AL JABAR
Jurnal Pendidikan dan Pembelajaran Matematika
E-ISSN: 2828-6731
P-ISSN: 2828-5573
Sekolah Tinggi Agama Islam Muhammadiyah Probolinggo

COMPARATIVE STUDY OF ETHNOMATHEMATICS LITERATURE ON WEST JAVANESE ANGKLUNG: CONSISTENCY OF THE RELATIONSHIP BETWEEN GEOMETRIC FORM AND ITS INFLUENCE ON SOUND PRODUCTION

***Malika Hasana Sausan[1], Nurlela[2], Rifa Nailah Yusriani[3], Wahyunengsih[4]**
[1,2,3,4]Program Studi Matematika, Universitas Islam Negeri Syarif Hidayatullah Jakarta
[*]Email correspondence: malikasausan08@gmail.com

Article History:		
Submitted: 29 Mei 2025	Accepted: 05 Juni 2025	Published: 02 Juli 2025

Abstract
Ethnomathematics is the study of the relationship between mathematical concepts and culture. This research aims to compare findings regarding the geometric forms of West Javanese Angklung and the sound they produce when played, drawing from three previous studies. Specifically, this study investigates the consistency of the relationship between geometric forms and the resulting sound characteristics based on data presented in the studies above. The researcher uses a document analysis method to review and compare data and information related to the geometric forms of West Javanese Angklung and their sound. The research showed that the angklung's length and diameter greatly affect the sound produced when played.
Keywords: ethnomathematics, angklung, geometric forms, sound characteristics

INTRODUCTION

Although mathematics is not merely theoretical and is truly integrated into various cultural practices and daily life, this connection is often overlooked. Many people perceive mathematics as a complex subject with little direct relevance to practical life (Serin, 2023). The relationship between mathematics, culture, and everyday life can be understood more deeply through an approach, namely ethnomathematics (Mollah & Kanu, 2024).

The Ethnomathematics approach makes local culture an essential basis for understanding and developing a more contextual and meaningful perspective on mathematics. D'Ambrosio (1985) states that mathematics exists in all cultures as part of how people solve problems and structure their living spaces. He also pointed out that the ethnomathematics perspective views mathematics as more than abstract concepts but an expression of a society's cultural values, traditions, and cognitive frameworks embedded in everyday life.

Through the ethnomathematics approach, understanding the application of mathematical concepts in people's cultural settings can be expanded in greater depth. It emphasizes that mathematics is not universal but varies depending on cultural backgrounds, reflecting unique ways communities interpret and engage with mathematical ideas (Manolino, 2024). This approach also opens opportunities to explore cultural objects as an authentic source of mathematical understanding (Purnamayanti, 2024). In conclusion, ethnomathematics places local culture as an essential foundation in understanding and developing a more contextual and meaningful perspective on mathematics.

Ethnomathematics has many applications in cultural life, one of which is in traditional musical instruments. A concrete example of this integration can be found in angklung, a traditional Indonesian musical instrument, which is one of the valuable resources for exploring ethnomathematical concepts (Astria & Kusno, 2023). Angklung applies mathematical principles through its tonal patterns, rhythms, and the geometric structure of its bamboo tubes (Nursanti et al., 2024). The geometric shape of angklung has aesthetic value and fundamentally affects the sound characteristics it produces (Rahmat et al., 2024). Therefore, angklung functions as a musical instrument and represents the close relationship between culture and mathematical concepts reflected in its shape and sound.

To deepen this analysis, particularly regarding how the geometric structure influences sound, an acoustic approach is also needed to support the ethnomathematical exploration. Chaigne and Kergomard (2016) explain that the geometric dimensions of a musical instrument, such as length, diameter, shape, and resonator configuration, directly affect the instrument's frequency spectrum and resonance behavior. They also explained that resonance plays a vital role in determining the pitch, intensity, and timbre of the sound produced. In the context of the angklung, geometric variations in the bamboo tube affect the acoustic characteristics that emerge, including the pitch. Therefore, this theory is the basis for analyzing the relationship between the geometric shape of the angklung and the sound it produces from an ethnomathematics perspective.

As a representation of local culture, Angklung holds ethnomathematical potential that has yet to be fully revealed through in-depth studies. Previous research shows that angklung contains mathematical elements such as pattern, sequence, ratio, symmetry, and geometric structure that can enrich contextual learning and increase understanding of local culture (Kristyasari & Sukoco, 2022). Meanwhile, Apriliana et al. (2023) identified that angklung reflects the concept of two-dimensional geometry, such as circles and rectangles, three-dimensional shapes, such as tubes, and number patterns associated with tones. However, these studies have not comprehensively analyzed the consistency of the

relationship between the geometric shape of angklung and the sound characteristics it produces, especially in the typical angklung of West Java. Indeed, the form and sound of angklung are two main elements that cannot be separated in understanding this musical instrument's cultural involvement and function. The limited number of comparative studies examining the consistency of this relationship from various literature sources indicates the need for further research.

This research examines how consistently the angklung's geometric shape relates to its sound characteristics through a comparative analysis of relevant literature. The primary focus is on the West Javanese angklung as an object of ethnomathematical study to explore how the geometric shape of the instrument contributes to its distinctive acoustic aspects. In addition, this research is also intended to fill the gap of studies that have not yet systematically reviewed the relationship between shape and sound from a cultural perspective.

This research is expected to contribute to expanding the insights of ethnomathematics studies by revealing the consistency of the relationship between geometric aspects and the sound produced on angklung instruments, especially the types of angklung that developed in West Java. Applicatively, the findings of this research can be helpful as a basis for developing cross-cutting studies between mathematics and culture, as well as being an inspiration in preparing learning materials that are contextual and rooted in local culture. This research also has the potential to support the preservation of angklung through an integrative and relevant scientific approach.

METHOD

The research method employed in this journal is document analysis. Researchers conduct document analysis by identifying various scientific sources from credible academic databases as the first step in collecting information. This characteristic makes it an essential approach to obtaining real information systematically and objectively (Kutsyuruba, 2023). Researchers choose this research method because they obtain study data by analyzing written documents such as articles, books, and scientific works. The articles obtained need to meet the benchmarks of relevance regarding the topic and excellence of the journal.

This research was conducted using data sources from Google Scholar. Pérez (2023) states that Google Scholar is a tool widely used by researchers to access various scientific articles from multiple disciplines. The articles available on this service have passed selection and are recognized by reputable journals so that researchers can find credible references (Balqis et al., 2023). To obtain relevant articles, researchers used Ethnomathematics of Angklung Musical Instruments as the keyword. The selected

articles were published from 2020 to 2025, specifically discussing the ethnomathematics of geometric shapes on West Java Angklung. After searching documents on Google Scholar, 3 Indonesian-language articles were obtained that met these criteria, namely articles entitled *Etnomatematika pada bentuk alat musik tradisional angklung* by Yusi, Maya and Rahmatullah (2023), *Eksplorasi etnomatematika pada alat musik angklung dalam pembelajaran matematika* by Fika, Nurul, Milah, Eka, and Miftakhur (2022), and *Mengetahui etnomatematika melalui angklung: Harmoni matematika dalam tradisi musik sunda* by Zulha (2024).

A systematic process guided the research steps. The steps include (1) Identification: identifying and selecting relevant documents after searching on Google Scholar using the specified keywords. (2) Making Research Instruments: The researcher compiled an analysis table containing several questions. The questions were used as indicators that refer to the theory of Ubiratan D'Ambrosio, Robert Ascher, Marcia, Milton Rossa, Daniel Clark Orey, Roshni Vithal, and Ole Skovsmose, experts in ethnomathematics, especially in traditional cultures. (3) Screening: The researcher checks and ensures that each document meets the existing indicators. Articles that meet the indicators will be given a check mark to show that the article can be analyzed further. (4) Analysis: In the last step, the content of the articles was analyzed to obtain information related to the research objectives. After analysis, the articles were compared using the research indicators to ensure whether the data obtained supported or stated the hypothesis. Through these steps, the selected articles can obtain comprehensive data on the ethnomathematics of geometric shapes in West Java angklung to support the achievement of research objectives in a structured and objective manner.

RESULTS AND DISCUSSION

This study analyzes the relationship between ethnomathematics and the traditional musical instrument angklung based on three relevant scientific articles. The results are presented in Table 1.

Table 1. Analysis Results

No.	Observed Aspects	ARTICLE		
		(1) Etnomatematika pada Bentuk Alat Musik Tradisional Angklung	***(2) Eksplorasi Etnomatematika pada Alat Musik Angklung dalam Pembelajaran Matematika***	***(3) Mengenal Etnomatematika Melalui Angklung: Harmoni Matematika dalam Tradisi Musik Sunda***

1.	Relationship between tone interval pattern and bamboo length	It is mentioned that the length of the bamboo affects the tone produced.	It is mentioned that the tone produced on the angklung is closely related to the length of the bamboo tubes.	It is mentioned that each bamboo tube on the angklung is cut in a particular proportion. The longer the bamboo tube, the lower the pitch, and vice versa.
2.	The relationship between the length or size of bamboo and the sound frequency.	It is mentioned that the larger the tube, the lower the pitch. Vice versa, the smaller the tube, the louder and higher the tone.	It is mentioned that angklung produces different sounds depending on the length or height of the angklung, the length or height of the resonance tube, and the diameter of the bamboo.	It is mentioned that the length and diameter of the tube determine the frequency of the sound produced, which is an application of the physical principle of resonance.
3.	Alignment of angklung physical geometry and sound quality or frequency.	It is mentioned that the sora tube (the central resonator part) is shaped like a cylindrical tube. The volume and diameter of the tube affect the frequency/tone: the larger the tube, the lower the pitch; the smaller, the higher.	It is mentioned that the shape of the tube resembles a one-sided open cylindrical tube, producing specific sound waves. The tube's length and diameter influence the sound frequency.	It is mentioned that the longer the tube, the lower the pitch. The geometric arrangement of angklung plays a role in tonal harmony.
4.	The shape of the bamboo is used mathematically to generate sound patterns.	Not found.	It is mentioned that the size of the bamboo blade indicates a graded arithmetic pattern. The longer the blade, the lower the pitch.	It is mentioned that measuring the length and diameter using specific proportions shows the application of mathematical concepts.

This study begins with the hypothesis that the traditional musical instrument angklung incorporates mathematical principles that can be interpreted through the lens of ethnomathematics. Analysis of the three scientific articles supports this finding, revealing

a consistent correlation between the physical characteristics of the angklung, particularly the length and diameter of the bamboo tube, and the sounds it produces. Proportions and the principle of resonance have long been applied in making angklung, as shown by the tones produced following a specific pattern. Such integration of mathematical logic into cultural artefacts exemplifies how mathematics can be practised and preserved through artistic and musical traditions.

All three articles consistently emphasize this relationship. Article 1 focuses on the frequency of sound as a function of the size of the bamboo tube, which is in line with the theory of resonance. Article 2 explains how the angklung tube functions like an open cylindrical resonator, producing natural air vibrations. Article 3 emphasizes the length of the tube in determining the order of notes to create harmonious music. These three findings are validated by a mathematical model that incorporates the tube's physical and geometric characteristics, including its length, outer and inner diameters, and bamboo wall thickness, which shows that the length and diameter of the tube have a significant effect on the frequency of the tone, the resulting frequency being inversely proportional to the length of the tube (Arifin & Pribadi, 2019).

Regarding explicit mathematical application, only articles 2 and 3 discuss using number patterns and proportions in angklung design. Article 2 explains that the size of the bamboo blades is arranged in a tiered arithmetic pattern, where the longer the blade, the lower the tone produced, indicating the use of number patterns in the angklung-making process. Article 3 adds that the length and diameter of the bamboo tubes are measured using specific proportions to produce certain tones consistently. However, article 1 does not directly mention mathematical calculations in shaping the bamboo, although it discusses geometric forms and their acoustic outcomes. This consistent use of proportional measurements suggests that angklung artisans have applied the concept of mathematical proportionality across generations, even though it is not always formalized within academic mathematics.

The content analysis supports the idea that angklung's sound production is a product of intentional geometric design, where specific tube measurements are central to its resonant behaviour. This shows that the size of the tube, such as length and diameter, plays a direct role in producing the sound of the angklung, and this reflects the existence of a consistent design pattern in traditional manufacturing. Therefore, the physical form of the bamboo tube can be explained systematically through the principles of resonance and regular geometric patterns. This explanation illustrates the application of scientific concepts in mathematics and physics internalized in the traditional process. Thus, it can be concluded that the relationship between geometric shapes and angklung sounds is a systematic and consistent pattern that can be explained scientifically.

Ethnomathematics theory offers a valuable interpretive framework for this phenomenon. D'Ambrosio (1985) defines ethnomathematics as culturally situated ways of understanding and organizing knowledge. According to Ascher and Ascher (1997), cultural artefacts' patterns, ratios, and symmetries represent mathematical reasoning in everyday contexts. Practices like angklung making can be considered contextual mathematical modelling, grounded in cultural interaction and local knowledge (Rosa & Orey, 2013). Furthermore, Vithal and Skovsmose (1997) caution that identifying cultural mathematics requires careful interpretation, and not all mathematical forms are explicit.

While this theoretical lens enhances the understanding of how mathematics is embedded in cultural practices, this study's findings are constrained by the absence of direct engagement with angklung artisans. Without observational or participatory methods, whether the identified mathematical patterns are applied consciously or are embedded tacitly through cultural transmission remains unclear. Future research should incorporate ethnographic approaches to better understand how instrument makers practice traditional knowledge.

CONCLUSION

Based on the research that has been done, it is evident that math is not just a numbers game but contains a deeper meaning than that. However, it also has a connection with the culture of society. Many mathematical concepts are included within the local culture, one of which is found in the traditional musical instrument Angklung. The analysis of three articles shows a consistent relationship between the physical dimensions of the angklung and the notes produced. The longer and larger the diameter of the tube, the lower the note produced, and vice versa. The notes and the length and diameter of the angklung tube can influence the frequency of the sound produced by the angklung.

This research shows that mathematical elements naturally exist in cultural products. Based on this, this research only focuses on the ethnomathematics of geometric shapes in traditional West Javanese angklung. For further research development, exploring the ethnomathematics aspects of geometric shapes in traditional Angklung from other regions in Indonesia is recommended. Such research can show how mathematics is present in everyday life, particularly in cultural contexts.

REFERENCES

Apriliana, Y. N., Nurfitriyanti, M., & Rahmatullah. (2023). Etnomatematika pada Bentuk Alat Musik Tradisional Angklung. In *Original Research*.

Arifin, P., & Pribadi, I. (2019). Modeling of angklung to determine its pitch frequency. *Acoustical Science and Technology*, *40*(3), 178–185. https://doi.org/https://doi.org/10.1250/ast.40.178

Ascher, M., & Ascher, R. (1997). Ethnomathematics. In A. B. Powell & M. Frankenstein (Eds.). In *Ethnomathematics: Challenging Eurocentrism in Mathematics Education* (pp. 25–50). State University of New York Press.

Astria, R. T., & Kusno. (2023). Eksplorasi Etnomatematika pada Alat Musik Tradisional. *Plusminus: Jurnal Pendidikan Matematika*, *3*(2), 171–182. https://doi.org/10.31980/plusminus.v3i2.1334

Balqis, A. R., Siregar, A. H., Fridalisa, A., & Maulana, M. F. (2023). Pemanfaatan Google Scholar Dalam Pencarian Informasi. *El-Mujtama: Jurnal Pengabdian Masyarakat*, *3*(3), 753–759. https://doi.org/10.47467/elmujtama.v3i3.2933

Chaigne, A., & Kergomard, J. (2016). *Acoustics of Musical Instruments*. Springer New York. https://doi.org/10.1007/978-1-4939-3679-3

D'Ambrosio, U. (1985). Ethnomathematics and its place in the history and pedagogy of mathematics. *For the Learning of Mathematics, 5(1), 44–48.*

Purnamayanti, E. (2024). MATEMATIKA DAN PEPUTIQ CINA SEBAGAI ADAT PERNIKAHAN SUKU MANDAR. *MEGA: Jurnal Pendidikan Matematika*, *5*(1), 672–683. https://doi.org/10.59098/mega.v5i1.1379

Pérez, Álvaro. M. F. (2023). Google Académico: el buscador especializado para la ayuda a la investigación. *Hospital a Domicilio*, *7*(1), 31–43. https://doi.org/10.22585/hospdomic.v7i1.188

Kristyasari, Y. S., & Sukoco, H. (2022). Ethnomathematics in ten Indonesian traditional musical instruments. *Ethnomathematics Journal*, *3*(2), 62–73. https://doi.org/10.21831/ej.v3i2.53151

Kutsyuruba, B. (2023). *Document Analysis Document Analysis. Dalam J. M. Okoko, S. Tunison, & K. D. Walker (Eds.)* (pp. 139–146). https://doi.org/10.1007/978-3-031-04394-9_23

Manolino, C. (2024). Cultural semiotics for mathematical discourses. *Semiotica*, *2024*(259), 61–77. https://doi.org/10.1515/sem-2023-0030

Mollah, A. T., & Kanu, A. R. (2024). Folk Mathematics in Everyday Life. *International Journal for Multidimensional Research Perspectives*, *2*(9), 19–26. https://doi.org/10.61877/ijmrp.v2i9.187

Nursanti, Y. B., Cahyani, R. A., Regita, A. S., Ramadhani, N. D., Fikriyani, F. F., & Saputra, R. Y. (2024). Systematic Literature Review: Implementasi Etnomatematika pada Alat Musik Angklung untuk Penanaman Konsep Geometri

dan Pola Bilangan. *Jurnal Cendekia : Jurnal Pendidikan Matematika*, *8*(2), 1173–1184. https://doi.org/10.31004/cendekia.v8i2.3169

Rahmat, A. D., Kuswanto, H., & Wilujeng, I. (2024). Integrating local culture and science: Exploring physics concepts through Angklung craftsmanship. *Journal of Physics: Conference Series*, *2900*(1), 012019. https://doi.org/10.1088/1742-6596/2900/1/012019

Rosa, M., & Orey, D. C. (2013). Ethnomodeling as a research lens on ethnomathematics and culture. In M. Rosa & D. C. Orey (Eds.). In *Ethnomathematics and its diverse approaches for mathematics education* (pp. 1–17). Springer.

Serin, H. (2023). The Significance of Mathematical Literacy in Today's Society. *International Journal of Social Sciences & Educational Studies*, *10*(2). https://doi.org/10.23918/ijsses.v10i2p396

Vithal, R., & Skovsmose, O. (1997). The end of innocence: A critique of "ethnomathematics." *Educational Studies in Mathematics*, *34*(2), 131–157. https://doi.org/10.1023/A:1002971922833