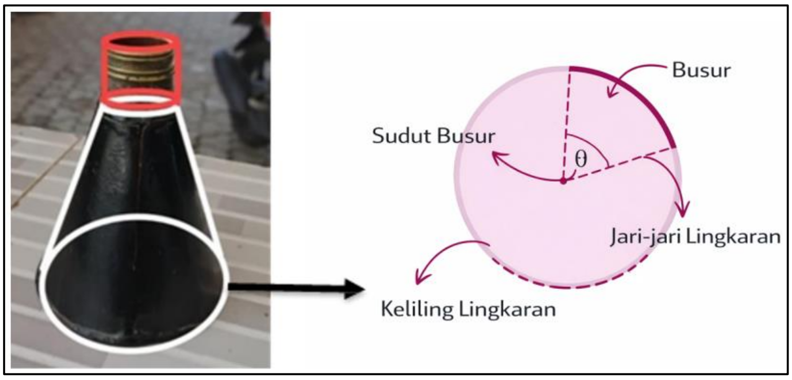

Figure 7. Circle

Several basic formulas are commonly used to calculate certain dimensions of a circle, namely:

i. Circumference of a Circle
The circumference of a circle can be calculated using the formula $K = 2\pi r$
Where :
r is the radius of the circle
π is a mathematical constant with a value of approximately 3,14
ii. Area of a circle.
The area of a circle can be calculated using the formula $L = \pi r^2$
Where :
L is the area of the circle
π = 3,14 or 22/7

4) Sphere
A sphere is a geometric figure formed by the set of all points equidistant from a fixed point called the center. Furthermore, a sphere is a geometric figure formed by circles of equal radius, all centered on a single point.

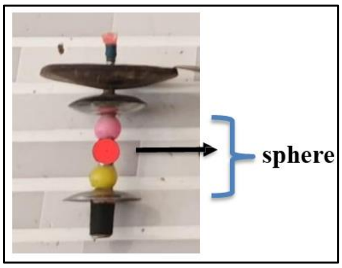

Figure 8. Sphere

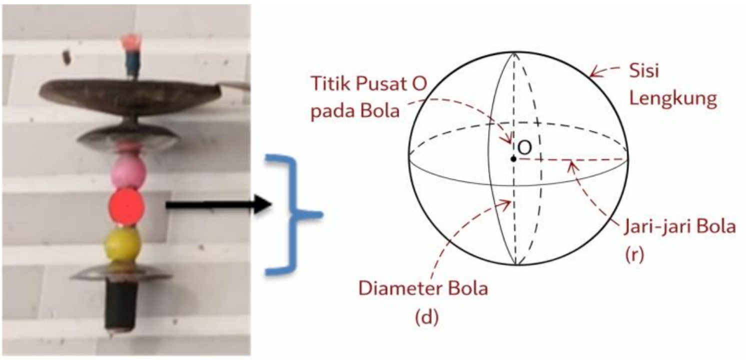

Figure 9. sphere and its parts

i. Formula for the circumference of a sphere
   The formula for the circumference of a ball is $\frac{4}{3} \times \pi \times r^2$
   Where
   $\pi = \frac{22}{7}$ or 3.14
   r = radius of the ball
ii. Formula for the volume of a sphere
   Volume of a sphere is $\frac{4}{3} \times \pi \times r^3$
   Where
   $\pi = \frac{22}{7}$ or 3.14
   r = radius of the ball
iii. Formula for the surface area of a sphere
   Surface area of a sphere is $4 \times \pi \times r^2$
   Where
   $\pi = \frac{22}{7}$ or 3.14
   r = radius of the ball

b. Symmetry: Funnel and Funnel Stem
   The funnel part is shaped like an open cone, while the horn stem is cylindrical with circular ornaments. If you draw a vertical line from top to bottom, the left and right shapes appear symmetrical, and when viewed from a field angle, the top and bottom of the horn will show balance when rotated.

Figure 10. Funnel and Funnel Stem

3.2. Discussion

Based on research conducted through direct observation, in-depth interviews with cultural experts, and visual documentation of the traditional musical instrument Serunai in Bengkulu, this instrument was found to have high aesthetic and cultural value and to contain mathematical elements, particularly in geometry and symmetry. The structure of the Serunai consists of several important parts, namely the sound funnel at the bottom, the main stem or elongated body of the serunai, the tone holes, and the decorative ornaments found on the top of the musical instrument. Each of these parts contains geometric shapes commonly found in mathematics learning at the junior high school level. The Serunai's mouthpiece is shaped like a truncated cone, a geometric shape formed by cutting a cone parallel to its base. This shape visually and mathematically shows the characteristics of symmetry and regularity. The main stem of the serunai resembles a tube or cylinder, with a curved surface of constant diameter, making it amenable to analysis using spatial geometry. The tone holes on the Serunai are arranged regularly and are small, circular, with symmetrical spacing. Apart from that, the decoration or ornamentation on the surface of Serunai also features repetitive patterns and rotational symmetry, which strengthen the concept of symmetry in this cultural object. In terms of symmetry, two types of symmetry are clearly identified. First, vertical symmetry is seen in the mouthpiece of the Serunai. If a vertical line is drawn from top to bottom right through the center of the instrument, the left and right sides appear similar or symmetrical. Second, rotational symmetry is evident in the main stem of the Serunai, where its circular, long shape shows balance when rotated around a central axis. Even in some circular ornaments, rotational symmetry is evident, reflecting both visual and mathematical regularity. Overall, this research proves that the Serunai serves not only as a tool.

The Serunai is not only a traditional musical instrument, but also a cultural object with high educational value in the context of mathematics learning. Geometric concepts such as cylinders, truncated cones, and circles, as well as symmetry concepts such as vertical reflection and rotational symmetry, can be identified and analyzed concretely through the physical form of the Serunai. This research opens up opportunities for teachers to integrate local cultural heritage into the mathematics learning process, making learning more contextual, enjoyable, and meaningful for students.

4. CONCLUSION

This study concludes that the traditional musical instrument *Serunai* from Bengkulu embodies rich mathematical concepts that can be meaningfully interpreted through an ethnomathematical perspective. The analysis reveals that geometric forms and symmetry principles embedded in the physical structure of the Serunai reflect the close relationship between local culture and mathematical ideas. These findings reinforce the view that mathematics is not only an abstract discipline but is also deeply rooted in cultural practices and traditional artifacts. The implications of this research are significant for mathematics education, particularly in supporting culturally responsive teaching. Integrating ethnomathematical objects such as the Serunai into classroom instruction can help bridge formal mathematical concepts with students' cultural backgrounds, thereby enhancing conceptual understanding, learning motivation, and appreciation of local cultural heritage. This approach also encourages teachers to explore alternative learning resources beyond conventional textbooks.

However, this research has certain boundaries. The study focuses solely on the Serunai as a cultural artifact and emphasizes qualitative analysis of geometric and symmetry concepts. It does not examine the effectiveness of implementing these findings directly in classroom learning nor measure students' learning outcomes. In addition, the scope is limited to one traditional musical instrument from a specific regional culture, which may not fully represent other cultural contexts. Future research is recommended to extend this study by developing ethnomathematics-based learning materials derived from the Serunai and testing their impact on students' mathematical abilities, including critical thinking, creativity, and spatial reasoning. Further studies may also explore other traditional musical instruments or cultural artifacts from different regions to enrich the body of ethnomathematics research. This research contributes to the general public by promoting awareness of the educational value of local cultural heritage and encouraging its preservation through meaningful integration into formal education.

REFERENCES

[1] J. Intersections *et al.*, "Peran etnomatematika dalam konsep dasar pembelajaran matematika," vol. 7, no. 2, 2022.

[2] A. Asmara, "Students' Mathematical Literacy Ability at Application of Besurek Learning Model," *International Journal of Multicultural and Multireligious Understanding*, vol. 9, no. 8, pp. 394–399, 2022.

[3] E. A. Sigit and M. Syofiana, "Exploration Of Mathematical Concepts In Kite," vol. 9, no. May, pp. 403–416, 2024.

[4] R. Marlina, "Eksplorasi Etnomatematika Pada Monumen Tugu Kebulatan Tekad," vol. 6, pp. 76–84, 2017.

[5] A. N. Z. I. Zulviansyach, F. K. Risaldi, S. Hartini, and M. Rachmaniah, "Slingshot : Between Traditional Games and Learning Mathematics," vol. 2, no. 1, pp. 75–88, 2023.

[6] F. Susanty, "Peningkatan Kemampuan Membaca Dan Memahami Teks Bahasa Inggris Melalui Teknik Skimming-Scanning Pada Mahasiswa Stit Ru Semester Ii 2017/2018," *Raudhah Proud To Be*

Professionals : Jurnal Tarbiyah Islamiyah, vol. 4, no. 1, pp. 43–54, 2019, doi: 10.48094/raudhah.v4i1.41.

[7] Abdul Wahad Syakhrani and Muhammad Luthfi Kamil, "Budaya Dan Kebudayaan: Tinjauan Dari Berbagai Pakar, Wujud-Wujud Kebudayaan, 7 Unsur Kebudayaan Yang Bersifat Universal," *Journal form of Culture*, vol. 5, no. 1, pp. 1–10, 2022.

[8] S. Sumarto, "Budaya, Pemahaman dan Penerapannya," *Jurnal Literasiologi*, vol. 1, no. 2, p. 16, 2019, doi: 10.47783/literasiologi.v1i2.49.

[9] K. K. M Mahmud, HS Siregar, "Budaya, Pendidikan Lingkungan Sosial," *digilib.uinsgd.ac.id*, 2015.

[10] A. Amirah and M. T. Budiarto, "Etnomatematika : Konsep Matematika pada Budaya Sidoarjo," *MATHEdunesa*, vol. 11, no. 1, pp. 311–319, 2022, doi: 10.26740/mathedunesa.v11n1.p311-319.

[11] M. U. Jemamun, I. K. S. Karlina, and W. S. Dominikus, "Etnomatematika pada Tarian Tradisional Nusantara dan Perannya dalam Pembelajaran Matematika," *Prosiding Santika 3: Seminar Nasional Tadris Matematika UIN K.H. Abdurrahman Wahid Pekalongan*, pp. 529–542, 2023.

[12] D. Y. Aditya, "Eksplorasi Unsur Matematika dalam Kebudayaan Masyarakat Jawa," *Formatif: Jurnal Ilmiah Pendidikan MIPA*, vol. 7, no. 3, pp. 253–261, 2018, doi: 10.30998/formatif.v7i3.2236.

[13] S. A. Harahap and F. Rakhmawati, "Etnomatematika dalam Proses Pembuatan Tempe," *Jurnal Cendekia : Jurnal Pendidikan Matematika*, vol. 6, no. 2, pp. 1291–1300, 2022, doi: 10.31004/cendekia.v6i2.1354.

[14] A. M. Abi, "Integrasi Etnomatematika Dalam Kurikulum Matematika Sekolah," *JPMI (Jurnal Pendidikan Matematika Indonesia)*, vol. 1, no. 1, p. 1, 2017, doi: 10.26737/jpmi.v1i1.75.

[15] N. T. Huda, "Etnomatematika Pada Bentuk Jajanan Pasar di Daerah Istimewa Yogyakarta," *NPM (Jurnal Nasional Pendidikan Matematika)*, vol. 2(2), no. 217, 2018.

[16] E. Journal and L. Mauluah, "Studying Mathematics Around Keraton," vol. 3, no. 1, pp. 11–18, 2022.

[17] L. Hidayah and H. Husnial Pardi, "Studi Etnomatematika: Konstruksi Bangun Ruang Sisi Lengkung Pada Pembuatan Gerabah Di Desa Banyumulek," *Journal of Math Tadris*, vol. 2, no. 1, pp. 58–79, 2022, doi: 10.55099/jurmat.v2i1.59.

[18] D. Suparno, Geri.A, "Mempertahankan Eksistensi Budaya Lokal Nusantara Ditengah Arus Globalisasi Melalui Pelestarian Tradisi Gawai Dayak Sintang," *Pendidikan Kewarganegaraan*, vol. 3, no. 1, pp. 43–56, 2018.

[19] Syaldanis and Agung Kharisma, "Pengenalan Alat Musik Tradisional Bengkulu Menggunakan Augmented Reality," *Jurnal Processor*, vol. 15, no. 2, pp. 127–134, 2020, doi: 10.33998/processor.2020.15.2.875.

[20] W. et. al Widada, "'Augmented Reality Assisted by GeoGebra 3 - D for geometry learning,'" *in Journal of Physics: Conference Series . IOP Publishing, pp.*, pp. 120–134, 2018.

[21] Y. Yusanto, "Ragam Pendekatan Penelitian Kualitatif," *Journal of Scientific Communication (Jsc)*, vol. 1, no. 1, pp. 1–13, 2020, doi: 10.31506/jsc.v1i1.7764.

[22] A. Asmara, W. Ramadiandi, R. Jumri, Ristontowi, and Masri, "Improving the Quality of Mathematics Education Through Innovative Approaches : a Literature Review," *International Journal of Teaching and Learning (INJOTEL)*, vol. 2, no. 1, pp. 282–296, 2024.

[23] A. McCurdy, David W. Shandy, Dianna J. Spradley, *The cultural experience : ethnography in complex society*. Illinois: Waveland Press, INc, 1988.