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Improving Mathematics Learning Outcome Through Outdoor Learning Based on Ethnomathematics of Bengkulu's Traditional Game 'Gotri Ayo Gotri

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ABSTRACT

Many high school students have difficulty learning probability material. Meanwhile, probability is very important to be applied in everyday life, for example, in estimating and drawing conclusions based on the analysis of an experiment. Therefore, students' understanding of probabilities needs to be improved through learning that invites students to real situations. This study aims to improve the mathematics learning outcomes of probability topics (counting, permutations, combinations, and probabilities) through ethnomathematical outdoor learning based on the game 'Gotri Ayo Gotri (GAG)' for XII Class senior high school. The research method is a classroom action research with the following cycle stages: planning, action, reflection, and evaluation. The research subjects were 33 students (20 female students and 13 male students). The research instrument was a learning outcome test about the probability of as many as five items. Data were analyzed qualitatively. The results of the study are as follows: outdoor learning based on the ethnomathematics of the game 'Gotri Ayo Gotri (GAG)' can improve mathematics learning outcomes on probability topics with an average score of cycle 1 of 65.91, cycle 2 of 79.97, and cycle three score of 89.97. The novelty in this research is the form of the traditional Bengkulu GAG game. As an alternative to learning, it is recommended for high school mathematics teachers to apply traditional game-based learning outside the classroom to increase motivation and learning outcomes in mathematics.

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A. INTRODUCTION

Probability material is the topic in mathematics lessons at XII grade in the even semester of 2021-2022, including counting, permutation, combination, and probability material (As'ari et al., 2018). In Singapore, probability material is included in the collection of mathematics material contained in the holistic curriculum (Atencio et al., 2015). This curriculum is the basis for selecting material from a subject (Dolan, 2016). Based on interviews with several students of class XII IPA2 SMA IT Iqro Bengkulu, information was obtained that probability material is one of the problematic materials for high school students to understand. Many students have difficulty understanding the mathematical concepts contained in the probability material. This problem can be seen from the average score of the initial test results on probability material in class XII IPA 2 SMA IT Iqro Bengkulu, which is 58. According to the mathematics teacher who

teaches the class, the low mathematics learning outcomes of probability material are caused by students not being careful in understanding the concept of counting abstractly, students being less interested in the material, and the learning process is monotonous (Widiasworo, 2017). The tedious conventional teaching process makes students experience boredom in learning mathematics (Husamah, 2013).

Other high school students also experience students' difficulties in understanding probability material. Fitri & Abadi (2021) mentioned students' difficulties in understanding mathematical concepts in the enumeration material, namely the difficulty of understanding counting problems at as much as 64.1%, transformation at 71.1%, process skills at 89.4%, and concluding at 94%. Other difficulties in the probability material are understanding the problem, planning, implementing the plan, and re-checking the completion of the counting problem (Kurniawan, 2017). Ron et al. (2017) explained that students' difficulty with enumeration lies in constructing events that may occur in a group of events.

To improve students' mathematics learning outcomes on probability material in the aspects of accuracy and interest, outdoor learning is carried out using real situations involving the students, namely the game Gotri Ayo Gotri (GAG), a typical Bengkulu game (ethnomathematics) in the Rejang Lebong and Kepahiang regencies. Pratiwi & Pujiastuti, (2020) revealed that traditional games, especially marbles, have benefits in learning mathematics. Outdoor learning transforms from conventional to modern learning, combining learning with play (Hill & Brown, 2014). Potter & Dyment (2016) explained that implementing outdoor learning requires the discipline of both teachers and students so that learning activities can achieve learning objectives.

The game 'Gotri Ayo Gotri' is a Bengkulu traditional/local game that reflects Bengkulu culture (Depdikbud, 1984). Prasetya et al. (2020) explain that outdoor learning effectively makes students careful in solving a problem. Meanwhile, Junaedah et al. (2020) mention that outdoor learning using traditional games can make students interested in mathematics, so learning outcomes increase. Likewise, Richmond et al. (2018) explain that outdoor learning has a better impact on learning outcomes than conventional learning.

The "Gotri Ayo Gotri (GAG)" is a traditional Bengkulu game, especially in the Rejang Lebong and Kepahiang regencies. This game is carried out by 5 or 7 children using stones, music, and soil in a circle divided into several parts as many players. Some children look after, and other childrenswear. The child was guarding and tried to catch the child who was hiding. When all the children have been caught, the game is over. The GAG game is related to the mathematical concepts contained in the probability material. For example, they determined the probability of getting caught by player "A" from all game participants. Game activities can help students understand mathematical material. Such as understanding number patterns can be made by student activities (Chan et al., 2021).

Based on the results of previous studies, an action hypothesis can be formulated, which says that the learning outcomes of mathematics in probability material can be improved through the Bengkulu Gotri Ayo Gotri traditional game. Therefore, the research problem is how to improve students' mathematics learning outcomes on probability material through the Gotri Ayo Gotri (GOG) game in class XII IPA2 SMA Iqro Bengkulu? Therefore, this study aimed to

improve mathematics learning outcomes on probability through ethnomathematical outdoor learning based on the game 'Gotri Ayo Gotri (GAG)' for Class XII IPA2 SMA IT IQRA Bengkulu.

The culture represents the values and activities of community life in an area. Through culture, it is possible to know the views of a society towards a particular phenomenon. Like the Gotri Ayo Gotri game culture, which originated from Bengkulu, specifically in the Rejang Lebong and Kepahiang regencies, it can be seen how Bengkulu people love their children to be able to play an educational games. Play is an activity a child needs to develop his personality, interests, and creativity; as explained by Polycarpou et al. (2010) and Bowen et al. (2014), playing activities can broaden children's mathematical insight and knowledge. By playing, children think of winning the game. They did various ways to win a game. In the Gotri Ayo Gotri game, a child who serves as a guardian tries to find a child who is hiding. At the same time, the child who is hiding tries to avoid being noticed by the child who is 'guarding' in this game the efforts made by the children who played resulted in a better understanding of the probability material. Students can understand the number of events that may occur. In addition, students can determine the probability of an event, like the probability of being caught by a player from seven people who play in the game Gotri Ayo Gotri, namely $\frac{1}{7}$.

Outdoor learning using the traditional game Bengkulu Gotri Ayo Gotri overcomes the monotony of conventional learning gaps in the classroom. Outdoor learning carried out outside the classroom makes students happy in learning mathematics. This is because students interact with their natural environment. In addition, traditional games make students more familiar with their own culture while preserving it. This study aims to improve students' mathematics learning outcomes through outdoor learning using the Bengkulu Gotri Ayo Gotri traditional game.

B. METHODS

The type of this research is action research classroom. The cycle is carried out as follows: (1) planning; (2) action; (3) reflection; and (4) evaluation. Planning is the stage of planning the action to be taken in the form of a lesson plan which includes outdoor learning activities based on the Bengkulu traditional game, GAG. Action is the stage of implementing outdoor learning based on the Bengkulu traditional game, GAG. Reflection is the stage of reviewing the implementation of learning that has been carried out for improvements in the next cycle. Finally, the evaluation stage is an activity to evaluate learning outcomes. Outdoor learning based on the ethnomathematics of the GAG game is carried out in the schoolyard of SMA IT Iqra Bengkulu.

The research subjects were 33 students of class XII IPA 2 SMA IT Iqro Bengkulu City in the even semester of the academic year 2021-2022, consisting of 20 female students and 13 male students. The research instrument is a learning outcome test that consists of 5 essay questions about probability with based competencies: analyzing addition rules, multiplication rules, permutations, and combinations through contextual problems. Data was collected using tests, observation guidelines, and interviews. The data analysis method used is the content analysis method (Bungin, 2007), with an indicator of learning success of 85. The determination of this success indicator is based on the results of discussions with the school, where the school wants the average ability of its students to be in the very good category, namely a score above 85.

The results of the instrument validity test by five experts in mathematics education using the Aiken test obtained a Content Validity Index (CVI) value of 0.75, which is in the medium category. While the assessment consistency test by experts using Kendall's test, the asymptotic significance result is 0.048 or has a probability below 0.05 which means that H0 is rejected or the five validators have the same perception that the five items of instrument questions regarding probability material have content validity in accordance. Thus, the instrument is feasible to be used for the data collection on student learning outcomes regarding probability. The action hypothesis in this research is that ethnomathematics-based outdoor learning can improve mathematics learning outcomes on probability topics for Class XII IPA2 SMA IT IQRA Bengkulu.

C. RESULT AND DISCUSSION

Outdoor learning is conducted outside the classroom to develop relevant knowledge (Widiasworo, 2017). Learning activities outside the classroom in this study were Bengkulu traditional games, namely the Gotri Ayo Gotri game, to develop knowledge of enumeration, permutations, combinations, and probabilities. In this study, the Gotri Ayo Gotri game was used as a theme in outdoor learning. According to (Gray & Birrell, 2015), outdoor learning requires a theme to lead students to understand the subject matter.

The learning took place in 3 cycles. Each cycle lasts for two games, followed by seven players, including one player as a guard. Before playing the game, the teacher gives directions about the purpose and how to do the game. As part of game preparation in outdoor learning, guidance is necessary to avoid an accident in the game (North & Brookes, 2017). After the game, discussions, and conclusions were drawn, as well as an evaluation of learning outcomes.

Gotri Ayo Gotri is a traditional Bengkulu game, especially in the Rejang Lebong and Kepahiang regencies. Usually, this game is played by 5 or 7 children. Each child holds a stone, where one stone is decisive. At first, the children form a circle divided into 6 or 8 equal parts. Traditional games in ethnomathematics can foster social interaction (Zayyadi et al., 2018), as shown in Figure 1.

Figure 1. Game Participants Make a Circle While Holding a Stone

After that, the seven stones will be placed in each part of the circle, including one decisive stone. Then the kids sing "Gotri Ayo Gotri" while turning around (Figure 2).

Figure 2. Seven stones are placed in each part of the circle

When the song ends, a child will play the role of a guardian by holding the guardian stone, while the others will hide, as shown in Figure 3.

Figure 3. A Guarding Child Closes His Eyes While the Other Children Try to Hide

Then the guarding child looks for his friends who are hiding. When the guarding child finds a friend hiding, the two children race to the circle. If the child guarding gets to the circle first, he steps over the stone while saying 'asin.' But if the friend who was caught first gets to the circle, the child destroys the arrangement of the stones; then the child can hide again. After that, the child on guard looks for his friends again until all his friends are caught, then the game is over. This activity provides an experience for students to socialize with peers. Students can adapt to their friends and their environment. Through outdoor learning with traditional games, teachers can directly see students' prosocial behavior (cooperation, helping, sharing with friends, and appreciating friends) (Junaedah et al., 2020).

Traditional games not only contain social aspects but also utilize theories that are not independent of the field of mathematics. Like the gaple card game, it is a vehicle for practicing numeracy and higher-order thinking skills (Alghadari & Son, 2018). Games can stimulate students' ability in mathematic thinking (Fouze & Amit, 2018). The growth of thinking skills is influenced by the environment in which children play (Clarke & McPhie, 2014). A comfortable and educational environment where children play GAG makes students think about winning the game. Outdoor learning can also give students awareness of the school environment (Thorburn, 2018). Besides, games can also grow mathematical concepts (Turmudi et al., 2021). The results of the research by (Febriyanti et al., 2018) stated that the mathematical concepts

contained in the traditional engklek game had elements of flat geometry, namely squares, rectangles, half circles, and tubes. A child that is guarding will look for the other six hiding children in GAG will stimulate a thinking pattern, as shown in Figure 4.

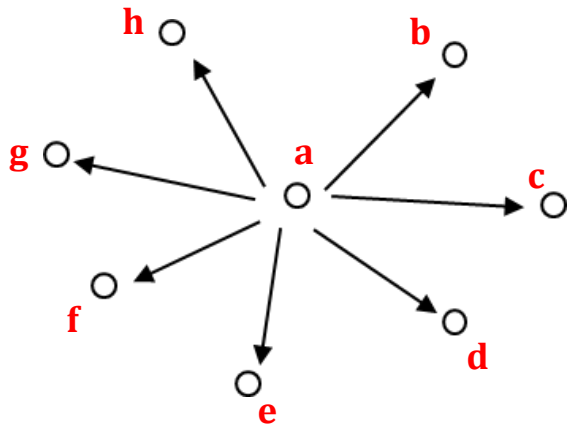

Figure 4. Diagram of a Guardian with Six Persons Hiding

The formation can be written as ordered pair such as follows: (a,b), (a,c), (a,d), (a,e), (a,f), (a,g), (a,h). If set P = {a} and Q = {b, c, d, e, f, g, h}, so P × Q = {(a,b), (a,c), (a,d), (a,e), (a,f), (a,g), (a,h)}. P' Q is a set of ordered pairs from sets P and Q. The concept of ordered pair sets can be made from the GAG activity forms. The development of the ordered pair sets concept is to deliver a better understanding for students of the permutation concept:

$$P_r^n = n \times (n-1) \times (n-2) \times \ldots \times (n-r+1) = \frac{n!}{(n-r)!} \text{ (Jones, 2005)}$$

And combination concept: $C_r^n = \frac{n!}{r!(n-r)!}$. (Jones, 2005)

It can be seen from students' work in solving the problems about permutation and combination, such as the following. "One group of 6 students of class XII IPA2 SMA IT Iqra Bengkulu will take pictures to be placed in the school yearbook. They are taking pictures in a line-up position. If 3 out of 6 students want to be side by side, the possible number of position arrangements is . . . ways", as shown in Figure 5.

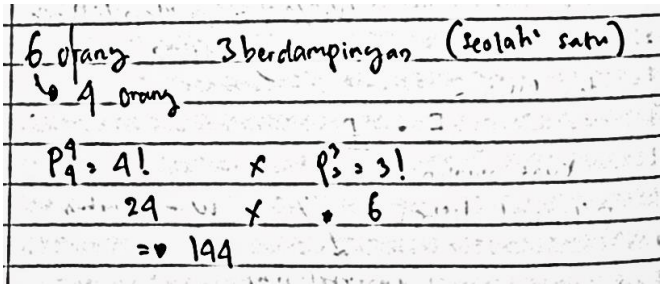

Figure 5. Example of a Student's Answer about Permutation

Through the experience of students playing GAG, inspiring solving the permutation problem, students visualize the position of the person taking the photo with the letters ABCDEF with a box on ABC. Visualization of a real phenomenon in outdoor learning can simplify a complex phenomenon, such as an earth phenomenon visualized with an image of the earth

(Gray & Birrell, 2015). The image of the visualization of the photo formation permutation problem carried out by counting is shown in Figure 6.

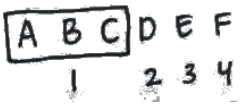

Figure 6. Permutations of Photo Formation

For example, three persons close by are A, B, and C, so ABC can be considered as one arrangement where the total will be four instead of 6, which is: (ABC), D, E, and F (Figure 6.). The ABC's position can also be scrambled, for example, into ACB, BAC, and so on.

$$\text{Permutation} = P_4^4 \times P_3^3 = 4! \times 3! = 24 \times 6 = 144.$$

The total arrangement is 144 ways. Outdoor learning based on the GAG game takes place effectively. Students play the games with pleasure in a dynamic atmosphere. The game of determining who is the 'guard' has inspired the concepts of counting, permutations, combinations, and probabilities. Students count from 7 participants in the game. The concept of permutation is developed by determining one person as the guardian of 7 participants. While the combination concept is built by placing seven stones in a circle, provided two stones must be close together while the other stones are free. The ability of students to determine the combination of a phenomenon can be seen from the results of their work as follows. Students are correct in determining the combination of 5 out of 10 in the case of determining the school basketball team as many as five people out of 10 available. The results of student work are as follows, as shown in Figure 7.

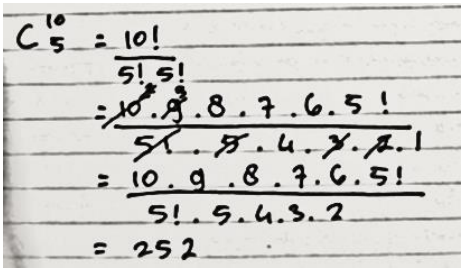

Figure 7. Example of a Student's Answer about the Combination

Outdoor learning based on the GAG game positively impacts students' mathematics learning outcomes in enumeration, permutations, combinations, and probabilities. In cycle 1, students' mathematics learning outcomes reached more than 50 (score range 0-100), which is 65.91. This shows that the student's mathematical ability is above average ability. However, the results of the reflection show that the student's mathematical ability is still below the score of the success indicator of this study, which is 85. Reflection activities are one way to determine the success of learning (Smith et al., 2016). So the learning continues to cycle two by improving the game's quality from the participants' obedience to the game's rules. Like the rules in determining a person as a 'guard.' In addition, the accuracy in dividing the circle into seven equal parts.

Improving the quality of the game in cycle two impacts students' mathematics learning outcomes. There was an increase in mathematics learning outcomes from cycle 1 to cycle 2.

Students' mathematics learning outcomes in cycle 2 were 79.97. Because students' mathematics learning outcomes in cycle 2 are still smaller than the success score indicator, namely 85, the learning is carried out in cycle 3. The improvement in learning in cycle 3 is the accuracy of a game guard finding/catching friends who are hiding. Traditional games positively impact students' understanding of the subject matter. This improvement positively impacts students' mathematics learning outcomes to 89.97. Because these results exceed the indicators of success, the research cycle is stopped. The following picture presents the average learning outcomes of mathematics in each cycle, as shown in Figure 8.

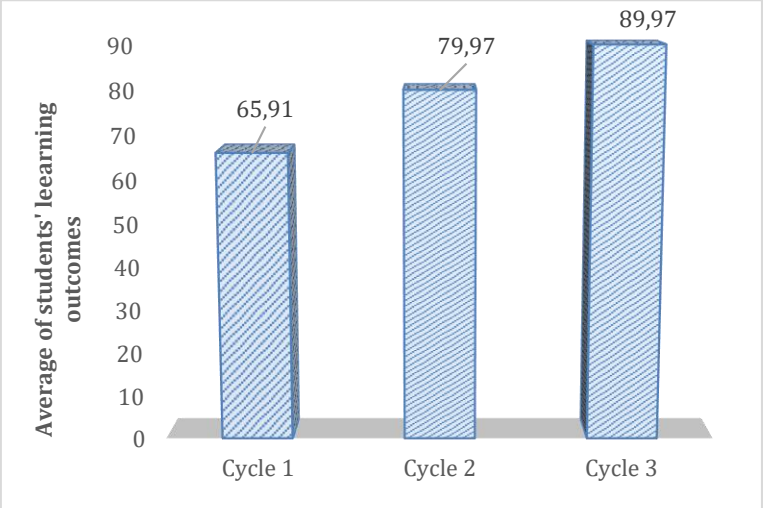

Figure 8. Students' Mathematics Learning Outcomes in Each Cycle

The improvement in learning outcomes from cycle 1 to cycle 2 is 14.06, greater than the increase in learning outcomes from cycle 2 to cycle three, which is 10. This is because students are still enthusiastic about playing GAG games compared to cycle 3. In cycle 3, most of the students are tired, so their understanding of the concept of probability material is somewhat reduced.

The results of this study indicate that learning outside the classroom based on Bengkulu GAG traditional games can improve student learning outcomes on probability material. The novelty of the results of this study is the use of GAG games in mathematics learning. In addition, another novelty is the impact of the GAG game on students' understanding of probability material. This is different from the results of previous studies, such as research by (Rosa et al., 2019) stated that the jumping frog game can improve students' mathematics learning outcomes. Mathematics learning outcomes that can be improved through traditional games are aspects of understanding concepts and the ability to prove theorems (Riskianto et al., 2020).

The results of this study are from the research conducted by (Mei et al., 2020) which states that playing marbles in third-grade elementary school students can improve understanding of mathematical concepts. Likewise, the traditional 'Main Ki' game can enhance the ability of elementary school students to understand data processing material (Dewi et al., 2020). Learning outside the classroom by combining traditional games makes students enthusiastic about learning probability material. Overall, traditional games in ethnomathematics can broaden the horizons of mathematical concepts related to everyday life (Rahmawati et al., 2019).

D. CONCLUSIONS AND SUGGESTIONS

This research shows that outdoor learning based on ethnomathematics in 'Gotri Ayo Gotri' (GAG) games can improve the mathematics learning outcome in probability topics for students of class XII IPA2 SMA IT Iqra Bengkulu. The average learning outcome score in cycle 1 is 65.91, cycle 2 is 79.97, and cycle 3 is 89.97. The results of this study strengthen the results of previous studies, which resulted that learning outside the classroom affected increasing students' abilities. Learning outside the classroom causes students' awareness of the importance of the environment for human life (Clarke & McPhie, 2014). Responsibility, social interaction, and decision-making ability can be improved through outdoor learning (Thorburn, 2018). Self-confidence, self-exploration, and social connectedness can be built in classrooms that apply outdoor learning (Richmond et al., 2018). Aries (2018) said that applying CPS outdoor learning can improve students' mathematics learning outcomes. Likewise, traditional game-based outdoor learning can improve mathematics learning outcomes (Junaedah et al., 2020).

This study has limitations, including the type of play only in one traditional game for several learning sub-topics. This makes students bored. The study was also conducted in only one class. Therefore, for the development of future research, a wider traditional game-based outdoor learning research can be performed, both in terms of the number of games and the number of classes and schools studied.

The results of this study have implications for theory and practice in learning mathematics in schools. The theoretical implication is that these study results complement mathematics learning theories, namely, outdoor learning based on traditional ethnomathematical games can improve students' mathematics learning outcomes. Practical implications of the traditional game-based outdoor learning model can be used as alternative learning to improving mathematics learning outcomes.

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