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EXPLORATION OF ETHNOMATHEMATICS IN BOJONEGORO THENGUL DANCE CONCEPT

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ABSTRACT

This research explores the relationship between dance and mathematical concepts through the analysis of Thengul Dance from Bojonegoro. The purpose of this research is to understand the mathematical patterns contained in the dance movements. Using the qualitative method and ethnographic approach, this research identifies mathematical elements in dance movements, floor patterns, and costumes. The results show that Thengul Dance contains mathematical structures that can be used as an interesting learning tool for students. The integration of ethnomathematics in education is expected to improve students' understanding of mathematics in the context of local culture and preserve cultural heritage. This research contributes to relevant curriculum development and encourages the younger generation to love their culture, as well as opening opportunities for further exploration of other traditional arts.

Keywords: Ethnomathematics, Thengul Dance, Patterns and Symmetry, Geometry

INTRODUCTION

The rapidly growing era of globalization has a major impact on various aspects of life, including education. The rapid development of information technology provides wide access to information and learning resources. However, behind this convenience, there is a big challenge in preserving local, national, and cultural values. Globalization often leads to cultural homogenization that can marginalize the diversity of a nation (Yuliana Setyawati, 2021). Therefore, it is important to filter the impact of globalization and technology in learning, by integrating local cultural values into the education system.

Indonesia is a country rich in cultural diversity, with various tribes, languages, and traditions spread throughout the region. Traditional dance is one of the cultural heritages that reflect the values of local wisdom and community identity (Indrawati, 2024). Thengul dance from Bojonegoro, East Java, is one example of a traditional dance that contains high aesthetic and cultural values. Thengul dance is an adaptation of wayang thengul which is an icon of Bojonegoro's original art. This dance is generally performed by a group of dancers with movements, expressions, and costumes that resemble wayang

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thengul (Putra, 2021) . Thengul dance is a work of art creation that was not only created for artistic purposes but also as a form of appreciation and an effort to revive the art of wayang thengul which is almost forgotten with the times.

Thengul dance has dynamic and expressive movements, which are usually performed at certain traditional events or celebrations. Apart from being a form of entertainment, Thengul dance also holds a deep philosophical meaning, which can be a rich source of learning to get to know the local culture more closely (Sumpana, 2022). The movements in Thengul dance contain mathematical concepts such as pattern, symmetry, geometry, and ratio. Therefore, the exploration of local culture as a learning resource in mathematics learning is very relevant to increasing students' interest and understanding.

According to D'Ambrosio (1985), ethnomathematics is a broad field of mathematics, because it includes not only mathematical aspects but also cultural aspects. Ethnomathematics is the study of mathematics by looking at how mathematical forms, such as symbolization, measuring, and comparing, but in a particular cultural context (Rosa, 2017). This approach recognizes that each culture has its way of understanding the mathematical world that is reflected in art, architecture, agriculture, and other daily activities.

In the Indonesian context, ethnomathematics can be found in various forms of cultural expressions, including traditional dance arts such as Tari Thengul (Wiwit Kurniawan, 2019). The mathematical concepts that can be explored in this dance, such as movement symmetry, time proportion, and rhythmic patterns, provide new insights into how mathematics is applied in people's cultural lives. Ethnomathematics recognizes that mathematics grows and develops in certain societies and cultures so that mathematics learning can be linked to the cultural context and environment around students (Zahar, 2021). By integrating culture and contexts familiar to students, ethnomathematics can help students visualize and concretize abstract mathematical concepts (Muhtadi, 2017).

Thengul Bojonegoro dance, characterized by its rhythmic and structured movements, can be used as a media to teach various mathematical concepts (Fitriatien, 2017). The movements in this dance can be analyzed to explore concepts such as patterns, symmetry, coordinates, and geometry. However, due to the development of globalization, the culture in Indonesia began to fade and was eroded by the outside culture that came to Indonesia so easily (Nada, 2023). So using dance as a learning media, students not only learn math in the abstract but also appreciate the cultural values contained in traditional arts. This also plays a role in fostering a sense of love for local culture while improving their understanding of mathematics in a more concrete and relevant context.

The purpose of this research is to examine and develop a culture-based mathematics learning approach, particularly through the exploration of ethnomathematics concepts in Thengul Bojonegoro dance. Through an approach that combines art and mathematics, it is possible to see how mathematical concepts are applied in real life, especially in local culture. In addition, this exploration also aims to

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introduce and preserve Thengul dance as part of Bojonegoro's cultural wealth. By integrating Thengul dance into learning, it is hoped that the younger generation will not only get academic benefits but also play a role in maintaining and preserving cultural traditions that have existed for a long time while fostering a sense of love and pride in the nation's cultural heritage.

Research on the exploration of ethnomathematics in Bojonegoro Thengul Dance concept presents a new perspective in understanding the relationship between dance and mathematics in the context of local culture. One of the interesting things is the identification of geometric patterns in dancer formations, costume designs, or dance movements, such as symmetry and rotation, which reflect both visual beauty and mathematical concepts. This research also explores the spatial patterns and trajectories of dancers' movements, the analysis of which can be related to graphs, vectors, or geometric transformations. Furthermore, this research offers innovation in mathematics education by linking the concepts found in Thengul Dance, making learning more contextual and interesting for students. Thus, the integration of local wisdom with modern mathematical concepts not only bridges culture and formal education but also contributes to the preservation of local culture. This helps to maintain the existence of Thengul Dance while enriching people's understanding of the interrelationship between culture, art, and science.

METHODS

This research uses a qualitative method with an ethnographic approach, which aims to understand cultural phenomena in depth by exploring mathematical patterns in Thengul dance. This approach was chosen because it can explore the meaning of local culture while connecting it to mathematical concepts through direct observation and interaction with cultural actors (Sari, 2023). The research subjects include dance performers, Thengul dance choreographers, and Bojonegoro cultural or community leaders who understand the cultural context of this dance. Meanwhile, the object of research is Thengul Dance, focusing on elements related to mathematical concepts, such as floor patterns of dance movements, symmetry, and geometric motifs on costumes.

Data collection was conducted through three main techniques (Sugiyono, 2010). First, observation, namely field observations to analyze floor patterns and dancer movements performed in Bojonegoro. Second, interviews with artists, choreographers, and local culturists by interviewing Mr. Suyanto to dig up information about the philosophy of movement, choreographic concepts, and cultural values contained in this dance. Third, documentation, which includes collecting photos, videos, and literature related to Thengul dance, as well as relevant historical records.

The data obtained was analyzed descriptively through two main stages (Noor, 2012). The first stage was the identification of mathematical elements, symmetry in costumes and movements, and floor pattern coordinates. The second stage is data interpretation, which connects the elements of Thengul

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Dance with mathematical concepts, such as geometry, number patterns, and symmetry, and explores their application in culture-based mathematics learning. This study aims to describe the results of ethnomathematics exploration, including ethnomathematical activities and mathematical concepts contained in Thengul Bojonegoro dance movements.

FINDINGS

The result of this research found that Thengul Bojonegoro dance contains various identifiable mathematical elements, which are not only seen in aesthetic form but also the structure of movement and careful planning. These mathematical elements can be found in the movement patterns, floor patterns, and costumes used in the performance. One of the most striking aspects is the movement patterns of the dancers, which often form diverse geometric formations, such as circles, straight lines, triangles, and other symmetrical shapes. These patterns not only create a beautiful and harmonious visualization but also serve as a guide that regulates the position and movement of the dancers in space. A deeper analysis of the movement patterns shows that each formation taken by the dancers has a purpose and meaning that is more than just an aesthetic arrangement.

The movements in Thengul Dance also show elements of symmetry, both individually and in groups. Symmetry in these movements is not only reflected in visual balance but also in the use of body angles designed to create order and harmony. Each position of the dancer's hands, feet and body contains certain angles that not only serve to embellish the movement but also reflect the principles of mathematics, particularly angular geometry, which is crucial in creating a sense of balance. Hand and foot movements that form certain angles indicate harmony between the two sides of the body, such as the right angle in the upright position of the hands or feet, or the acute angle formed when the dancer bends her body or limbs. These angles, though seemingly simple, provide the foundation for the dancer to maintain body balance, create visual beauty, and demonstrate control and precision in each movement. For example, when the dancer raises the hands at a certain angle, the body must adjust the angle of the legs or body position to remain balanced, creating harmony between the upper and lower body angles.

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Table 1. Symmetry Element of Thengul Dance Movement

Image	Shaped Angle	Movement Meaning
 **Figure 1.** Movement 1	➢ Hand • The right hand forms an acute angle of 30° • The left hand forms an acute angle of 30° ➢ Feet • The right and left feet are aligned to form a straight angle of 180°	This starting position shows readiness and harmony between body and soul. It symbolizes order and respect for nature and life.
 **Figure 2.** Movement 2	➢ Hand • The right hand forms an obtuse angle of 120° • The left hand forms a straight angle of 180° ➢ Feet • The right foot forms a straight angle of 180° • The left foot forms an obtuse angle of 110°	This movement reflects flexibility and adaptation. Its philosophy relates to how people can adjust themselves in various situations.
 **Figure 3.** Movement 3	➢ Hand • The right hand forms a right angle of 90° • The left hand forms a right angle of 90° ➢ Feet • The right foot forms an obtuse angle of 130° • The left foot forms an obtuse angle of 130°	This movement expresses stability and strength. It illustrates the importance of balance between actions and results.
	➢ Hand • The right hand forms an acute angle of 45° • The left-hand forms an acute angle of 45°	This movement depicts humility and respect. Its philosophy is connected to the humble nature of Javanese culture.

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Figure 4. Movement 4	➢ Feet • The right and left feet form an acute angle of 80°	
 **Figure 5.** Movement 5	➢ Hand • The right hand forms a right angle of 90° • The left hand forms a right angle of 90° ➢ Feet • The right and left feet are aligned to form a straight angle of 180°	This movement shows harmony and cohesion, reflecting cooperation within the community.
 **Figure 6.** Movement 6	➢ Hand • The right hand forms a right angle of 90° • The left hand forms a right angle of 90° ➢ Feet • The right foot forms an obtuse angle of 130° • The left foot forms a straight angle of 180°	This movement teaches the balance between the goal and the way to achieve it, illustrating the principle of harmony in life.
 **Figure 7.** Movement 7	➢ Hand • The right hand forms an obtuse angle of 130° • The left hand forms an obtuse angle of 130° ➢ Feet • The right and left legs do not form an angle so 0°	Representation of flexibility and freedom of expression. It symbolizes the openness of mind and heart.
 **Figure 8.** Movement 8	➢ Hand • The right hand forms a right angle of 90° • The left hand forms a straight angle of 180° ➢ Feet	The end of the series of movements shows courage and firmness in accomplishing something. The philosophy is about solid resolution.

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	• The right foot forms a right angle of 90° • The left foot forms a right angle of 90°	

As a whole, the series of Thengul dance movements reflect life values such as harmony, adaptation, stability, humility, harmony, balance, flexibility, and courage, all of which are closely related to the Javanese worldview. The application of angles in Thengul Dance also strengthens the visualization of unity built from geometric regularity. In some movements, the dancers form clear sharp angles, such as the acute angle between the hands and feet that create clean and defined lines. In addition, the floor patterns in this dance often form larger geometric angles.

Floor patterns in Thengul Dance create a variety of flat shapes and lines that vary in each floor pattern used. Some of the floor patterns that are commonly applied include pentagon, trapezoid, zigzag, equilateral triangle, and straight line. The following are the flat shapes and lines formed in each different floor pattern.

Table 2. Thengul Dance Floor Patterns

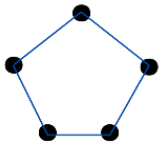
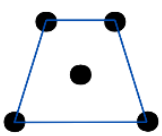
Image	Graphic	Pattern Shaped
 **Figure 9.** Floor pattern 1	 **Figure 10.** Graph 1	Floor Pattern 1 Zig Zag Line
 **Figure 11.** Floor pattern 2	 **Figure 12.** Graph 2	Floor Pattern 2 Pentagonal Flat Shape
 **Figure 13.** Floor pattern 3	 **Figure 14.** Graph 3	Floor Pattern 3 Trapezoidal Flat Shape

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Figure 15. Floor pattern 4

Figure 16. Graph 4

Floor Pattern 4

Straight Line

Figure 17. Floor pattern 5

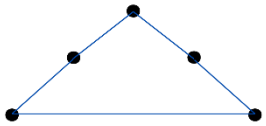

Figure 18. Graph 5

Floor Pattern 5

Equilateral Triangle Flat Shape

In addition to movement patterns and floor patterns, mathematical elements are found in the costumes and makeup used by the dancers. The dancers' costumes are decorated with various symmetrical patterns that can be observed in the embroidery designs, headdresses, and other accessories worn during the performance. These patterns, which are often geometric shapes such as parallel lines, triangles, or other repeating shapes, demonstrate the attention to detail and order in traditional textile arts. The symmetry in the costumes not only serves as a visual aesthetic but also illustrates the underlying philosophy of balance in this dance.

The geometric motifs found in the traditional cloth worn by the dancers also reinforce Thengul Dance's connection to mathematical concepts. Fabric patterns such as triangles, squares, and repeating motifs show the application of geometry principles in textile craft. These motifs are often made with techniques that require precise calculations, thus reflecting the practical math skills that have long been applied in local culture. Here are the Thengul dance costumes.

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Figure 19. Thengul Dance Costume

In Thengul dance costumes worn by dancers, there is a meaning and philosophy of each attribute.

Table 3. Meaning and Philosophy of Thengul Dance Costumes

Attributes	Meaning	Philosophy
Cunduk Mentul	Headdress resembling the shape of a Thengul puppet.	Symbolizes the majesty and traditional artistry of the Bojonegoro people.
Thengul Crown	A crown-shaped decoration is placed on the dancer's head.	Symbolizes wisdom, authority, and noble position in local culture
Bledak Cloth	A brightly colored traditional patterned cloth.	Symbolizes cultural diversity and the spirit of Javanese society.
Cundhuk Cloth	The bottom cover cloth with a distinctive pattern	Depicts the aesthetics of traditional beauty and harmony with nature.
Kemben and Sewek	The cloth is used to cover the upper and lower body.	Symbol of modesty, honor, and beauty of Javanese women.
Sampur	A shawl tied around the waist.	Symbolizes the flexibility and beauty of dance movements.

The combination of movement patterns, costumes, and geometric motifs emphasizes that Thengul Dance is not only an expression of traditional art and culture but also contains deep mathematical values. These elements not only beautify the appearance of Thengul Dance but also have the potential to become a contextual and relevant mathematics learning media, especially in introducing concepts such as geometry, symmetry, and number patterns to students. By integrating existing mathematical elements, Thengul Dance can be one of the real examples of the application of ethnomathematics in education.

DISCUSSION

The data from this research was obtained from several sources with various methods, but the main data came from interviews with the resource person Mr. Suyanto a Bojonegoro cultural and regional historian, he stated

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"Thengul dance was first introduced to the public in 1992 during the East Java Regional Dance Festival which was part of a series of Culture and Tourism Week in Madiun, East Java."

According to Sugiyanto, dance is a movement that is arranged, creates rhythm, and pays attention to time in space. Dance art can be interpreted as an expression through stylized or stylized movements and performed continuously, with elements of beauty in it (Sari, 2023) (Sugiyanto, 2024)

According to Wibisono in his book Dance Education, the development of dance until the modern era can be classified into two types, namely traditional dance and creation dance. Traditional dance is divided into popular traditional dance and palace traditional dance. Meanwhile, creation dance is a form of composing new dance works that are expressed freely without being bound by existing rules or patterns (Wibisono, 2011). In this context, Thengul Dance is included in the category of modern creation dance.

In the East Java Regional Dance Festival, each region was asked to explore its local potential. Bojonegoro Regency, which has long been known for its Wayang Thengul tradition, took advantage of this moment to elaborate the puppet art into a distinctive dance with traditional nuances. Joko Santoso, assisted by accompanist Ibnu Sutawa (alm), was given the task of composing a dance piece by the Bojonegoro P and K department. The artists in Bojonegoro agreed to create a dance inspired by Wayang Thengul, one of the three-dimensional puppets that developed in Java. Thengul Dance was created and became one of the best performance categories at the Regional Dance Festival (Firdaus, 2023)

Thengul Dance is interpreted as the movement of the human body that resembles the movements of Wayang Thengul, combined with choreography and additional innovations to give a unique and distinctive artistic impression. However, along with the changing times Thengul Dance has undergone changes and innovations. Thengul dance which is currently trending is the result of innovation from an association of cultural arts teachers when a cultural festival will be held in Madura. In 2018, Thengul Dance was officially recognized as Bojonegoro's distinctive intellectual heritage, strengthening the region's cultural identity.

Thengul Dance has a very distinctive characteristic, namely rigid facial movements with bulging eyes directed to the left and right, resembling puppets moved by the puppeteer. This tense and dramatic facial expression illustrates the strength of the character in the story being performed, showing intense emotions as if describing conflict or tension. These movements, performed in time with traditional music, serve as a means to convey the meaning and philosophy contained in the dance (Martutik, 2013). The dynamic, up-and-down rhythmic beating of the drums is a very important element in creating a lively and energetic atmosphere. The sound of the drums not only serves as a musical accompaniment but also acts as an emotional guide in the performance, providing a regular rhythm and providing tension at the right moment. The sometimes fast and sometimes slow rhythm of the drums, with thunderous or slow beats, can provoke spontaneous reactions from the audience, often inviting smiles or laughter.

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This rhythm seems to "tease" the audience with its changing dynamics, creating an atmosphere full of surprises and excitement.

> *"Thengul dance is an adaptation of wayang thengul. Some people say Thengul comes from two words, namely from the word "methentheng" and ngul from the word "methungul" which means "methentheng (extra energy) "methungul" (appear and be seen by the audience)"*

With expressive movement characters and unique musical rhythms, Thengul Dance succeeds in creating an enchanting and entertaining atmosphere. The uniqueness of body movements, facial expressions, and dynamic musical accompaniment make Thengul Dance a very interesting performance, not only in terms of dance art but also in terms of entertainment (Dewi, 2020). Every performance always manages to attract the attention of the audience and provide a deep experience. This success makes Thengul Dance a special attraction, not only for the local community but also for wider cultural art lovers. With its distinctive and colorful character, Thengul dance continues to make achievements as one of the works of art that represents the cultural wealth of Bojonegoro, providing unforgettable entertainment while preserving traditions that are rich in historical and philosophical values.

> *"Thengul dance was originally presented as a couple dance. However, along with the development of the times Thangul dance is usually performed by seven female dancers with white costumes and makeup like dolls. The form of presentation of Thengul dance includes movement, accompaniment, stage sets, makeup, fashion, lighting, and floor patterns. Thengul dance movements are strongly influenced by movements"*

The cultural experts hope that future generations can preserve Thengul Dance through various performances and cultural arts activities. Through these efforts, this original Bojonegoro art can be better recognized as part of the local wisdom of the region. As a form of preserving local cultural heritage, the younger generation of Bojonegoro continues to show enthusiasm for learning Thengul Dance (AyoSurabaya.com, 2020). Especially now that there are ethnomathematics that can integrate local culture into mathematics learning to make it more realistic.

Currently, Thengul Dance is taught in various schools in Bojonegoro Regency through art lessons and various school activities, such as farewell events, carnivals, and competitions organized by the local government and the school. In addition, Thengul Dance is also taught in art studios in Bojonegoro, one of which is Pamardisiwi Studio (Yasinta, 2016). This studio plays an important role in publicizing Thengul Dance until it becomes popular and recognized as a traditional dance. The development of art studios throughout Bojonegoro continues as an effort to preserve the nation's culture, especially traditional dance.

CONCLUSION AND SUGGESTION

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In this study, it has been discussed in depth about the relationship between dance and mathematical concepts, especially in the context of Thengul Dance. The result of the research shows that:

a) The conclusion of this research shows that Thengul Dance integrates elements of symmetry in its movements including acute angles, right angles, obtuse angles, and straight angles to create aesthetic harmony.
b) Each dancer's body position and floor pattern during Thengul Dance reflects the principles of geometry that are commonly applied, including the flat shapes of the pentagon, trapezoid, zigzag, equilateral triangle, and straight line to create balance and beauty in the order of the rows.
c) This research confirms the importance of understanding mathematics in traditional cultural arts, which shows the close relationship between art and science.

Further research could be conducted to explore other mathematical elements in Bojonegoro traditional arts or other regions so that more local cultures are documented and utilized in education. It is recommended to explore more deeply the application of mathematical concepts in other traditional art forms, to broaden the understanding of the interaction between art and science.

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