ETHNOMATHEMATICS IN PEKALONGAN SINTREN DANCE: ANALYSIS OF GEOMETRY AND SYMMETRY IN LOCAL CULTURAL MOVEMENTS

Adiman*, UIN K.H Abdurrahman Wahid Pekalongan, Indonesia
Kinanti Diaz Febianti, UIN K.H Abdurrahman Wahid Pekalongan, Indonesia
Nabila Putri Callista, UIN K.H Abdurrahman Wahid Pekalongan, Indonesia
*e-mail: adiman@mhs.uingusdur.ac.id (corresponding author)

Abstract: Etymologically, the word "sintren" is formed from two syllables, namely "si" which means "she" and "tren" which is the name for a princess. Sintren art is a traditional art that developed in the northern coastal region of Java, especially in Central Java and West Java. As a performing art that has elements of magic and ritual, Sintren is an important part of local community life. Sintren not only has aesthetic and spiritual value, but also contains mathematical concepts in it. This research was conducted using qualitative methods and an ethnographic approach. Using data collection techniques, namely Literature Study and observation, the subjects of this research are Sintren dancers. The results of the research show that there are various mathematical concepts reflected in Sintren art, such as geometric concepts in dance floor patterns, geometric transformations in dance movements, geometric patterns in costumes and musical instruments used during performances. This shows that Sintren art has the potential to be a source of contextual learning in teaching mathematics based on culture. By integrating ethnomathematics elements from Sintren art, it is hoped that students can understand mathematical concepts more effectively while recognizing and preserving local culture.

Keywords: sintren, ethnomathematics, local culture

INTRODUCTION

Sintren Dance is a form of traditional art originating from the Pekalongan area, Central Java. This dance has a characteristic that combines strong elements of dance, music and ritual with local cultural nuances (Komala, 2012). Sintren art etymologically comes from the word sintren which consists of two syllables, namely "si" and "tren". Si means "she" and the trend itself is a nickname for princesses. Sintren can also be interpreted as "she is a princess" (Darmoko, 2014). Apart from that, Sintren also shows in the main exhibition of this art, namely a princess who acts as the main dancer in this art.

Sintren is traditionally performed at certain rituals and celebrations, depicting the relationship between humans and nature, as well as the spiritual values held by local communities. In the current era of globalization, the existence and appreciation of Sintren Dance faces significant challenges, especially when local cultural values begin to be displaced by the current of modernization (Komala, 2012). This problem not only threatens the preservation of Sintren Dance, but also makes us question the relevance of the values contained in it, especially in the context of ethnomathematics.

Ethnomathematics is a science that studies the relationship between mathematics and culture (Hariastuti et al., 2019; Pathuddin & Nawawi, 2021; Sianturi et al., 2022; Sulaiman & Nasir, 2020). Meanwhile, according to (Peni & Baba, 2019) Ethnomathematics is a very promising approach in helping students so that they can explore their culture to gain ideas from mathematical concepts. Ethnomathematics is the study of certain patterns or distinct colors of mathematics that live and develop in society (Nursyahidah et al., 2018; Suprayo et al., 2019). So, Ethnomathematics is a study that examines the relationship between culture and mathematics, which believes that various cultures have unique ways of viewing, understanding, and applying mathematical concepts.

Ethnomathematics is a science used to understand how mathematics is adapted from a culture and serves to express the relationship between culture and mathematics (Ghoni & Hidayati, 2023). According to D'Ambrosio (Hasan & Budiarto, 2022) Ethnomathematics is the study of the ways mathematics develops in a society's culture. Ethnomathematics is the study of certain patterns or distinct colors of mathematics that live and develop in society. In the context of Sintren Dance, there are various elements that show a connection with mathematical concepts, such as movement patterns, costumes and musical instruments that can be described mathematically. A simple example in this dance is the grouping of repetitive movements (polarity) and the division of rhythm which gives structure to the performance. This art can be an effective medium for exploring mathematical concepts in the context of local culture and providing a deeper understanding of how Pekalongan people interpret and apply these concepts in their daily lives.

However, there is a gap between the ideal that wants Sintren Dance to be preserved and the values of ethnomathematics upheld and the existing reality. Many of the younger generation are more interested in foreign cultures and no longer appreciate traditional arts such as Sintren Dance. Recent studies show that the younger generation's understanding and appreciation of traditional culture is decreasing (Ayatullah et al., 2024). This causes a decrease in participation in the preservation of this art. On the other hand, the clear connection between the artistic elements of Sintren Dance and the principles of ethnomathematics is often overlooked, so that the potential to strengthen understanding of mathematics through this art is not explored optimally.

The aim of this research is to explore and analyze the relationship between ethnomathematics and Sintren Dance, with the hope of providing new insights in understanding the role of local culture in mathematics learning and promoting the

preservation of traditional dance arts. It is hoped that this research will also be able to attract the attention of the younger generation to further explore local cultural values and integrate them in the context of mathematics education. By understanding this connection, it is hoped that we can find more innovative ways to convey essential mathematical concepts to the younger generation without losing existing cultural identities.

Thus, this research not only offers new learning values in the field of education, but also opens the way to encourage efforts to preserve Sintren Dance as part of Indonesia's cultural richness. This research will use qualitative methods to collect data through literature study and observation. In the end, it is hoped that the results of this research can provide significant benefits not only for the development of mathematics education, but also for the preservation of local culture.

METHOD

In this research, the method used is qualitative research with an ethnographic approach. Qualitative research is a scientific approach that aims to understand social and cultural phenomena in a natural context, with an emphasis on human experience in the area. Meanwhile, the ethnographic approach focuses on describing the culture of the community, including behavior, customs, language and symbols that are part of their lives. The subject of this research is the Pekalongan Sintren dance. a traditional performing art that is rich in cultural value. Data collection techniques used include literature study and observation. Literature studies are carried out to obtain information from various written sources such as books, journals, articles and other documents (Rahayu et al., 2024). Sintren Dance Performance, which provides a detailed overview of cultural and mathematical elements. As research material, video documentation is used to analyze the patterns that emerge in Sintren Dance performances, supported by systematic observation notes. The data collection methods in this research are. The data obtained was analyzed using content analysis techniques. The analysis process includes coding, categorization, and interpretation of findings related to floor patterns, dance movements, musical instruments, and dancer costumes. In addition, analysis was carried out by linking the findings with mathematical concepts, such as geometry, symmetry and transformation, to explain the relationship between dance and mathematics.

Based on the results of observations, researchers found various geometric concepts found in floor patterns, costume designs and musical instruments in Sintren Dance. The floor patterns reflect the use of geometries such as lines, circles and symmetry, while the costume designs feature repeating motifs with aesthetic proportions. In addition, geometric transformations such as rotation, reflection, and translation are

clearly visible in the dance movements and changes in floor patterns, which makes the dance more dynamic and interesting. Researchers also identified the application of the concept of angles in movements such as the mendak, which shows the close connection between dance and mathematics. These elements emphasize that the exploration of geometric transformations and floor patterns plays an important role in creating dances that are varied and not monotonous.

RESULTS AND DISCUSSION

Sintren Dance, a typical Pekalongan cultural heritage, contains various interesting elements that not only reflect the beauty of art, but also mathematical values. In this dance, there is a close relationship between culture and mathematics which is manifested through movement patterns, symmetry, and stage layout.

The Sintren Dance movement patterns illustrate geometric concepts such as rotation and translation, while the repetitive movement sequences display rhythmic patterns that reflect fractal concepts in mathematics. Symmetry is seen in the balance of the dancers' body movements, which reflects reflection and harmony, while the stage layout applies the principles of proportion and measurement. Ethnomathematics elements in Sintren Dance include geometric patterns, symmetry, mathematical rhythms, and spatial layouts that represent harmony between art and science.

A. Dance moves

1. Geometric concept in dance floor patterns

Rectangle Concept

In the Traditional Sintren Dance Performance, a group of dancers accompany the Sintren to enter the room carrying a cage into which the sintren will be inserted which forms a floor pattern.

figure 1

The floor pattern formed by the dancer in Figure 1.a shows the concept of ethnomathematics in a rectangular flat shape. In a mathematical context, a rectangular shape has two pairs of parallel sides of different lengths and all four

corners are 90 degrees. This floor pattern not only has aesthetic value but also represents mathematical elements, especially geometry.

Trapezoid Concept

When the sintren enter a cage to change clothes, the dancers prepare a dance accompaniment with the intention of waiting for the clothes changing procession carried out by the sintren in the cage where this forms a floor pattern.

figure 2

The floor pattern formed by the dancers in Figure 2 shows the ethnomathematics concept in the basic shape, namely the trapezoid. This pattern consists of two sides that are not parallel and two other sides that are parallel which give the impression of being conical to form a dividing wall which gives the impression of protecting the cage containing the Sintren. This floor pattern not only provides deep meaning but also represents the elements of mathematics, namely geometry.

Circle Concept

In the Sintren dance, dancers perform the dance by circling a cage containing sintren by waving their scarves over the cage. This is done as a procession in waiting for the sintren to change the clothes that have been given in the cage. In this dance, a floor pattern is formed.

figure 3

In Figure 3, the floor pattern formed by the dancers is circular. This circular movement not only has aesthetic value in the performance, but also reflects the natural application of geometric concepts. The circle pattern in the dance has a philosophical meaning, namely symbolizing unity and balance in local culture.

Half Circle Pattern

Sentren dance has various floor pattern formations, namely there are dancers surrounding a cage containing the sintren where the sintren is changing clothes. After the dancers surround the cage, the dancers form a semicircle pattern. This floor pattern emphasizes the focus on the cage which is the center of the performance.

figure 4

The floor pattern formed by the dancers is a semicircle which not only highlights aesthetic value but also has a mathematical concept, namely geometry.

This phenomenon not only shows the connection between dance and mathematics, but is also proof that geometric concepts have long been applied in the cultural activities of society for generations. Through the floor patterns found in various dance arts, students can recognize geometric forms, one of which is flat shapes.

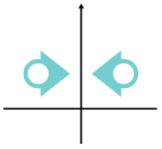
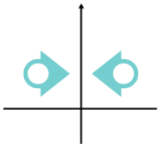
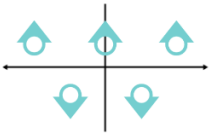
2. Geometry Transformation

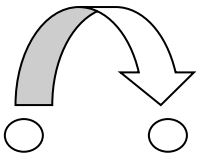
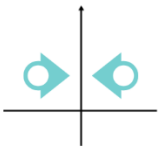
Transformation is a change in position or movement of an object or an object from its initial position to another position. There are 4 types of geometric transformation, namely translation, rotation, reflection and dilation (Rani Nurmaya, Reni Herawati, 2021). A plagiarism is a transformation from one set to another set (Hanafi et al., 2017). Translation is a shift or movement of a point in a certain direction in a straight line on a flat plane. Reflection is a reflection of all points using the mirroring properties of a flat mirror so that the shape or size does not change. Rotation is the movement of an object with a certain rotation angle in one direction or another. Dilation is the enlargement or reduction of an object.

In dance, geometric transformation often occurs in every movement made by dancers. The existence of this transformation concept ensures that the dance performed is not monotonous and has various positions that can entertain the audience. The following is a transformation of the typical Pekalongan Sintren dance.

Table 1. Dance geometric transformations

Picture	Illustration	Illustration Type

		When the lady-in-waiting gives clothes to the sintren there is a concept of transformation, namely reflection on the Y axis
		When the dancer changes position, there is a concept of reflection on the y-axis
		Dancers perform dance poses that are opposite to each other, which forms the concept of reflection on the x axis.
		Dancers make hand movements that form rotations, namely rotations with 180°.
		The dancer moves around the cage, where the movement illustrates the concept of 360 rotation.

		There is a 360 rotation in the dancer's hip movements
		There is a concept of translation, namely when a scarf is thrown where the scarf changes position.
		In the dance there is a concept of Reflection there is a y-axis
		When the dancer moves the scarf to the right, it goes up and when it goes to the left, it goes down, which contains the concept of rotation of the scarf which moves like the wheel of life.
		When the dancer is about to leave the stage, there is a 360 rotation concept, namely the dancer turns first and then leaves the stage

3. Corner

In dance, various body movements of dancers naturally form various types of mathematical concepts, one of which is angles. Angles not only serve as an aesthetic element in dance, but also play an important role in balance and coordination of movements (Naja et al., 2021). The following are the angles formed in the sintren dance:

Obtuse angle

In the Sintren dance, the dancer assumes a standing leg position, that is, the dancer stands low with the bend of the knee, which is done with the thighs open. In this position, mathematical concepts are formed. The mathematical concept of this position is that it forms an obtuse angle.

figure 5

Obtuse shrinkage is an angle that has a magnitude greater than $90°$ but less than $180°$. This angle is formed when two lines or segments meet with an opening that is greater than a right angle but has not yet reached a straight line, namely $180°$. In mathematical notation it is written as $90° < X < 180°$.

Acute angle

In dance, various mathematical concepts are formed, one of which is angles. When a dancer performs a dance, the dancer moves by waving his arms to the side which will form an acute angle as in the picture below.

figure 6

An acute angle is an angle that is greater than 0° but less than 90° written in mathematical notation $0° < x < 90°$. In ethnomathematics, the concept of angles in dance not only shows counting but also in culture also functions to create balance and beauty.

Right angle

In the sintren dance, the dancer makes movements with the arms raised to form a right angle.

figure 7

A right angle is an angle that is exactly 90 degrees. This angle is formed when two lines meet and form a perpendicular slope to each other. Dance is related to mathematics, namely its connection to the concept of second dimension geometry.

B. Costume

1. Sintren Crown

Sintren crowns are one of the accessories or head jewelry used in traditional Sintren art, especially by the main dancers who play sintren characters.

figure 8

Mahkota Sintren, as part of Javanese culture, not only has aesthetic and philosophical value, but also contains many mathematical concepts that are interesting to analyze. The Sintren crown contains a mathematical concept, namely a triangular geometric shape in the basic shape of the headdress used. The crown is generally in the shape of an equilateral triangle or an isosceles triangle, which is decorated with traditional ornaments which add to its beauty. This triangular shape is not only an aesthetic element, but also contains geometric elements such as side length, height, area, perimeter and angles which can be analyzed mathematically.

2. Belt

Sintren belts are one of the accessories used in traditional Sintren art performances.

figure 9

The belt in the Sintren Dance costume contains a mathematical concept, namely a rectangular geometric shape in its basic form. The belt is rectangular in shape with traditional ornaments on the edges that form a repetitive pattern. Apart from adding aesthetic value, this belt also contains mathematical elements that can be explained through geometric properties, such as length, width, circumference and area.

The belt in the Sintren Dance costume is not only a decorative element, but also contains various mathematical concepts that can be explained and applied in everyday life. Through the analysis of form, repetitive patterns, and measurement, we can see the connection between art, culture, and mathematics.

3. Sintren Shawl

Sintren shawls are one of the important accessories in the traditional art of Sintren, which have a role both aesthetically, functionally and symbolically. Sintren shawls are usually made from light, smooth, flowing fabrics, such as silk or high-quality cotton fabric. This scarf is usually worn wrapped around the shoulder, waist, or held by the dancer while dancing. The length of the scarf is usually adjusted to the needs of the dance movements, so that it can be played flexibly.

The sintren shawl is an element that not only beautifies the dancer's appearance, but also has deep meaning in a cultural, spiritual and ritual context. It is a symbol of elegance, magical power and cultural identity of the Javanese coastal community. Through this shawl, the audience is invited to feel the mystical and magical nuances that are the main attraction of the Sintren performance. Sintren shawls are clear proof of how rich and meaningful traditional Indonesian art is.

figure 10

The shawl in the Sintren Dance costume contains mathematical concepts, namely rectangular geometric shapes in their basic shape. The shawl has a certain length and width, and is decorated with tassel-like ornaments at the ends, which can also be linked to a repeating pattern. Apart from adding aesthetic value, this shawl contains mathematical elements that can be explained through geometric and series concepts.

The shawl in the Sintren Dance costume contains various mathematical concepts, such as rectangular geometry, repetitive patterns, symmetry, and arithmetic series. The beauty and regularity of this shawl design not only enriches

the aesthetic aspect, but also teaches the relationship between traditional art and mathematical principles.

4. Sintren Cage

The cage in the Sintren Dance costume is one of the important elements used in this traditional art performance. This cage is shaped like a cylinder, made from a circular frame covered with cloth, and functions as a symbol and supports the aesthetics of the dance. In Sintren Dance, the cage is a place for dancers to carry out movements or transformations that depict the magic and magic of the performance.

As part of traditional art, cages not only function as symbolic elements, but also reflect order and harmony which are closely related to mathematical concepts. Geometric elements such as radius, height, perimeter, surface area, and volume can be found and explained through this cage structure.

figure 11

The cage contains mathematical values that can be seen like a cylindrical geometric shape. The basic shape of the cage is a cylinder, so its geometric properties such as perimeter, surface area and volume can be calculated using geometric formulas.

Through this cage, traditional art shows how mathematical principles can be applied in real life. This element is not only part of cultural performances, but also provides contextual learning about mathematical concepts in everyday life.

C. Musical instrument

1. Kendang

Kendhang is a Javanese gamelan instrument which is played by hitting with the palm of the hand. Kendhangs are made from wood in an elongated round

shape, with a hollow inside (Supriyono et al., 2021). One or both ends are covered with leather as a surface that is hit to produce sound.

figure 12

In Figure 12 it can be seen that the kendhang contains a mathematical concept, namely the circular geometric shape on the top and bottom surfaces of the Kendang which is made of leather. Each kendhang surface has a circular area.

figure 13

In Figure 13 it can be seen that the kendhang has a tubular spatial element. Through the traditional kendhang musical instrument, students can observe the characteristics of these shapes which resemble circles and tubes. Students can learn about the radius, chord, circumference, radius, area and volume of the circle and cylinder elements in the Kendhang.

2. See

Bonang is a gamelan instrument in the form of a kettle or pot placed on strings in a wooden frame (rancak). The way to play it is by hitting the depression or cover with a special bat.

figure 14

In Figure 14 it can be seen that the surface of the bonang is a flat, circular shape, which can be recognized because it has no corners. This circle has a total of 360 degrees and has symmetry properties, both folding symmetry and an infinite number of rotational symmetries.

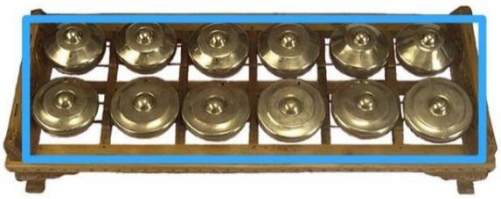


figure 15

The rancakan, namely the wooden place where the bonang is placed, can be categorized as a rectangular shape as seen in figure 15. This is because the rancakan has four corners in the form of right angles (90°) and two pairs of opposite sides of the same length. In addition, plancakan has two lines of symmetry and rotational symmetry.

figure 16

In Figure 3.5 it can be seen that the rectangular design is mapped into several square sections to make it easier to place the bonang in the middle. The part is said to be a square because it has right angles at all four corners.

3. Saron

Saron is a gamelan instrument consisting of metal blades arranged in a hollow wooden container. The number of bars in the saron corresponds to the main notes in the scale, namely between 6 and 7 bars.

figure 17

In Figure 17 it can be seen that the wooden container where the saron blade is placed is in the shape of an isosceles trapezoid. This shape is called a trapezoid because it has one pair of parallel sides and two other sides of the same length.

figure 18

In Figure 18 it can be seen that the saron blade is rectangular, because it has four corners in the form of right angles (90°) and two pairs of opposite sides of the same length. In addition, the blade has two lines of symmetry and rotational symmetry.

4. Gong

Gong is a round and flat musical instrument made of bronze or other metal. This instrument is played by hitting the center using a special bat or percussion (in Javanese terms).

figure 19

In Figure 19 we can see that the surface of the gong is circular. A circle has a total of 360° angles, and has an infinite number of symmetric folds and symmetric turns.

figure 20

In picture 20 we can see that in the middle of the gong there is a part that protrudes slightly and is shaped like a half ball. It is called a half sphere because it only has half a curved surface without any corners on the inside.

5. Knock

Kethuk has a shape similar to bonang, but only one kethuk is mounted on a plank and supported by a rope. The way to play kethuk is by hitting it using a bat covered in cloth, called a bindi.

figure 21

In Figure 21 we can see that the kethuk has a mathematical concept, namely that the top is half-spherical, which is part of three-dimensional geometry. Hemispherical elements can be obtained through direct measurements. The main elements of the ball include the radius and chord. Meanwhile, the basic part of Tap has a circle shape, which is a two-dimensional geometric shape. In this basic part, various elements can be determined such as radius, diameter, arc of a circle, center, circumference, radius, and area of a circle.

Ethnomathematics in gamelan can be an innovative and contextual learning for teaching mathematics in schools. Through Javanese gamelan students can learn mathematical concepts, especially geometry. By integrating Javanese gamelan into learning, students not only understand geometry in depth but also learn about local culture.

This research develops previous studies conducted by (Harisah et al., 2022) by adding a more in-depth analysis regarding geometric concepts in Sintren dance floor patterns, especially in the aspects of transformation and angles. This research also adds to the study of geometric concepts found in musical instruments used in Sintren performances.

This research explores the ethnomathematic content contained in the Sintren dance, especially in the rule that dancers must be female. Every movement of the dancer's hands holding and swinging the scarf forms a certain pattern that reflects

geometric concepts, so that this dance not only has aesthetic and cultural value, but also contains mathematical elements.

The impact of the results of this research is that more and more mathematical concepts are explored from the Sintren dance, so that mathematical literacy becomes richer and more diverse. This research strengthens the understanding that mathematics is not only limited to arithmetic operations or formal formulas, but is also related to cultural aspects, including floor patterns, dance equipment such as clothing and musical instruments as well as dance movements used in traditional dance.

This research contributes to the development of ethnomathematics studies in the community and educators so that they can better understand that mathematics is not a scientific discipline that is separate from everyday life, but is part of a culture that is passed down from generation to generation.

This research can also be a reference for educators in designing learning methods that are more contextual and interesting for students, especially in linking mathematical concepts with local culture. In this way, people's awareness of the existence of mathematical concepts around them will increase, which in the end can enrich their perspective on mathematics as a science that is dynamic, applicable, and close to everyday life.

CONCLUSION

This research shows that the Pekalongan Sintren Dance is a harmonious combination of local cultural arts and mathematical concepts that can be explained through an ethnomathematics approach. Geometric concepts are found in floor patterns, costume designs, and musical instruments, such as rectangular, trapezoidal, circular patterns, and symmetry that supports the structure of the performance. Geometric transformations, such as rotation, reflection, and translation, are visible in dance movements, which create dynamic variation and beauty in the performance. Apart from that, the concept of angles is also identified in the movements of the dancer's hands and feet.

The results of this research confirm that the mathematical elements in Sintren Dance not only strengthen cultural aesthetic values, but also have great potential to be used as a medium for learning mathematics based on local culture. Thus, it is hoped that this exploration can contribute to the preservation of the Sintren Dance and introduce innovative approaches in mathematics education that are relevant to the cultural context.

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