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# The GeoGebra-Aided Visualization of Geometric Concepts in Bugisnese Traditional Musical Instruments *Gendrang* and *Pui-pui*

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**Abstract.** This study lies in the need to bridge school mathematics with local cultural heritage by emphasizing the relevance of the ethnomathematics framework in promoting contextual learning. Traditional musical instruments, such as *Gendrang* (Bugisnese drums) and *Pui-pui* (Bugisnese flutes), serve as cultural artifacts that can be explored through the lens of three-dimensional geometry. However, the integration of these cultural elements into mathematics education remains underexplored. This research aims to identify and model geometric concepts embedded in the two Bugisnese traditional musical instruments using GeoGebra as a visualization tool. Employing a qualitative ethnographic approach, data were collected through observation, interviews, and documentation. The analysis involved identifying geometric shapes in the instruments and constructing mathematical models in GeoGebra. Findings reveal that *Gendrang* corresponds to a cylindrical shape, while *Pui-pui* resembles a conical shape. The volumes of both instruments were calculated using the concept of solids of revolution, and visualized interactively. The study concludes that the exploration of ethnomathematics through Bugisnese traditional musical instruments, supported by dynamic visualization in GeoGebra, enhances students' understanding of three-dimensional geometry, fosters cultural appreciation, and reinforces the contextual relevance of mathematics in local traditions.

**Keywords**: Bugisnese Culture; Ethnomathematics; GeoGebra; Geometry; Traditional Musical Instruments

**Abstrak.** Studi ini dilandasi oleh kebutuhan untuk menjembatani matematika sekolah dengan warisan budaya lokal dengan menekankan relevansi kerangka etnomatematika dalam mempromosikan pembelajaran kontekstual. Alat musik tradisional, seperti *Gendrang* (gendang suku Bugis) dan *Pui-pui* (suling suku Bugis), berfungsi sebagai artefak budaya yang dapat dieksplorasi melalui konteks geometri tiga dimensi. Namun, integrasi elemen budaya tersebut ke dalam pendidikan matematika masih kurang dieksplorasi. Penelitian ini bertujuan untuk mengidentifikasi dan memodelkan konsep-konsep geometri yang tertanam dalam dua alat musik tradisional suku Bugis tersebut menggunakan GeoGebra sebagai alat visualisasi. Dengan menggunakan pendekatan etnografi kualitatif, data dikumpulkan melalui observasi, wawancara, dan dokumentasi. Analisis data melibatkan identifikasi bentuk-bentuk geometris dalam alat musik tradisional dan memodelkannya di GeoGebra. Temuan penelitian mengungkapkan bahwa *Gendrang* sesuai dengan bentuk silinder, sementara *Pui-pui* menyerupai kerucut. Volume kedua instrumen tersebut dihitung menggunakan konsep padatan revolusi, dan divisualisasikan secara interaktif. Penelitian ini menyimpulkan bahwa eksplorasi etnomatematika melalui alat musik tradisional Bugis, didukung oleh visualisasi dinamis dalam GeoGebra, meningkatkan pemahaman siswa terhadap geometri tiga dimensi, menumbuhkan apresiasi budaya, dan memperkuat relevansi kontekstual matematika dalam tradisi lokal.

**Kata kunci**: Alat Musik Tradisional; Budaya Bugis; Etnomatematika; GeoGebra; Geometri



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## INTRODUCTION

Mathematics is a branch of science that has developed from human ideas, methods, and techniques in addressing problems or phenomena encountered in everyday life (Tampubolon et al., 2019). These various concepts, methods, and techniques are part of human activities that reflect their culture (Risdiyanti & Prahmana, 2020). As expressed by Freudenthal (2005), mathematics is a human activity, and mathematics education in schools should connect theoretical concepts with the realities surrounding students. However, mathematics is often perceived as a discipline detached from students' everyday lives, seen as abstract and irrelevant to their real-world experiences (Harahap, 2022; Septiani, 2024). This perception arises because mathematics education in schools frequently fails to relate to students' cultures and daily activities directly. This disconnect leads to several negative impacts, such as students' lack of understanding of the practical applications of mathematics in their lives, anxiety when learning mathematics, and the belief that mathematics is unimportant and irrelevant (Cholily et al., 2024).

One approach that can be used to bridge school mathematics with students' culture and everyday activities is ethnomathematics, which refers to the study of mathematical ideas, methods, and techniques that are possessed and utilized by a cultural community in addressing real-life situations (D'Ambrosio, 1985). This approach allows students to connect mathematical concepts more easily with real-life experiences (Fatimah et al., 2024). Ethnomathematics will enable students to understand that the mathematical concepts they learn in school are part of the cultural heritage passed down by their ancestors and part of their daily social and cultural lives (Kholisa, 2021; Kou & Deda, 2020). This makes mathematical concepts more relevant and easier to comprehend, relating to familiar elements and practices in students' everyday lives.

One culture rich in artistic and technological heritage is the Bugisnese culture, one of the ethnic groups in South Sulawesi, Indonesia (Rahmatiar et al., 2021). The Bugisnese possess various traditional musical instruments imbued with cultural values and mathematical concepts, particularly in geometry. Traditional musical instruments, such as *Sasak Gendrang* (Novitasari et al., 2022), *Batak Toba flute* (Simanjuntak, 2022), and *Burdah Gendrang* (Nasution & Yahfizham, 2023), not only serve as tools for creating music but also embody mathematical concepts closely related to geometry, such as symmetrical shapes, proportions, and the relationship between sound and frequency. Previous studies have shown that traditional musical instruments from various cultures, including the Bugisnese, contain numerous mathematical concepts, especially in geometry. Research such as that conducted by Rosmiati et al. (2024) highlights that traditional musical instruments worldwide incorporate mathematical concepts closely linked to geometry, symmetry patterns, and proportions. However, the exploration of ethnomathematics in Bugisnese

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traditional musical instruments remains limited despite their immense potential as a context for mathematics learning, particularly in teaching geometric concepts.

The results of observations made on one of the Bugisnese traditional musical instrument players and makers revealed that conventional musical instruments are increasingly less popular with the younger generation, with only a handful of people still learning or playing them. This is reflected in the use of musical instruments such as drums, lutes and flutes, which were previously often used in various traditional and traditional events but are now rarely found in society. The musical instrument maker also said that although conventional Bugisnese musical instruments have cultural value and rich geometric shapes, interest in learning them is decreasing. This condition shows the importance of efforts to revive the existence of traditional musical instruments through a more relevant approach, such as integrating them with geometry learning in mathematics education, to provide added value and increase appreciation of local cultural heritage.

Traditional musical instruments have many elements that can be used to teach geometric concepts to students. Research has found geometric concepts in various instruments, including Toba Batak traditional instruments (Sitanggang, 2021), *Tihar* music from Belu (Bitin et al., 2023), Reyog Ponorogo *gamelan* (Damaningrum & Budiarto, 2021), Sulim flute (Simanjuntak, 2022), *Gendang Beleq* from Sasak (Novitasari et al., 2022), Javanese *gamelan* (Nuryadi & Kholifa, 2020), and Burdah instrument (Nasution & Yahfizham, 2023). These instruments demonstrate two-dimensional and three-dimensional geometry, transformations, and arithmetic series. By using traditional Bugisnese musical instruments as a learning context, students will more easily understand that mathematics is not only found in the classroom or in an abstract form but can also be found in their own culture that they know and appreciate.

Along with technological developments, software such as GeoGebra can also become a tool to support ethnomathematics-based mathematics learning (Inuhan et al., 2023). GeoGebra, with its ability to visualize mathematical concepts, allows students to explore and understand various geometric concepts (Naibaho et al., 2023) contained in the design and shape of traditional Bugisnese musical instruments more interactively. With the help of GeoGebra, students can learn how geometric concepts are applied in the manufacture and design of conventional Bugisnese musical instruments, as well as carry out experiments to see how changes to geometric elements can affect the shape or sound of the musical instrument.

Exploration of ethnomathematics-based geometric concepts has been carried out in various cultural elements, such as Sasak traditional crafts (Alditia & Nurmawanti, 2023; Fauzi & Setiawan, 2020), Javanese *Joglo* houses (Kholisa, 2021), Lampung traditional houses (Noprisa et al., 2024) (Noprisa et al., 2024 ), and Boti tribal artefacts (Dosinaeng et al., 2020). These studies show how cultural elements can be a relevant learning context for understanding mathematical concepts.

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However, until now, no research has specifically explored traditional Bugisnese musical instruments as a medium for learning geometry.

Traditional Bugisnese musical instruments, such as drums (*Gendrang*), flutes (*Pui-pui*), and lutes have unique geometric shapes, such as tubes, cones and triangular prisms, which can be used as a context for learning geometry. This research aims to explore the relationship between traditional Bugisnese musical instruments and geometric concepts using GeoGebra. GeoGebra visualizes the geometric shapes of musical instruments interactively (Anggreini et al., 2023) so that students can understand geometric concepts more concretely and connect with their local culture.

Therefore, exploring how traditional Bugisnese musical instruments can be used as a context for learning mathematics, especially in teaching geometric concepts, is essential. This research aims to explore the geometric concepts within the ethnomathematics framework by analyzing traditional Bugisnese musical instruments. GeoGebra is utilized as a research tool to facilitate the visualization, modeling, and verification of geometric properties, thereby enhancing the accuracy and depth of mathematical analysis in this study. Hopefully, this research can contribute to developing mathematics learning models that are more contextual and relevant to students' daily lives and help students better understand and appreciate the relationship between mathematics, culture and their lives.

## METHOD

This study employs a qualitative approach with an ethnographic research design to explore ethnomathematics in traditional Bugisnese lutes and flutes musical instruments, specifically *Gendrang* (Bugisnese drums) and *Pui-pui* (Bugisnese flutes), and to visualize spatial geometric concepts using GeoGebra. The research was conducted in Sidenreng Rappang Regency, South Sulawesi, a region with a strong Bugisnese cultural heritage. The study subjects included members of the local Bugisnese community, particularly instrument makers and musicians involved in crafting and playing *Gendrang* and *Pui-pui*.

### Data Collection Procedures

Data collection was conducted through participant observation, in-depth interviews, documentation, and field notes. Observations focused on identifying geometric structures found in *Gendrang* and *Pui-pui*. *Gendrang* was observed to exhibit a cylindrical shape, while *Pui-pui* demonstrated a conical form. Interviews were conducted with artisans and musicians to explore their understanding of the geometric concepts inherent in the crafting and use of these instruments. Photo documentation was utilized to capture the structural elements of the instruments, supporting

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the visualization process in GeoGebra and strengthening the relationship between traditional craftsmanship and mathematical principles.

### Data Analysis Procedures

Data analysis followed a systematic qualitative approach, consisting of two primary stages: domain analysis and taxonomic analysis. Domain analysis stage involved identifying and categorizing the geometric structures present in *Gendrang* and *Pui-pui*. The analysis focused on classifying their fundamental geometric forms, which were then mapped to their mathematical properties. While in taxonomic analysis stage, geometric elements were examined in the context of Bugisnese cultural and mathematical knowledge systems. The relationships between mathematical concepts and traditional practices were analyzed to determine the extent to which mathematical thinking is embedded in the craftsmanship of these instruments.

### Interpretation and Theoretical Framework

The results of this analysis were integrated with visualization techniques using GeoGebra, enabling an interactive representation of the geometric structures. This visualization served as a bridge between ethnomathematics and formal mathematical learning, making abstract geometric concepts more tangible. The findings were interpreted through the lens of ethnomathematical theory, which highlights how indigenous knowledge systems inherently contain mathematical principles. Additionally, the study was guided by constructivist learning theory, emphasizing the importance of contextualized mathematical learning that connects cultural practices with formal education.

By systematically integrating qualitative ethnographic analysis, mathematical modeling, and digital visualization, this study provides a comprehensive framework for understanding the interplay between cultural heritage and mathematics education. The findings contribute to the growing discourse on ethnomathematics, demonstrating how *Gendrang* and *Pui-pui* can serve as meaningful educational tools for teaching three-dimensional geometry.

## RESULTS AND DISCUSSION

This study aims to integrate mathematical concepts into traditional Bugisnese musical instruments, which the people of Baranti Village, Baranti District, Sidenreng Rappang Regency still preserve. Based on the results of observation and documentation, it was found that *Gendrang* has a unique geometric shape relevant to the concept of spatial and volume of rotating objects. The musical instruments explored are *Gendrang* and *Pui-pui*. G*endrang* resembles a tube (cylinder) because of its symmetrical shape, which has two circular ends and a curved surface. Meanwhile *Pui-pui* has a shape resembling a cone, seen from the tip, which tapers and resembles a cone point. GeoGebra software modelled these geometric shapes to provide an interactive visual

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representation. This visualization offers a more precise and concrete picture of geometric shapes in traditional Bugisnese musical instruments, such as cylinders and cones.

### *Gendrang*

*Gendrang*, also known as *gendang* in Indonesian, is one of the traditional musical instruments of Makassar tribe that still exists today. In addition to accompanying traditional dances, *Gendrang* also functions as a marker for various traditional ceremonies, such as Makassar traditional weddings (Ihsan & Sayidiman, 2022). The rhythm produced by this musical instrument can attract the attention of modern society and is enjoyed by various groups.

*Gendrang* has been played since long before Indonesian independence, precisely during the reign of the Gowa Kingdom. Its use is closely related to the *pakarena* dance, which is estimated to have reached the peak of its popularity in the 16$^{th}$ century, so this musical instrument likely became part of the palace environment at that time. The presence of *Gendrang* in South Sulawesi is estimated to have occurred through the process of interaction and trade with outside communities at that time. Although there is no definite record of when this instrument began to be used by the Makassar people, *Gendrang* has become an integral part of their lives and cultural traditions (Rachmat et al., 2020). The form of *Gendrang* is as in Figure 1.

Figure 1. *Gendrang* (Bugisnese Drums)

From the image of *Gendrang* in Figure 1, the geometric concept formed is a cylinder, a geometric figure with a base and lid in the form of a parallel and congruent circle and a vertical side in the form of a rectangle that curves around the base and lid. A cylinder is a geometric figure with the several properties: has two circular bases that are parallel and congruent, has one curved vertical side connecting the two bases, and has two curved corner points and three sides (two bases and one curved vertical side) (Diu et al., 2020).

*Gendrang* visually reflects the cylinder through its shape, which resembles a tube with circular ends as the base and lid and a curved middle part connecting the two ends. Figure 2 shows is G*endrang* modelled using GeoGebra software.

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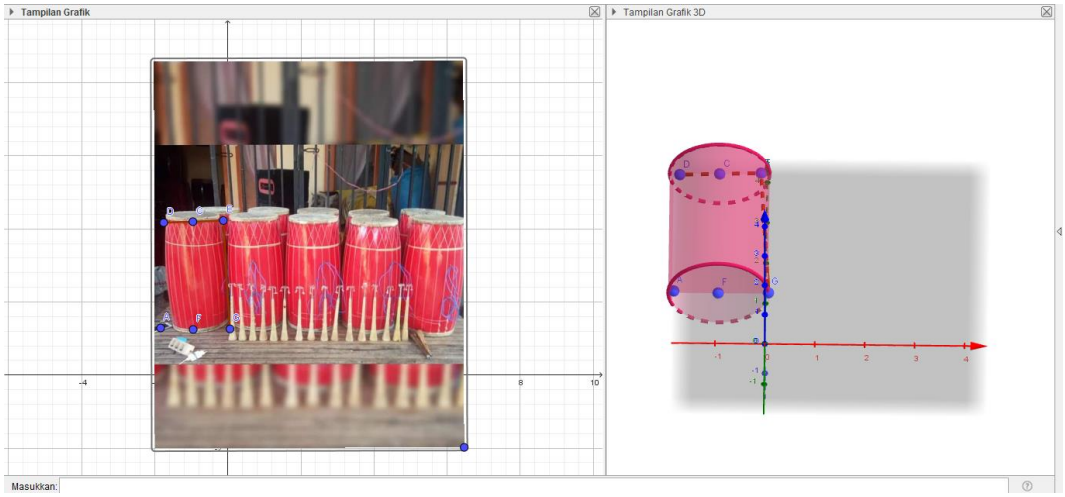


Figure 2. *Gendrang* Model using GeoGebra Software

In addition to modeling the geometric shape of a cylindrical space, *Gendrang* can also be explored as a volume model of a rotating object. The modelling carried out on *Gendrang* is part of an ethnomathematics exploration to generate a polynomial function that represents *Gendrang's* shape. This modelling is done using the concept of point interpolation with the help of the GeoGebra application (see Figure 3).


Figure 3. Interpolation of the Function of the Outer Side of *Gendrang*

In Figure 3, the interpolation of selected points along the outer contour of *Gendrang* produces a function that initially approximates a cylindrical shape. However, when this function is rotated around the *x*-axis, as shown in Figure 4, the resulting 3D model exhibits a hyperboloid-like form. This transformation occurs due to the curvature of the interpolated function, which does not maintain a perfectly cylindrical profile but instead follows a nonlinear pattern that results in a more complex surface structure.

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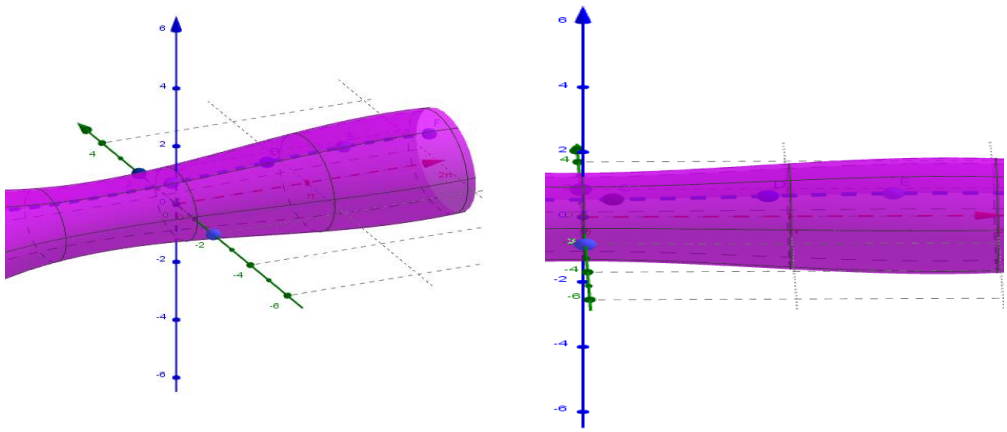

Figure 4. Simulation of Curve Rotation around the *x*-axis

Figure 4 shows the results of function interpolation and curve rotation simulation around the *x*-axis. Through the concept of interpolation from several points obtained based on the contour of the outer side of *Gendrang*, the following nonlinear equation model is obtained, which represents the outer side of *Gendrang*.

$$f(x) = 0{,}03x^3 + 0{,}03x^2 + 0{,}05x + 1{,}16$$

*Interpolation of the outer side function of Gendrang*

In the interpolation graph, the function *f(x)* obtained describes the outer side of *Gendrang* based on the interpolation points entered into the GeoGebra software. These points are generated from observations of *Gendrang* contour with coordinates C(0.44,1.22), D(2.16,1.46), E(4.18,1.66), and F(6.76,1.62).

*Rotation Simulation of Curve x*

In the interpolation graph, the function *f(x)* obtained describes the outer side of *Gendrang* based on the interpolation points entered into the GeoGebra software. This surface is visualized in the GeoGebra 3D view using the rotation command.

Based on the volume model of rotating objects, the following mathematical model *Gendrang* volume is obtained.

$$V_G = \pi \int_a^b \big(f(x)\big)^2 dx$$

$$V_G = \pi \int_{0.44}^{6.76} (0{,}03x^3 + 0{,}03x^2 + 0{,}05x + 1{,}16)^2 dx$$

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The integral above represents the volume of a solid of revolution formed from the rotation of the function $f(x)$ around the $x$-axis. The integral limits ($x = 0.44$ to $x = 6.76$) are obtained based on the domain of the interpolation function curve.

## *Pui-Pui*

*Pui-pui* is a traditional musical instrument from South Sulawesi and is played by blowing. This musical instrument is made of ironwood, made into a cone, and there is a pipe at the base as a sound producer (Purnamasari & Makmur, 2022). The base of *Pui-pui* is made of metal plate. The pipe produces sound from pieces of blown palm leaves. Before use, the palm leaves are usually wetted first so that they can make a sound. Usually, on *Pui-pui*, there are two palm leaves, one of which is a spare if the other palm leaf is damaged. Because it uses palm leaves, blowing this traditional musical instrument requires special skills. If blown carelessly, *Pui-pui* will only produce a strange or no sound. For people who are not yet proficient in using it, blowing and producing a tone will be very difficult. *Pui-pui* is played like an Indian flute in a snake summoning ritual (Ramli, 2020).

*Pui-pui* is usually played together with other traditional musical instruments and is used to accompany traditional art performances originating from South Sulawesi, such as the Pakkarena dance and the Maraga agility performance. Because it is rarely played by the younger generation, this traditional musical instrument is on the verge of extinction (Erlangga, 2022). The form of *Pui-pui* is as in Figure 5.

Figure 5. *Pui-pui* (Bugisnese Flutes)

From the image of *Pui-pui* in Figure 5, the geometric concept formed is a cone, a geometric figure with a circular base and one vertex connected by a curved side. A cone is a geometric figure with the several properties: has one circular base, has one curved side that connects the vertex and the edge of the base, and has one vertex, one base, and one curved side.

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*Pui-pui* visually mirrors cones through its shape and resembles a musical instrument with a circular base and a tapering tip to a single point. Its curved sides connect the edges of the base to the apex, forming a perfect cone geometry. Figure 6 shows the modelling of *Pui-pui* using GeoGebra software.

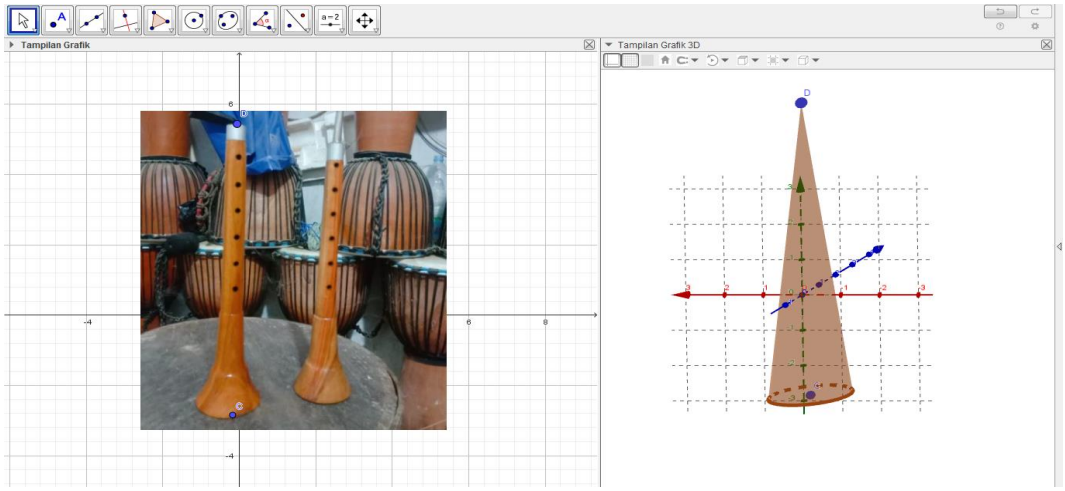


Figure 6. *Pui-pui* Model using GeoGebra Software

In addition to modelling the geometric shape of the cone space, *Pui-pui* can be explored by modelling the volume of rotating objects. The modelling on *Pui-pui* is part of ethnomathematics exploration to generate polynomial functions representing the shape of the traditional musical instrument *Pui-pui*. This modelling is done using the concept of point interpolation with the help of the GeoGebra application (see Figure 7).

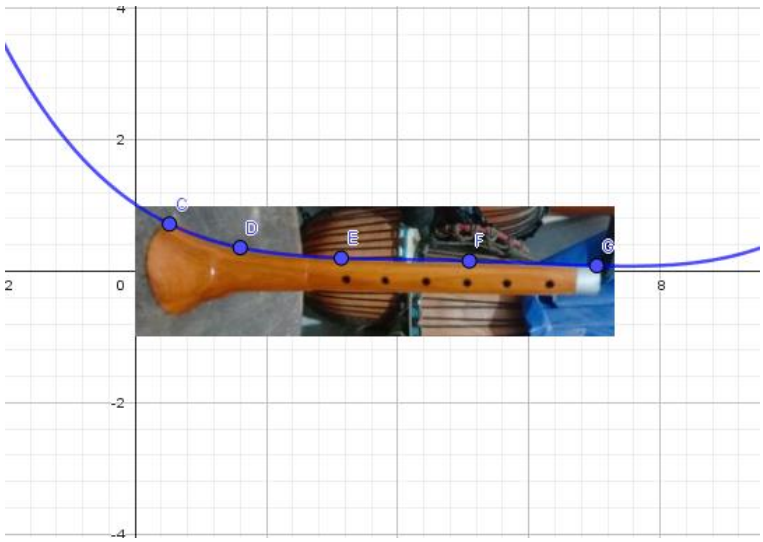


Figure 7. Interpolation of Function of the Outer Side of *Pui-pui*

In Figure 7, the interpolation of selected points along the outer contour of *Pui-pui* instrument generates a mathematical function that represents its shape in two dimensions. This function exhibits a curvature that deviates from a purely cylindrical form. When this function is rotated around the *x*-axis, as illustrated in Figure 8, the resulting three-dimensional model takes on a

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hyperbolic-like structure. This transformation is a direct consequence of the nonlinear characteristics of the interpolated curve, which leads to a surface geometry resembling a hyperboloid rather than a simple cylinder.

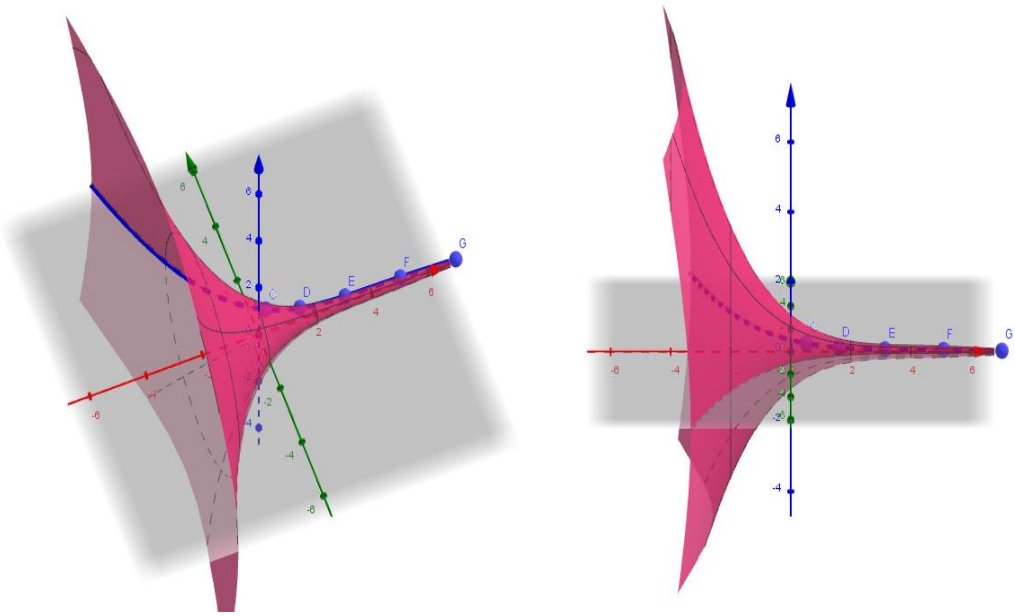


Figure 8. Simulation of Curve Rotation around the *x*-axis

The Figure 8 shows the results of function interpolation and curve rotation simulation around the *x*-axis. Through the concept of interpolation from several points obtained based on the contour of the outer side of *Pui-pui*, the following nonlinear equation model is obtained, which represents the outer side of *Pui-pui*.

$$f(x) = -0{,}03x^4 - 0{,}03x^3 + 0{,}21x^2 - 0{,}68x + 1{,}02$$

*Interpolation of the Outer Side of Pui-pui Function*

In the interpolation graph, the function *f(x)* obtained describes the outer side of *Pui-pui* based on the interpolation points entered into the GeoGebra software. These points are generated from observations of *Pui-pui* contour with coordinates C(0.52,-072), D(1.6,0.36), E(3.14,0.2), F(5.09,0.16), and G(7.03,0.08)

*Rotation Simulation of Curve x*

In the interpolation graph, the function *f(x)* obtained describes the outer side of *Pui-pui* based on the interpolation points entered into the GeoGebra software. This surface is visualized in the GeoGebra 3D view using the rotation command.

Based on the concept of the volume model of rotating objects, the mathematical model of *Pui-pui*'s volume is obtained.

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$$V_G = \pi \int_a^b \left(f(x)\right)^2 dx$$

$$V_G = \pi \int_{0.52}^{7.03} (-0{,}03x^4 - 0{,}03x^3 + 0{,}21x^2 - 0{,}68x + 1{,}02)^2 dx$$

The integral above represents the volume of a solid of revolution formed from the rotation of the function *f(x)* around the *x*-axis. The integral limits ($x$ = 0.52 to $x$ = 7.03) are obtained based on the domain of the interpolation function curve.

The exploration of geometry in traditional Bugisnese musical instruments, specifically *Gendrang* and *Pui-pui*, serves as an effort to bridge the connection between local cultural heritage and mathematical concepts. This study employs an ethnomathematics approach, linking mathematical principles with cultural artifacts in this case, traditional Bugisnese musical instruments that have been an integral part of Bugisnese traditions for centuries. The unique geometric structures of *Gendrang* and *Pui-pui* can be systematically analyzed through spatial geometry, particularly using polynomial interpolation and the concept of solids of revolution.

Prior research has demonstrated that traditional musical instruments from various regions contain embedded mathematical concepts that can be leveraged for mathematics education. Studies such as Lubis et al. (2018) and Maya et al. (2024) which explored *Gordan Sambilan*, a traditional musical instrument from Mandailing, North Sumatra, have revealed the presence of arithmetic and geometric sequences that can be applied as instructional materials. Their study employed physical measurements, including diameter, radius, height, and volume, using cylindrical and conical spatial approximations. Similarly, Simanjuntak (2022) investigated the *Sulim* instrument, focusing on calculating its area and volume based on the cylindrical shape of the flute.

Meanwhile, Busrah et al. (2023) examined *Gendrang Pattahang* and *Gandarang Jong*, traditional musical instruments from Bulukumba, using interpolation techniques to generate polynomial functions. Their study modeled the curved shape of these instruments mathematically and applied the volume of solids of revolution approach to determine the air capacity inside the instruments. The findings highlighted how interpolation functions can be used to describe the contours of traditional instruments mathematically.

Building upon these studies, this research extends the mathematical analysis of traditional musical instruments by focusing on *Gendrang* and *Pui-pui*, integrating both polynomial function interpolation and GeoGebra-based visualization. The findings reveal that *Gendrang*, a traditional percussion instrument commonly used in Bugisnese ceremonies, exhibits a cylindrical shape consisting of two parallel circular bases connected by a curved surface. By applying polynomial

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function interpolation, the contour of *Gendrang* is mathematically modeled and rotated around the *x*-axis to determine its volume, aligning with previous findings on cylindrical volume approximations. However, this study introduces a new perspective by demonstrating how digital mathematical tools like GeoGebra enhance the visualization and interactive modeling of such objects. Meanwhile, *Pui-pui*, a traditional Bugisnese wind instrument, presents a conical form, where its structure tapers from a circular base to a pointed tip. The polynomial interpolation approach used in this study allows for a precise representation of its outer contour, which is then rotated around the *x*-axis to obtain its volume. While previous research has applied conical approximations to musical instruments, this study refines the mathematical modeling process by using a more accurate polynomial-based approach.

This research also provides new insights by integrating interactive 3D modeling via GeoGebra, a feature that has not been extensively explored in previous ethnomathematics studies on traditional musical instruments. GeoGebra facilitates dynamic visualization, allowing for real-time manipulation and analysis of geometric structures. This aspect significantly enhances mathematical comprehension, particularly in the study of solids of revolution, and demonstrates how traditional cultural artifacts can be used as meaningful mathematical learning tools. Unlike previous research that primarily focused on theoretical calculations, this study bridges the gap between theory and practical application by incorporating technology to modernize ethnomathematics research, making it more accessible to educators and students.

Through this exploration, it is evident that traditional Bugisnese musical instruments contain diverse geometric properties that are highly relevant to contemporary mathematics education. *Gendrang* exemplifies cylindrical geometry, while *Pui-pui* represents conical geometry. By employing polynomial function interpolation and integration to calculate the volume of rotating objects, this study provides a scientifically grounded explanation of their geometric structures. More importantly, the findings support the broader ethnomathematical framework, reinforcing the need to preserve and integrate cultural heritage within mathematics education. This research not only highlights the mathematical richness of Bugisnese musical instruments but also promotes a deeper understanding of how culture and mathematics intersect, offering innovative ways to make mathematical learning more engaging and contextually meaningful.

## CONCLUSION

This study demonstrates the strong relationship between traditional Bugisnese musical instruments, *Gendrang* and *Pui-pui*, and fundamental geometric concepts, particularly cylinders and cones. Using the volume approach of rotating objects, *Gendrang* is mathematically modeled as a cylindrical shape, while *Pui-pui* is represented as a conical structure. The volume of each

instrument is determined through the rotation integral of the interpolation function curve around the *x*-axis, visualized interactively using GeoGebra. This integration of mathematics, culture, and technology offers significant contributions to education. For students, it provides a contextualized approach to learning geometry, making abstract mathematical concepts more tangible and relevant. For educators, it serves as an alternative pedagogical strategy that connects mathematics to cultural artifacts, promoting an engaging and meaningful learning experience. Schools can benefit by incorporating ethnomathematical approaches into the curriculum, enhancing both mathematical literacy and cultural awareness. This research highlights the importance of preserving local heritage through mathematics education while demonstrating that modern digital tools like GeoGebra can effectively bridge traditional knowledge with contemporary learning methods. The findings reinforce the role of ethnomathematics in fostering an inclusive and culturally responsive mathematics education, where students not only develop mathematical competencies but also gain a deeper appreciation of their cultural identity. Ultimately, this study contributes to a broader educational perspective that integrates mathematical understanding with local wisdom, ensuring that cultural traditions remain relevant in modern STEM education.

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