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Ethnomathematics Eksploration of The Traditional Game of Congklak

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abstract

Congklak is a traditional game that has a long history and contains philosophies in its development. The aim of this study is to explore congklak from ethnomathematics side so that they can know the cultural value of traditional congklak games and their connection to mathematics, describe the mathematical elements contained in congklak and to find out the role of congklak in mathematics learning. This research uses qualitative research approach with type of ethnographic research supported by literature research methods. Data collection techniques that researchers do use interviews, observations, documentation, and literatur studies. This research instrument is the researcher himself using recorder aids, cameras, and stationery. The results of ethnomathematic exploration in traditional congklak games are seen from the mathematical elements, namely there are arithmetic, geometry, graphs, and probability. Cultural elements in congklak are honesty (sportive), accuracy, patience, and sharing. Congklak in mathematic learning act as ethnomatematics-based learning media. The results of this study are as information for teachers to make congklak as a medium of mathematics learning both as conventional and digital games.

Keywords:
Congklak, Cultural Value, Ethnomathematics, Graph, Learning Media

INTRODUCTION

Traditional congklak games today are rarely played by children, most of them play digital games that have no cultural value, especially Indonesian culture. Traditional congklak games for example, people are now more familiar with congklak only limited to ordinary games with no meaning other than winning and losing. Not all people know and play it. Though congklak games in addition to being used to play can also be used as a learning medium, especially learning mathematics. This is evidenced by the many studies on traditional games that show their role as a process of learning mathematics. In addition, congklak games are also full of cultural values.

Discussion of research in understanding mathematics, now has been widely associated with culture. This can be proven by the many studies on ethnomatematics, these studies explain that in a culture there is an element of mathematics and even the results of research can be useful for mathematics learning and improve social interaction (Febriyanti et al., 2019; Hasanuddin, 2017; Taus et al., 2022; Zayyadi et al., 2018). In addition, the discussion of mathematics associated with culture was also carried out by this study, namely in traditional congklak games. Traditional congklak games are rich in cultural value even when viewed from the form and way of playing, then this game has a mathematical concept. The study of science in understanding mathematical concepts through a culture is called ethnomatematics.

Ethnomatematics was introduced by a mathematician and as the philosophy of Brazilian mathematics education, Ubiratan D'Ambrosio. Powell & Frankenstein (1977) referred to D'Ambrosio as "The intellectual father of the ethnomathematics program", because since the mid-1970s at forums around the world he has been percentageizing his ethnomatematics programs. D'ambrosio goal is to percentage and introduce ethnomatematics, one of which is so that mathematics education can encourage the creation of new knowledge (Rosa et al., 2016). In addition, with ethnomatematics, mathematics education in rural and coastal areas will be easily accepted, so it will reduce the thought that mathematics is abstract and less related to everyday life. Based on this, ethnomatematics can act as a bridge so that mathematics learning can be more real and easy to understand because it is in accordance with reality.

At the beginning, researchers explained that congklak is a traditional game that is full of cultural values. In addition, congklak games have many benefits, namely, training children's fine motor skills, training children's emotions such as being patient, honest, conscientious, and teaching to do sportsmanship (Mulyani, 2016). The philosophy and cultural values of congklak games are also very closely related to the characteristics of the Indonesian state, namely the agrarian country. Traditional congklak games can be played indoors, so if you cannot play outdoors then congklak games have a solution to play indoors. Playing congklak requires the game tools, namely congklak boards and congklak seeds. Game tools and how to play congklak have something to do with mathematics. This has been widely known from various kinds of research related to congklak. Therefore, congklak games are very suitable when researched based on ethnomatematics.

This study examined ethnomatematics found in traditional congklak games. The goal is to find out the cultural elements and mathematical elements contained in it, as well as the relationship between traditional congklak game culture and mathematics. Another purpose is to describe the mathematical elements found in traditional congklak games and to find out their role in the process of learning mathematics. Based on the purpose of research, the results can be used for mathematics learning so that abstract mathematical understanding becomes more concrete. In addition, the understanding from the cultural side can foster the character of the nation and can preserve one of Indonesia's cultures.

METHODS

Types and Research Methods

This research uses a qualitative approach. This qualitaive approach is intended to reveal an object and situation in finding meaning and in depth understanding of a problem at hand. The qualitative approach has various types of research, and this research uses an ethnographic type of research. In the literature, ethnography is concluded as a research that focuses more on cultural meaning. In addition, this research was also conducted to explore new interesting thing so that cultural themes were also obtained. The culture to be explored is from the traditional game of congklak. The cultural theme to be researched focuses on the ethnomathematics found in the traditional game of congklak. According to Yusuf (2014) in qualitative research data collection can be done using library research and field research methods. This research uses both methods, but tends to use library research methods. The library research method is a method of collecting data or obtaining research data based on library sources (Zed, 2014).

Data Collection and Analysis

Data collection techniques that researchers perform use interviews, observations, documentation, and literature studies. This research instrument is the researcher himself using recorder aids, cameras, and stationery. The data analysis technique used in this study is miles and Huberman data analysis technique, which is analyzing by reducing data, disdisturing data, and drawing conclusions / verifying (Yusuf, 2014).

RESULT AND DISCUSSION

Congklak is one of the traditional games in form of a board and has a hole. This game is played using an oval base where a row of holes is located. The game usually uses kuwuk (a type of sea shell), seeds, or pebbles, we call it congklak seeds. In general, congklak in indonesia has a total of 16 holes consisting of 2 large holes and 14 small holes that form two pairs of rows between the two large holes.

Figure 1
Congklak tools

The way to play the traditional game of congklak in general is to first prepare the tools, namely the congklak board and seeds. The second is to invite your opponent to play congklak by: (1) Fill each small hole with 7 seeds, but the large hole remains empty, (2) Determine who will start the game first, (3) Then spread the seeds in the hole. The small hole into each other small hole and the player's large hole, clockwise. Each small hole is filled with 1 seed except the opponent's big hole, (4) If the last seed falls into the player's small hole, it means the player can choose another small hole to start spreading seeds again, but if the last seed fall in one of the smaller holes that empty, meaning it's the

opponent's turn to play, so the player stops playing and waits for the next turn, (5) After all the small holes are empty, the last step is to count the seeds collected in each of the player's big holes. The winner is determined by the number of seeds obtained.

Cultural Values of The Traditional Game of Congklak

According to Mr. Saefulloh (interview, 07 August 2018) as part of education at the National Museum that congklak philosophy has something to do with the agrarian life of Indonesian society. Starting from the philosophy of the number of holes, the flow of the game, and the philosophy of collecting seeds on large holes to gain profits. Based on this, then this requires accuracy then a strategy is needed to win the game. Therefore, the meaning of cultural value that can be taken from all these games is in order to get a lot of results in collecting seeds by devising a good strategy. This is also true in the life of farmers who describe that a farmer in planting until harvesting must be able to produce a harvest with good and abundant results for them to collect in barns. Collecting harvests to the barn is also through processes and strategies, so when playing congklak must also be able to go through it with a good process and the right strategy as well.

Another opinion about the value of congklak culture was expressed by Alif (2016) that cultural values that can be taken, namely accuracy, intelligence, and honesty. Thoroughness is required so that when entering children the game is not wrong. Intelligence is needed so that a player can win the congklak game. Meanwhile, the value of honesty is expected so that each player is sportsmanlike and when the opponent is caught off guard the player does not deceive his opponent. According to Dharmamulya (1985) congklak games can train numeracy. In addition, this game can be done by sitting in a calm atmosphere, so the game is good for women. Because while educating sitting politely, regularly, carefully and relaxed. At the same time practice settling the rules that apply and practice playing honestly (sportive).

The Connection Between Congklak and Mathematics

Based on the observation made by the researchers, congklak has a connection with mathematics. This can be seen from the shape of the game tools and also from the way they are played, even before starting a game there is an element of mathematics. Regarding the relationship, it can be seen in the following table.

Table 1
Congklak Connection to Mathematics

Congklak	Connection	Mathematics
Game tools	Congklak board Shape	Geometry
	Amount of seed congklak	Arithmetic
How to play	Prepare for the game by filling in the small holes of 7 seeds each	Arithmetic
	Determine who is the first player	Probability
	Distribution flow seed	Graph
	Start the game by selecting a collection of seeds in a small hole to scatter	Arithmetic
	Distribution of congklak seeds to collect in the player's big hole	Arithmetic
	The end of the game by counting amount of results form collecting congklak seeds in the big hole	Arithmetic

Ethnomathematics on Congklak

If ethnomathematics is very useful in understanding mathematics through a culture, then it is better to teach the younger generation about mathematics through the traditional game culture of congklak. The culture in addition to understanding mathematics also teaches the values of life based on the research, the mathematical elements in the traditional game of congklak that researchers can find are in fields, arithmetic, geometry, graph, and probability.

a. Arithmetic
Arithmetic in congklak is associated with arithmetic operations, modular arithmetic, linear equations in one variable, social arithmetic, and integer comparison. First, arithmetic operations found in congklak include addition, subtraction, multiplication, and division. This mathematical element is entirely related to the seeds of congklak. These seeds are divided by the same amount, multiplied to find out the total number of seeds, summing up to find out how many seeds are obtained and decrease when congklak seeds are spread. Second, modular arithmetic contained in this congklak can be done to find out where the last seed positions in the hand grip when spread. This is based on Hasanuddin's research (2017) which suggests that traditional congklak games are closely related to the modulo system. Here's an example of its application to a 16-hole congklak using modulo 15.

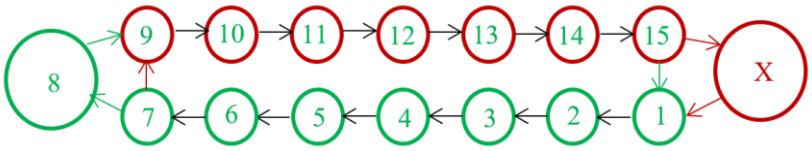

Figure 2
Hole Position Number

Before heading to the problem, look and remember the location of the hole position number in Figure 2. See Figure 3, suppose you want to know where the last seed falls on hole no. 6 which amounts to 17 seeds, then sum the position number of the hole by the number of seeds to be spread using mod 15.

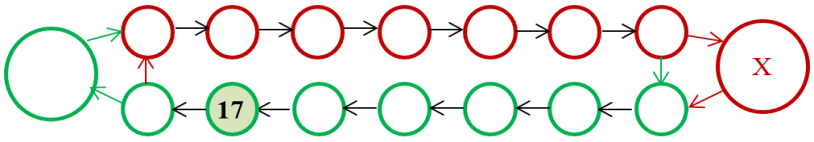

Figure 3
Starting Position

The calculation is seen Figure 3 which is 6 + (17 mod 15) = 6 + 2 = 8, then it is known that the starting position of hole no. 6 ends in hole no. 8 as in Figure 4.

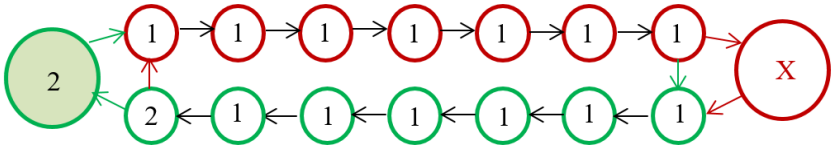

Figure 4
Posisi Akhir

The modulo rule according to Hasanudin (2017) above after the researcher re-analysis the results only apply if the seeds are more than equal to 15. If the seeds are less than 15 then just add up the number of the position of the hole with the number of seeds to

be spread. The exception for congklak seeds is less than 15 which if the position number of the hole is summed with many seeds is more than 15, then the use of mod 15 can still apply but with slightly different rules. The difference lies in the operation of the modulo. If previously modulo is calculated from the number of seeds only, then in this case the operation of the modulonya from the addition of the position of the hole with many seeds less than 15. The result of the operation immediately becomes the determinant of the position of the hole falling the last seed from the grasp.

Third, based on Putri (2020) research that in congklak there are linear equations in one variables. Linear equations in one variables in congklak can be seen application when you want to put seeds into a large hole, but the seeds are less in number to arrive at a large hole. Suppose in hole number 3 (see Figure 2) there are 4 seeds, so that the last seed is right in the big hole then requires how many seeds? The seeds that are attempted can be used as variables, then the calculation is as follows.

$$\begin{aligned} x + 4 &= 5 \\ x + 4 - 4 &= 5 - 4 \\ x &= 1 \end{aligned}$$

Based on the calculations above, the seeds that are attempted are 1. Linear equation in one variable is also applied when you want to know how many seeds must be worked on in order to become a winner. Generally being a winner is able to collect seeds beyond the initial seed, otherwise it will lose and then lose or players and opponents can be a draw. Suppose the player in a big hole has collected 22 seeds, in order to exceed the initial 49 seeds then have to work on how many seeds? The calculation is as follows.

$$\begin{aligned} x + 22 &= 49 \\ x + 22 - 22 &= 49 - 22 \\ x &= 27 \end{aligned}$$

The result of the calculation above is 27 seeds, so that in order for the player to win or not lose then at least have to try 27 seeds so that the game is series and exceeds 27 seeds to become a winner. Fourth, the social arithmetic found in congklak is the calculation of profit and loss. Fifth, the comparison of integers contained in congklak is done when the player wants to know the comparison of the number of seeds obtained by the player with the number of seeds obtained by the opponent. The first, fourth and fifth arithmetic elements are usually not used as strategies by players to become winners.

b. Geometry

The results of the analysis of the observation of the shape of the congklak board, known to be related to reflection in transformation, then there is a flat wake and build space. The reflection on the congklak board observed is only reflected against the cartesian coordinate line, the x-axis and the y-axis. note Figure 5 the blue line in the picture is the mirror, the straight line is the x-axis and the upright line is the y-axis. Reflections against the x-axis that is, A' produces shadow A", A_1 produces shadow B_7, A_2 produces shadow B_6, A_3 produces shadow B_5, A_4 produces shadow B_4, A_5 produces shadow B_3, A_6 produces shadow B_2, and A_7 produces shadow B_1. Reflection on the y axis that is, A produces shadow B, A_1 produces shadow A_7, A_2 produces shadow A_6, A_3 produces shadow A_5, A_4' produces shadow A_4", B_7 produces shadow B_1, B_6 produces shadow B_2, B_5 produces shadow B_3, and B_4' produces shadow B_4".

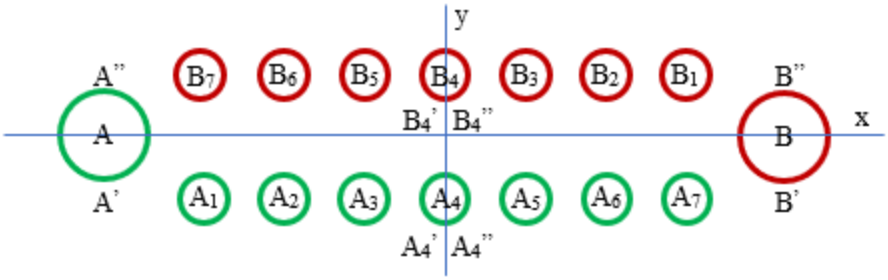

Figure 5
Reflection

Geometry on the second congklak board is that there is a flat wake that in general there is a rectangle and circle, while the build space there is a beam and half a ball, then the shape of two sides of the congklak board can be half a tube or half a cone reflected. Consider Figure 6, the image below is based on the congklak board image that researchers observe and is generally easy to find in the market. The image of the congklak board shape that is widely marketed can be seen back in the previous Figure 1.

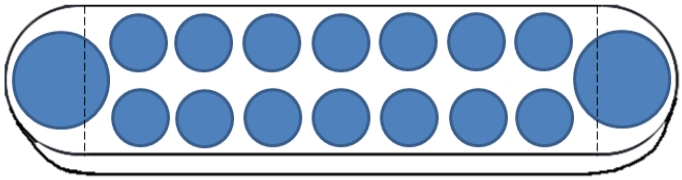

Figure 6
Congklak Board Shape

c. Graph

Another mathematical element found in congklak is the hamilton circuit which is included in the graph theory material. This study was analyzed based on Utomo's research (2017) which discussed congklak 14 holes and 16 holes. This study only discusses congklak in general, which is where there are 16 holes. Hamilton's circuit search, however, has several terms that apply to the traditional game of congklak. The first term "road" is the stop of seeds on a small hole, when in the first experiment stopped at a small empty hole then it is called one road, while if it stops at a small hole there is at least one seed then it is called two roads and so on. The second term "iteration" is when the spread of the last seed on the hand grip falls on the player's big hole.

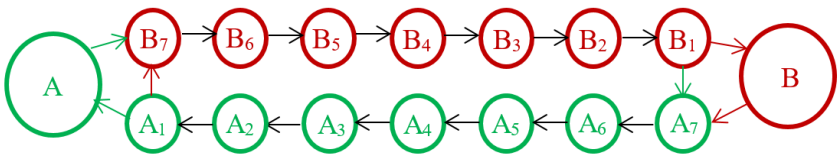

Figure 7
Hole Position Name and Gameplay

Information: ○ = Vertex

→ = Edge

In Figure 7, as in graph theory there are terms vertex and edge, then it is marked by a circle meaning vertex and the direction of arrow means edge. Hamilton's 16-hole circuit for one hole filled with 7 seeds will be found two ways. The first way to get the fastest hamilton circuit, the first player simply picks up and spreads the seeds from

holes A_1, A_2, ..., A_6. Picking seeds anywhere on player A's hole, at the beginning of the game will get the hamilton circuit. This is because the seeds in ai hole will stop at the hole B_{7-i}, i = 0, 1, 2, 3, 4, 5 which will amount to 8 seeds. Based on this, it only takes one road and zero iterations to find the Hamilton circuit. The second way to find the hamilton circuit can be seen in Figure 8 whose result required eleven roads and two iterations.

	1	13	13	13	2	4	13	
	1	13	5	13	2	4	13	
	0	12	4	12	1	3	12	
	12	11	3	11	0	2	11	
	11	11	3	11	0	2	11	
	11	11	3	11	11	1	10	
	10	10	2	10	10	1	10	
	9	9	1	9	9	0	9	
	9	9	1	9	9	9	8	
	8	8	0	8	8	8	8	
	8	8	8	7	7	7	7	
	7	7	7	7	7	7	7	
A	B_7	B_6	B_5	B_4	B_3	B_2	B_1	B
	A_1	A_2	A_3	A_4	A_5	A_6	A_7	
0	7	7	7	7	7	7	7	
1	8	8	8	8	8	8	0	
2	9	9	9	9	0	8	0	
2	9	9	9	10	1	9	1	
3	10	10	10	0	1	9	1	
4	11	11	11	1	2	10	2	
4	11	11	12	0	2	10	2	
5	12	12	0	0	2	10	2	
5	12	12	0	0	2	11	3	
6	13	13	1	1	3	0	3	
7	14	14	2	2	4	1	4	
7	14	15	3	3	5	2	5	
8	15	0	3	3	5	2	5	
8	15	1	4	4	6	3	6	
8	15	1	4	4	6	3	6	

Figure 8
Calculation Table in Getting Hamilton Circuit

Ethnomatematics in congklak, especially those related to graph theory, if further analyzed, it can be represented in the matrix and can then be inputted into the computer program in question. However, a full explanation of the inputs and outputs from the repressnation of graphs on the matrix to becoming digital congklakes in this study is not explained. This is because the explanation is not related to research that discusses ethnomatematics in congklak. The representation of graphs into the matrix in this research can be the development of ethnomatematics-based mathematical learning media in congklak. Just as mathematics can be formed in culture, so mathematics can shape other cultures such as making traditional congklak games that are conventional into practical digital games. In addition, ethnomateamic-based learning media at any time can be used in the implementation of online learning by using digital congklak as a medium of mathematics learning.

d. Probability

Probability is the magnitude of the possibility of an event occurring. The mathematical element is present when the game has not started or when doing a suit. In addition, the mathematical element of odds in congklak is also present when you want to know the chances of ending the game that occurs in each player.

The Role of Congklak in Mathematics Learning

Success in the learning process large or small will still affect the quality of education. Learning is part of an education, so the understanding of education has a broader meaning than learning. in connection with that, successful mathematics learning will improve the

quality of education. However, so far the understanding of the values in mathematics learning delivered by teachers and learned from other sources has not touched all aspects. Therefore, a component of learning is needed. According to Rusman (2017) its components are goals, learning resources, learning strategies, learning media, and learning evaluation. The learning component is the determinant of the success of the learning process. These components each role has its own function in the learning process.

Traditional congklak games when viewed from previous explanations, researchers concluded that congklak can act as an ethnomatematics-based learning medium. Presenting learning media is certainly very useful for achieving a learning goal. In addition, the selection of the right learning media and able to be managed properly by teachers, so that students in learning are able to understand it or get better learning outcomes than before, then this can also have a good impact in improving the quality of education, especially mathematics education. In addition, ethnomatematics-based learning media can also provide a concrete picture in understanding abstract mathematical materials.

CONCLUSION

Congklak is a traditional game that originated in Indonesia. Traditional congklak games are full of cultural values and have a connection with mathematics. Ethnomatematics in traditional congklak games is seen from the mathematical elements in the form of arithmetic, geometry, graphs, and opportunities. In connection with that, the cultural elements are honesty (Sportive), accuracy, patience, and sharing. Traditional congklak games can act as a medium of ethnomatematic-based mathematics learning. The application of congklak learning media can change the perspective of society, especially students who say that mathematics is difficult because the material tends to be abstract. In this context, ethnomatematics can understand abstract mathematical materials into concrete understandings. This learning medium can be practiced with its game tools directly as well as with digital game forms. Meanwhile, ethnomatematic understanding contained in congklak can be used by the community and students to win the game. This is done by applying the knowledge of mathematics that has been known, then making it a strategy in winning the game.

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