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ETHNOMATHEMATICS EXPLORATION IN THE TRADITIONAL ART OF RANDAI MINANGKABAU

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ABSTRACT

Mathematics is a scientific field that delves into numbers, measurements, and formulas. When mathematical concepts intertwine with culture, it forms what is known as ethnomathematics. Integrating mathematics with cultural elements can significantly enhance the learning experience. This research aims to identify and elucidate mathematical elements in the traditional Minangkabau art form of Randai. The methodology employed in this study is qualitative descriptive, utilizing a library research approach. No field studies were conducted; the research relied solely on a literature review. The data utilized comprises documents derived from studies of Randai art and other written references relevant to the research problem. The researcher serves as the primary instrument, indispensable to this study. Data collection methods include documentation and an extensive literature review. The findings reveal that traditional Minangkabau randai art encompasses not only artistic expression but also philosophical insights, cultural values, and mathematical elements, known as ethnomathematics. Ethnomathematics manifests in Randai art through its form, spatial dimensions, and musical instruments.

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INTRODUCTION

Culture and education are inherently intertwined and inseparable. Culture serves as the foundational pillar of education, while education plays a crucial role in both preserving and advancing culture. Without the presence of culture, education lacks direction. Both culture and education stand as fundamental aspects of human life; culture is an integral part of society, while education addresses the primary needs of individuals, profoundly influencing national values and shaping individual character based on noble cultural principles (Ulum, 2018).

Research by D'Ambrosio (1986) marked a pivotal moment in recognizing the significance of ethnomathematics in education. This perspective was further endorsed by Bishop (198.) and extended to regions like Africa, Japan, and China. Recognizing Indonesia's rich cultural diversity, research and development efforts have been undertaken to integrate ethnomathematics into teaching materials. The findings emphasize the crucial role of ethnomathematics in motivating and engaging students, alleviating monotony, and infusing mathematics learning with fresh perspectives (Abi, 2016)

Ethnomathematics serves as a platform for integrating cultural elements into mathematics education. D'Ambrosio's (1985) definition characterizes ethnomathematics as an anthropological exploration of mathematical culture, bridging the connection between culture and mathematics. The ethnomathematics approach juxtaposes mathematical concepts taught in educational settings with cultural elements inherent in society, where mathematical principles are embedded (Muslimin et al., 2019)

Mathematics is a core subject taught to children from an early age, encompassing both formal and informal education settings. Early exposure to mathematics fosters the development of critical, systematic, and creative thinking skills in children. This aligns with Minister of National Education Regulation Number 22 of 2006, which underscores that mathematics education in schools aims to cultivate logical and analytical thinking abilities, as well as promote collaborative skills. Consequently, mathematics education is expected to empower students to enhance their capabilities within and beyond the classroom environment. (Fauzi & Setiawan, 2020)

he negative impact on students' ability to reason and solve problems in mathematics arises from the insufficient emphasis on reasoning and problem-solving training within

mathematics education. This deficiency is cited as a contributing factor to Indonesia's low ranking in mathematics, according to Roosilawati (2016). A pressing concern is the limited ability of students to apply mathematical concepts in real-world problem-solving scenarios. The goal of mathematics education extends beyond exam preparation; it aims to equip students with practical mathematical skills for everyday life.

Challenges in elementary mathematics learning can stem from various factors, including inappropriate teaching methodologies, inadequate curricula, or difficulties in grasping mathematical concepts. One potential causal factor is ethnomathematics, which examines how culture and societal context influence the understanding and application of mathematics within specific communities. In an educational context, ethnomathematics sheds light on how students' cultural backgrounds and experiences shape their approaches to learning mathematics.

An interview with an elementary school teacher revealed that conventional teaching methods, such as lectures, practice exercises, and discussions, often lead to student disengagement and apathy towards learning mathematics. Overreliance on textbooks, which primarily present material in textual format, further diminishes student interest in the learning process. Notably, instructional media play a pivotal role in influencing student learning outcomes.

Ethnomathematics explores the development of mathematical concepts within cultural contexts and their societal implications. The term "ethnomathematics" comprises "ethno-," denoting culture encompassing values, norms, cultural artifacts, and "-mathematics," referring to mathematical knowledge like measurement, calculation, comparison, and sorting (Ambrosio, 1985; Utami et al., 2019). Ethnomathematics characterizes mathematics as practiced by specific cultural groups (Ambrosio, 1985).

It is a mathematical inquiry into cultural forms, including ideas, activities, or artifacts distinctive to particular social groups, conducted by individuals possessing expertise in mathematics (Fajriyah, 2018). Ethnomathematics scrutinizes the ideas and activities of cultural groups, thus enabling the exploration of mathematical concepts within various Indonesian cultural domains. Bridging culture, education, and mathematics, ethnomathematics encompasses mathematical activities embedded within society, encompassing concepts intertwined with culture, such as temples, inscriptions, pottery, traditional artifacts, batik motifs,

embroidery, traditional games, traditional arts, and ceremonial practices (Imaniyah & Zuroida, 2020)

Minangkabau, one of the tribes in West Sumatra, boasts customs that serve as the foundation of community life. Its culture and customs stand apart from those of other regions in Indonesia. The Minangkabau tribe showcases an art form known as Randai. Embedded within the traditional randai art, a cornerstone of Minangkabau culture, are numerous elements of mathematical concepts evident in every movement, rhythm, and pattern. Through its precise timing, symmetrical dance sequences, and harmonious integration of various artistic elements, Randai not only captivates audiences but also underscores the Minangkabau people's profound grasp of mathematical concepts within the realm of art and culture (Setiawan Arif, 2018)

Randai is a performance art that encompasses dance, music, and theater. These performances often narrate epic, mythological, or legendary tales and are staged in nan bapaneh fields. Consequently, pamenan adaik or pamenan anak nagari, including Randai, has become an integral facet of Minangkabau cultural life. Far from being merely a traditional pastime for children, this art form holds deep significance as an expression of Minangkabau culture and identity (Primadesi, 2013)

Randai, a traditional Minangkabau art form, unfolds as a group game within a circular arrangement, intertwining storytelling, walking, and singing. Its elements encompass song, dance, music, storytelling, and pencak silat. The narratives in randai often depict the daily lives of the Minangkabau people. Executed rhythmically, the movements in Randai are complemented by music and follow systematic patterns. Pencak silat, a martial art, is seamlessly integrated into Randai performances, characterized by well-coordinated actions. While randai's stage movements and actions are meticulously choreographed, its mathematical relevance lies more in interpretation. Randai embodies a performance art that amalgamates dance, music, and narrative dialogue. Within the choreography and musical rhythms of Randai, one can discern regular and symmetrical patterns infused with mathematical elements. Group formations or stage arrangements, for instance, may adhere to geometric principles like symmetry, proportion, angles, and mathematical sequences. Furthermore, the analysis of movement and spatial configuration in Randai performances encompasses mathematical concepts such as distance, time, and comparison (Hadi et al., 2021)

In essence, randai art demonstrates how the Minangkabau people seamlessly integrate mathematical concepts into their daily lives, particularly within the context of randai performances. Whether determining group formations or organizing stage layouts, they leverage geometric principles like symmetry, proportion, angles, and mathematical sequences. For instance, in configuring a circular formation, attention is paid to the angles and distances between group members to maintain symmetry and proportion. Moreover, the analysis of movement and spatial arrangement in Randai performances involves mathematical concepts such as distance, time, and comparison. The synchronization of movements with musical rhythms and the utilization of crops (traditional musical instruments) also necessitate precise mathematical calculations.

Several relevant studies demonstrate that incorporating ethnomathematics into learning can enhance students' grasp of mathematical concepts. For instance, in their research titled "Ethnomathematics Exploration in Piring Dance Movements, Farah Salsabila Gazanofa and Wahidin (2015) identified various mathematical concepts within plate dance movements, including angles, lines, plane shapes, distances, and coordinate points. These concepts can effectively aid teaching by elucidating abstract mathematical ideas and introducing cultural elements to students, underscoring the significance of ethnomathematics in plate dance and emphasizing the integration of mathematical concepts with cultural practices (Gazanofa & Wahidin, 2023)

This study seeks to delve into ethnomathematics within the traditional art of Randai Minangkabau, aiming to identify and explore mathematical concepts inherent in this art form. Through this approach, innovative and effective learning methods can be developed, enriching students' understanding of mathematical concepts and deepening their appreciation of local cultural heritage. Given this objective, the researchers are motivated to uncover further mathematical concepts intertwined with Randai art.

METHOD

This research employs a qualitative descriptive approach with a library research methodology. Field studies were not conducted; instead, the study relied solely on a literature review. The data comprised documents derived from studies on Randai art and other written references pertinent to the research problem. The researcher's role extended beyond mere documentation to include formulating new findings related to emerging phenomena through

data analysis. By reviewing previous research outcomes and referencing Randai art, the study generated new insights into the wisdom embedded in Minangkabau culture within Randai performances (Bahardur, 2018) .

The researcher serves as the primary instrument indispensable to this study. Their responsibilities encompass data collection and active engagement in research activities. Documentation and in-depth literature review constitute the data collection techniques, involving primary sources such as journals, research reports, theses, dissertations, and proceedings, as well as secondary sources like books and internet materials. Data analysis entails several steps: reviewing literature and documentation related to the research object, summarizing key findings, presenting data in narrative form, and drawing conclusions based on the analyzed data (Putra et al., 2020).

RESULTS AND DISCUSSION

Ethnomathematics

The term ethnomathematics was first introduced by Ubiratan D'Ambrioso, a mathematician and mathematics teacher from Brazil in 1977. D'Ambrioso proposed ethnomathematics as a methodology for tracing, analyzing, and understanding the processes of mathematical production, transfer, dissemination, and institutionalization across various cultural systems. He distinguished between academic mathematics, taught in formal settings such as schools, and ethnomathematics, which he described as the mathematics practiced within identifiable cultural groups such as communities, tribes, labor groups, children of certain ethnicities, and professional classes (Ulum, 2018)

Ethnomathematics is defined as the unique ways in which specific cultural or societal groups engage in mathematical activities. These activities involve abstracting real-life experiences into mathematical concepts or vice versa, encompassing tasks such as grouping, calculating, measuring, designing structures or tools, creating patterns, determining locations, playing games, and explaining phenomena. Ethnomathematics serves as an alternative teaching method for educators aiming to facilitate students' comprehension of mathematics. It is hoped that through ethnomathematics, students can further develop their metacognitive abilities, think critically, and solve problems (Marinka et al., 2018)

Ethnomathematics serves as an approach to elucidate the interconnectedness between environmental culture and mathematics as bodies of knowledge. The successes of countries like

Japan and China in mathematics education have been attributed to their incorporation of ethnomathematics into learning. This underscores the potential for ethnomathematics to enhance the meaningfulness and effectiveness of mathematics education for students (Putri, 2017) .

Exploring cultural activities related to mathematics provides insights into the diverse nature of Indonesia's local culture. This endeavor aims to deepen the understanding of the relationship between mathematics and culture, refine students' and society's perceptions of mathematics, adapt mathematics education to the cultural context of students and society, and make mathematics more accessible by dispelling the notion of it being foreign to students and the community (Princess, 2017)

The origins of Randai in Minangkabau

Randai is a traditional children's art form in Nagari that conveys moral messages through its performances. It typically involves group performances arranged in a circular formation and is often showcased at traditional Minangkabau events such as headman appointments, weddings, and other ceremonies. Randai is a quintessential Minangkabau art form that integrates elements of music, dance, pencak silat (traditional martial arts), and theater. The term "randai" itself signifies storytelling (Putri, deria, 2015)

In West Sumatra, randai is renowned as a traditional performing art that combines music, dance, movement, and storytelling. It is frequently featured at secular events like harvest festivals, weddings, and similar celebrations (Bahardur, 2018) .

The Randai dance holds special significance for the people of West Sumatra, particularly the Minangkabau, making it an integral part of traditional activities in the region. Beyond its role as a medium for conveying messages, randai captivates audiences, swiftly delivering profound messages in an engaging manner (Bahardur, 2018).

Apart from that, Randai, typically presented as an art form combining elements of music, dance, movement, and storytelling, requires skilled and meticulous performers. The execution of Randai involves numerous considerations, including the positioning of each participant, the number of participants, and the spacing between them, all of which must be meticulously arranged.

Elements in Randai art

The West Sumatra Province boasts traditional arts, including children's games and entertainment, collectively known as Randai, originating from the creative expressions of its

people (Marzam, Darmawati, & Mansyur, 2019). Randai encompasses several key elements such as movement, music, songs, and storytelling, which are interconnected within the performance. Over time, Randai has garnered appreciation from diverse groups, spanning generations (Yuda & Padang, 2020)

Randai, a traditional Minangkabau children's game, is popular throughout the West Sumatra region and is presented in a distinctive theatrical form typical of Minangkabau culture. Randai encapsulates nearly all elements of Minangkabau artistry, incorporating storytelling through dialogue or sung narratives known as dendang or gurindam, dance movements inspired by silat, music, and acting. Despite its characteristic traits, Randai remains adaptable to evolving societal needs and conditions, allowing for continual artistic development (Primadesi, 2013). Furthermore, Randai exhibits the following distinctive features: Firstly, the narratives stem from oral traditions, known as kaba, prevalent within Indonesian communities, which are then adapted into written manuscripts or scripts.

Secondly, storytelling extends beyond dialogue to include sung narratives accompanied by traditional musical instruments such as talempong, saluang, rabab, and gandang. Thirdly, dramatic depth is cultivated through improvisation among performers, fostering spontaneity within the performance. Fourthly, Randai emphasizes a close bond between performers and the audience, fostering interaction and engagement. Fifthly, Randai performances often take place outdoors, commonly referred to as *Medan Nan Bapaneh*. Sixthly, Randai exhibits flexibility in terms of narrative, duration, and staging, accommodating performances ranging from two-hour shows to multi-day productions while maintaining audience engagement. Seventhly, performances are conducted in the Minangkabau language, preserving cultural authenticity (Primadesi, 2013)

In the art of Randai Minangkabau, the number of dancers is contingent upon the spatial characteristics of the performance venue. Spacious venues allow for larger dance ensembles with greater freedom of movement, while more confined spaces necessitate adjustments to ensure unimpeded movement. Additionally, the stage layout in Randai is significantly influenced by the flooring pattern. Each movement and formation, whether forming circles or lines, must consider the dimensions and layout of the space. The chosen flooring not only enhances the aesthetic appeal but also facilitates safe and precise execution of movements within the available area (Firdaus et al., 2022)

Figure 1. Randai player formation is in the form of a line

Figure 1 depicts the arrangement of Randai performers in a row resembling a straight line. Upon entering the stage, the performers organize themselves into two rows, adjusting the spacing between each participant. To ensure order among Randai performers, the spacing between them must be consistent. For instance, in a Randai performance with two rows, each participant in both rows should have an equal number, such as 5:5, indicating uniformity. The regularity in Randai performances can be quantified using mathematical methods, including determining distances, player counts, combinations of moves, and beat changes during the performance.

Ethnomathematics, particularly in the context of Randai dance, facilitates the measurement and regulation of distances between dancers, preventing overlap. In mathematical discourse, distance refers to the numerical measurement of the separation between two objects (Palupi et al., 2021). Furthermore, a straight line is a geometric construct traced by a moving point. Lines possess a singular dimension, length, and the shortest distance between two non-coincident points (Sa'o et al., 2022).

As Randai performances evolve and adapt to modern stages, the spacing between performers may vary based on stage requirements. Larger stages necessitate greater distances between performers, especially when numerous individuals participate. This adjustment can accommodate the movements and narrative of the performance (Sandhi, et al. 2018:164) Additionally, dancers engage in measuring activities when adapting to changes in floor patterns, executing movements synchronized with the music (Mukarromah & Darmawan, 2022)

Figure 2. Randai player formation in the form of a circle

Figure 2 illustrates the arrangement of Randai players in a circular formation. A circle, a mathematical concept, represents a flat shape. Randai performances are often structured in circular or Garak malingka formations. Malingka denotes circular, indicating that all activities occur within a single circle. The circle symbolizes unity, openness, and integration among individuals. Spectators encircle the Randai performance, while the players themselves perform within the circle. This circular arrangement persists throughout all Randai performances (Hartinah et al., 2019) .

The formation pattern assumes a dot-like shape, which, when extended, forms a circular pattern. In Randai art, the number of dancers varies based on the stage's size. A minimum of 9 participants is typically involved, including main and supporting dancers who animate the dance scenes within the staged narrative. These dancers execute dynamic and expressive movements, blending dance, pencak silat, and acrobatics. Larger Randai performances can encompass tens to hundreds of dancers. Prominent Randai groups may feature anywhere from 50 to 100 dancers or more. Performances with a larger cast are typically staged at significant cultural festivities, festivals, or special events.

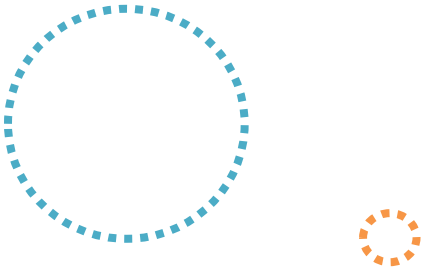

Figure 3 depicts the various formations of Randai dance players.

The blue circle image represents the maximum formation of Randai dance players, ranging from 50 to 100 dancers, forming a large circular shape. Meanwhile, the orange circle image illustrates the maximum formation of Randai dance players, totaling 9 people, forming a smaller circular shape. Dance movements executed in space inherently encompass dimensions of length, width, breadth, and height. Each dance movement constitutes a three-dimensional work of art, observable from multiple perspectives—front, right, or left. Dance composition involves movements that cannot be altered once executed, characterized by their volume and scale. Balancing these movements with utilized levels further contributes to the dance's dynamic (Daryusti, 2005) .

Geometry plays a crucial role in determining suitable theater dimensions for Randai performances. It facilitates the assessment of length, width, area, and height, ensuring an optimal space to accommodate Randai dance movements. Room dimensions directly influence the range of movement; smaller rooms restrict movements, while larger spaces allow for more expansive actions. Ethnomathematics aids in gauging room dimensions, enabling a comparison of width and length based on movement dynamics. For instance, rooms conducive to transverse movements, like jumping and spinning, require greater width, whereas those facilitating back-and-forth motions necessitate lengthier dimensions. Employing geometric principles in theater design enhances the dance space's functionality, elevating both performer and audience experiences while preserving the authenticity and allure of Randai dance (Bachtiar, 2016)

Randai movement instruction integrates ethnomathematics, with trainers demonstrating dance sequences. Key movements in Randai performances include the opening prayer, thematic sequences, wave patterns, and closing rituals. The opening prayer initiates the performance, followed by thematic movements depicting natural phenomena or activities. Wave patterns entail upper body movements forming undulating formations, while closing rituals signify the dance's conclusion(Intan & Rifa, 2023)

Additionally, Randai performances may feature musical accompaniment, with players assembling, clapping, and forming a circle. Following this, performers offer salutations by raising their hands toward the audience before assuming a seated posture with one knee on the ground and hand on the forehead. A singer, bearing gurindam, initiates the performance with Dendang Pasambahan. The beginning of a Randai dance is exemplified in the sketch below:

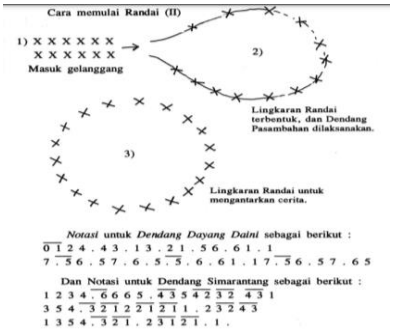

Figure 4 illustrates the procedure for commencing a Randai performance

To initiate Randai, two parallel lines are formed, which then separate to create a circle while accompanied by singing and offerings. In Minangkabau singing, each song typically adheres to a rhythm established in the first two lines of the entire pantun. The subsequent two lines, known as the rhyme content, follow or repeat the rhythm of the initial lines. Following the completion of offerings, Randai begins with a shout of "Hep..ta!" by the Gurutuo Silek or 90 Wave Carriers Cultural Tourism Library. This marks the commencement of the Randai round or legaran. The Gurindam Bearer proceeds to sing the Prelude to the Gurindam, comprising several verses that include the name of the story to be performed, the name of the Randai group, the group's hometown, as well as the story scenes (Kaba) and characters. Some Randai groups may proceed directly to the first scene without altering the Dendang and Ombak. However, others may modify their drum rhythms and waves after the Gurindam Prelude's conclusion, signaled by shouts of "Hep..ta Hep..ta" from the wave bearer and others. Players then engage by patting the loose part of their trousers between their thighs, producing various sounds. The number of claps depends on the rhythm and wave type, accompanied by shouts from all players. Once the Gurindam has concluded, Randai participants are seated, and the individual assuming a role in the story enters the circle to commence dialogue and acting. Another scenario involves the Galombang Introduction shouting "Hep ta Hep ta!" prompting all players to converge at the circle's center before returning to their original positions, leaving only the storyteller. These role holders, referred to as "Pambao Carito" (Story Tellers), remain in the center for dialogue and acting. Upon completion of this scene, the Galombang Carrier shouts "Hep.." signaling players to stand and gather around the storyteller, initiating singing for the second legaran, and so forth until the break. During the break, the Gurindam is sung to announce Randai's rest period, which typically includes Piring Dance, Sewah Saluang, Dendang Dance, and sometimes martial arts

events. While awaiting the continuation of Randai, talempong, puput rice stalks, and songs are played (Harun, 1992)

1. Talempong

Talempong serves as one of the musical instruments employed in Randai performances. It comprises a set of percussion instruments crafted from a blend of bronze and metal brass. While categorized as a type of gong, talempong is considerably smaller in size compared to traditional gongs. The shape and dimensions of talempong have been documented by Bustanul Arifin Adam (1986/1987: 10) in various Nagari in Minangkabau, as depicted below.

Figure 5. Talempong musical instrument

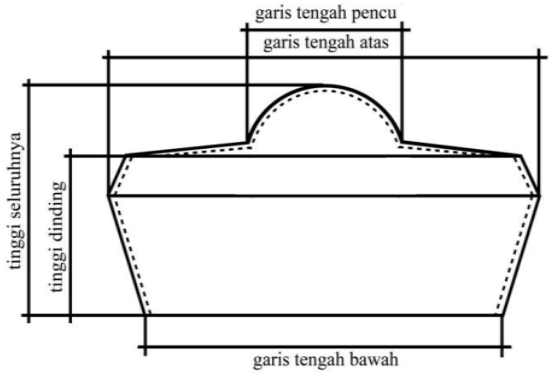

Figure 6. Talempong size

In the image above, the dimensions of the talempong, as measured by Minagkabau historian Mr. Bustanul Arifin Adam in 1986, are presented. The total height ranges from 8.5 cm to 9 cm, with a wall height of 5 to 6 cm, a lower midline spanning 12.5 to 17 cm, and an upper midline measuring 16.5 to 17 cm. Additionally, the pencu diameter ranges from 2 to

2.5 cm. A complete set of talempong comprises six dan-shaped pieces, nearly identical in size, each associated with specific notes and songs it produces (Darsono, 2016). In terms of mathematical concepts, the shape of the talempong is a composite of several flat shapes: 2 parallelograms, 1 rectangle, and 1 semicircle. The area and perimeter of each flat shape can be calculated using the following formulas:

a. Parallelogram

   Area = base × height

   Perimeter = 2 × (a + b)

b. Rectangle

   Area = length × width

   Perimeter = 2 × (p + l)

c. Semi-circle

   Area 1/2 × π × r^2

   Perimeter = π × d

Tulus Handra Kadir (1993: 64) suggests that the term "talempong," in the context of a musical instrument, does not refer to a single instrument but rather a group of musical instruments. It is oriented toward principles of sound production, playing techniques, and the sounds produced. Based on these principles, Tulus Handra Kadir defines talempong as a musical instrument classified as idiophones, where the sound originates from the body of the instrument itself and is played by striking with a tool for assistance (Darsono, 2016)

2. Pupuik Rice Stalk Fertilizer

Pupuik rice stalk fertilizer originates from Agam Regency, West Sumatra. The Agam people craft Pupuik during cultural celebrations marking the harvest period or the conclusion of the rice harvest, utilizing harvested rice stalks. As the name implies, Pupuik thrives in agricultural areas abundant with paddy fields. Historically, Minangkabau individuals played Pupuik during rest periods while tending to their livestock. Additionally, in the past, this musical instrument was played in the late afternoon, signaling dusk and the time to return home. Initially, it served as a form of personal entertainment or communal play during breaks. However, over time, this musical instrument has become increasingly rare. In efforts to preserve it, the community has repurposed this wind instrument from West Sumatra as an accompaniment to various traditional events in Minangkabau (Hafizhah, 2023)

Figure 7. Rice fertilizer musical instrument

The image above depicts the Pupuik Padi musical instrument. Unlike wind instruments like the Saluang or Bansi, the Pupuik Stem Paddy does not have holes to adjust tone and sound; it produces a single tone. However, through various modifications, this musical instrument can produce unique and varied melodies. The process of making this musical tool is relatively simple. First, take a harvested and aged rice stem, then slowly break it with care near the base. The fragments of the stem will form rudimentary vocal cords capable of producing a shrill voice.

Although this method can produce sound, it may not be very loud. To enhance the sound, roll a coconut or a pandan leaf into a trumpet-like shape, narrower at the base and wider at the end. The rolled leaves should be tightly wound and dense, then attached to the broken end of the rice stem. When blown, this arrangement produces a much louder sound, audible from distances of up to 2 km. The pandan leaf rolled in this manner is known as "fertilizer laole" (Hafizhah, 2023)

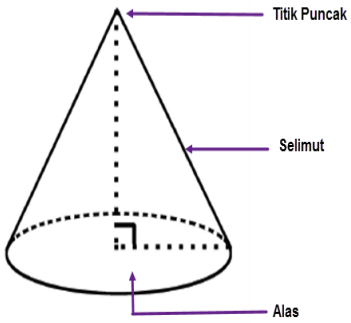

Figure 8 illustrates a cone-shaped fertilizer room.

In mathematical terms, the paddy fertilizer resembles a cone, where the end of the fertilizer is shaped like a circular base to produce sound. As it approaches the end circle, it becomes progressively smaller, forming a cone. Its function is to enable people to blow into it, thus producing sound. Although this fertilizer is trumpet-shaped, it is crafted in a traditional manner. The paddy fertilizer

takes the form of a geometric cone. The surface area and volume of this geometric shape can be calculated using the following formulas:wide surface area of the cone =$(\pi \times r^2) + (\pi \times r \times s)$
volume of the cone = 1/3 × π r² × t

3. Drum

Next, let's examine the drum known as Tambua. It is a type of gandang (kendang) musical instrument that originated in Minangkabau, particularly in the Pariaman area and several religious districts such as Tiku, Lubuk Basuang, Maninjau, and Malalak. The Tambua features two heads (double-headed), meaning that both ends are covered with skin membranes. This drum belongs to the cylindrical drum family and is crafted from lightweight woods like pulai wood and kapok wood. It typically has a diameter of approximately 60 cm and a length of about 80 cm. The membrane used is typically goat skin or cow skin. To play the Tambua, it is worn over the shoulder with the gandang positioned in front of the player. To enhance comfort during play, the Tambua is equipped with straps on both sides made of thick cloth or a belt-like fabric to prevent shoulder discomfort. The striking tool (pelvis) is made of wood, rounded at both ends, with different sizes to accommodate different playing positions (Wardizal, 2022).

Figure 9. Drum musical instrument

Figure 9 depicts a drum musical instrument. The mathematical concept applicable to this drum is that of tube geometry, as the drum is shaped like a tube. The drum has a diameter of approximately 60 cm (radius), a height of around 80 cm, and is equipped with two small circular ends of differing sizes. One end is larger for double-head hitters in the top position, while the other end is smaller for double-head hitters in the bottom position. This drum resembles a geometric tube, enabling us to calculate its surface area and volume using the following formulas:

surface area of the tube = 2 × (π × r^2) + 2 × π × r × t

volume = π × r^2× t

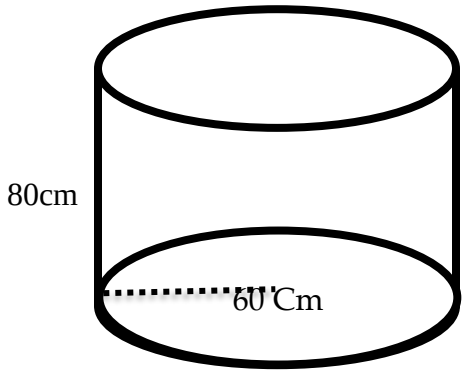

Figure 10. Building a tube chamber

Figure 10 illustrates the construction of a tube chamber. After a break, the Randai players gather again in a circle. The Wave Maker signals the start of Randai with a shout of "Hep ta!". Then, the Gurindam bearer sings the pantun, typically as follows: "Diulang sedulang lagi Balingka emas pahat Diulang saulang lai Pandai mengambil hidup Kaba yang tiga" This continues with the Gurindam, which narrates a story. This cycle repeats until the conclusion of the Randai performance that night (Harun, 1992)

MATHEMATICAL CONCEPTS IN RANDAI ARTS

Randai, a traditional Minangkabau theater form, seamlessly integrates drama, dance, music, and silat. Beyond its profound artistic aspects, Randai also harbors intriguing mathematical concepts. This stems from the close relationship between Randai's elements and mathematical principles, such as row arrangement and player numbers. Consequently, the spatial arrangement is greatly influenced by room dimensions, necessitating the application of mathematical formulas to measure stages, whether square, rectangular, or circular. Circles, with geometric properties like diameter, radius, and circumference, offer avenues for exploration.

Moreover, musical instrument usage in Randai intertwines with mathematical concepts. For instance, each talempong's varying sizes, as noted by Darsono (2016), prompt mathematical analysis through related formulas. Musicians, too, leverage mathematical principles in rhythm, tempo, and harmony determination. Thus, Randai serves not only as a conduit for cultural enrichment but also as a platform for creatively integrating mathematical concepts into traditional art.

CONCLUSION

Randai, a traditional Minangkabau art form, transcends mere artistic expression, encapsulating philosophical depth, cultural significance, and mathematical elements known as

ethnomathematics. Dancers, regardless of gender, are meticulously arranged, influenced by performance space characteristics that demand wider spaces for enhanced movement freedom. Geometry, instrumental in determining distance, facilitates the creation of spaces conducive to Randai dance.

Randai stages adopt diverse patterns, such as straight lines or circles, each imbued with philosophical connotations, reflecting principles of unity and openness. Dancer numbers vary according to stage size, from nine individuals to potentially hundreds. Every Randai movement encompasses three dimensions: length, width, and height. Mathematical concepts also underpin traditional musical instruments supporting performances, such as talempong, rice stem pupuik, and drums, enriching the auditory experience.

Furthermore, the Randai performance, encompassing elements like gurindam, singing, and waves, fosters a distinctive ambiance. This amalgamation of elements not only dazzles artistically but also encapsulates philosophical profundity, cultural significance, and mathematical prowess, enriching the Minangkabau heritage. By nurturing and preserving Randai, it remains a vital component of Indonesia's cultural legacy.

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