Mathematical Concepts in 8 Traditional Games from Hulu Sungai Tengah, South Borneo

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***Abstract--**The rich regional culture in Indonesia has numerous potentials that might be benefitted for introducing the mathematical concept to the children. One of the cultural potentials that might be benefitted in the mathematical learning process is found in the traditional games. With regards to the statement, in the Province of South Borneo, specifically in the County of Hulu Sungai Tengah (HST), there have been at least 8 traditional games that might be integrated into the mathematical learning process within the elementary school degree, the junior high school degree and even the senior high school degree. The eight traditional games are Tali Ulai, Tali Sol, Kelereng Segitiga, Cuk-Cuk Bimbi, Daku, Kompak Gambar, Asin and Dasprak Lingka. Within these games, the mathematical concepts such as odd and even numbers, summation, inequalities, parabole, linear line, two linear lines, angle and measurement with units of length, forecast, gain, loss, break even, node, line, plane, probability, multiplication as repetitive summation, division as repetitive subtraction, sets, rectangle, congruency, congruency in two planes, quadrant and ratio. Through these games, the children might be made familiar toward numerous mathematical concepts so that they might appreciate the usefulness of Mathematics in the daily life.*

***Key words--**traditional games, mathematical concept, Hulu Sungai Tengah (HTS)*

I. INTRODUCTION

The wealth of Indonesia is not only represented by the abundant natural and human resources but also the diverse regional cultures. In fact, from the aspect of regional cultures, every region, every province and even every county has cultural potentials that might be benefitted for certain objective. For example, these cultural potentials might be integrated into the educational process such as the mathematical learning process. Unfortunately, the achievement of this end has been obstructed by the minimum understanding from the children as the children toward the significance and the meaningfulness of cultures within the life of the Indonesian society [1]. The children's lack of understanding has encouraged them to be ignorant toward the culture from their native regions whereas the culture has potentials for assisting the introduction of mathematical concept. Specifically, traditional games as part of the native culture has significant value for introducing the young generation of the country into the domain of creation, imagination and media for the sake of surviving in the middle of a society [2], [3].

As having been implied from the previous paragraph, the native Indonesian cultures might be represented by the traditional games. Principally, the traditional games describe the concept of being heterogeneous in multiculturalism [4]. Traditional games grow and develop within a society as a reflection of the nuance from the

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local culture. In the traditional games, there have been the rules and the tools of the games that should be implemented during the game session. The rules and tools of these traditional games contain numerous mathematical concepts that might be introduced to the children in the elementary school degree, in the junior high school degree and even in the senior high school degree. Games, including the traditional ones, encourage the establishment of natural situations for social interaction such as the agreement among the children to define the strategy for defining a fair game [5].

The introduction and the teaching of mathematical concepts should be started since the children have been familiar with Mathematics so that the children will gain a pleasant first impression with the subject. By doing so, in the future the children will not consider Mathematics as their opponent [6]. By using traditional games, the children might learn Mathematics in a more meaningful manner instead of being stuffed with overwhelming mathematical formulas, mathematical propositions and mathematical theorems since they will attain knowledge based on the direct experience [7]–[9]. In other words, traditional games might be benefitted for teaching the matical concepts and thus the children will not only memorize the mathematical concepts but also construct their own knowledge so that they will be able to implement the concepts into the problems in their daily life [10]. Then, within the mathematical learning process, if a teacher is able to associate the learning materials to the children' conditions, hobbies, needs, cognitive development, dailly environment and knowledge, then the children will enjoy the positive impact from the learning process since they learn the mathematical concepts through an enjoyable manner [11, p. 157], [12].

II. METHOD

The descriptive qualitative study took place from July until August 2019 in the County of Hulu Sungai Tengah (HST), the Province of South Borneo, Indonesia. The approach that had been implemented in the study was the ethnography approach. The ethnography approach was selected because the researcher would like to uncover the facts about the traditional games in the County of Hulu Sungai Tengah Selatan. Then, the subject in the study was a local figure from the County who understood well the traditional games in the County. On the other hand, the objects in the study were the eight traditional games from the County of Hulu Tengah Selatan. The aspects that the researcher would like to analyse from these traditional games were the name of the game, the rules of the game, the manners for determining the winner and the mathematical concepts that might be found in the traditional games. The data were gathered by means of interview and documentation. After having been gathered, all of the data were analysed by means of qualitative analysis with data presentation, data reduction and data verification [13].

III. RESULTS AND DISCUSSIONS

The County of Hulu Sungai Tengah (HST) has kept a lot of traditional games that might be benefited for conducting the mathematical learning process. Throughout the study, the researcher would like to uncover eight traditional games that originally come from the Province of South Borneo and that have been usually played by the children in the County of Hulu Sungai Tengah.

The (Children's) Traditional Games in the County of Hulu Sungai Tengah (HST) and Their Benefits for the Conduct of Mathematical Learning Process

The County of Hulu Sungai Tengah is located in the Province of South Borneo. In this county, there are many cultures that might be categorized into ethnomathematics and these cultures might be found in the historical buildings, the habits of the local people and even the traditional games. Although nowadays we have entered the era of technological advancement, the children in the County still enjoy playing the traditional games after the school period has been over. With regards to the statement, there are 8 traditional games that the children in the County have still been playing and these games contain the mathematical concepts that might be benefitted for the conduct of the mathematical learning process. These traditional games will be elaborated further in the following sub-section.

1. Tali Ulai Rope Game

Tali Ulai Rope Game should be played by at least three people. Within the game progress, 2 players will swing (*ulai*) the rope and one player will be jumping over the rope. As a result, the game might be played individually until the game is over. If the player wants to add more fun, then the player should find more partners so that the players might be divided into several groups with equal members. For example, if there are 9 players then the players should be divided into 3 groups and each group will consist of three players.

Figure 1. Tali Ulai Rope Game

To play the game is not easy yet it is not difficult because the game consists of 20 stages and in each stage the player should jump over the rope with different style. Then, in the Final Stage, the player should perform all the 20 styles in one single jump. The only difference is that when a player hits the Stage 8 it means the players should jump for 8 times with the same style while in the final stage the player should jump for 20 times with different style in each style. Therefore, in the final stage the player should jump for 20 times with different 20 styles. When the player steps on the rope or when the jump style is not in accordance to the previous stages, then the player will lose the game and therefore he or she may not continue the game. If the player hits Stage 20 and enters the Final Stage, he or she will become the winner.

Whether it is realized or not, as the children play *Tali Ulai* they indirectly have understood or have even implemented numerous mathematical concepts. The first mathematical concept that has been implemented in the game is the concept of odd and even number. The even number is represented by the two *pengulai tali* (rope players) while the odd number is represented by the single player (one jumper). Then, the second mathematical concept that has been implemented in the game is the concept of summation. The number of the players who have been involved in the game, namely two *pengulai* and one jumper, might be written into 2 + 1 and thus the

commutative characteristic in summation, 2 + 1 = 1 + 2 = 3, is applied. Next, the third mathematical concept that has been implemented in the game is the concept of inequalities. The concept of inequalities is shown by the statement "minimum 3 persons." For example, if the number of *pengulai* is symbolized by *x* and the number of jumper is symbolized by *y* then an inequality for the requirement of *Tali Ulai* game might be attained as follows: $2x + y \geq 3$. This inequality might be operated in order to define the number of *pengulai* and jumper that should be involved. The maximum 20-style jumps or 20-times jumps might be modelled as $s \leq 20$ with s = number of styles/jumps.
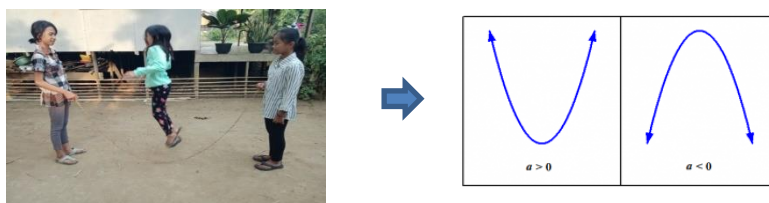

Figure 2. Concept of Parabola in Tali Ulai Rope Game

Last but not the least, the fourth mathematical concept that has been implemented is the concept of parabola. The rope that has been swung around (*ulai*) will create a parabola track both the opening parabola track $a > 0$ and the closing parabola track $a < 0$. The position of the jumper who jumps in the middle of the rope indicates the symmetrical axis of the parabola track, which divides the parabola track into two congruent parts. Therefore, it is possible for the jumper to win the game by jumping at the side of the rope.

2. Tali Sol Game

The rules of the game for the *tali sol* game is similar to the rules of the game for the *Tali Ulai* game. The only difference is that instead of being swung the rope should be stretched. Then, the *Tali Sol* game consists 15 stages and in each stage the player should shout "Sol!" every time the player has crossed over the rope. From Stage 1 until Stage 8 the rope should be stretched in a squatting position; meanwhile, from Stage 9 until Stage 18 the rope should be stretched in a standing position.

Figure 3. Tali Sol Game

From the Stage 1 until the Stage 4, during the jump the body of the player may not touch the rope. Then, from the Stage 5 until the Stage 10 the body of the play may touch the rope. Next, from the Stage 11 until the Stage 13 the player may lower the rope by holding the rope using 1 finger so that the rope will not be too high to be crossed over by the player. Furthermore, from the Stage 14 until the Stage 15 the player may lower the rope by using all of the five fingers. If the player does not shout "Sol" in any of Stage 1 to Stage 15, if the player touches the rope in any of Stage 1 to Stage 4 or if the players step on the rope in any of Stage 1 to Stage 15, then

the player will not continue playing the game. Eventually, if the player has reached the Stage 15 then he will be the winner of the game.

Looking at the rules of the game, *Tali Sol* rope game might be benefitted for assisting the mathematical learning process because it contains several mathematical concepts. In addition to the concept of odd and even number in the *Tali Ulai* Rope Game, there are also several mathematical concepts that might be introduced by benefitting *Tali Sol* Rope Game. The first mathematical concept that might be introduced is the concept of linear line, linear angle and two linear lines. From the Stage 1 until the Stage 4 (the rope holder is still in the squatting position), the body of the player (jumper) may not touch the rope. The rope is still stretched by the holder on the low height; as a result, the player (jumper) should will not need any assistance. The rope represents the linear line and the linear angle which is 180°. Both holders represent the position of the two linear lines since the angle that has been formed by the two linear lines is perpendicular and the distance between the first rope holder and the second rope holder has equal length.
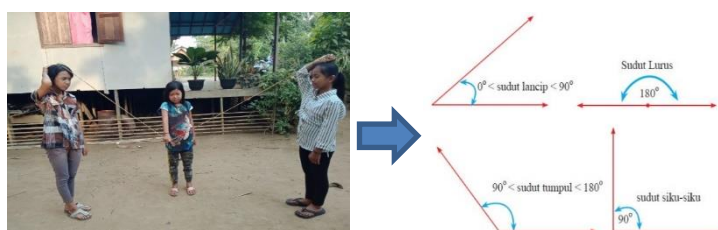

Figure 4. The Concept of Angle in Tali Sol Rope Game

Then, the second mathematical concept that might be implemented in the study is the concept of acute angle, right angle and obtuse angle. This concept appears when the player (jumper) uses 1 finger to lower the rope that has been set in the high position. The feet of the angle are formed by the line between the first rope holder and the finger of the player (jumper) and the line between the second rope holder and the finger of the player (jumper). From the without-assistance position (linear angle), the obtuse angle ($> 90°$) is formed when the finger does not press the rope too tight, the right angle is formed when the finger form exactly 90° position and the acute angle ($< 90°$) is formed when the finger presses the rope too tight.

3. Kelereng Segitiga Game

In *Kelereng Segitiga* (literary translated into Marbles in a Triangle) Game, the rules of the game proceed as follows. First of all, all players should submit an equal number of marbles as their "tribute" in the game. For example, there are four players in the game and each of them submits 10 marbles. Therefore, the number of the payment is 40 marbles and the 40 marbles should be arranged in the triangle that has been drawn on the ground. Then, all players should stand behind the START line and toss the pion or the playing marble. If the marble that they toss hit any marble within the triangle and the marble that has been hit is out of the triangle, then the marble that has been out of the triangle belongs to the given player and thus the given player will be the main player.

However, if the playing marble only hits the marble and thus the marble is still inside the triangle then the given player will earn the last turn in the game. If none of the playing marbles hit the marbles inside the triangle, then the player whose playing marble is the closest to the triangle will be the main player. Unfortunately, if the playing marble hits the marbles inside the triangle but the playing marble does not go out of the triangle

then the given player may not play and thus the 10 marbles that belong to the given player will be given to the other players.

Figure 5. Kelereng Segitiga Game

In this game, all players strive to get the marbles outside the triangle because the marbles that have left the triangle will belong to the players. Therefore, at least the players should get more marbles than their "tribute." Then, if a player is able to get the marbles outside the triangle then he or she might hit the other players (known as the opponent) until the other players will not be able to play anymore. The other player that has been hit should not be playing the game anymore and thus his or her marbles should be returned into the triangle and consequently the player earns zero marble. The player who earns the most marbles will be the winner, while the player who earns the least marble will be the loser.

Departing from the game, there are several mathematical concepts that might be introduced namely. The first mathematical concept that might be introduced is the concept of distance, unit of length and approximation. The players who will take the first turn, the second turn, the third turn and alike is defined by the closest distance between the playing marble and the triangle. The distance itself is measured from two sites namely the position of the triangle (the border of the triangle) and the position of the playing marble. Then, the distance might be identified by measuring the track length through the use of a rope and the length of the rope might be consulted to a ruler. By doing so, the children will learn about the unit of distance namely centimetre (on the ruler). If a measurement tool such as ruler is unavailable then at least the children will learn about the concept of approximation in defining which playing marble is in the closest distance to the border of the triangle.
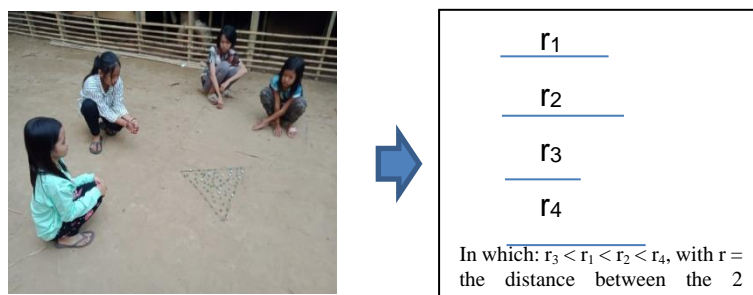

In which: $r_3 < r_1 < r_2 < r_4$, with r = the distance between the 2

Figure 6. Concept of Distance in Kelereng Segitia Game

The second mathematical concept that might be introduced is the concept of gain, break even and loss. When a player already makes a mistake from the START line, then he or she will be in the loss position. As a result, the 10 marbles as his or her "capital" in the game will not be returned. In other words, the player will earn marble that is lower than the tribute (< 10). Loss is a condition in which the final amount of marbles is lower than the beginning amount of marbles as the "capital." However, when a player is able to earn the equal amount

of marbles from the beginning until the end of the game, then he or she will be in the break even condition the number of the marbles in the beginning of the game is equal to the number of the marbles in the end of the game. However, if a player earns more than 10 marbles (> 10) then he or she will be in the gain condition since the number of the marbles in the beginning game is lower than the number of the marbles in the end of the game ("capital").
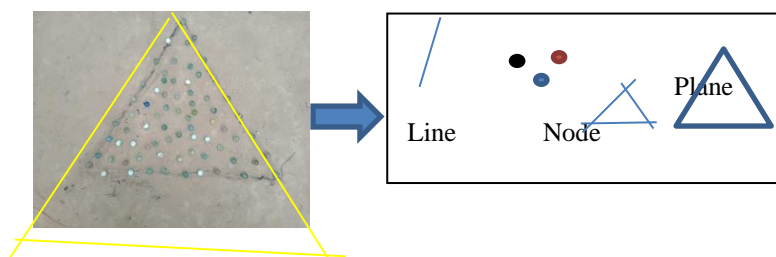

Figure 7. Concept of Node, Line, Plane and Triangle

The third concept that might be introduced is the concept of node, line and plane. These aspects are the elements that should not need further elaboration (undefined) according to the Euclid geometry. The marbles might represent the node and thus there might be colinear nodes and the non-colinear nodes along with the plane in the form of triangle. The plane, or the triangle, is formed by three linear lines that cut each other and consequently form an angle.

4. Cuk-Cuk Bimbi Game

Before playing Cuk-Cuk Bimbi, all players should do *hompimlah* (a kind of traditional toss). If one player shows different hand part in the toss than the other players, then he or she should guess what has been hidden under the hands of the other players in a table-like position. Then, the other players will put their hand on his or her back and they will sing the following verse while they are moving the small object:

Cuk-cuk bimbi, bimbi dalam sarunai Tacucuk takulibi, muhanya kawa panai Sangingci liwi-liwi, sanginci liwi-liwi

Figure 8. Cuk-Cuk Bimbi Game

After the final line of the verse has been sung, the small object should be hidden in the hands and be turned over and over. The squatted player should guess in which hand the small object has been hidden. If the squatted player is able to guess the small object, then the other player will replace him or her. On the contrary, if the player is unable to guess the small object, then he or she should stay in the squatted position until he or she is able to guess the small object right.

There is a mathematical concept that might be introduced through the Cuk-Cuk Bimbi Game. This concept is the probability of an event. The capacity of the squatted player to guess in which hand the small object has been hidden implies the probability to guess the small object right or wrong. In the same time, through Cuk-Cuk Bimbi Game another mathematical concept might be introduced namely the frequency of expectation since the squatted player is provided with more than one chance to guess the small object right or wrong. Furthermore, the Cuk-Cuk Bimbi Game might be used for introducing the discreet uniform probability distribution as an apperception. For example, if there are four players in the game then there will be eight hands to hide the small object. As a result, the probability of the squatted player to guess the small object might be stated as follows:

$$f(x;k) = \frac{1}{8}, k = 1,2,3,4,\cdots,8.$$

5. Daku

The rules of the *Daku* Game are simple. The game area of *Daku* is an oval platform (*Dakuan*) made of plastic or wood with 12 holes on it and the 12 holes are divided as follows: 5 holes are made in pairs, one hole serves as the bank for the seed of the five holes on the left and another hole serves as the bank for the seed of the five holes on the right. These holes are usually filled with five seeds of sapodilla, five marbles or alike.

Figure 9. Daku Game

In order to begin the game, one player should proceed by moving one seed of sapodilla or one marble from the intended hole to the bank of the opponent one by one. The last seed of sapodilla or the last marble that fall into the already filled hole should be taken away and be distributed to the other hole. If the seed of sapodilla or the marble falls into an empty hole then this situation is known as *tumbukan*. Furthermore, the last seed of sapodilla or the last marble that is in direct opposition with the already filled hole should be distributed again to the bank of the player. However, if the last seed of sapodilla or the last marble falls into the player's own bank then he or she may not continue the game. Consequently, the opponent plays the game again under the same rules. The player with the highest amount of saving in the holes will be the winner.

The *Daku* Game is actually a popular game in Indonesia. The only matter that differentiates *Daku* from the other similar game is the name. For example, in Java the game is known as Dakon or Congklak. Then, this traditional game might be benefitted for introducing several mathematical concepts. The first concept that might be introduced is the concept of number. Through the game, the children will learn to pronounce the number 1, 2, 3 and so on. Then, the second mathematical concept that might be introduced is repetitive summation and division (repetitive subtraction) as the inverse of multiplication. The multiplication of two numbers, *a* and *b*, that might be stated by $a \times b$, refers to the repetitive summation that has *a* number and each number is equal to *b* [1], [14]. Through the *Daku* (Dakon) Game, the learning interest of the children might be improved [15].

6. Kompak Gambar

The rules of *Kompak Gambar* Game are also simple. One picture is selected for the game and another picture is selected as the payment of the game in case if the player loses the game. The *Kompak Gambar* Game is usually played by two players. The two players hold a rectangle-shaped picture or a square-shaped picture on their hands and toss the pictures by using their hands until the pictures fall down onto the ground. The pictures that have fallen onto the ground might show the front part or the back part.

Figure 10. *K*ompak Gambar Game

If the one of the pictures shows the back part then the opponent should pay one picture to the winner. On the contrary, if both pictures show the back part then the two players should perform should do a lottery for taking the picture; the loser in the lottery will pick his or her picture and pay the picture to the winner. Usually, all pictures in the game have the same pattern on the back part.

Figure 11. Kompak Gambar

If the player picks the wrong picture, then he or she should pay one picture to the opponent. The players with the most pictures will be the winner of the game.

There are several mathematical concepts that might be introduced by benefitting the *Kompak Gambar* Game. The first concept that might be introduced is the concept of set. A set implies a group of objects with similar traits and characteristics. In this game, the set might be pictures with certain themes such as cartoon characters, names of fruit, and name of animals with the similar characteristics. However, the concept of set in this game is intended only to serve as a mere introduction; therefore, the children will not be invited to pursue more in-depth understanding toward the set by differentiating the set and the non-set.
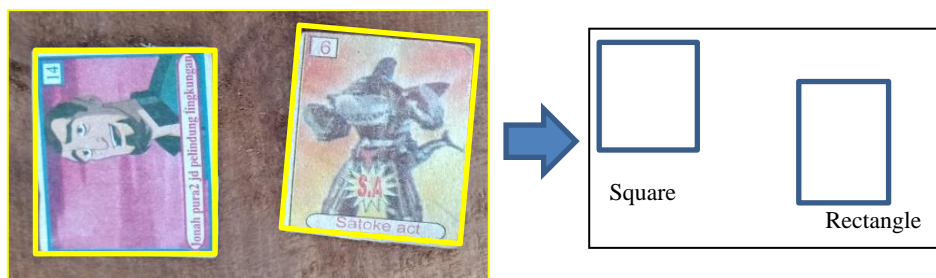
Figure 12. The Concept of Rectangle on the Kompak Gambar Game

Then, the second mathematical concept that might be introduced is the concept of rectangle. The picture might be square or rectangle depending on its shape. Next, the third mathematical concept that might be introduced is the concept of congruency between two planes. When the pictures are well cut, the result will be that each picture has a certain size with the congruent length and width under one set.

7. Asin Game

The *Asin* Game demands a lot of player. The players will be divided into two teams and each team should consist of at least 3 players. One player will defend the area of his or her tea while the other team attacks the defended area.

Figure 13. Playing Area of Asin Game

The team that will attack the defended area should be able to pass the squares that have been drawn on the ground and the members of the attacking team should not be touched by the members of the defending team. The members of the attacking team should get over the guards in each square and shout "*Asin*!" as they reach the end of the playing area. By the time the attacking team does this, the members of the attacking team will be the winner. As an illustration, an attacking team might consist of three players and if two players have been touched by the guards while one player is free from the guards and hit the end of the playing area then the attacking team will be the winner although the point is not significant since two of the three members are kept in captivity.

Figure 14. Playing the Asin Game

However, if all members of the attacking team are unable to hit the end of the playing area or have been touched by the members of the defensive team then the attacking team should take the turn as the defensive team. The team with the highest point will be the winner of the game.

The playing area of *Asin* Game might be benefitted for introducing the concept of square (area and circumference) and the congruency of two planes. The concept of square is apparent from several shapes of rectangle, while the concept of congruency is apparent from the small rectangle and the big rectangle which sides are equal from one to another. In addition, there is also the concept of ratio or comparison between the length of the small rectangle and the length of the big rectangle. If the length of the small rectangles is equal and it might be benefitted for calculating the area of the big rectangle. Furthermore, based on the length of the small rectangles, the number of the rectangle that will be necessary for covering the area of the big rectangle might be identified as well.
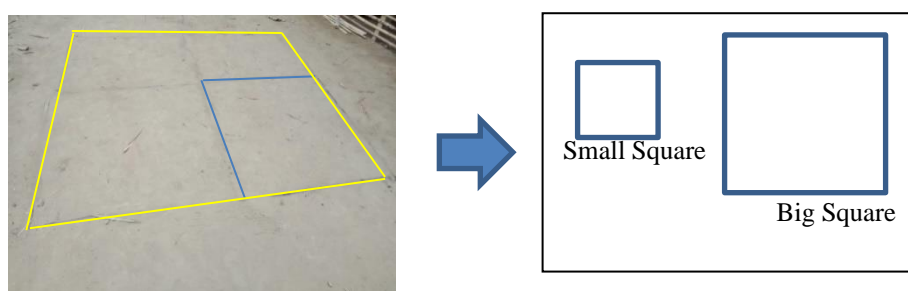

Figure 15. The Concept of Congruency in the Asin Game

The concept of ratio or comparison in the two unequal planes will apply if the size of the small rectangles is unequal. As a result, the length of the small rectangles that is congruent to the length of the big rectangle should be identified.

Figure 16. The Concept of Quadrant on Asin Game

The concept of quadrant might also be introduced by using the playing area of *Asin* Game. Quadrant I, Quadrant II, Quadrant III and Quadrant IV are the safe area for the members of the attacking team; in these areas, they will not be touched by the members of the defending team. The reason is that the members of the defending team have already set their guarding lane for chasing the members of the attacking team.

8. Dasprak Ingka Game

In *Dasprak Ingka* Game, the players are asked to throw flat pebble. The flat pebble should be put into the first square and be marked by using the symbols that the player favours. Later in the game, the symbol will be the mark of the player's house or square. Then, the box that has been marked will be the playing area or the ruling area of the player. The pebble will serve as the playing pion within the game. Furthermore, in moving from one box to another the player should jump by lifting one of his or her legs. When the player hits the top area (half-

circled shape at the end of the playing area), the player should hit the sixth square on the left side with both legs and turn around to return to the given playing area. When the player returns to the start, he or she is allowed to toss the pebble to the next square.

Figure 17. Dasprak Ingka Game

If the toss of the player does not reach the next playing box or if the toss of the player hits the line of the next box, then the player may not continue the game and thus the opponent will take over the turn. As an alternative, during the game the pebble should be tossed into the sixth square at the turning back point; then, in the sixth box the pebble should be hidden under the feet. The opponent who has lost his turn should guess under which feet the pebble is hidden. If the guess is wrong, then the opponent is still allowed to continue playing by tossing the pebble over his head with the playing area behind him or her. If the pebble falls onto the right position within the square, then the square will be the opponent's playing area and will be marked with his or her symbol. In this game, the player should not step into the playing area of the opponents; when the player hits his or her own playing area, he or she should use both legs. The player with the highest number of playing areas will be the winner of the game.

This game might be benefitted for introducing the geometrical shapes to the children. Looking at the playing area of *Dasprak Ingka*, the children might be familiar to the planes such as rectangle or half-circle.
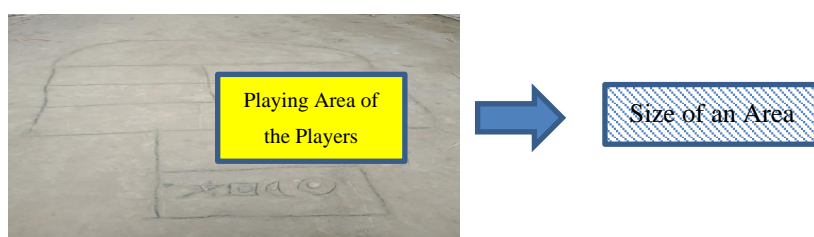

Figure 18. The Concept of Area in the Dasprak Ingka Game

In the same time, the children will also be familiar with the shaded area that becomes the playing area of the opponent. Furthermore, the children might be familiar with the congruency of two planes by measuring the congruent sides and angles and by defining whether these sides are equal in terms of length and size. Thus, these activities might lead to the conclusion of mutually congruent or, on the contrary, mutually incongruent.

IV. CONCLUSION

The eight traditional games from the County of Hulu Tengah Selatan (HST), the Province of South Borneo, that have been elaborated in the study contain numerous mathematical concepts. Through these traditional games, the children might learn more about the mathematical concepts such as: (a) odd and even number; (b) summation; (c) inequalities; (d) parabola; (e) linear line; (f) two linear lines; (g) angle; (h) distance and

measurement unit by length; (i) forecast; (j) loss, break even and gain; (k) node; (l) line and plane; (m) probability; (n) multiplication as repetitive summation; (o) division as repetitive subtraction; (p) set; (q) rectangle; (r) congruency of two planes; (s) quadrant; and (t) ratio or comparison. As a result, it is expected that the children might appreciate the usefulness of Mathematics in the daily life.

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