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Discovering Ethnomathematics in Sundanese Gamelan: Explore Mathematics Aspect in Gamelan

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ABSTRACT

Ethnomathematics is important in recent decades, specifically in the production of gamelan instruments. Therefore, this research aimed to examine the intricate relationship between mathematics and cultural craftsmanship in Sundanese gamelan instruments made at Gong Factory in Bogor, West Java. Ethnographic methods were used to observe and describe the practices of gamelan craftsmen and the data collection process comprised carefully selected artists. These individuals actively acquire data by reviewing relevant material, observing, analyzing, and interviewing. Miles and Huberman's framework for data analysis included data reduction, presentation, inference, and verification. The procedures understood the delicate relationship between mathematics and culture in the investigated setting. The results showed that Gong Factory in Bogor preserved and promoted a unique musical heritage. Furthermore, the instruments were known for exceptional sound quality, serving as cultural relics and didactic tools, as well as teaching visitors about the manufacturing process. The factory preserved culture through the manufacture of gamelan instruments including gong, bonang, and saron. In this context, the craftsmanship used mathematical principles, specifically precise proportions and ratios. The instruments' visual and auditory qualities depended on geometry. The results significantly impacted mathematics education by enhancing cross-cultural connections, improving proportional reasoning and mathematical comprehension, and recognizing the wider relevance of principles. Culture, mathematics, and education were connected, showing that conserving Indonesian musical tradition benefited local and global populations.

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A. INTRODUCTION

Ethnomathematics is the exploration of the connection between cultural practices and mathematical concepts. Research of Indonesian crafts, gamelan, and gong production show the provision of insight into cultural traditions. Gamelan in particular has a long, rich history of cultural interaction and development. The ensemble and gong forging are complex practices that provide an ideal subject for studying ethnomathematics (Akmalia, 2020; Enmufida et al., 2021; Yudianto et al., 2020). Several research found ethnomathematics present in Indonesian batik-making and bamboo crafts. For example, Yudianto et al. (2020) observed the exploration in the bamboo crafts of Osing community, including measuring lengths in meters and calculating drying times. Enmufida et al. (2021) also found ethnomathematics in Minangkabau songket weaving, including the use of geometry in pattern designs.

Gamelan is also deeply rooted in Javanese culture, with a long history of cultural interaction and development. Vetter & Sumarsam (1996) traced the origin from Hindu-Buddhist rituals adapted to Islamic Sufi traditions, and influenced by European styles. The bronze percussion instruments of gamelan reflect the cultural blending. Tenzer (2000) provided a comprehensive research of 20th-century Balinese gamelan gong kebyar, analyzing the musical structures and compositions. Furthermore, gamelan should be studied with the same rigor as Western classical music. The production of gong is also an important cultural practice that shows ethnomathematics (Jacobson et al., 1975). Reported the complex processes used by Javanese craftsmen to forge the instrument. According to Sanger & Kippen (1987), gamelan ensemble could be used successfully in music therapy for the physically handicapped. The non-Western methods of learning and practicing helped students develop musical skills and confidence.

Gamelan has a long and rich history in Java and Bali as the traditional Indonesian orchestra. Bronze instruments, such as knobbed gong, have been forged in Java for centuries (Jacobson et al., 1975). The town of Bogor in West Java is a center of gamelan production, with craftsmen specializing in casting and tuning bronze key and gong. The earliest records of gamelan in Bogor date to the 19th century and most of the instruments were produced through manual forging and tuning (Priambadi & Sugita, 2019). Bronze alloy had to be meticulously hammered and shaped by hand. Currently, many craftsmen use mechanical forging and tuning methods, which provide more consistent results and require less time (Priambadi & Sugita, 2019). However, some argue that manual forging still produces instruments with a superior tone (Agustana et al., 2020). Bogor is best known for producing the large gong gede, which is used in Balinese Hindu rituals. The ensembles possess over a dozen musicians and contain many large gongs and bronze keys (Hood, 2010). Gamelan gong gede is deeply embedded in Balinese religious traditions and the musical style has changed over time. However, the popularity of the modern and virtuosic gamelan gong kebyar has led some communities to adopt the intrument (Rismandika, 2019).

In recent decades, gamelan from Bogor has spread around the world, with ensembles found in many Western countries. The American composer Lou Harrison was instrumental in introducing the instrument to the United States. This was achieved by building the first American gamelan in California using instruments imported from Bogor (Miller & Lieberman, 1999). Gamelan is recognized as an important part of Indonesian cultural heritage and plays an important role in educating community about history. Bogor and skilled bronze craftsmen have been producing gamelan for generations. Even though the production methods have modernized, the instruments are renowned for artistic quality and cultural significance. Gong gede in particular remains an integral part of Balinese Hindu life, even after adapting to the influence of more popular styles. The spread of gamelan has also helped introduce Indonesian culture to new audiences.

Ethnomathematics explores the mathematical concepts embedded in cultural traditions and practices. Several research analyzed traditional crafts and technologies to uncover the elements. Meanwhile, weaving and textile crafts have been a popular focus of ethnomathematics research. Wahyudi & Putra (2022) reviewed research showing the integration of mathematical ideas such as geometry and pattern into weaving activities across cultures. Rencitia (2022) also reviewed literature showing the mathematical complexity of

traditional weaving, specifically in geometric patterns. Ernaningsih (2021) explored ethnomathematics of crafts in Kulon Progo, Indonesia, discovering geometry, sequences, and transformations embedded in textile designs. Suherman (2018) investigated the Lampung tapis, a traditional woven cloth in Indonesia, and the result reported concepts from science, technology, engineering, and mathematics. Pradana et al. (2022) reviewed research in various traditional cultures, mapping trends showing increasing interest in the topic. Bhaskar (2021) used ethnographic methods to study indigenous craft clusters in India and enabled students to learn cultural sensitivity. Some analyses have taken a broader view of craft practices. Eglash (2007) discussed the development of culturally situated design tools to support traditional Native American crafts and connect mathematical underpinnings to school curricula. Marchand (2017) compiled research examining the problem-solving skills of craftsmen, considering the effects of social, cultural, and environmental factors on intelligent design and practices. Ethnomathematics research showed the deep mathematical foundations of many traditional crafts and technologies. Research of textile arts, indigenous craft clusters, and craft practices broadly have reported the embodiment of cultural traditions to mathematical concepts such as geometry, pattern, and problem-solving. Analyzing crafts through ethnomathematics lens shows these connections and gains a richer understanding of cultural knowledge systems.

The production of gamelan instruments includes complex mathematical concepts and practices. The process starts with calculating the proper copper alloy composition as well as melting, casting, and forging the metal into the correct shapes (Marchand, 2017). Forging process requires precise calculations to achieve the proper density, hardness, and microstructure of the bronze. Haryono et al. (2017) explained that designing an entire gamelan set included setting up an intricate mechanical system to produce the range of tones required. Susanti (2021) found that the traditional Javanese game of Tong Tong Galitong Ji incorporated mathematical concepts such as addition, subtraction, multiplication, modulo operations, arithmetic sequences, and probability. According to Widyastuti (2022), the glass gamelan instruments produced at Song Meri Studio require precise mathematical calculations to tune each glass blade to the proper pitch. Producing a set of glass instruments is an innovative process that applies precision to an unconventional material. Some research discussed the business and operational aspects related to gamelan production. Therefore, mathematical concepts and practices are evident in the production from calculating alloy compositions to tuning each element, as well as in managing the operational and business aspects of traditional craft businesses. Applying mathematical precision and innovative thinking to gamelan production has allowed craftsmen to push the boundaries of traditional art forms.

The field of ethnomathematics has experienced a growing interest in recent years, with a particular focus on the application in the context of gamelan instrument production. The traditional Indonesian musical ensemble serves as an intriguing domain for exploring the intricate relationship between mathematics and cultural craftsmanship. Several key research analyzed various aspects of the relationship, showing the multifaceted role of mathematics in the production and development of the instruments. Therefore, this research aims to investigate the intricate mathematical aspects inherent in the production of gamelan instruments. Considering previous results, the mathematics behind copper alloy composition calculations, metalworking methods, and the design of gamelan sets will be analyzed.

B. METHODS

The research method focuses on investigating the complex relationship between mathematics and culture in the manufacturing process of Sundanese gamelan instruments at Factory Gong. This method is grounded in an exploratory and anthropological framework (Asegap & Putra, 2021). The exploratory aspect includes carrying out a comprehensive evaluation of symptoms and phenomena to shape data analysis according to distinct perspectives and concepts. This method is consistent with ethnographic concepts to gain a deep understanding of developing aspects such as language patterns, behavior, and beliefs in a dynamic cultural context. The primary focus of the research revolves around ethnographic methods, which includes the systematic observation and detailed description of the activities carried out in the production of gamelan. Participants consisted of individuals who owned gamelan and experienced craftsmen from Gong Factory. These individuals were selected with great care due to high level of expertise in gamelan creation, which was a crucial requirement for the application of ethnomathematics principles (Imswatama & Lukman, 2018). During the data collection process, a rigorous methodology incorporated a wide range of methods, including literature review, observational analysis, documentation analysis, and conducting interviews. Furthermore, interviews have played a crucial role in uncovering cultural elements and enhancing relationships with gamelan owners and craftsmen. By adopting a holistic method, the intricate cultural traditions that formed the foundation of gamelan creation was documented. A thorough analysis of the mathematical elements in the production process and gamelan was conducted, using diligent observation methods.

To ensure the accuracy and reliability of data, thorough documentation was diligently included for all the information gathered (Lewis, 2015). The data analysis follows the established framework developed by Miles and Huberman, which comprises the essential steps of reduction, presentation, inference, and verification. The primary nature of the research is qualitative and anthropological, centering on the examination of the application of Sundanese gamelan instruments as creative resources (Lambriex-Schmitz et al., 2020). The primary objective is to analyze the cultural attributes and characteristics of a particular community or group in a culture. Meanwhile, the research site is located at a specific address: Jl. Pancasan No.17, RT.02/RW.07, Pasar Jaya, West Bogor Regency, Bogor City, West Java 16119. The individuals were carefully selected through a rigorous process using purposive sampling methods. The primary data sources were Mr. Krisna and Mr. Hidayat and the collection methods covered a varied range, including observation, interviews, and documentation. To ensure the validity of the data, the Spradley method, which consisted of domain analysis, taxonomic analysis, component analysis, and theme analysis was used.

Furthermore, the data validation methods were implemented, including the expansion of participation, the assurance of the durability and coherence of observations, as well as the use of triangulation of sources and methodologies to strengthen credibility (Lewis, 2015). Involved in the validation procedure are two doctoral-level ethnomathematics specialists who are authorities on ethnomathematics research. The instrument utilized in this investigation was a validation document, which underwent qualitative analysis. The content and structure of the validation sheet were subject to expert evaluation in order to ascertain its accuracy and

pertinence to the study. The individuals offered comprehensive evaluations and recommendations for enhancement, drawing from their profound knowledge in the field of ethnomathematics research. The suitability of the validation document for the study was confirmed subsequent to the integration of their feedback, thereby underscoring the criticality of expert validation in the realm of research methodology.

C. RESULT AND DISCUSSION

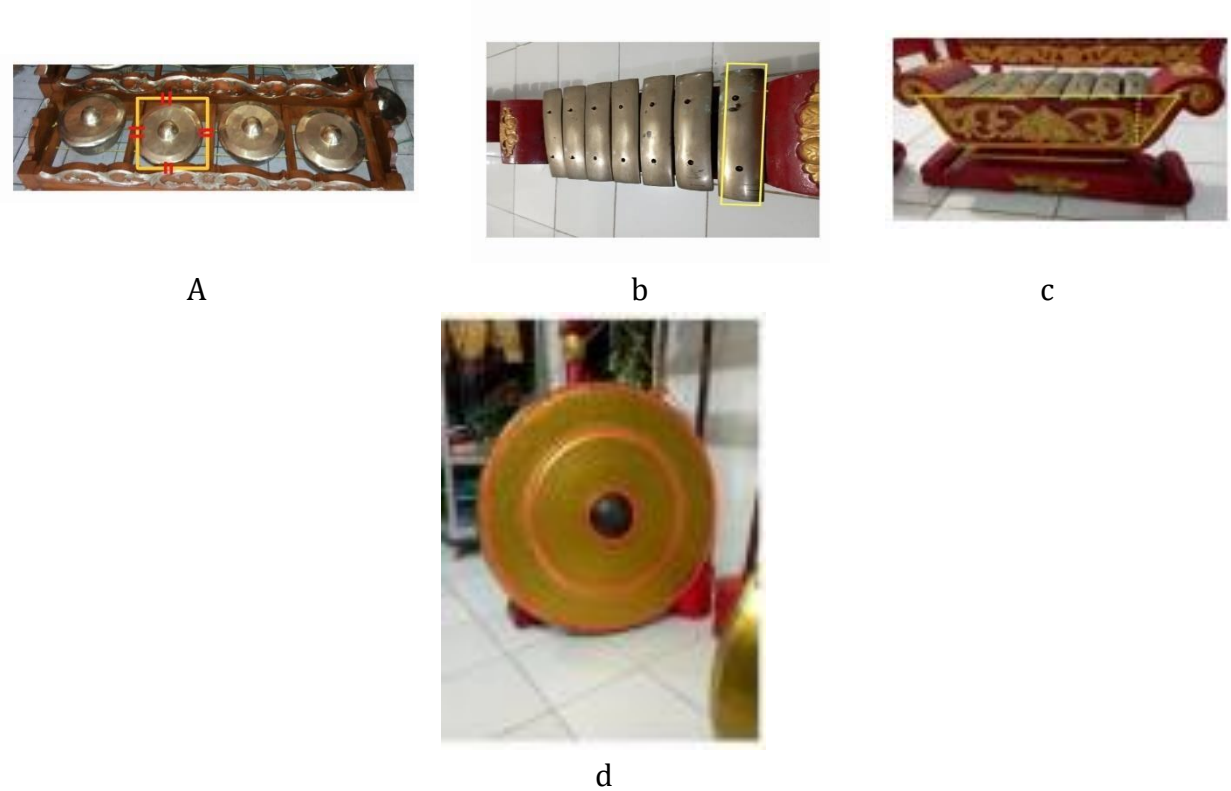
Gong Factory, located in Bogor, West Java, holds considerable importance in the domain of traditional Indonesian music and culture. The factory plays an important role in the preservation and promotion of culturally significant Indonesian musical legacy. Furthermore, bronze gong possesses a distinctive and resonant auditory quality generated by rhythmic hammering. In addition to serving as a popular tourist destination, Gong Factory offers an enriching educational opportunity, affording visitors the chance to observe the intricate process of manufacturing and engage in hands-on exploration of playing melodic instruments. The factory is located in Bogor, a city well-known for floral gardens and pleasant environment. Convenient accessibility has contributed to the popularity among travelers interested in exploring Indonesian music and culture. Additionally, Gong Factory includes a gift shop that offers tourists the opportunity to procure gong and several other traditional Indonesian musical instruments. The significance of Bogor is shaped by the presence of Chinese immigrants belonging to the Fujian tribe. The city has a comparatively restricted presence of major industrial establishments in comparison to the regional counterparts. However, the factory serves as an establishment that plays a crucial role in safeguarding and advancing traditional Indonesian music and culture. The creation of gamelan instruments comprises rigorous workmanship, where experienced artisans use specialized knowledge and expertise to guarantee the authenticity and quality of individual items. The dedication to the preservation of traditional craftsmanship plays a crucial role in the transmission of information and skills to future generations. Therefore, the commitment of Gong Factory contributes to the cultural milieu of Indonesia. The factory was founded in 1842 under Dutch colonial rule by Abah Panarang, a skilled artist and artisan specializing in gong production. The primary objective at the time was the creation of gong specifically designed for Sundanese artistic expression. Over the development, the organization broadened the manufacturing capabilities to include the creation of gong used in several Indonesian artistic traditions, including Javanese, Batak, and Balinese gamelan. The production process of gong includes the precise crafting of a tin and copper alloy, which is cast using clay molds. Subsequently, gong is forged and cleaned to effectively remove any oxidation scale. The instrument is offered in a range of sizes, and distributed to many regions. The factory is under the management of Krisna Hidayat, who is a seventh-generation descendant. Krisna Hidayat is dedicated to upholding the family heritage and ensuring the continuity of gong-making tradition. Furthermore, the factory holds a significant position as the exclusive gamelan production facility in West Java, characterized by a commitment to upholding traditional manufacturing methods. Gong is renowned for exceptional quality and have garnered respect in Indonesia and on a worldwide scale. The factory serves as a tangible testament to the development of Sundanese arts and gamelan, firmly grounded in extensive historical and cultural importance.

The observations have obtained insights into ethnomathematics elements associated with proportion and ratios in the manufacturing process of musical instruments, specifically gong, bonang, and saron. Bronze, an essential material used in the construction of these musical instruments, is subjected to a careful crafting process including the correct combination of tin and copper in a consistent ratio of 1:3. This meticulous process obtains a total of 4 kilograms of bronze for each mixture. The amount and ratio play an important role in the manufacturing process of gamelan. The production includes the use of bronze forging methods to mitigate porosity concerns, showing the indispensability of the particular stage in the fabrication of gamelan. The influence of porosity on the sound quality of bronze materials is considered to be an important factor. The mathematical principles of proportion and ratios play a crucial role in the craftsmanship of gamelan instruments. The need to maintain precise and consistent ratios of tin to copper with careful attention to forging process is stated by the findings. This is crucial for attaining the intended sound quality and distinctive attributes in conventional musical instruments (Figure 1).

Figure 1. The process of smelting tin and copper to produce bronze as raw material for gamelan

Geometry plays a crucial part in the design and construction of classic gamelan instruments, such as bonang, saron, and gong. Each of these instruments possesses unique geometric attributes that enhance visual attractiveness and acoustic excellence. The architectural structure known as the "rancakan," which serves as a housing for Bonang instruments, shows a square design, while saron is characterized by rectangular "bilah". After inversion, the saron reports a distinctive aesthetic characteristic as the structure takes on the form of an isosceles trapezium. In contrast, gong shows circular patterns on the posterior, central, and anterior regions, with the anterior circle assuming prominent visibility when observed from a frontal perspective. The geometric characteristics of traditional musical instruments are important in determining aesthetic and aural attributes. In the broader framework of ethnomathematics, the discipline of geometry assumes a crucial role in the attainment of the desired auditory excellence and acoustic attributes reported by gamelan instruments. A comprehensive understanding of geometric principles is important for craftsmen to fabricate instruments of proper auditory frequencies. Acquiring accurate

geometric data poses significant challenges and requires substantial resources but plays a crucial role in improving the construction of instruments (Figure 2).



A b c d

Figure 2. Gamelan from the aspect of geometry (a) rancakan, (b) bilah, (c) saron, (g) gong

The investigation of ethnomathematics elements in the framework of Sundanese gamelan presents a significant potential for enhancing mathematics instruction in the areas of proportional reasoning, concepts, and geometry. According to Tourniaire and Pulos (1985), proportional reasoning holds significant importance in the field of mathematics education. However, it is also acknowledged as a complex subject requiring new strategies to improve mathematical literacy and problem-solving abilities. In the given framework, Sundanese gamelan offers an exceptional and culturally significant perspective to address the disparity in mathematical instruction.

Ethnomathematics significance of Sundanese gamelan is exemplified by the thorough use of proportional principles in the construction of musical instruments. An example of proportions deeply established in culture is the continuous 1:3 ratio of tin to copper employed in the manufacturing of bronze for several gamelan instruments. The implementation of practical application serves to strengthen mathematical concepts and enhance a stronger bond between students and Sundanese culture, as well as artistic legacy. This enriches the learning experience by immersing students in a culturally significant context.

The deliberate choice and arrangement of materials in various components of gamelan instruments, including the incorporation of buffalo leather and goat skin, present a captivating opportunity to investigate the mathematical dimensions of materials science. By engaging in a research of the densities and vibrational properties of materials, a deeper understanding of the scientific concepts can be acquired. The use of a multidisciplinary method in education

promotes the recognition of mathematics as an essential component of the environment to facilitate a more holistic comprehension of mathematical principles.

By redirecting attention to the examination of ethnomathematics in the context of Sundanese gamelan, important correlations are reported with fundamental geometric principles to present a novel pedagogical strategy for imparting mathematical knowledge. As a fundamental branch of mathematics, geometry holds significant importance in the measurement and quantification of two-dimensional surfaces. The distinctiveness becomes readily evident when analyzing the structural composition of square-shaped Bonang musical instruments in the framework of Sundanese gamelan. Geometry teaching familiarizes students with basic shapes such as squares, which are defined by four sides of equal length and corners. The design of the Bonang accurately reflects the fundamental principles of elementary geometry. In geometric parlance, the computation of the square is achieved by multiplying the length of the sides.

The compelling aspect is the practical implementation of geometric principles in the making of bonang and the instrument is composed of smaller squares, with an area of 1 Unit^2. The practical implementation of geometric principles in the construction of musical instruments facilitates the comprehension of mathematical concepts and shows practical relevance in various aspects of daily existence. Furthermore, bonang necessitates the consideration of the concept of circumference, which is a fundamental geometric term. The concept pertains to the total length of a two-dimensional geometric figure and in the case of a square, the perimeter is determined by adding the measurements of all four sides, denoted as K.

By incorporating Sundanese gamelan as a pedagogical tool, teachers enhance students' knowledge of geometric principles while showing the practical applications of geometry in crafting musical instruments. This instructional method reports the intrinsic connection between mathematics and culture, providing students with a holistic perspective on the pragmatic significance of mathematical principles across diverse contexts. Ethnomathematics research obtained valuable insights into the effective integration of geometry concepts in Junior High School mathematics education. Historically, challenges faced by teachers, such as a lack of understanding and the perception of geometry as a challenging subject, have affected the efficiency of teaching geometry. The adoption of methods offers a viable solution by establishing a meaningful link between the research of geometry and the immediate surroundings. Ethnomathematics recognizes the influential role of cultural factors in shaping students' acquisition of geometric concepts. This places significant focus on the social constructivist method, asserting that knowledge is constructed through social interaction and personal experiences.

A series of observations were made over a span of two months, which provided a multitude of findings pertaining to the production of gamelan instruments in the research duration. Gamelan ensemble comprised bonang, saron, and gong, which were meticulously crafted by skilled artisans at gong manufacturing facility. The aim is to comprehensively comprehend the intricacies of mathematical processes, including measurement, symmetry, and design concerns while acknowledging the fundamental integration of mathematics in the craft. Furthermore, semi-structured interviews were conducted with craftsmen used at Gong Factory to elicit

different perspectives on the mathematical dimensions inherent in the production process. This provides an in-depth exploration of the interviewee's viewpoints, attitudes, and knowledge related to the integration of mathematics in the fabrication of the instruments.

Bonang is a frequently used musical instrument in Sundanese gamelan. Ricikan, which is a type of decoration, may be observed in sekaten and ageng ensembles (Teguh & Widiandari, 2021). Generally, bonang barung serves as a ricikan garap, which refers to the role in the balungan gending, or the primary melody. Bonang is characterized by the presence of two distinct patterns known as pipilan and nibani (Setyawati et al., 2021). Gamelan is commonly performed with various instruments, including the saron demung, saron barung, saron penerus, kempyang, bedhug, and gong. Variations in the shape and size of Sundanese gamelan, particularly bonang, may be observed when constructed with black bamboo resonance (Kurdita et al., 2019). These variations have a discernible impact on the tonal quality produced by the instrument. Bonang is recognized for non-harmonic tonality, frequently used with harmonically-based instruments or vocalizations within the context of Javanese gamelan (Marjieh et al., 2022).

Bonang in Sundanese gamelan shows ethnomathematics dimension intricately connected with the customary games and activities of the culture (Abdullah, 2016). Gamelan is performed through precise methods and patterns that incorporate mathematical components, including rhythm, dynamics, and notation (Kurniawati et al., 2023). Bonang is capable of producing diverse patterns depending on the rhythm and dynamics of the music, posing a challenge for inexperienced players. Furthermore, Sundanese gamelan instruments, such as bonang, show variations in physical characteristics, including diverse shapes and sizes. These variations have been found to have an impact on the tonal quality produced by the instruments (Kurdita et al., 2019). Therefore, the use of bonang instrument exemplifies the amalgamation of mathematical principles and methodologies in the specific cultural milieu of Sundanese music.

Saron is a musical instrument frequently used in Sundanese gamelan ensembles and holds a prominent position within the musical repertoire. The metallophone is an instrument comprising a linear arrangement of metallic bars percussed by mallets to generate auditory vibrations (Shen, 2014). Saron is a crucial component of the melodic ensemble in gamelan tradition, commonly performed with other instruments including bonang, kendang, and gong. The instrument assumes an important function in the provision of primary melodic lines and ornamentations in the context of Sundanese gamelan. Saron is available in various sizes and pitches, with saron demung being the most substantial before saron barung and peking. Saron is renowned for sonorous and resonant acoustics, contributing to the sonic complexity and timbral intricacy of gamelan ensemble. This shows the fundamental role of mathematics, particularly in the field of frequencies.

Gong holds a major position in Sundanese gamelan, assuming a role in the ensemble. The object is a sizable metallic disc that is suspended and struck with a mallet, resulting in the production of a profound and reverberating auditory tone (Stevens et al., 2013). Gong fulfills a crucial role in gamelan ensemble, serving as a rhythmic and structural foundation. This plays a significant role in guiding transitions, focusing on accents, and indicating shifts in the musical composition. The instrument is often played with other musical counterparts, including saron, bonang, and kendang, augmenting the collective sonic qualities and expressive nuances of the

ensemble. Incorporating gong into Sundanese music performances serves to cultivate a regal and ceremonial atmosphere. Gamelan ensemble is enhanced through the infusion of diverse timbral elements and rhythmic patterns in an elevated musical experience. The melodic component of the composition is delivered through the tuned instruments (Tenzer, 2000). The conclusion of significant melodic segments in a musical composition coincides with the use of gong tone produced by the instrument. Therefore, gong tone shows certain resemblances to the tonic tone in the Western diatonic scale.

Gong used in gamelan includes various mathematical principles connected with the design and performance methods. The existence of harmonics in the auditory output is a mathematical phenomenon (Krueger et al., 2010). The unique tone and beating frequency can be ascribed to the instrument size, shape, and structure. The function of gong in gamelan ensemble, with regards to establishing rhythm and pace, includes the incorporation of mathematical elements relating to time and synchronization (Pryatna & Santosa, 2021). The equilibrium is pertinent since gong plays a role in the comprehensive dynamics of music (Aditya Putra et al., 2020). In addition, the analysis of vibrations and modes can be conducted by the application of mathematical methodologies, such as interferometry and finite-element modeling (Perrin et al., 2014). The comprehension and admiration of gong function in gamelan are enhanced by the use of mathematical concepts.

The integration of ethnomathematics components derived from Sundanese gamelan into mathematics education serves to augment student inclusion and facilitates the cultivation of cross-cultural comprehension. A significant focus is placed on the integration of proportion content to show the universal nature of mathematical principles in many cultural contexts. This reports the common human experience of engaging in problem-solving and using mathematical reasoning. The integration of theoretical comprehension and practical applications is a comprehensive method that enhances students' outlook on the practical and cultural significance of mathematics. In addition, the integration of ethnomathematics methods into the teaching of geometry establishes a connection between the subject and the personal experiences of students. The results show the significance of research in the ability to provide valuable insights and improve the instruction of geometry in Junior High School mathematics education. This has the potential to make the subject more captivating and culturally pertinent for students.

D. CONCLUSION AND SUGGESTIONS

Gong Factory in Bogor, West Java, was reported to represent the preservation and enrichment of Indonesian music and culture. Indonesian culturally valuable musical tradition was preserved and promoted by the exceptional acoustics of bronze gong. The factory was a popular tourist attraction and an educational platform for tourists. Bogor, known for the beautiful scenery, attracted many foreign visitors interested in Indonesian music and culture, while gift shop enriched the cultural center. Gong Factory was known for Chinese-inspired cuisine and culture. This lone gamelan production factory in West Java preserved and advanced Indonesian music and culture. For high quality and exquisite craftsmanship, gong contributed to cultural legacy. Gamelan instruments such as gong, bonang, and saron contained ethnomathematics traits because of complicated mathematical principles. The conventional

musical instruments' auditory qualities depended on proportions and ratios, such as a 1:3 tin-to-copper ratio in bronze. Geometry created musical instruments with improved aesthetics and sound. The results advanced Sundanese gamelan knowledge and improved mathematics education by connecting diverse cultural contexts, as well as enhancing proportional reasoning, mathematical concepts, and geometry. Ethnomathematics method to geometry instruction increased student participation and cultural relevance. This showed the cross-cultural relevance of mathematical concepts and the use of geometry by Junior High School math teachers. By connecting mathematical concepts to cultural contexts, ethnomathematics assisted students to understand practical and cultural value in daily life. Gong Factory preserved Indonesian musical legacy and reported the profound mathematics of traditional gamelan instruments. These phenomena enriched local and global societies by stating the longstanding relationship between culture, mathematics, and education.

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