



Exploration ethnomathematics in the SAS program (Arek Suroboyo School) math game at SMP Negeri 13 Surabaya

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ABSTRACT

This study aims to describe the mathematical concepts contained in the PENGMATIKA game at SMP Negeri 13 Surabaya as well as students' responses after participating in the game. This research uses a qualitative approach with an ethnographic method, employing data collection techniques such as in-depth interviews, documentation, and observations involving teachers and students. The results show that the PENGMATIKA game contains mathematical concepts such as flat shapes including squares, rectangles, rhombuses, as well as circle nets. Students stated that learning through PENGMATIKA made it easier to understand flat shapes, solid shapes, and nets. This study contributes to the development of mathematics learning by demonstrating that traditional games can be used as an engaging and effective educational medium in schools.

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INTRODUCTION

Mathematics is part of a culture that grows from human activity in responding to the environment, so that its understanding is also influenced by a person's cultural background (Fadli & Afwan, 2024). The concept of ethnomathematics was introduced by D'Ambrosio (1989) as a way for a cultural group to carry out mathematical activities from everyday experiences. Ethnomathematics, as a culture-based mathematical approach, aims to help students not only understand mathematical concepts, but also recognize and instill cultural values in themselves from an early age (Fitriani & Putra, 2022). This approach allows for exploration of mathematical concepts in Indonesian culture and has proven effective in improving students' understanding, from translating symbols to solving problems (Andriono, 2021). Traditional games that are full of cultural values are part of ethnomathematics because they reflect local wisdom and shape the social character of the community, such as togetherness and strategy (Cahyani et al., 2023). However, in the digital era, this game is starting to be marginalized, even though it is important to reduce children's dependence on technology which has an impact on social interaction and cognitive development (Ulya et al., 2021). Children who are exposed to screens too often tend to

have difficulty focusing, thinking critically, and solving problems (Nur Miyazaki et al., 2024). In fact, around 20% of Indonesian children are already addicted to gadgets (FKUI). Therefore, traditional games play a role in maintaining the balance between culture and modern technology (Musyafak & Subhi, 2023).

To maintain the balance between tradition and technology, there needs to be concrete support from various parties. One of them is by integrating traditional games into the curriculum as part of efforts to preserve culture and character education (Fadli & Afwan, 2024). This is in line with the spirit of liberating education, where students are encouraged to develop according to their nature and needs, such as in the Merdeka Curriculum which emphasizes strengthening character and 21st century skills. The concrete implementation of liberating education is the Arek Program Sekolah Suroboyo (SAS) (Qomariyah, 2023). The SAS (Arek Suroboyo School) program is a concrete example of contextual education that combines formal learning with traditional games as a medium for preserving culture as well as an effective educational tool (Aries, 2023). This approach has proven to be able to shape the character and achievements of students, as seen in SDN Sambikerep I Surabaya through the remo dance activity which teaches appreciation for culture from an early age. This change requires teachers to act as facilitators who encourage students to be active, creative, and directly involved in the learning process (Arnetta et al., 2024).

Traditional games in the SAS Program, such as Engklek, Gobak Sodor, and Kites, not only preserve culture, but also become a fun learning medium (Aqobah et al., 2023). Through modifications such as PENGMATIKA (Engklek Matematika Game), students learn concepts of geometry, aerodynamics, and social values contextually. The uniqueness of Pengmatika lies in the combination of the traditional Engklek game with active and enjoyable mathematics learning. Students do not just sit passively, but learn while moving, which makes them more enthusiastic and focused. The questions given are adjusted to the flow of the game, so the mathematical material feels more concrete and easier to understand. The healthy competitive atmosphere and collaboration between students also become a distinctive attraction of this game. Active and curious children will find it easier to understand the material because this game stimulates motor skills, logic, and character at the same time, in line with the principle of ethnomathematics that mathematics has been part of culture for a long time (Aqobah et al., 2023). By using the SAS program as a learning medium, it gives a new impression to students in receiving material information packaged in the form of games.

In the context of learning, traditional games such as Engklek can be used to teach the concept of flat shapes, which can then improve students' mathematical abilities (Setiawan, 2020). In line with this research (Matulesy et al., 2022) shows that the Congklak game is also effective in improving numeracy skills, so it can be a fun alternative method in learning mathematics. In addition to providing pleasure, traditional games also function as a means to get to know culture and improve students' thinking and numeracy skills. Therefore, traditional games are recommended as a context in the design of mathematics learning in elementary schools, because they are easier for students to understand (Merliza, 2021). The application of a cultural approach in mathematics learning also aims to make learning more concrete and meaningful, as well as preserving local culture. This approach is expected to make mathematics material easier to understand and relevant, while introducing students to local culture to foster a sense of love for their cultural heritage (Huri Suhendri & Ningsih, 2023).

Culturally Responsive Teaching (CRT) is a method that integrates cultural elements, including local culture, into the planning and implementation of learning. The goal is to appreciate the diversity of learners so that they feel valued and more motivated, which has a positive impact on learning outcomes (Putri et al., 2024). Learning about this culture has been implemented in SMP Negeri 13 Surabaya through a program called SAS, where this program has not been widely implemented in other schools in Surabaya. SAS itself is a learning program created for students and has various activities that can be chosen by students according to their interests and talents. In

SAS SMP Negeri 13 Surabaya there are approximately 17 fields, both traditional and modern, in traditional games there are games of engklek, dakon, bekel, Benteng, Banjari and gobak. Sodor. In today's IT-based games, there are mobile legend games, photography, coding, podcasts, billiards, free fire, and PUBG. And for other talents there are dance, choir, sewing, and cooking.

Several previous studies have discussed ethnomathematics in traditional games. Research conducted by (Octaviani et al., 2021), This study discusses the exploration of mathematical elements in traditional hopscotch games of the mountain, flat, and rectangular types, which include the concepts of geometry, algebra, translation, sets, and probability, and have implications for geometry learning. Research (Harahap & Jaelani, 2022) discusses the ethnomathematics elements contained in the traditional game of hopscotch and its potential as a medium for learning mathematics for students. Research (Taskiyah & Widyastuti, 2021) discusses the exploration of ethnomathematics elements in the traditional game of hopscotch and the presentation of the character values of love for the homeland contained therein. This study identifies various mathematical concepts such as spatial shapes, cube nets, reflection, congruence, plane shapes, probability, and mathematical logic, as well as character values such as mutual cooperation, tolerance, and justice. This study will discuss the exploration of mathematics in the hopscotch game through SAS at SMP Negeri 13 Surabaya. The difference between this study and previous studies is that in this study the researcher not only found mathematical concepts in the hopscotch game but also different rules in the game called PENGMATIKA, so that hopscotch can be a fun learning medium.

Most students gave positive responses to the Pengmatika approach because they felt learning mathematics became more enjoyable and easier to understand. The activity of playing while learning makes the lessons not boring and more interesting. However, challenges remain, such as some students still having difficulty remembering flat shape formulas despite being helped by the game. This shows that although responses to Pengmatika are very positive, deeper understanding of the material still requires special attention. The purpose of this study was to describe the mathematical concepts contained in the PENGMATIKA game at SMP Negeri 13 Surabaya in the SAS program and student responses after participating in the game. The benefits of this study are that it can encourage teachers to be more creative and innovative in integrating traditional games into the learning process, thus creating a dynamic and inclusive learning environment.

RESEARCH METHODOLOGY

This research uses an ethnographic method with ethnomathematics specifications, namely an investigation into the culture of a community in its natural environment through observation, direct participation, in-depth interviews, documentation, and observation, without the aim of testing a hypothesis, but rather to describe certain variables, symptoms, or conditions (Karina et al., 2021).

This research was conducted from February to May 2024. The subjects of the research were students of SMP Negeri 13 Surabaya, especially for students who chose interests and talents in the SAS program in the field of traditional engklek games. During the process of the Pengmatika game, the researcher acted as an observer. The researcher did not participate actively in the game but observed the activities, recorded students' answers, and conducted in-depth interviews to explore students' responses and understanding of the learning media. Thus, the researcher's involvement was limited to observation and data collection without direct participation.

To ensure that students truly understood the mathematical concepts, not just experienced them visually, the researcher provided math problems to be answered before the game. These responses were scored to assess prior understanding. After playing Pengmatika, which integrates *engklek* with questions on plane figures, students showed improved understanding. A comparison

of pre- and post-activity scores revealed better grasp of geometric concepts. This indicates that Pengmatika supports contextual and enjoyable mathematics learning. In-depth interviews were also conducted to explore students' experiences, difficulties, and motivations. A semi-structured interview guide was used, covering key questions about the purpose of Pengmatika, mathematical elements in the game, and its impact on learning. This approach allowed for deep exploration while keeping the conversation focused.

Data analysis used in qualitative research was carried out during data collection, and after data collection was completed within a certain period of time. The technique used to analyze the data in this study is a descriptive technique or more specifically using an interactive method. The data analysis technique used in this study is the Miles and Huberman model, which includes: (1) data collection, (2) data condensation, (3) data presentation, and (4) drawing conclusions or verification (Rezhi et al., 2023). Data densification is done to select the game section in the SAS program that is related to the mathematical concept. Data presentation is done to see the overall picture of the results of the mathematical concept found (Harahap & Rakhmawati, 2022) in the traditional game of hopscotch. Then a conclusion can be drawn about ethnomathematics in the traditional game of hopscotch and its contribution to mathematics learning.

RESULTS AND DISCUSSION

The SAS program has been running in several schools in Surabaya, including SMP Negeri 13, adapting the implementation to suit each condition. In SMP Negeri 13, the program introduces online games such as Mobile Legends and PUBG (Player Unknown's Battlegrounds), to develop students' talents, as well as traditional games such as engklek, gobak sodor, bola bekel, and Benteng to preserve culture. Students are also introduced to various regional dances. This research focuses on the development of the traditional game engklek into PENGMATIKA, which integrates elements of mathematics.

The game of engklek (Javanese) is a traditional game by jumping on a flat surface drawn on the ground using stones or chalk, usually played by 2 to 5 children in the yard. However in the traditional game of hopscotch At SMP Negeri 13 Surabaya, the rules of the hopscotch game were modified to become PENGMATIKA, which links the game with mathematics learning, such as plane figures and nets, different from the rules of the traditional hopscotch game.



Figure 1. Traditional engklek game

In SMP Negeri 13 Surabaya there are three types of hopscotch tiles, namely square hopscotch tiles, mushroom hopscotch tiles, and windmill hopscotch tiles. In these tiles, mathematical elements are found, as in the picture below.



Figure 2. Square plot

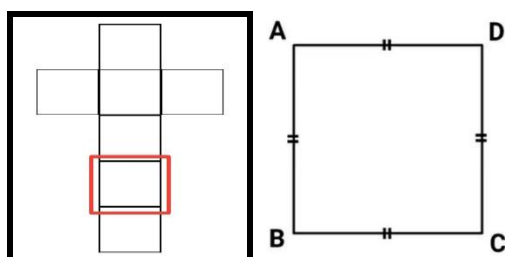


Figure 3. Cube nets and square plane buildings

- a. The properties or identities of a square that can be known from a square are: It has fourfold symmetry, has rotational symmetry of the fourth degree, the length of all sides of the square is the same, the square has 2 pairs of parallel opposite sides, each corner is a right angle, the two diagonal sides of the rectangle are the same length, the two diagonal sides of the square intersect exactly in the middle and form a right angle, each corner is divided into two equal parts by its diagonal.
- b. The properties or identities of a cube net that can be found from a square are: It has 6 equal side planes. The sides ABCD, ABFE, ADHE, EFGH, DCGH, BCGF, have 12 equal edges, have 8 equal corner points (90). Corner points A, B, C, D, E, F, G, and H, the cube has dimensions $s \times s \times s$, has 12 side diagonals.

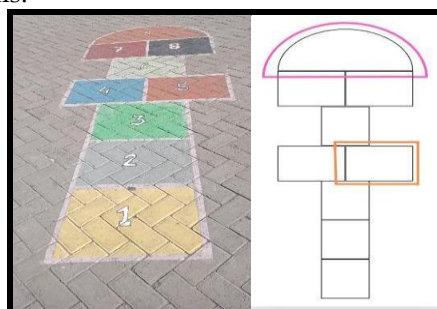


Figure 4. Mushroom shaped hop hop tiles

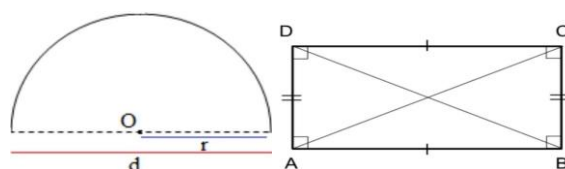


Figure 5. Making semicircles and squares flat length

- a. The properties or identities of a semicircle that can be found in a hopscotch square are: It has one curved side called the circumference and one straight side called the diameter.

- b. The properties or identities of a rectangle that can be found from a square are: The sides are parallel and the same length, the four angles are right angles, the diagonals are the same length and bisect each other.

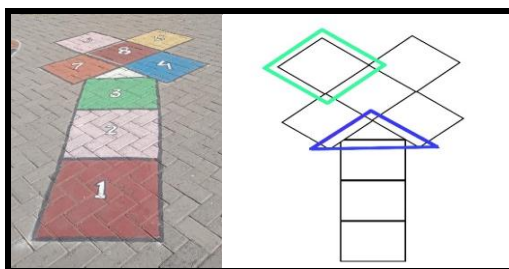


Figure 6. Windmill shaped engklek plot

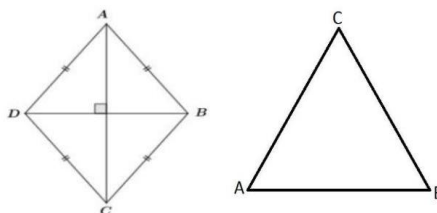


Figure 7. Triangle and split

- a. The properties or identities of a triangle that can be identified from a square are: It has three sides, has three angles, the sum of the three angles is 180° .
- b. The characteristics or identities of a rhombus that can be found in a cactus fruit are: It has four sides of equal length, namely sides AB, BC, CD, and DA. It has two pairs of opposite angles that are the same size, namely angle ABC with angle ADC and angle BAD with angle BCD. It has two diagonals that intersect at right angles, namely diagonal AC and diagonal BD. One diagonal divides the other diagonal with another diagonal that is the same length. Diagonal AC divides diagonal BD into two that are the same length, likewise diagonal BD divides diagonal AC into two that are the same length. It has two lines of symmetry and also rotational symmetry, where each axis of symmetry is sandwiched between diagonal AC and diagonal BD.

Based on the image above, and the previous explanation, it can be seen that the shape of the hopscotch game arena contains flat geometric elements. This is also reinforced by several opinions from the results of interviews according to mathematics teachers and students, namely:

- Researcher : On what basis did you modify the rules of the hopscotch game into a mathematics learning medium?
- Math teacher : Because on Traditional hopscotch games contain mathematical elements, namely flat shapes and nets. To facilitate learning and so that children do not get bored and tired quickly, learning can be done while playing.
- Researcher : In your opinion, what are the mathematical elements in the field of hopscotch?
- Math teacher : To wake up. The square-shaped hopscotch can be used to make a cube net. The square-shaped flat shape can also be used. In other hopscotch shapes, there are also semicircular flat shapes, and it can also be used to calculate the area and circumference.
- Researcher : In your opinion, are there any flat shapes in mathematics in this game?
- Student : There are, like squares have sides, and there are also rectangles.

This is reinforced by the results of interviews with mathematics teachers who stated that in square geometric shapes, mathematical elements such as square shapes that form cube nets and plane shapes are found. The results of interviews with students also stated that there are plane shapes such as squares and rectangles. SMP Negeri 13 Surabaya created a slightly varied rule in playing the hopscotch game called Pengmatika, namely (Mathematical Hopscotch Game) by utilizing hopscotch geometric shapes as a fun medium for playing mathematics. The following are the rules in the Matikan game at SMP Negeri 13 Surabaya. First, students will line up to wait for their turn to play. The order of the line is determined by the type of card, the student who wins the card first will be the first to play.



Figure 8. Students form a line backwards

The student who gets the first turn to play starts the game by throwing a small brick as a 'gaco' on the first square of the number. Before students start walking on the hopscotch square, students are given math problems, examples of problems given are none other than the mathematical elements contained in the hopscotch game.



Figure 9. Students answer questions



Figure 10. Students start playing

Students who successfully answer the question can continue the game, and the 'gaco' that the student threw in box number 1 will appear in box number 2. After the first student finishes

playing, he will return to the back row, and the second student will come forward to play. Still with the same rules, namely students answer the correct questions to be able to play. If the student is wrong in answering the questions given, the student can play hopscotch but the 'gaco' thrown in box number 1 cannot go up in box number 2 or the student can also immediately return to the back row to wait for their turn to play in the 2nd round.

The higher the square number, the more difficult the questions given. The student is said to win or the game ends if the 'gaco' thrown by the student has reached square number 8 or it can also be said that the student wins if the 'gaco' thrown is in a higher square than his other friends, so it does not have to reach square number 8.

Researchers took data to measure students' understanding of mathematics through the traditional game of engklek by taking a sample of 5 students. Researchers only took data up to the 5th round. The following are the results of the scores of students who can answer math problems with 5 rounds in the traditional game of engklek. Students who answer correctly will be given a score of 20 points and students who answer incorrectly will not get any points.

Table 1. Student answer results for mathematics questions

Student Name	Chapter 1 (Question 1)	Chapter 2 (Question 2)	Chapter 3 (Question 3)	Chapter 4 (Question 4)	Chapter 5 (Question 5)	Amount
Faliha	20	20	20	20	0	80
Dewi	20	0	20	20	0	60
Puput	0	20	0	0	0	20
Kevin	20	20	0	0	0	40
Rudi	0	20	0	0	0	20

From the table above, from the results of the hopscotch game experiment of 5 rounds, it can be seen that the highest score of the student who can answer the questions correctly is the first student, who gets 80 points. From this it can be concluded that the first student named Faliha won the hopscotch game with only 5 rounds.

Some math problems that can be used in animated games (engklek math games) are questions about the elements found in traditional engklek games. Such as, what is the circumference of a square?, what is the area of a square?, showing which side of a square? showing which side is the diameter of a circle, showing which side is the radius of a circle? and others.

Based on the explanation above, it can be seen that the shape of the hopscotch playing arena is not only composed of flat geometric shapes, but its circumference and area can also be known, and the number of rectangles arranged in the hopscotch playing area can be calculated, whether they are square, mushroom-shaped, or windmill-shaped. After the game was played, to find out the students' responses to whether the hopscotch game media helped in understanding mathematical concepts, the researcher conducted in-depth interviews with 5 students who were the subjects of the research.

Researcher : What can you get from this game?

Student 1 : It turns out that in the game of hopscotch you can also learn mathematics, I got new knowledge, it turns out that in hopscotch there are also mathematical elements that can be learned.

Student 2 : I learned about flat buildings in mathematics.

Student 3 : Besides playing, I can also learn through games.

Researcher : What makes this game easier for you to learn and remember math lessons?

Student 1 : I remember it, because every time I see an inch square, I can imagine the flat shape that is in the square. And learning with hopscotch is easier because it is not boring. And in the game we also compete to be the champion, so it can be a challenge.

Student 4 : I like to play while learning. So I can easily understand the developments in hopscotch. However, I also find it a bit difficult to remember the formulas for flat shapes, but with hopscotch I can learn while playing.

Student 5 : I prefer to learn with hopscotch rather than in class, maybe at first I forget to remember the formula. However, if I often try it while playing hopscotch, it becomes easier for me to remember it.

Based on the interview, students showed positive responses to the math game, especially in understanding the concept of flat shapes. Student 1 stated that Engklek made it easier to understand mathematics and made it more fun. Students 4 and 5 also felt that this game made learning easier, although there was a little difficulty in remembering the formula, but they felt it was easier to memorize it because they practiced often.

The application of ethnomathematics-based learning has a positive impact by making mathematics more interesting and relevant, changing the perception that mathematics is difficult and abstract, and introducing a culture that can increase awareness to appreciate and preserve culture. Other impacts are (1) learning mathematics becomes fun and contextual, (2) reducing the impression that mathematics is difficult, (3) getting to know one's own culture and other cultures, (4) fostering a love for culture, and (5) contributing to the preservation of culture through education. (Andriono, 2021)

CONCLUSION

Based on the research and observations conducted, it was found that the traditional game of hopscotch contains mathematical elements, including geometric shapes such as squares, rectangles, triangles, rhombuses, and circle nets. The game was modified into a version called PENGMATIKA to incorporate these mathematical concepts. Interviews with students revealed that learning through PENGMATIKA helped them better understand flat shapes, geometric solids, and nets in a more engaging and contextual way. This study shows that integrating traditional games like hopscotch into the SAS program enriches students' learning experiences by combining formal education with cultural values, creating a dynamic and inclusive environment. The main contribution of this research to ethnomathematics literature is demonstrating that the use of traditional games as culturally based mathematics learning media effectively enhances students' contextual understanding and enjoyment, while simultaneously supporting the preservation of local culture through education. Based on these findings, further research is suggested to explore ethnomathematics in other traditional games and to utilize the results as a foundation for developing culturally relevant mathematics teaching materials.

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