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Ethnomathematics in Dengklaq Games as a Media for Learning Mathematics in Sinunukan 1 State Junior High School

[1*]Suparni, [2]Torang Siregar

[1,2]UIN Syekh Ali Hasan Ahmad Addary Padangsidimpuan

[*]**Corresponding Author**: *Email: torangsir@uinsyahada.ac.id*

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A B S T R A C T

Ethnomathematics is an instructional approach that establishes connections between cultural components and mathematical concepts inside educational settings. The incorporation of ethnomathematics-based learning holds significant importance in cultivating character values and nurturing children's appreciation for local culture, which has experienced neglect as a result of technological advancements. The objective of this study is to provide a comprehensive analysis of the mathematical components inherent in the conventional game of dengklaq. This study employs an ethnographic research methodology, utilizing a qualitative approach. This study centers on the Dengklaq gaming arena, the katuk players involved, the laws governing gameplay, and the Dengklaq players themselves. The employed methodologies for data collecting encompassed observation, interviews, field notes, and documentation. The present study used triangulation as a method of data analysis, encompassing the processes of data reduction, presentation, and drawing of findings. The research findings indicate the presence of mathematical components within the Dengklaq game, specifically in the realm of plane geometry, angle relationships (such as opposite angles, straight angles, and opposite angles), cube nets, the concept of reflection, mathematical logic, and the notion of probability.

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1. INTRODUCTION

Traditional games encompass activities that are voluntarily engaged in, fostering a sense of delight and a congenial ambiance rooted in the customs of specific localities. These games are conducted with or without the aid of implements, and adhere to pre-established regulations prior to commencement (Widodo & Lumintuarso, 2017). The preservation and dissemination of cultural values to youngsters are crucial with regards to traditional games. In addition to possessing cultural significance, several traditional games incorporate educational components, such as mathematical instruction.

One potential method for elucidating the actuality of the correlation between environmental culture and mathematics in educational settings is through the application of ethnomathematics, as proposed by Rusliah (2016). Irawan and Kencanawaty (2017) assert that ethnomathematics serves as a cultural component inside the realm of mathematics education. According to Nursyahidah, Saputro, and Rubowo (2018), ethnomathematics can be defined as the branch of mathematics that emerges from human activities within a cultural context. Based on a variety of perspectives on the concept of ethnomathematics, it can be inferred that ethnomathematics serves as an instructional approach that establishes connections between cultural components and mathematical instruction. The field of ethnomathematics aligns closely with the constructivist theory, which posits that students enhance their comprehension and mastery of mathematics by establishing connections between academic subjects and their prior experiences and knowledge (Rosa & Oray, 2011; Brandt & Chernoff, 2015).

Indonesia is renowned for its rich tapestry of cultures, encompassing a wide array of races and regional languages. Indonesia possesses a diverse array of traditional games that incorporate mathematical components, among which the traditional game known as dengklaq may be found. Dengklaq, also known as Sundanese Manda or Engklek, is a traditional game that is prevalent in many parts of Indonesia, such as the Pesisir tribe, Sinunukan, and Mandailing Natal Regency. The term "dengklaq" exhibits regional variations. The game commonly referred to as "dengklaq" is typically played by coastal indigenous communities. Dengklaq is a customary game that involves the act of leaping over squares positioned on a level surface while maintaining balance on a single foot. The Dengklaq game exhibits a diverse range of geometric configurations for its plots, including squares, triangles, and semicircles. This observation provides evidence for the presence of mathematical aspects inside the traditional game of Dengklaq.

Numerous prior research have examined the mathematical components inherent in the conventional game of dengkleq. The objective of the study conducted by Muzdalipah and Yulianto (2015) is to explore the inherent possibilities of ethnomathematics within the pecle (dengklaq) game, which encompasses the fundamental principles of geometry, folding symmetry, and geometric nets. The study conducted by Siregar and Lestari (2018) examines the many components of mathematics, counting exercises, and the representation of two-dimensional shapes inside the dengklaq game. The study conducted by Aprillia, Trapsilasiwi, and Setiawan (2019) examines the concept of ethnomathematics in relation to dengklaq plots. These plots encompass various mathematical elements such as flat figures, reflection, congruence, nets, and counting. Additionally, the research identifies a sequential pattern among dengklaq players that incorporates elements of counting and chance.

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Furthermore, the gaco form of dengklaq exhibits characteristics of flat figures, while mathematical logic is also observed within the context of this traditional game. This study aims to examine many mathematical aspects of the dengklaq game, specifically focusing on the different categories of bucket dengklaq, mattress/sasor dengklaq, and ship dengklaq.

Numerous scholarly investigations have also examined the efficacy of the conventional Dengklaq game as a pedagogical tool for enhancing mathematical comprehension, while concurrently fostering positive character development among pupils. According to a study conducted by Rahmawati, Buchori, and Bhihikmah (2017), the Dengklaq game has been found to be a highly effective tool for facilitating the learning of mathematics. According to a study conducted by Fitriyah and Khaerunisa (2018), the utilization of the drill method in conjunction with the modified Dengklaq game has been found to have a significant impact on the enhancement of mathematical problem-solving skills among students at elementary and junior high school levels.

According to a study conducted by Rusnilawati, Muthmainnah, Mufti, Istiqomah, Ulima, and Hidayati (2018), it was found that the utilization of the traditional Dengklaq game as a learning tool positively influences the motivation of primary school pupils. The study conducted by Nugraha, Handoyo, and Sulistyorini (2018) demonstrates a correlation between the implementation of traditional game-based learning and the development of social skills among primary school children. According to a study conducted by Kawuryan, Hastuti, and Supartinah (2018), it has been demonstrated that the implementation of a theme learning model, which incorporates traditional games and emphasizes a scientific approach, yields a noteworthy and beneficial impact on the creative thinking capabilities of primary school pupils. According to a study conducted by Imswatama and Lukman (2018), it has been demonstrated that the utilization of mathematics teaching materials grounded in ethnomathematics has yielded positive outcomes in terms of problem-solving abilities and the cultivation of critical thinking skills among students in elementary and junior high school settings.

In the contemporary 21st century, commonly referred to as the epoch of globalization, human endeavors are inextricably intertwined with the utilization of technology. Smartphones represent a prevalent technological application that finds extensive utilization, not alone among adults but also among children. Typically, children utilize smartphones as a means to access the internet and engage in recreational gaming activities. A growing number of children allocate their leisure time to engaging in smartphone games within the confines of their residences, so constraining their opportunities for social interaction with peers beyond the domestic sphere. In contemporary society, mobile games have garnered greater appeal and engagement compared to conventional games, leading to a diminished prevalence of traditional games among youngsters.

The predominant mode of mathematics instruction in contemporary educational institutions remains centered within the confines of the traditional classroom setting. Occasionally, students may find it beneficial to enhance their creative abilities through the acquisition of mathematical knowledge beyond the confines of the traditional classroom setting. One educational tool that can be employed for the acquisition of mathematical knowledge beyond the confines of the classroom is the traditional game of dengklaq. The utilization of traditional games as a pedagogical tool can

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facilitate students' cultural awareness and understanding.

Based on the above background information and a review of relevant literature, it may be inferred that the traditional game of dengklaq exhibits mathematical characteristics. The traditional game known as dengklaq has proven to be a valuable tool for facilitating the learning of mathematics. Hence, the primary objective of this study is to provide a comprehensive analysis of the mathematical components inherent in the conventional game of dengklaq, thereby augmenting the existing body of research in this field.

2. METHOD

This study employs an ethnographic research methodology with a qualitative approach to investigate the mathematical elements inherent in traditional dengklaq games. Specifically, the research focuses on the traditional games played by the coastal community, including the dengklak arena, dadu (dice), and a game referred to as "frog" by the coastal community. The study aims to explore the rules of play and the participants involved in dengklaq.

The data gathering approaches employed in this study encompass observations, interviews, field notes, and documentation. The focus of this study encompasses three distinct variants of dengklaq games, namely dengklak ember, dengklak Kasur/sasor, and denklaq ships. The present study utilized the aforementioned research as a primary source during the interview process to gather insights into the constituent aspects of traditional coastal games. Dengklaq, an esteemed academician specializing in mathematical education and cultural arts of the region, served as the interviewee.

The methodology employed in this study involves the application of triangulation, which encompasses the processes of data reduction, presentation, and conclusion derivation. Data reduction is a method of analysis that prioritizes, filters, guides, and eliminates extraneous elements. The present study involved the collecting of data through interviews, observations, and documentation on traditional dengklaq games. The collected data was afterwards analyzed by identifying the relevant information required for this study. The outcome of the data reduction process revealed several key aspects included in this game, including geometric elements, cubic grids, relationships between angles, reflection, and the concept of chance. Subsequently, following the process of reduction, the subsequent phase involves the display of the collected data. This study presents the outcome of the data reduction process, which involves providing a description of the game Dengklaq's arena and its associated mathematical parts. Following the data reduction and presentation, a conclusion was drawn to ascertain the mathematical components inherent in the game. These components encompass the game arena, the player's frog, the game regulations, and the player's own attributes.

3. RESULTS AND DISCUSSION

The Dengklaq game holds significant cultural value as a traditional pastime within coastal communities, garnering considerable popularity among children, particularly those between the ages of 7 and 15. The Dengklaq game features a straightforward gaming concept, accommodating a player count ranging from two to five individuals. Coastal communities derive both enjoyment and educational benefits from engaging in the Dengklaq game. The game in question portrays an individual's endeavor to assert control over a specific area by adhering to a set of mutually agreed-upon regulations. The regulations governing the game are straightforward: There are three key rules that players must adhere to in the game:

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(1) Each participant is required to maintain one foot on each square within the designated playing arena. (2) It is prohibited for players to extend their reach beyond the boundary line of the playing field. (3) The katuk, the object used in the game, must land precisely on the target plot. In the game, if the katuk is thrown onto the arena line or an unintended plot, the player is deemed to have lost. Additionally, it is prohibited for a player to step onto a plot that contains the opponent's katuk. Furthermore, all squares within the arena must be occupied by the players' cards. It is also forbidden for players to enter territory that has already been occupied by the opponent. The game concludes when all plots within the Dengklaq arena become the player's territory, at which point it is declared finished. Finally, the player who possesses the greatest amount of territory is declared the winner.

Figure 1. *Dengklaq* Games

The Dengklaq game, as depicted in Figure 1, is a popular activity among children. The Dengklek game has several sequential steps. Firstly, the participants are required to construct a Dengklaq arena on the ground. Secondly, each player must own a katuk, which is fashioned from fragmented roof tiles or ceramics, and place it on the initial square of the Dengklaq arena. Lastly, the players engage in a hompimpa activity to establish the sequence of play. In step 4, the initial player commences by advancing with one foot from the second square to the final

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square, subsequently retracing their steps to retrieve the katuk positioned on the first square. In step 5, the same player propels their katuk into the second square, proceeding to traverse the remaining squares before retracing their path to retrieve the katuk from outside the designated playing area. This sequence is repeated in a continuous manner until all squares have been occupied by the players taking their turns. It is important to note that players are prohibited from stepping on squares already occupied by katuk. (7) In the event that the first-place player commits an error by stepping on the boundary line of the playing field or by throwing an inaccurate pass, the second-place player is substituted in their position. (8) The second-place player follows the same sequence of actions as the first-place player until they make an error, at which point it becomes the third-place player's turn. This process continues until it reaches the last-place player. Once all the squares in the Dengklaq playing area have been filled with players' cards, the players are provided with the chance to identify and assess regions of control. In order to determine territory, the player assumes a position with his back facing the playing area and subsequently propels his stick into the arena. The location where the player's stick lands designates his territory. Once a player successfully claims a territory, other participants are prohibited from entering that specific area throughout the duration of the game. The player who successfully acquires territory is designated as the victor.

The Dengklaq game possesses the potential to indirectly influence the character development of youngsters due to its numerous benefits for their overall growth and progress. This game offers several benefits, including the development of children's physical and mental balance through the act of stepping on one foot. Additionally, it enhances children's concentration as they aim to throw katuk onto the target plot. Moreover, the game fosters the development of children's cognitive abilities as they engage in counting the steps required to progress. Furthermore, it promotes the cultivation of obedience to rules, facilitates socialization among peers, and nurtures children's creativity. According to Dharmamulya (2008), traditional games encompass cultural values such as honesty, leadership, togetherness, instilling a sense of responsibility, and facilitating the development of counting, reasoning, and logic skills in youngsters.

In addition to its role in character development, the Dengklaq game incorporates mathematical components. The exploration results of the Dengklaq game revealed various mathematical aspects, including plane geometry, angle relationships, nets, congruence, reflection, mathematical reasoning, and the concept of probability or chance. The subsequent discourse pertains to mathematical components centered around the entities of interest to researchers, specifically the gaming area, players' heads, playing rules, and idle players.

Dengklaq Game Arena

There exist a multitude of traditional Dengklaq games. Nonetheless, bucket dingklaq, mattress/sasor dingklaq, and boat dingklaq are the three predominant forms of playthings commonly utilized by children residing in coastal towns. Figure 2 displays visual representations of each variant of dengglaq.

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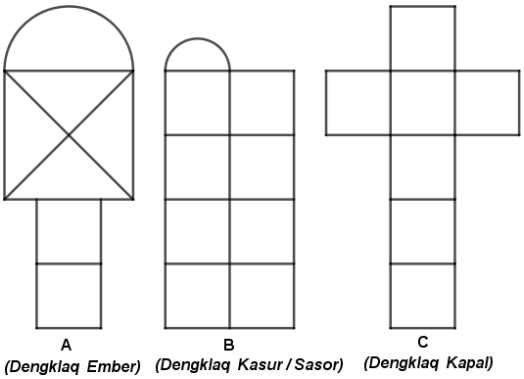

Figure 2. Dengklaq arena sketch

The findings of the study and investigation conducted on the Dengklaq game arena revealed the existence of several mathematical components. These components encompass elements of planar geometry, interconnections between angles, nets, congruence, and reflection. Figure 3 illustrates the representation of mathematical elements in the form of plane geometric notions, as well as the depiction of connections between angles.

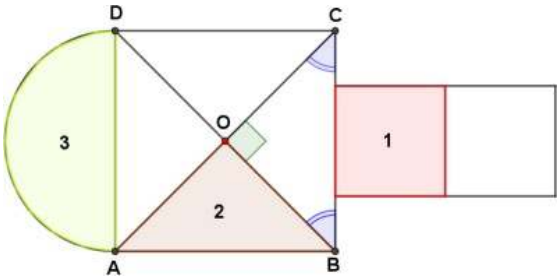

Figure 3. The concept of plane geometry in the Dengklaq game arena

Figure 3 displays the composition of the map within the Dengklaq game arena, consisting of three distinct plane elements: a square, a triangle, and a semi-circle. When examining the square ABCD, the act of drawing its two diagonals, namely diagonals AC and BD, results in the formation of four isosceles right triangles. These triangles share a common vertex at point O, which serves as the intersection point for all four triangles. The measurement of the angle generated in an isosceles right triangle can be determined. In the above triangle BOC, it can be observed that angle BOC measures 90 degrees due to its right angle at point O. Additionally, angles OBC and OCB are congruent, each measuring 45 degrees. Furthermore, an additional mathematical component pertains to the notion of the interconnections of angles.

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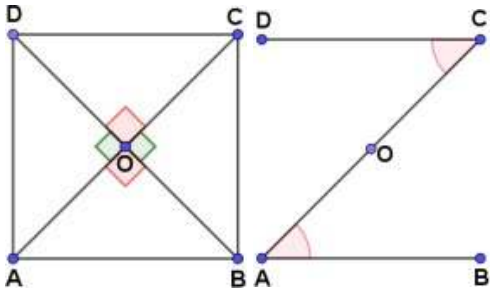

Figure 4. Illustration of the concept of relationships between angles

The fundamental principles governing the connections between angles include the notion of opposed angles, the concept of straight angles, and the occurrence of opposite angles. Figure 4 depicts a visual representation of the Dengklaq game arena map, incorporating several features pertaining to the notion of relationships. Figure 4 depicts an image showcasing the notion of opposed and straight corners (refer to Figure 4a), while Figure 4b illustrates the concept of opposite angles (refer to Figure 4b) as portrayed in the layout of the Dengklaq game arena. Upon observing Figure 4a, it becomes evident that the drawing depicts a pair of opposite angles, namely angle AOB in conjunction with angle COD, as well as angle AOD in conjunction with angle BOC. The equality of opposite angles can be inferred from the fact that angle AOB measures 90° and angle COD measures 90°. In the interim, it can be observed that the angles AOB and BOC form a straight line, as do the angles BOC and COD. The above illustration demonstrates that the total of the angles classified as straight measures 180°. Subsequently, we encounter the antithetical angle, denoted as the BAO angle, which stands in opposition to the DCO angle. The observation that the measure of angle BAO is 45° and the measure of angle DCO is 45° leads to the inference that opposite angles possess equal angle measures.

The subsequent mathematical component present inside the Dengklaq game arena pertains to nets. Upon further examination, it becomes evident that the Dengklaq plots exhibit a distinct pattern characterized by the formation of a grid composed of interconnected cubes. Figure 5 depicts an image showcasing the cube nets within the Dengklaq game venue.

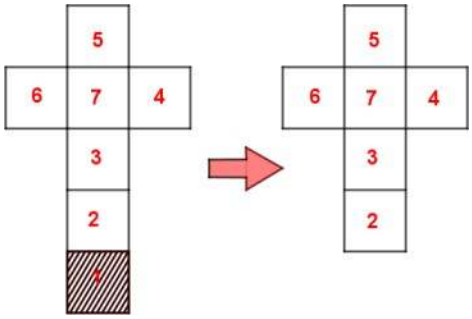

Figure 5. Cube meshes in the Dengklaq arena

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The shape of the cube net is depicted in Figure 5. Upon commencing the game, the knock of each player is positioned on the initial layout, specifically denoted as the shaded region in the accompanying image. Based on the stipulations outlined in the regulations of the game, participants are prohibited from traversing the areas designated for katuk. Conversely, they are permitted to traverse the plots numbered two through seven, which collectively constitute a cube net. Moreover, the notion of congruence is also included inside the Dengklaq arena map. This observation is evident from the geometric configuration of the aforementioned plots, which exhibit a square shape.

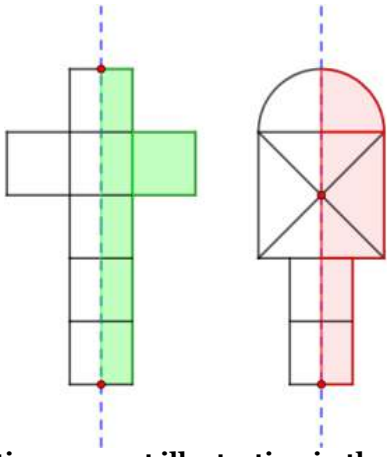

Figure 6. Reflection concept illustration in the Dengklaq arena

The subsequent mathematical component present inside the Dengklaq game arena pertains to the notion of reflection, also referred to as mirroring. The Dengklaq game arena incorporates mathematical concepts, specifically the principle of reflecting or reflection. According to a study conducted by Aprilia, Trapsilasiwi, and Setiawan (2019), which examines the existence of mirrored features on ship decks, the research findings indicate the presence of reflecting elements in another variant of dengklaq known as dengklaq ember.

Figure 6 depicts the reflections observed within the arena of the ship and bucket game. When the axis of symmetry is drawn, it bisects the playing area into two congruent sections, specifically the right and left portions. In the Dengklaq game, the right side of the traditional arena exhibits symmetrical properties in relation to the left side, suggesting that the former might be regarded as a mirrored image of the latter.

The stick the player uses

Katuk serves as an integral component of the Dengklaq game, fulfilling the role of a playing tool. Typically, it is constructed with fragmented roof tiles or shards of ceramic material. When selecting a katuk, the player seeks a katuk with a flat shape to minimize the risk of hitting oneself or causing the katuk to roll and miss the intended target plot when thrown within the Dengklaq playing arena. Based on the findings of the investigation, it can be observed that the structure of the katuk exhibits characteristics associated with flat-plane geometry. This study aligns with the findings conducted by Aprilia, Trapsilasiwi, and Setiawan (2019). The many shapes of the katuk, including square, triangular, circular, and trapezoidal, serve as visible indicators of

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this characteristic. The geometric configuration of katuk, characterized by the inclusion of planar attributes, is depicted in Figure 7. Students can acquire knowledge of flat shapes in a more efficient and relevant manner through the utilization of katuk, a tool available in the educational game Dengklaq.

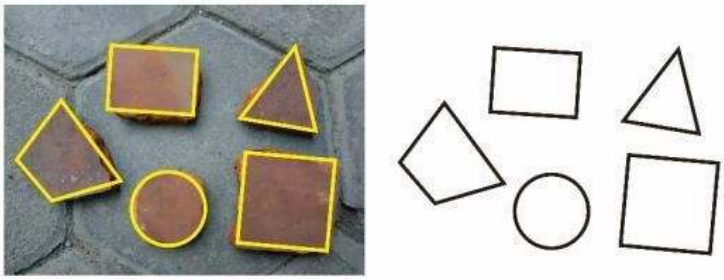

Figure 7. Plane geometric elements in katuk

Playing rules

The rules of the Dengklaq game exhibit components of mathematical logic, as evidenced by the research findings and illustrative examples provided by Aprilia, Trapsilasiwi, and Setiawan (2019). The rule of implication is employed to ascertain the outcome of a player's continuation or demise. An illustrative instance is the presentation of two statements outlining the regulations of the Dengklaq game, specifically:

p= Yasir threw his katuk not exactly at the target area
q = Yaris couldn't continue playing so he was replaced by another player

The implication of these two statements is $p \rightarrow q$ = In the event that Yasir inaccurately throws his katuk onto the designated square, he is rendered unable to proceed with the game, resulting in his replacement by another participant. An additional illustration is provided by the subsequent pair of assertions:

q= Ardila has the most territory
r = Ardila won the Dengklaq game

From the statement above, the implication is $q \rightarrow r$ = If Ardilla possesses the most amount of land, then Ardila emerges as the victor in the Dengklaq game.

Dengklaq player

In addition, the Dengklaq game has mathematical components inside its gameplay. The mathematical component observed among Dengklaq players pertains to the notion of probability, which encompasses the concept of chance. This scenario serves as an illustration of the concept of territorial acquisition. Upon successful completion of the initial round of tasks in the Dengklaq game, a player is granted a designated sphere of influence. When employing the ship and bucket configuration, characterized by a total of seven squares, the probability of a player obtaining a territory is 1:7 or 1/7 (one in seven). In contrast, while employing the Dengklaq mattress variant, characterized by nine distinct sections, the probability of a player securing a region is 1:9 or 1/9 (one in nine).

According to a study conducted by Aprilia, Trapsilasiwi, and Setiawan (2019), the Dengklaq game incorporates the notion of probability or chance. For instance, this method is employed to ascertain the pattern of the playing

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sequence. As an illustration, consider a group of five children, namely Denis, Wan, Aprisal, Yasir, and Bayu, who wish to engage in a game of dengklaq. In order to establish the order in which they will participate, the children engage in a traditional game known as hompimpa. This game serves the purpose of determining the sequence in which each child would play, assigning them respective positions of first, second, third, fourth, and fifth. The application of permutations enables the determination of the quantity of playing sequence patterns that manifest.

$$P(n,n) = P(5,5)$$
$$nPn = 5P5$$
$$5P5 = 5!/(5-5)!$$
$$= 5! = 5x4x3x2x1 = 120$$

The number of sequence patterns that occurred during the game of Dengklaq, played by a group of five children, was determined to be 120. According to Febriyanti, Prasetya, and Irawan (2018), in their study, they emphasized the significance of mathematics as an essential component alongside character education. They argued that elements such as honesty, togetherness, and excellent sportsmanship in playing traditional games were equally important as the research findings. Moreover, a study conducted by Damayanti and Putranti (2016) utilizing the traditional game dengklaq demonstrated that the mathematics learning outcomes of students exhibited improvement. Additionally, the students' perception of learning mathematics through the use of games was highly positive, as they found it enjoyable and became more engaged in the subject matter.

4. CONCLUSION

The findings of this study indicate that the traditional game of Dengklaq serves not only as a form of amusement for children, but also possesses an educational aspect that has the potential to influence the development of children's character. The game has several advantages, including the development of children's physical and mental equilibrium, enhancement of attention skills, cultivation of intelligence, promotion of adherence to rules, fostering of sportsmanship, encouragement of honesty, and stimulation of creativity in youngsters. In addition to its advantages for youngsters, the Dengklaq game can serve as an educational tool for mathematics due to its incorporation of numerous mathematical components. The traditional game incorporates mathematical elements that pertain to plane geometry, specifically within the Dengklaq and Katuk game arenas. These elements encompass concepts such as similarity, congruence, cube nets, and reflection or mirroring within the game arena. Additionally, mathematical logic concepts are evident in the game rules, while the concept of probability is present among Dengklaq players.

The implementation of ethnomathematics-based learning holds significant importance inside educational institutions. This can perhaps foster an appreciation for cultural values among children in an indirect manner. Hence, it is advisable to undertake study pertaining to ethnomathematics in alternative traditional games. In addition to games, certain cultural factors can also function as a means of facilitating mathematical learning.

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