



Implementation of Ethnomathematics Strategy in Indonesian Traditional Games as Mathematics Learning Media

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Abstract: The learning strategy by associating cultural elements with mathematics is called ethnomathematics. The application of ethnomathematics in learning is very important in fostering a love for local culture which is currently almost abandoned due to modernization. This study aims to explain the mathematical elements contained in the Indonesian traditional game, namely engklek (hopscotch). The research method used ethnographic research. Data collection techniques used were observation, interviews, field notes, and documentation. The data analysis used was a triangulation analysis which consisted of data reduction, presentation, and drawing conclusions. The results of the study show that there are several mathematical topics in the game, including plane geometry, the concept of the relationship between angles (opposite angles and straight angles), cube net, congruence, the concept of reflection, the concept of mathematical logic, and the concept of probability. Hopscotch can be used as a medium for learning mathematics as a learning innovation in schools. The application of ethnomathematics strategies can improve elements of character education in the form of honesty, togetherness, and high sportsmanship in carrying out traditional games.

Keywords: engklek (hopscotch), ethnomathematics, learning media

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INTRODUCTION

The development of mathematical ideas, methods, and techniques has always been used by every culture in the world to support transactional activities between humans and the realities of life (D'Ambrosio, 1985, 2016; Risdiyanti et al., 2019; Rosa & Orey, 2016). The process of learning mathematics for students is part of the development and application of mathematical concepts in everyday life (Tanujaya et al., 2017; Madani et al., 2018; Prahmana et al., 2012). Freudenthal (2006) explains that human activities in everyday life contain mathematical concepts. However, the general public, including teachers, does not think that mathematics is related to culture, and it can be said that learning mathematics in the classroom has almost nothing to do with culture (Revina & Leung, 2019; Risdiyanti et al., 2019; Runisah et al., 2017).

Ethnomathematics is a cultural element that includes learning mathematics (Fauzi & Lu'luilmaknun, 2019). Meanwhile, according to Nursyahidah et al. (2018), ethnomathematics is mathematics that emerges from human activity in an environment that is influenced by culture. The relationship between mathematics and culture is commonly known as ethnomathematics. Ethnomathematics is a bridge that connects culture and education where these two things cannot be avoided in everyday life (Utami et al., 2018). In addition, ethnomathematics is a bridge that connects mathematics with everyday life (Abdullah, 2017). Ethnomathematics according to Mahuda (2020), is part of the culture with characteristics of mathematics (counting, measuring, connecting, sorting, and guessing). Ethnomathematics can be interpreted as mathematics that arises in a culture and is used to understand mathematics as a tradition in society (Rahmawati & Muchlian, 2019). According to Wahyuni et al. (2013), ethnomathematics is a form of mathematics influenced by culture. Culture is a hereditary custom within a community group (Freudenthal, 2006). Through the application of ethnomathematics in education, mathematics is expected that students can master targeted math skills without leaving cultural values. From several opinions about the meaning of ethnomathematics, it can be concluded that ethnomathematics is a learning strategy linking cultural elements in mathematics lessons. Ethnomathematics has begun to be widely studied by researchers in Indonesia starting from research on the Baduy people who always develop and use mathematical concepts in dealing with everyday life problems, while these people do not attend formal education (Arisetyawan et al., 2014; Karnilah et al., 2013).

Several previous studies have implemented several types of traditional games in learning mathematics,

such as *congklak* to improve numeracy skills (Nataliya, 2015), the *congklak* game to introduce the concept of counting operations in Mathematics Learning (Siregar et al., 2014), the *engklek* game as a media for learning mathematics (Fauzi & Lu'luilmaknun, 2019), the *kempren* games to explore the concept of counting operations (Elly, 2020), the use of marble games in mathematics learning (Febriyanti et al., 2019), connecting hopscotch and top games with mathematical material about flat shapes and geometric shapes (Febriyanti et al., 2018). The results of these studies on traditional games are known to increase learning achievement in understanding students' mathematical concepts. Research by Fitriyah and Khaerunisa (2018) shows that the modified traditional game-assisted drill method has an effect on junior high school students' mathematical problem-solving skills. Research by Muthmainnah et al. (2018) shows that the *engklek* traditional game as a learning method has a positive effect on the learning motivation of elementary school students. Research by Utami et al. (2018) shows that there is an effect of traditional game-based learning on the social skills of elementary school students. Meanwhile, a study by Kawuryan et al. (2016) reveals that traditional game-based thematic learning models and scientific approach orientations are proven to be positive and have a significant effect on the creative thinking skills of elementary school students. Imswatama and Lukman (2018) present that ethnomathematics-based mathematics teaching materials have proven to be effective in improving problem-solving skills and mathematical critical thinking of junior high school students.

One of the teacher's strategies in learning that stimulates students' problem-solving skills is Realistic Mathematics Education (RME) (Tanujaya et al., 2017; Hidayati & Prahmana, 2022; Matang & Owens, 2004; Saleh et al., 2018). Therefore, this study uses RME as a learning approach. One context that can be used is the culture that is applied in realistic mathematics learning and modified according to the local context where the school is located (Damayanti & Putranti, 2016; Gravemeijer & Doorman, 1999; Haris & Lma, 2011; Oktiningrum et al., 2016; van den Heuvel-Panhuizen, 2005). As a result, if taught in schools, it can lead to enthusiasm for contextual learning. In addition, the cultural context can be used as a solution to cultivating cultural values and student characters that are almost extinct due to the influence of modernization (Abdullah, 2017; Maryati & Prahmana, 2019; Muhtadi et al., 2017; Risdiyanti & Prahmana, 2017; Sembiring et al., 2008). Each regional traditional game has its own characteristics (Harahap & Jaelani, 2022; Nursyahidah et al., 2018). Lestari (2022) explains that *jinggi*, which is a game from Indonesia called *jingki*, originates from Italy, Rome, which is known as the *jingkit* game. Hopscotch comes from the words hop and scotch. Hop means to jump or skip and scotch means the line played. One of the traditional Indonesian games that contain ethnomathematics and can be used as mathematics teaching material is *Engklek* (hopscotch). This is in line with research by Haris and Lma (2011) and Rahmawati and Muchlian (2019) which shows that the hopscotch game is effectively used for learning mathematics. Engklek is a traditional game found in various regions in Indonesia, including in North Sumatra.

The procedure for playing this hopscotch game is quite simple because this game is carried out on a flat surface, usually on the ground in the form of a grid image. The hopscotch game is usually played by several children and mostly by girls. Each child must have a stone to throw at one of the patterns of rectangles outlined on the ground and then jump over every available square using one of his/her feet. The stone is called *gacok* in North Sumatra. This study aims to describe the mathematical elements contained in the traditional Indonesian game and complement the studies from previous studies. Engklek is one of Indonesia's traditional games in a cultural context. This game is chosen because it is very closely related to mathematics and can be done outside the classroom so that it can be used as an exercise to stimulate the growth of student creativity and innovation in implementing learning outside the classroom. This game is also very familiar to the participants both in terms of culture and everyday life. Prahmana et al. (2012) state that traditional games are fun because they contain concepts.

METHODS

This study used an ethnographic research method, that is qualitative research developed from anthropological methodology (Gusterson, 2008; Ren, 2016). This method investigates society and culture by examining human, interpersonal, social, and cultural relations in all their complexity (Shagrir, 2017; Draper, 2015; Hammersley & Atkinson, 2007). In line with this, this study described what are the mathematical elements contained in the traditional game of *engklek*, so this research focused on the traditional game of the North Sumatra society which is called *engklek*. The game consisted of a game area and a ladder which is called *gacok* by the people of North Sumatra. Then there were rules for playing and players. Data collection techniques used were observation, interviews, field notes, and documentation. The objects of this study were three types of *engklek* (hopscotch) games, namely *engklek bara*, *engklek kasur*, and *engklek kapal*. The subjects were students in one of the public schools in North Sumatra. The informant of interviews to obtain information about the elements contained in the North Sumatran traditional game was one lecturer in mathematics education and one lecturer in traditional arts and culture.

Data analysis in this study used data triangulation. Triangulation is a technique to analyze the results of the same study using different methods of data collection (Sciberras & Dingli, 2023). Data reduction is a form of analysis that sharpens, classifies, directs, and removes unnecessary. In this study, the results of data collection which was carried out through interviews, observation, and documentation about the traditional game of *engklek* were reduced by selecting the information needed in this study. The results of data reduction show that the elements contained in this *engklek* game are elements of geometry, cube nets, angles, reflection or mirroring, and the concept of opportunity. Then after being reduced, the next stage was the presentation of the data where in this study the results of the data reduction were presented by depicting a sketch of the *engklek* game area and then explaining the mathematical elements contained in it. After reducing and presenting the data, conclusions were drawn to find out what the mathematical elements are in the *engklek* game, both from the game field, the players, the rules of the game, and the lagger.

RESULT AND DISCUSSION

Traditional games can be one of the most important activities for children to improve their social problem-solving (SPS) skills (Ivić, 1986; Yilmaz & Griffiths, 2023). The *Engklek* game is one of the traditional games of the North Sumatra people which is very popular among children, especially children aged 7 to 15 years. This *Engklek* game has a simple game system, where the players in the *Engklek* game are two to five people. People like this game not only as entertainment but there as an educational value contained in the *Engklek* game. This game describes a person's struggle in fighting over his territory with the rules of the game that have been mutually agreed upon. The rules of the game are simple, namely (1) players must use one foot to stand on every square on the game field; (2) players may not step on the line on the game field; (3) the stone thrown must fall exactly on the intended map. If the stone thrown is on the arena line or on a map that is not intended, then the player has declared a loser; (4) players may not set foot on a plot containing opponent's paws; (5) All maps in the arena must have been filled in by the player's ladders; (6) players may not set foot on territory that has been obtained by the opponent; (7) the game is declared finished if all the maps in the *Engklek* arena become the player's territory; (8) The player who has the most jurisdictions is declared the winner.

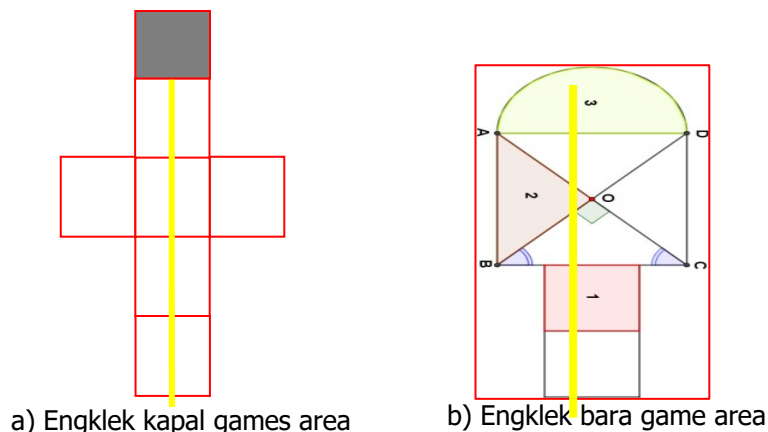


Figure 1. The Engklek game area

Figure 1(a) shows the *engklek kapal* game area which is a type of Engklek game often played by children. The steps in the *engklek* game are (1) the players make the *engklek* arena on the ground; (2) each player must have a lagger made of broken tiles or ceramics and placed on the first square of the Engklek arena; (3) players do *hompimpa* to determine the order of the game; (4) the first-placed players start using one foot from the second to the last square and return again to take the lagger in the first square; (5) the first player throws his lagger to the second square, then continues his footing until the last square and takes his lagger outside the game field again; (6) this is done continuously until all the squares have been filled with the lagger of the player who has a turn, and the player may not set foot on the square filled with the lagger; (7) substitution of the second order player, if the first order player makes a mistake by stepping on the line of the game field or the ball thrown is not on target; (8) the second order player takes the same steps as the first order player until he makes a mistake and changes turns for the third order player until the last order player; (9) after all the maps on the Engklek game field are filled with the player's lagger, the player is given the opportunity to search for territory; (10) to find territory, the player turns his back to the playing field and then throws his lagger into the arena, so that the map where the player's lagger falls becomes his territory; (11) territory won by a player, other players may not step on the map during the game; (12) the player who gains territory is

declared victorious.

This Engklek game will indirectly shape the child's character because this game contains many benefits for children's development. The benefits that can be taken from this game are to train the child's physical and balance when doing a foothold with one foot, train the child's concentration when throwing the ladder in the target area, train the child's intelligence because in the game they are trained to count step by step that must be passed, train children to obey the rules, train children to socialize with their friends and train children's creativity. This is in line with studies by Aleem et al. (2016), Cheng and Liu (2015), Kruskopf et al. (2021), and Misra et al. (2021) that there are cultural values in traditional games such as the values of honesty, leadership, togetherness, fostering a sense of responsibility and training children in numeracy, thinking and logical skills. In addition to forming students' characters, Engklek games have mathematical elements. The results of the exploration of the Engklek game present elements of plane geometry, relationships between angles, nets, congruence, reflection, mathematical logic, and the concept of probability or opportunity. The following is a discussion of the elements of mathematics based on objects that are focused on by the researchers, namely the game area, the players' ladders, game rules, and players. Basically, there are various types of Engklek traditional games. However, three types are often played by children in North Sumatra, namely *Engklek bara*, *Engklek kasur*, and *Engklek kapal*. The sketches of each type of *engklek* can be seen in Figure 1(a),(b) Engklek games area.

Based on the results of research and exploration of the Engklek game field, several mathematical elements are found, namely the existence of plane geometric elements, relationships between angles, flat shape nets, congruence between buildings, and reflections. This statement is in line with studies by Angraini et al. (2022) and Aprilia et al. (2019) that the game can be a context for teachers in remote areas in teaching geometry and be a reference for identifying other contexts which can make mathematics learning easy. Mathematical elements in the form of plane geometry and the concept of relationships between angles are presented in Figure 1(b). In Figure 1(b), three field elements form a map of the Engklek game field, namely square, triangle, and semi-circle. In the square ABCD, if the two diagonals are pulled, namely the diagonals AC and BD, it will form four isosceles right triangles where point O is the angle of the four triangles. In an isosceles triangle, you can find the angles formed. For example in the triangle BOC, because the angles are at the point. The concept of the relationship between angles that occurs is the concept of opposite angles and straight angles. Figure 2 presents an illustration of the map of the Engklek game field which contains elements of the relationship concept. O is a big angle $\square BOC \square 90^\circ$ and size between angle $\square OBC = \square OCB \square 45^\circ$. Furthermore, another element of mathematics is the concept of the relationship between angles.

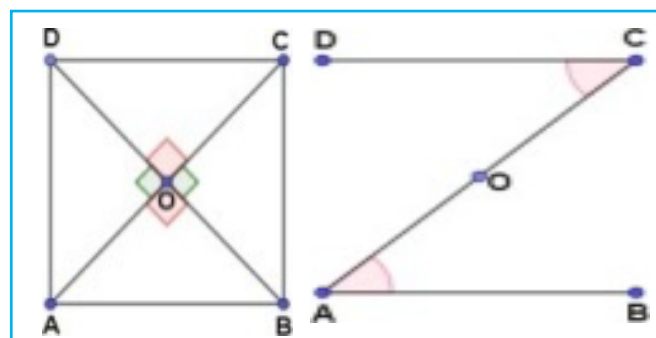


Figure 2. Illustration of the concept of the relationship between angles

Figure 2 presents an illustration of the concept of opposite and straight angles (see Figure 4a), and the concept of opposite angles (see Figure 4b) is found on the Engklek game field map. In Figure 4a, the opposite angles in the illustration are $\square AOB$ with $\square COD$ and $\square AOD$ with $\square BOC$. Because the size of $\square AOB \square$ size of $\square COD \square 90^\circ$ and the size of $\square AOD \square \square BOC \square 90^\circ$, it can be concluded that the opposite angles are equal. Meanwhile, the aligned angles are $\square AOB$ is aligned with $\square BOC$, and $\square BOC$ is aligned with $\square COD$. From this illustration, the sum of the straight angles is 180° . Furthermore, Figure 4b presents the concept of opposite angles where the $\square BAO$ is opposite the $\square DCO$. Because the size of $\square BAO$ is equal, then $\square DCO \square 45^\circ$, it can be concluded that opposite angles have the same measure. This is in line with a study by Zakiah and Nina (2020) that there is a geometry concept in the traditional game.

The next mathematical element contained in the *engklek* game field is the net. The Engklek game arena forms cube nets. An illustration of a cube net on the hopscotch game arena is presented in Figure 1(a). When starting the game, each player's head is placed on the first map, i.e., the shaded area of the image. In the rules of the game, the squares that contain a ladder cannot be stepped on by players, so the tiles that are allowed to be stepped on by players are the second to seventh maps so that the tiles that are allowed to be stepped on

by players will form a cube net. In addition, the concept of congruence also occurs in the Engklek arena map. This can be seen from the shape of the same arena, which is a square.

The mathematical elements contained in the next engklek game arena are the concepts of reflection or mirroring. The engklek game arena has a mathematical element, namely reflection. This is in line with research by Aprilia et al. (2019) which discusses the presence of a mirror element in *Engklek kapal*. This study shows that another type of *engklek* that has an element of reflection is *Engklek bara*. In Figures 1(a) and 1(b), there is a line of symmetry marked in yellow which can be presented as an illustration of the reflections found in the engklek game arena. If the axis of symmetry is pulled, it will cut the field into two equal parts, namely right and left. The right and left symmetry in the hopscotch game area, so it can be said that the right side is the reflection of the left side of the traditional hopscotch game area. The stone or ceramic shards used by hopscotch players are called *lagger* which is part of the engklek game used as a playing tool made of tile shards or ceramic shards. In choosing a *lagger*, players look for a *lagger* that has a flat shape so that if it is thrown on the map in the Engklek game arena, the player will not roll and fall right on the intended map. From the results of the study, the shape of the *lagger* contains flat-plane geometric elements. This research is in line with the research by Aprilia et al. (2019). This can be seen from the shape of the *lagger* which is a square, triangle, circle, or trapezoid. The shape of a *lagger* which contains flat plane elements is presented in Figure 3. Students can learn flat shapes contextually and more easily by using *lagers* from the *Engklek* game.

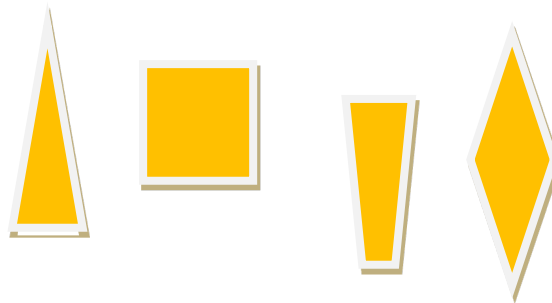


Figure 3. Field geometry elements on lagers

From the results of the research and completing the examples from research by Aprilia et al. (2019), Arisetyawan et al. (2014), Fauzi and Lu'luilmaknun (2019), and Febriyanti et al. (2018), the rules in the Engklek game have elements of mathematical logic. For example, the implication rule is taken to determine the continuation or death of the insider. A simple example is given two statements of the Engklek game rules, namely: x = Ardi throws his *lagger*, not on the target map, y = Ardi cannot continue the game so it is replaced by another player. The implication of the two statements is $x \rightarrow y$ = if Ardi throwing the *lagger* is not right on the intended map, Ardi cannot continue the game so he is replaced by another player. As another example, given the following two statements: k = Ira has the most jurisdictions, L = Ira wins the Engklek game. From the statement above, the implication is $K \rightarrow L$ = if ira has the most areas of authority then ira wins the engklek game. Furthermore, the Engklek game players also have a mathematical element. The mathematical element contained in Engklek players is the concept of probability or opportunity. In this case, the concept of opportunity to gain territory is exemplified. When one of the players completes the first round of missions in the Engklek game, the player is entitled to a territory. If you use the types of *engklek kapal* and *engklek bara* that have 7 tiles, then the player's chance of getting territory is $1: 7$ or $\frac{1}{7}$ (one to seven). Meanwhile, if you use the *engklek kasur* type which has 9 tiles, the chance for players to get a territory is $1: 9$ or $\frac{1}{9}$ (one to nine). This is in line with research by Aprilia et al. (2019) that the Engklek game has the concept of probability or opportunity. The example is used to determine the pattern of the order of play. For example, there are five children who want to play Engklek, then the five children do *hompimpa* to determine who will play first, second, third, fourth, and fifth. Because five children are playing, the number of sequence patterns that occur is as many as 120 sequence patterns for playing engklek is the five children.

From the discussion above, it can be concluded that the traditional game of *engklek* contains several mathematical concepts. The results of the exploration of the Engklek game find mathematical elements of plane geometry, relationships between angles, nets, congruence, reflection, mathematical logic, and the concept of probability or opportunity. This is in line with research by Damayanti and Putranti (2016), Febriyanti et al. (2018), Fitriyah and Khaerunisa (2018), Harahap and Jaelani (2022), Maulida (2020), and Muthmainnah et al. (2018). The *engklek* traditional game can be used as a medium for learning mathematics related to the material elements of plane geometry, relationships between angles, nets, congruence, reflection, mathematical logic, and the concept of probability or opportunity, so learning mathematics has innovations that are not monotonous

in the classroom. This can trigger students' interest and motivation towards learning mathematics. This is in line with experimental research conducted by Ivić (1986), Misra et al. (2021), and Sembiring et al. (2008) on the traditional game shows that students are more interested in learning mathematics, and the traditional game used is very fun, so students' interest and motivation can increase students' learning outcomes. This is in line with research by Baumert and Demmrich (2001), Borges del Rosal et al. (2012), Cavadini et al. (2021), and Kitsantas et al. (2021). The other research states that other important elements, besides elements of mathematics, are the elements of character education in the form of honesty, togetherness, and high sportsmanship in carrying out traditional games (Aleem et al., 2016; Cheng & Liu, 2015; Ivić, 1986; Kruskopf et al., 2021; Misra et al., 2021).

CONCLUSION

From the discussion above, it can be concluded that the traditional game of *engklek* contains several mathematical concepts. The results of the exploration of the *engklek* game find elements of plane geometry, relationships between angles, nets, congruence, reflection, mathematical logic, and the concept of probability or opportunity. Hopscotch can be used as a medium for learning mathematics related to that material, so learning mathematics has innovations that are not monotonous in the classroom. This can encourage students' interest and motivation in learning mathematics, so students' learning outcomes will increase. Other important elements, besides elements of mathematics, are the elements of character education in the form of honesty, togetherness, and high sportsmanship in carrying out traditional games. Ethnomathematics-based learning is very important to be implemented in schools. This indirectly instills cultural values in children. Therefore, it is suggested to conduct ethnomathematics research on other traditional games. However, other cultural elements can be used to serve as media for learning mathematics.

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