Absis: Mathematics Education Journal
Vol. 7., No. 2, November 2025, pp. 108-117
ISSN 2686-0104 (print), 2686-0090 (online)
http://journal.univetbantara.ac.id/index.php/absis/index

Exploration of Ethnomathematics in Roro Ngigel Dance: Representation of Motion and Pattern in Mathematics

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Received 28 November 2025; Accepted 29 December 2025; Published 31 December 2025

ABSTRACT

The purpose of this research is to express the representation of movements and patterns in Roro Ngigel dance in mathematics. The method used in this research is a qualitative method with an ethnographic approach. The instrument in this research is the researcher himself and cannot be represented. The data analysis technique was carried out by determining the geometry domain which was then described. The results obtained in this study are that there is ethnomathematics in the Roro Ngigel dance in the form of angles, lines, translations, and reflections. This research has implications in learning mathematics for learning through the development of mathematical skills, contextual learning, and cultural development or preservation. This can be done with learning strategies such as PjBL, PBL, or Inkuri Learning. The conclusion was obtained ethnomathematics in motion and pattern.

KEYWORDS

Exploration
Representation
Ethnomathematics
Roro Ngigel
Mathematics

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1. Introduction

Mathematics and culture are two aspects of human life that are closely intertwined. Ethnomathematics, as a study that connects these two aspects, offers a new perspective in understanding how mathematical concepts are manifested in various cultures. One cultural manifestation that is rich in mathematical elements is dance. Movements and patterns in traditional dances often contain elements of complex geometry. This is in line with the opinion that ethnomathematics can be explored from dance, one of which is Topeng Malangan dance in the form of lines and angles (Nurina and Indrawati 2021). Another study also revealed that in Javanese dance can also be explored mathematics, one of which is the Golek Manis dance (Ardiyansyah et al. 2024). In addition, in dance movements, mathematics can be explored, namely distance, points, and flat shapes that can be seen regarding in plate dance movements (Gazanofa and Wahidin 2023).

One of Yogyakarta's legendary dances is the Roro Ngigel Dance. This dance, created by Ida Manutranggana, depicts the growth of a girl as she approaches adulthood (adolescence). Etymologically, Roro means girl or virgin, and Ngigel means dance; thus, this dance represents the joy, agility, and elegance of a girl in expressing her identity. The combination of movements in this dance is very unique because it combines the assertive classical Yogyakarta dance style with the dynamic and agile Sundanese dance style. The visual richness of the Roro Ngigel Dance, from the curves of the body to the floor patterns formed, can be explored as representations of movement and patterns in mathematics. This exploration can be a medium for students in learning mathematics, which is often considered a difficult subject.. Math learning becomes difficult due to less innovative learning (Ayu, Ardianti, and Wanabuliandari 2021). Therefore, teachers must pay more attention to the learning methods they use to be more innovative to be able to improve student learning outcomes.

Learning by using learning media is included as innovative learning. This is supported by research which reveals that snakes and ladders learning media can improve student learning outcomes (Agustino, Susanto, and Wulandari 2024). Learning outcomes using snakes and ladders are also

evident in a similar study that tested the difference between learning that uses learning media and does not use it. The study revealed that there was a difference between the two lessons (Agustino and Abdillah 2024). Learning outcomes using snakes and ladders are also evident in a similar study that tested the difference between learning that uses learning media and does not use it. The study revealed that there was a difference between the two lessons (Harsiwi and Arini 2020). Besides the snakes and ladders learning media, other learning media, such as the use of multiplication cards, are also considered practical and innovative (Adawiyah and Kowiyah 2021). Furthermore, Canva is also said to be an innovative and engaging learning tool for students (Miftahul Jannah et al. 2023). This is supported by research that states that digital learning media can make learning more effective and innovative (Pratiwi, Larasati, and Berutu 2021)In addition to motivating students, learning media also affects student interest. This opinion is supported by research which reveals that there is an influence between the learning media used in carrying out learning and student interest in learning (Akbar and Hadi 2023). Therefore, one of the innovative learning that can be done is by using ethnomathematics in dance, especially in this study is *Roro Ngigel* Dance.

Less innovative learning causes an influence on student interest. This is in line with research that reveals that learning done by teachers has a positive relationship with the interests of students (Dewi and Lestari 2021). Student learning interest is an important thing that must be considered in learning. This is because there is a big influence in determining student learning achievement. This opinion is in line with research which reveals that there is indeed a positive and significant influence between learning interest and student learning outcomes (Nugroho, Muhajang, and Budiana 2020).

Student learning outcomes can be one aspect of the success of learning carried out by teachers. Good learning outcomes must start from teachers who can prepare learning tools properly such as preparing goals and strategies as well as digital teacher skills (Hidajat et al. 2024). Good student learning outcomes can be an illustration of education in a country. This is reflected in the role of education on human resources in a country. In line with this, there is research that reveals that education has a major influence on the productivity of human resources. (Desmawan et al. 2023).

This study aims to explore the representation of movements and patterns in Roro Ngigel dance in mathematics. The results of this exploration are expected to be used as an effort to increase student interest which in turn can improve student learning outcomes. This will be sustainable with the increasing quality of education. The novelty contained in this research is that not many dances have been explored. Therefore, researchers are interested in the representations that exist in the movements and patterns in this dance which can later be used as a new learning medium from ethnomathematics.

2. Method

This study uses a qualitative method with an ethnographic approach. Ethnography is an approach used to systematically study human culture, resulting in a realistic and authentic picture (Manan 2021). The data collection techniques used are observation, interviews, and documentation. After the data was collected, it was analyzed using the domain of geometry. The domain in this study is limited to the domain of geometry because the researcher wants to focus on exploring geometric objects in this dance. This research was conducted at the Sekar Danudara Dance Studio in Jatisobo Village. Data collection was carried out in stages to obtain in-depth result.

This ethnographic study involved three researchers. The first author, Vemas Dwi Agustino, and the second author, Isna Farahsanti, acted as outsiders, focusing on the theoretical framework and data analysis. Meanwhile, the third author, Eka Prasetyaningsih, had a significant dual role as a dance teacher and senior practitioner with more than 10 years of experience in teaching traditional Javanese dance and new creative dance at a dance studio. This insider position allowed the third researcher to conduct in-depth participant observation, where access to rehearsals, informal discussions, and understanding of technical dance vocabulary could be obtained authentically. The researcher's presence as a dance teacher may influence interactions in the field. Therefore, reflexivity is practiced continuously through field notes, documenting how the researcher's personal experiences aid interpretation, especially when interpreting the symbolic meaning of certain movements or teaching practices.

Vol. 7, No. 2, November 2025, pp. 108-117 ISSN 2686-0104 (print), 2686-0090 (online)

3. Results and Discussion

The Roro Ngigel dance is a dance that originated in Yogyakarta. This dance was created by Ida Wibowo, the daughter of one of the dance maestros, Bagong Kussudiardja. This dance tells the story of a girl who is growing up. This dance is a blend of Javanese and Chinese cultures. This is evident in the costumes worn by the dancers. The movements in this dance combine the smooth, flowing style of Yogyakarta with the more angular, broken movements of Chinese cultures.

Based on the data collection techniques used, the results of the study show that there are ethnomathematical elements in the Roro Ngigel dance. This can be seen from the floor patterns and movement patterns used by the dancers. These results will be analyzed based on the domain of geometry. The following will explain the mathematical aspects that can be explored in the Roro Ngigel dance.



Fig. 1 Maju Beksan Movement

The image above shows the opening movement of the Roro Ngigel dance. This movement begins with a *mendhek*, with the arms stretched straight down. The *mendhek* is the most important element in dance movements, with the legs slightly bent so that the body appears to be shortened (Yudhaningtyas, Hartini, and Afifah 2022). In addition to "mendhek," there is also "menthang" in the initial movement. Menthang is a movement where the hands are opened parallel to the body at an angle of approximately 45 degrees (Prastiyo 2024). The geometric element that can be analyzed in this movement is the position of the dancer's arms, which form an acute angle. An acute angle is an angle that measures more than 0° and less than 90°. Additionally, the dancer's bent legs also represent an obtuse angle, which is an angle greater than 90° but less than 180°. This is supported by research indicating that there is a concept of angles in a dance, which can be observed through the movements of the hands and feet (Sa'adah, Haqiqi, and Malasari 2021).



Fig. 2 preparatory Floor Pattern Turning To The Right



Fig 3. Floor Pattern Turns To The Right

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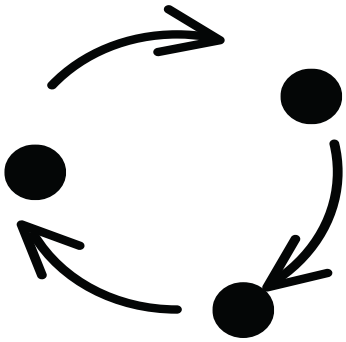

Fig. 4 Ilustration of Rotating Floor Movement

After the initial movement, the next movement is to turn. This movement is performed in a count of three times eight. The movement begins by facing forward, then stepping in a circular pattern until facing forward again. This is related to geometric transformation, namely rotation. In this movement, a 360° rotation is performed, starting by facing forward and then turning back to face forward again. The dancer can be represented as a point that is then rotated by 360°. This finding is supported by research revealing the presence of ethnomathematics in the circular dance floor pattern known as rotation (Ranali and Astuti 2023).



Fig. 5 *Ukel Wutuh* Movement

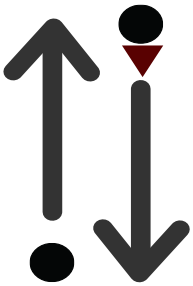

Fig. 6 Back and Forth Floor Pattern

The next movement that can be explored is *ukel wutuh*, which is a movement with the hands *menthang* and the wrists rotating. The floor pattern in this movement is from front to back. The movement in this pattern represents translation in geometric transformation. The dancer's body can be considered as a point that moves from front to back. This is supported by research indicating the presence of ethnomathematics in the form of translation in dance floor patterns involving forward and backward movements (Triyono et al. 2025).



Fig. 7 The starting point will move diagonally to the right



Fig. 8 The end point is diagonally to the right



Fig. 9 The end point is diagonally to the left



Fig. 10 The starting point will move diagonally to the left

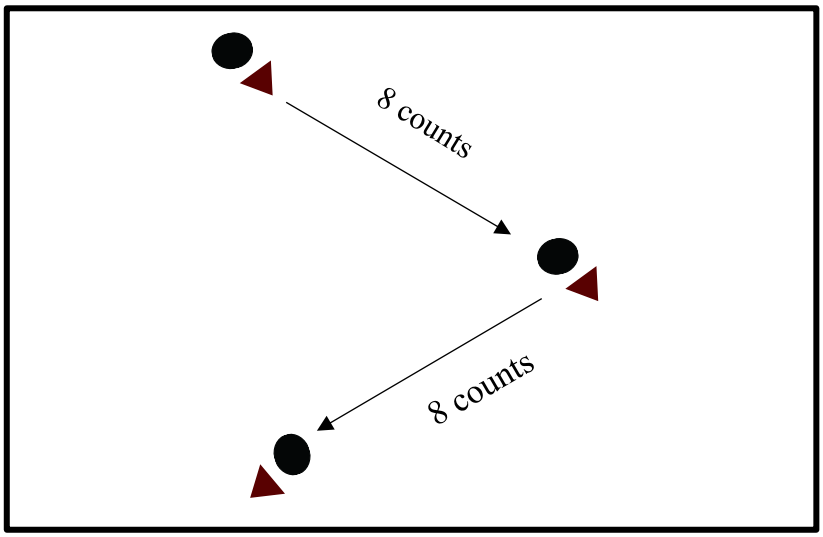

Fig. 11 Ilustration of Diagonal Movement Pattern

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Next is a forward step movement with alternating bent arms. This movement contains a diagonal floor pattern. Initially, the dancer stands at one point. Then, they step diagonally to the left with a count of one to eight and stop. Then, the movement is repeated in the opposite direction with the same count and stop. The floor pattern used by the dancer in this movement is a representation of a diagonal line, which is a line that can be drawn from two adjacent points but not vertically or horizontally. This view is supported by research revealing that there is ethnomathematics in floor patterns forming lines like diagonals (Rahayu, Hartati, and Kasyadi 2024).



Fig. 12 Move to the right and left with both arms extended and bent alternately.

The last movement that can be explored is moving to the right and left with both hands stretched out and bent alternately. This movement is performed by stepping to the left side with a count of one eight, then to the right with a count of one eight. In this movement, the hands are alternately extended downward and bent toward the shoulders. This hand movement represents reflection. This can be seen from the hand movements that move simultaneously between the right and left hands. This is supported by research indicating that there is a reflective representation in the hand movements of dancers when they are extended (Habibah, Zulkarnain, and Budiarti 2022).

In addition to the data described above, the movements and patterns analyzed earlier are also supported by the opinions of other dance teachers at the Sekar Danudara Dance Studio. These dance teachers were used as informants in this study. The following are the results of the interviews.

Interviewer : “Bisakah Anda memperlihatkan gerakan pembuka tarian sebelum penari-penari masuk ke panggung??”

Informant : “Gerakan awal penari adalah mendhek dengan tangan menthang. Kemudian penari bergerak maju sambil berputar tiga kali delapan hitungan.”

Interviewer : “Apakah gerak itu wajib dilakukan untuk awal tarian? Apakah boleh gerakan awal itu diganti dengan gerak lain?”

Informant : “Untuk gerak awal tarian dari pencipta dilakukan seperti itu, tetapi karena tari ini adalah kreasi baru maka geraknya boleh diubah disesuaikan dengan kemampuan penari.”

Interviewer : “Terkait dengan hitungan penari, apakah harus pakem sampai 8 hitungan?”

Informant : “Hitungan ini bergantung pada musik yang mengiringinya. Jika seperti di gerak awal menggunakan hitungan tiga kali delapan. Ada kala gerakan hanya menggunakan setengah hitungan yaitu satu kali empat.”

Interviewer : “Menurut Anda sebagai guru tari, apakah terdapat unsur matematika yang dapat dikaji dalam tari Roro Ngigel ini?”

Informant : "Menurut saya sebagai guru tari yang awam terhadap matematika secara khusus, saya melihat ada beberapa unsur matematika yang bisa diterapkan dalam tarian ini. Setau saya ada unsur pola melingkar yang membentuk lingkaran, pola diagonal, dan hitungan yang digunakan."

Interviewer : "Apakah menurut Anda tari ini bisa menjadi relevan jika digunakan sebagai media pembelajaran matematika untuk anak?"

Informant : "Ya, menurut saya ini sangat relevan karena bisa menjadi sarana anak mengenal matematika dengan cara yang asik."

Based on the interview above, it is known that the trainer also knows that there are mathematical elements that can be used in this dance. Although not everything discussed in this paper was conveyed by the informant, there are several things known by the informant related to mathematical elements that can be used. This is possible because the dance teacher does not have a background in mathematics.

Broadly speaking, this research is guided by the theory of Ethnomathematics proposed by D'Ambrosio, which reveals that a framework that recognizes that everyone does mathematics (*Mathema*) through culturally unique ways (*Ethnos*), resulting in a set of techniques and methods (*Tics*). The goal is to liberate mathematics from Eurocentric definitions and reconnect it with human cultural roots (D'Ambrosio 1993). Based on this theory, this study can proceed according to its objectives. Mathematics can be an alternative learning method that makes students feel less intimidated. This is also in line with research that reveals that ethnomathematics can be used as a medium for teaching mathematics to students (Irawan, Lestari, and Rahayu 2022). In addition to being a learning medium, ethnomathematics can also be used as an alternative method for solving mathematical problems (Astuningtyas, Wulandari, and Farahsanti 2017).

Ethnomathematics in the Roro Ngigel dance can have significant pedagogical implications in the world of education. There are implications that can be implemented, such as using it to develop mathematical skills as a means of fostering creative thinking in students through movement and patterns. Additionally, it can be used as contextual learning through hands-on student practice in analyzing mathematics within the movements and patterns of the Roro Ngigel dance. Beyond mathematics, these implications may also relate to the development or preservation of culture around the students. Students taught with ethnomathematics not only receive the material presented by the teacher but can also preserve their culture. This aligns with research indicating that ethnomathematics in a dance can be applied in education as well as cultural development or preservation (Tuzaman and Mulyatna 2024).

These pedagogical implications can be incorporated into learning through learning strategies. Learning strategies that can be implemented include Project-Based Learning (PjBL), which involves asking students to combine and develop dance movements related to mathematics, Problem-Based Learning (PBL) by presenting students with patterns and movements in the Roro Ngigel dance and asking them to solve the problem, and Inquiry-Based Learning, which can be implemented by asking students to research and analyze the movements and patterns in the Roro Ngigel dance related to mathematics and present their findings.

This study is based on previous research which revealed that there are mathematical elements in the movements and patterns of a dance, referred to as ethnomathematics (Faradhita, Harun, and Aini 2024). The results of this study are consistent with this, showing that there is ethnomathematics in the movements and patterns of a dance. The novelty of this study can be seen in the type of dance analyzed. Previous research used the Topeng Ayu dance, while this study uses the Roro Ngigel dance. The objects analyzed are also different, previous research only examined the counting and a few movements and patterns in the dance, while this study elaborates on the representation of movements and patterns in mathematics (geometry). This allows for a broader examination in exploring mathematics in movements and patterns.

Further research can be conducted by testing whether ethnomathematics-based learning can indeed be implemented. Of course, in further research, the methods and approaches used must be appropriate. For example, testing the relationship or influence of ethnomathematics-based learning

on student learning outcomes can be conducted. Thus, it will be clear how ethnomathematics can be applied in mathematics learning.

4. Conclusion

Based on the results and discussion, it can be concluded that the movements and patterns in dance contain mathematical elements known as ethnomathematics. This is reflected in the angles formed by the movements of the feet and hands, the lines formed according to the pattern of the dancer's floor, and the elements of geometric transformation, namely translation displayed in the front-back pattern and reflection in the dancers' intertwining hand movements. In addition, ethnomathematics can also be applied in education through the development of mathematical skills, contextual learning, and cultural preservation or development. These implications can be implemented through appropriate educational strategies. Recommendations in research can be developed not only by looking at mathematics from a geometric perspective, but also from other mathematical perspectives.

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