Teaching mathematics using snakes and ladders game to help students understand angle measurement

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Abstract. Mathematics for young learners should be taught in a fun way, using a familiar context. Incorporating games into the classroom is a way to engage students in mathematics and hence improve their learning outcomes. This article reports a qualitative study conducted to improve students’ understanding of angle measurement by implementing snakes and ladders game. A class consisted of 30 fourth-grade students at a primary school in Banda Aceh, Indonesia, participated in the study. Data on the students’ activity during learning and their learning outcomes were collected using observation sheet and tests. Results showed that the implementation of the snakes and ladders game in the teaching and learning of angles successfully improved the students’ attention during learning and their interactions with the teacher and their peers. There was also a significant improvement in the students’ learning outcomes from the average score of 45 for pre-test to 85 for post-test. These findings suggest that the implementation of snakes and ladders game is beneficial for students’ mathematics learning.

1. Introduction
Mathematics learning in elementary education focuses on the understanding of basic mathematical concepts. In these early stages of mathematics learning, the main goal is to help students truly understand basic operations and skills such as addition, multiplication, and measurement. For the students to have good understanding of mathematics, the teaching and learning process in elementary school must be carefully designed so that it provides meaningful experience for the students. The teaching and learning process should be able to help students grasp the abstract nature of mathematics. Therefore, experts suggest that teachers use manipulatives to help bridge abstract ideas of mathematics through manipulation of concrete objects [1]. Teachers should also pay attention to their teaching approach so that students do not see learning mathematics as a boring and meaningless activity. This is very important because student engagement plays an important role in their knowledge construction [2].

Implementing games in mathematics learning is a way to create fun and meaningful learning. Piaget suggested that the implementation of games help create a relaxed atmosphere through a fun and engaging activity which is crucial for students’ knowledge construction [3]. Moreover, games provide a simulation of a community where students can cooperate with each other in achieving a shared goal [4]. Various studies have reported the advantages of the implementation of various games in learning mathematics [5-7].
Traditional board games, such as snakes and ladders, have been reported to be beneficial for students’ mathematics learning [8,9]. The snakes and ladders game is suitable for elementary mathematics for many reasons: they are cheap, easy to use, and the students are familiar with them. Russo and Hopkins [8] argued that snakes and ladders game can be utilized in a wide range of mathematics lessons because the game can be modified to fit numerous elementary mathematics concepts such as numbers and algebra. Unfortunately, there has been no publication on the use of snakes and ladders game in the teaching and learning of angles.

An angle is a configuration of two segments meeting at a point [10]. Previous studies showed that most students struggle with the concept and measurement of angles [11,12]. A common misconception among students is that they consider the measure of an angle depends on the length of its two segments [12]. To overcome this problem, we modified snakes and ladders game and used it to help students learn about angle measurement. The goal was to help students understand how to measure angles of two-dimensional shapes using a protractor. Therefore, the research question that we address in this article is: does the implementation of snakes and ladders game improve students’ learning activity and students’ understanding of angle measurement.

2. Method
This qualitative study was conducted to improve students’ understanding of angle measurement by implementing snakes and ladders game. The students had learned about angle measurement using nonstandard units of measurement in grade 3. In line with Indonesian mathematics curriculum for grade 4, the goal of the learning activity in this study was to help students understand how to measure angles of two-dimensional shapes using a protractor. The activity was conducted in three learning sessions. It was planned in three sessions to make sure that each and every single student achieved the learning goal. A pre-test and a post-test were used to assess students’ understanding before and after the implementation of the game. The tests were similar. Each test consisted of 5 two-dimensional shapes and the students were asked to measure all angles of the shapes using a protractor. Each test was approximately 30 minutes long.

The board game used in the study was a modification of the traditional snakes and ladders board. Figure 1 shows the board that we used in the study. The board consisted of 36 cells, and all of the cells contained various two-dimensional shapes.

![Figure 1. snakes and ladders board](image)

A class consisted of 30 fourth-grade students at a primary school in Banda Aceh, Indonesia, participated in the study. They were 12 girls and 18 boys aged 9 years old. During learning, the students were grouped into 6 groups. Each group consisted of 5 students. Each group was given a snakes and ladders board as seen in figure 1, protractors and a worksheet where they recorded their measurement. The first group to finish the game with correct answers won the game. The rule was
similar to the traditional snakes and ladders game. The first player rolled the dice and measured angles on the figure that the dice landed on and made note on his or her worksheet. The second player took his or her turn, then the third player, and so on until they reached the Finish Cell.

The students’ learning activity and their learning outcome were assessed. Data were collected using observation sheets and tests. The observation instrument was designed based on Diedrich’s notion that learning activities for elementary students should encompass reading, listening, writing, discussing, playing, solving problems, and feeling enthusiastic [13]. Therefore, the focus of the observation was divided into three main aspects. The first aspect was students’ attention. It covered the activities of paying attention to teacher’s explanation, answering questions, and asking questions. The second aspect was student interaction. It covered the activities of discussing with peers, working together, and helping team-mates. The third aspect was student work. It covered the activities of solving a task, showing enthusiasm, staying on task, and staying focused throughout learning. Three observers recorded their observation using a 3-point Likert scale ranging from poor (P) = 1, average (A) = 2, and good (G) = 3. P indicates that less than 50% of the students performed the activity; A indicates that 50% to 70% of the students performed the activity; G indicates that more than 70% of the students performed the activity. The data obtained from the observers were analyzed statistically by calculating the mean score for each item. The observers were also invited to add comments or remarks if they wished to do so.

3. Results and Discussion
There are two main data that we presented in this article. The first one is students’ learning activity and the second one is students’ learning outcomes.

3.1. Students’ learning activity
Table 1 shows students’ learning activity. The data were obtained from three observers’ assessment during three learning sessions.

| Items No       | Session 1 |                   | Session 2 |                   | Session 3 |                   |
|----------------|-----------|-------------------|-----------|-------------------|-----------|-------------------|
|                | P  A  G  | Mean              | P  A  G  | Mean              | P  A  G  | Mean              |
| A Student attention |          |                   |           |                   |           |                   |
| 1   Pay attention in class | 2  1  1 1.67 | 2  1  2.33 | 1  2  2.67 | 1  2  2.67 |           |                   |
| 2   Answer questions   | 2  1  1.33 | 3  2.00 | 3  3.00 |                   |           |                   |
| 3   Ask questions      | 2  1  1.67 | 1  1  1  2.00 | 1  2  2.33 |           |           |                   |
| B Student interaction  |          |                   |           |                   |           |                   |
| 4   Discuss with team-mates | 2  1  2.33 | 1  2  2.67 | 3  3.00 |                   |           |                   |
| 5   Work together in group | 1  1  2.00 | 1  2  2.67 | 3  3.00 |                   |           |                   |
| 6   Help team-mates    | 2  1  1.67 | 1  2  2.67 | 3  3.00 |                   |           |                   |
| C Student work        |          |                   |           |                   |           |                   |
| 7   Solve task independently | 1  1  2.00 | 1  2  2.67 | 3  3.00 |                   |           |                   |
| 8   Show enthusiasm    | 1  2  2.33 | 1  2  2.67 | 3  3.00 |                   |           |                   |
| 9   Stay on task       | 1  1  2.00 | 1  2  2.67 | 3  3.00 |                   |           |                   |
| 10  Stay focus         | 1  1  2.00 | 1  2  2.67 | 3  3.00 |                   |           |                   |

Table 1 shows that there was an improvement in students’ learning activity from sessions 1, 2 and 3. In session 1, the highest mean score was 2.33 for the activities of discussing with team-mates and showing enthusiasm, while the lowest mean score was 1.33 for the activity of answering questions. In session 2, the highest mean score was 2.67 for 7 activities; and the lowest mean score was 2.00 for the activities of answering and asking questions. In session 3, almost all of the observation items scored 3, except the activities of paying attention and asking questions.
There were slightly different scoring between the three observers, especially in session 1. This is normal because there were 30 students to be observed and each observer might have rounded up or rounded down the number differently [14]. For sessions 2 and 3, the observers gave mostly similar scores. Particularly for session 3, all of the observers gave 3 for most of the observation items. This indicates that it was obvious to see that the majority of the students performed all of the learning activities.

For the aspect of student attention in session 1, it was revealed that most of the students paid attention to the teacher during the first 10-15 minutes of learning. Beyond that, some students were distracted with off-task activities such as chatting with friends and zoning out in class. This is not uncommon because as Gerschler [15] explained that the average attention span of a student is approximately 5 minutes and repeated refocusing was needed to re-engage the student. In sessions 2 and 3, the students’ attention improved. They had experience with session 1 so now they knew what to expect in the classroom and they wanted to do better. This is as Gerschler [15] suggested that students’ attention in class is affected by their interest and understanding of a given task. At first, the students were interested in the presentation of the board, which was colorful and familiar, and then they were interested in winning the game as well. Therefore they paid more attention in class.

For the activities of answering and asking questions, there was also an improvement from session 1 to sessions 2 and 3. This is as discussed earlier that the students wanted to win the game, so they asked questions to make sure that they understood the rules. The observers revealed that more students were becoming more active in answering questions from the teacher or their peers. They discussed with each other during the game as well while asking for explanations or assisting team-mates who were facing difficulties in solving the task. This is beneficial for student learning because as Vygotsky asserted that communication is an essential part of student learning [16]. By communicating, students improve their analyzing skill [7].

For the aspect of student work, there was huge improvement throughout the learning sessions. In session 1, few students could solve the task independently. When these brighter students saw their team-mates were struggling in measuring angles with a protractor, they tended to give the correct answer hurriedly without explaining how to get at the correct answer. This behavior resulted in lack of discussion and teamwork during the game. Less able students did not get to learn how to measure the angles correctly. Hence, unsurprisingly, they lost enthusiasm and focus during the rest of the activity. They relied on their more able friends to finish the task. This situation is a form of an ineffective collaboration where students do not work together effectively to achieve a shared goal.

Ineffective collaboration is a frequent problem among elementary school students [17]. Le [18] stated that this problem happens for four reasons: teacher and students focus on goals rather than collaborative skills, students concentrate on individual achievement rather than social interaction, active students tend to dominate group work while passive students feel inferior, and students’ hesitation to criticize each other because they do not want to jeopardize their friendship. These four conditions appeared during the first learning session.

In session 2 the teacher repeatedly reminded the students that their group work only counted if each team member could independently measure angles correctly, no free-riding. The students were encouraged to discuss and help each other by explaining the correct way to measure angles, but every student must contribute to group work by finishing their job on their own. Fortunately, during session 3 the students finally exhibited good collaboration and responsibility. Every student finished their own work independently during their turn, and they seemed focus measuring angles on the snakes and ladders board.

3.2. Students’ learning outcomes
Data on students’ learning outcomes were gathered from pre-test and post-test. During these tests, the students were asked to measure angles of various two-dimensional shapes. An example of these shapes is shown in figure 2.
Figure 2. Angles of a two-dimensional shape.

Table 2 shows the distribution of students’ scores on both pre-test and post-test.

| Scores  | Number of students | Pre-test | Post-test |
|---------|--------------------|----------|-----------|
| 21 – 30 | 2                  |          | 0         |
| 31 – 40 | 14                 |          | 0         |
| 41 – 50 | 7                  |          | 0         |
| 51 – 60 | 7                  |          | 2         |
| 61 – 70 | 0                  |          | 4         |
| 71 – 80 | 0                  |          | 9         |
| 81 – 90 | 0                  |          | 9         |
| 91 – 100| 0                  |          | 6         |
| Sum     | 30                 | 30       |
| Average score | 45   | 85       |

As shown in Table 2, the average score for pre-test was 45 and for post-test was 85. For pre-test, none of the students achieved scores greater than 60. The scores ranged merely from 21 to 60. In contrast with the pre-test score, the students’ score for post-test ranged from 51 to 100. It did not show in the table but the lowest score for post-test was in fact 60 which was earned by 2 students while the rest of the students earned greater than 60. The highest score was 91 – 100 achieved by 6 students.

In the pre-test, the students had difficulties using a protractor to measure an angle especially if the angle was not on the left side of the two-dimensional figure, for example ∠B in Figure 2, or if the angle was not on a horizontal line, for example ∠A, ∠B and ∠C in Figure 2. Clearly the students did not have sufficient experience using a protractor. They did not know how to position the protractor correctly. But after three learning sessions using a protractor to measure angles on various figures on the snakes and ladders board, the students’ measuring skill using a protractor improved significantly. Indeed, this type of mathematical skill requires a lot of hands-on experience. This is as Kolb asserted that students learn best when they are directly involved in the concrete experience [19].

The implementation of snakes and ladders game enabled the students to familiarize themselves with a protractor and used it to measure angles correctly. It can be said that the implementation of the game was suitable to teach angle measurement for fourth-grade students. This is important because only through suitable learning activity students are able to construct their understanding of a concept [20].

4. Conclusion
Through the implementation of the snakes and ladders game, the students learned important concepts about angle measurement. The activity helped eliminate students’ misconception that the measure of an angle depended on the length of the adjoining segments. Furthermore, the nature of the game where the students competed with other groups promoted their collaboration and communication skills.
through group discussion. The students learned to help each other constructively to make sure that all group members understand how to use a protractor correctly to measure angles so that during post-test every one earned good score. It can be concluded that the implementation of the snakes and ladders game is beneficial for student learning.

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