Application of the Kahoot game-based problem-based learning model to increase motivation and learning achievement in the calculus

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Abstract: The purpose of this study is to raise student achievement and learning motivation by implementing problem-based learning based on the Kahoot game. This research was carried out from February to April 2023. This type of research is classroom action research, which consists of 2 cycles, each with four stages: planning, implementing, observing, and reflecting. This research was conducted on 12 students of the mathematics study program, even in the semester 2022/2023, who took the Calculus 2 course. Data collection techniques were tests and observations. The results of this research are as follows: 1) There was an increase in learning achievement after implementing the Kahoot game-based problem-based learning model seen from the class average before learning. 57.87 and after cycles I and II, with a class average of 71.5 and 80.25. 2) increase student learning motivation. This is indicated by the results of the learning motivation data before the research, which met the good enough criteria; as many as seven students (58.33%) and five students (41.67%) met the good criteria. After taking action, eight students (66.67%) fell into the good criteria, and four (33.33%) fell into the very good criteria.

Keywords: Kahoot, Learning achievement, Motivation to learn, Problem-based learning

INTRODUCTION

Learning or the process of teaching and learning is a process of interaction between educators and students carried out in a learning environment. In the learning process there are two components that cannot be separated, namely educators and students. There needs to be mutually supportive interaction between these two components in order to create optimal learning outcomes.

The same thing is also expected in studying the Calculus 2 course which is one of the mandatory courses in the Mathematics Study Program at Nahdlatul Ulama University, Purwokerto. The Calculus 2 course consists of several materials, namely: area of polygons, integration techniques, integral applications and improper integrals. However, the results in the field show that students find it difficult and less interested in the Calculus 2 course. Students are less interested in the Calculus 2 course because the basic concepts of integrals are not yet understood, students feel that the integral material is difficult and abstract, the learning method is boring, only explaining the material and practicing questions. This is shown by students being passive and the tendency of students to only imitate the work of their friends or lecturers written on the board, so that logical thinking patterns, independence and problem-
solving abilities do not appear. This resulted in the average Calculus 2 score of 66.67% of students still being below 60.

This is in line with research results that students experience difficulties with learning in the Calculus 2 course, especially in integral application material. This is because students' ability to solve problems is still not good (Muhammad, Lukman, 2021). Apart from that, according to (Monariska, 2019) the factors causing students' learning difficulties in integral material are a lack of practice in working on Integral problems and pupils' inadequate comprehension of the basic calculus theorem. To overcome students' difficulties in studying calculus 2, especially integral application material, as lecturers or instructors we must be clever in choosing models, methods, approaches or learning strategies that can improve abilities and positive attitudes towards mathematics (Nasrullah, 2015). Since solving problems is the major objective of learning mathematics, pupils should be given, trained, and exposed to problem-solving techniques (Pujiadi, 2018). According to another opinion, problem solving in mathematics learning is a fundamental skill that all learners must possess. (Hidayat & Sariningsih, 2018). Therefore, in problem solving it is necessary to improve one's capacity for comprehending issues, build mathematical models, find solutions to issues, and analyze those answers.

Based on the problems experienced by students who are less active and interested in learning due to students' inability to comprehend the subject matter and weak understanding of the concept of the basic theorem of calculus so that their problem-solving abilities are low, it is necessary to immediately improve learning strategies and learning models. One of the learning strategies created to enhance problem-solving skills is the Project Based Learning (PBL) learning model. PBL is a cutting-edge instructional strategy that places a strong emphasis on contextual learning via challenging activities. The application of the Problem Based Learning model allows each student to be actively involved in expressing their ideas and thoughts. The study's findings show that using the Problem Based Learning the method with the discussion method has an effect on improving students' scientific attitudes, including attitudes of curiosity, critical thinking, collaboration and responsibility (Azmi et al., 2017). Apart from that, since a result of more research, it has been determined that problem solving skills the PBL model have an influence on students' better problem-solving abilities (Putri et al., 2019). However, in practice, not all students are actively involved in this learning activity, but instead tend to be less enthusiastic about participating in the process of learning.

For this reason, it is essential to create interesting learning conditions through the use of media in the process of learning. One educational tool that can be applied is the Kahoot educational game learning media. The use of the Problem-Based Learning approach was helpful by the Kahoot game media is expected to increase active involvement of students in the learning process. It is thought that this blended learning paradigm will raise student achievement and learning motivation because Kahoot is an application designed like a game. The advantages of Kahoot can be seen in the questions presented in the application with the presentation using a time limit for answering them. Due to limited time, when answering questions utilizing Kahoot media, kids are taught how to think swiftly and precisely. This can improve students' ability to solve problems. Research conducted by Lime shows that the use of Kahoot media in the learning process is very good and the percentage of learning completion learning outcomes is included in the very good category (Lime, 2018). Similar research results also concluded that the application of interactive quiz media based on the educational game Kahoot can enhance students' learning results (Ningrum, 2018).

Considering the explanation above, it is essential to carry out research related to the application of the Problem Based Learning model based on the Kahoot game to improve student achievement and learning motivation in the Calculus 2 course. With this research, the problems faced by students in the Calculus 2 course can be resolved by increasing their abilities. In solving problems, thinking critically and being more active in learning the Calculus 2 course. This research is important and needs to be carried out because the Problem Based Learning model based on the Kahoot game is a new innovation in Calculus 2 learning.
where researchers take advantage of digital advances in order to increase students' motivation for learning. Apart from that, learning the Calculus 2 course does not seem difficult and boring because so far learning Calculus 2 has been synonymous with formulas, concepts and difficult application questions so that learning seems boring. For this reason, Problem Based Learning based on the Kahoot Game will be implemented in order for student success and learning motivation can increase.

**METHOD**

The subjects in this research were students in the second semester of the study program for mathematics, Faculty of Science and Technology, Nahdlatul Ulama University, Purwokerto, academic year 2022/2023 who took the Calculus 2 course with 12 pupil total. The study was conducted via classroom action research to make improvements to the learning process. Classroom Action Research itself is designed as one of the efforts carried out by teachers in the form of various activities as a form of learning practice to improve learning in the classroom (Masitoh et al., 2021). Through this classroom action research, it is hoped that there will be improvements in the learning process and outcomes where student achievement and learning motivation will increase in the Calculus 2 course after implementing Problem Base Learning based on the Kahoot game.

The classroom action research method used is based on Kurt Lewin's model which consists of four stages: preparation, execution, observation and reflecting (Sidi & Yunianta, 2018) (Iskandar & Narsim, 2015). At the planning stage, problems or issues are identified that need to be addressed and planning the steps needed to overcome these problems. Next, at the implementation stage, researchers carry out plans that have been made to be implemented simultaneously with the observation stage, namely observing the changes that have been made to collect data and information to measure the impact of the changes that have occurred. The final stage of reflection is evaluating the results of the changes that have been made. Researchers will consider what has worked and what has not, and evaluate the change process as a whole. The results of this reflection can be used to improve action plans or take next steps. The four processes of planning, acting, observing, and reflecting make up each of the cycles in which this classroom action study will be conducted.

<table>
<thead>
<tr>
<th>No</th>
<th>Aspect</th>
<th>Indicator</th>
<th>Statement</th>
<th>Positive</th>
<th>Negative</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Feeling happy and diligent in learning</td>
<td>Enjoy the Calculus 2 course</td>
<td>1, 2, 6</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Enjoy doing Calculus 2 questions</td>
<td>3, 4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Willingness and interest in learning</td>
<td>Students’ willingness to work on Calculus 2 questions</td>
<td>7, 14</td>
<td>8, 12</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Students’ willingness to do exercises and assignments.</td>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>The student's desire to get good grades.</td>
<td>11, 13</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Intelligence and independence in learning</td>
<td>Student awareness of studying Calculus 2</td>
<td>16, 18</td>
<td>17</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Student awareness to deepen the material</td>
<td>15, 20, 21</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Student awareness not to cheat</td>
<td>19</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Achievement in learning</td>
<td>Encouragement from student parents</td>
<td>25</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Drive to achieve</td>
<td>23, 24</td>
<td>22</td>
<td></td>
</tr>
</tbody>
</table>

This research will apply Problem Based Learning based on the Kahoot game to enhance learning for students' achievement and learning motivation in each cycle until success indicators are achieved (see Table 1). This was done by researchers because PBL learning was deemed
appropriate to improve students' ability to solve problems. Apart from that, the presence of the Kahoot game media in learning can also increase student motivation in studying the Calculus 2 course. The implementation of this research began in February-March 2023 for cycle I, while the implementation of cycle II was in March-April 2023.

The following were the methods for gathering data used in this study: First, observation techniques. By carefully observing and documenting the symptoms under investigation, observation is a method for gathering data (Achmadi & Cholid, 2009). Meanwhile, observation is observation which includes the activity of paying attention to an object using all the sense organs (Arikunto, 2010). The observations in this research are to record and observe the process of learning activities using the Kahoot game-based problem-based learning whether it is going according to plan or not and to measure students during learning. The instrument used is a closed observation sheet. Observations were carried out at each learning meeting in cycle I and cycle II which implemented Problem Based Learning based on the Kahoot game. So, the criteria for the level of student learning motivation will be determined based on the number of students completing the learning motivation questionnaire. To get the value of student learning motivation using the Formula 1.

\[
SMB = \frac{JN}{100} \times 100
\]  

Information: SMB is Learning Motivation Score and JN is Total Learning Motivation Questionnaire Scores. From the learning motivation score from the calculation above, it is possible to establish the standards for student learning motivation. The following are the criteria for student learning motivation in Table 2.

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Score Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Good</td>
<td>85 – 100</td>
</tr>
<tr>
<td>Good</td>
<td>70 – 84</td>
</tr>
<tr>
<td>Currently</td>
<td>55 – 69</td>
</tr>
<tr>
<td>Not Good</td>
<td>40 – 54</td>
</tr>
<tr>
<td>Very Not Good</td>
<td>&lt; 40</td>
</tr>
</tbody>
</table>

Next, the second technique for collecting data uses tests and assignments. In this study, tests and assignments were used to obtain pretest and posttest data related to student learning achievement after implementing problem-based learning based on the Kahoot game. This post test is given to students at the last meeting in each cycle. The average score will be obtained from the results of this test to see the increase in student learning achievement.

The method of data analysis employed in this study is analyzing test and assignment result data as a result of student learning achievement, to see the improvement and success of actions according to predetermined success indicators. The same thing is also done for data on student learning motivation results which will be analyzed quantitatively descriptively adjusted to the student learning motivation criteria derived from the outcomes of the learning motivation questionnaire. To determine the success of action research, it can be seen from the changes that occur before, during and after the implementation of the action which has increased due to the application of a model, method, learning strategy. Based on this opinion, the success of this research is said to be successful if (1) The mean learning achievement score has increased, (2) every student who takes the Calculus 2 course is able to show an increase in learning motivation due to the media usage of the Kahoot game.

RESULTS AND DISCUSSION

Results

Description of Research Subjects

The subjects of this research were Mathematics Study Program pupils who completed the Calculus 2 course in the Even semester of the 2022/2023 academic year. This study program
There are 12 students taking the Calculus 2 course, where 7 students or 58.33% were still below the score of 60.

**Implementation of Classroom Action Research**

The Calculus 2 course is a compulsory subject in the Mathematics Study Program, where the material studied is related to the definition of integrals, definite and indefinite integrals, integration techniques, integral applications, etc. where student learning achievement results so far have not been good. For this reason, researchers carried out Classroom Action Research (PTK) in the Calculus 2 course in two cycles, with four meetings per cycle. This classroom action research consists of 4 stages, the following:

**a. Planning**

At this planning stage, what the researcher carried out was to prepare teaching material documents and research instruments needed during this research, such as: RPS for the Calculus 2 course which was modified using Kahoot game-based problem base learning, teaching materials related to Calculus 2 material, quiz questions. Assignments created in the Kahoot game application, observation sheets that have been adapted to RPS, learning motivation questionnaires, and final test questions (posttest) used each cycle, at the conclusion.

**b. Implementation**

The implementation phase in this classroom action research was carried out in 2 cycles, each cycle consisting of 4 meetings held from February - April 2023. For each cycle, a learning process was carried out by applying problem-based learning based on the Kahoot game. For Cycle I, 4 meetings were held on February 23, 2023, March 2, 2023, March 9, 2023 and March 25, 2023. Furthermore, for Cycle II there were also 4 meetings held on March 30, 2023, April 5, 2023, April 6, 2023, and April 13, 2023.

The results of the implementation of classroom action research for two cycles carried out on Mathematics Study Program students taking the Calculus 2 course with the application of Kahoot game-based Problem Based Learning are as follows: (1) lecturers prepare lecture materials, namely teaching materials, assignments and evaluation tools (quizzes or exercises) in the form of the Kahoot game; (2) Phase 1: explains the necessary fundamental information and objectives for learning and motivates students to be actively involved in solving the selected problem. (3) Phase 2: provides cases (Definite Integral, Indefinite and Integration Techniques) related to the material and helps students define and organize material related to the problem. (4) Phase 3: encourage students to collect appropriate information, plan problem solving to obtain solutions and problem-solving flow. (5) Phase 4: Students plan and prepare appropriate problem solutions such as reports, models and share assignments with friends. (6) Phase 5: evaluate student learning outcomes regarding the material they have studied and ask groups to present their work results. (7) At the 4th meeting, students carry out a final test (posttest) and fill out a questionnaire regarding student learning motivation. The following is documentation for learning the Calculus 2 course based on the Kahoot game in Figure 1.
c. Observation

Carrying out the observation stage out simultaneously with the implementation stage, where the research team observed the learning process and recorded important things that emerged during the learning. Observations of the learning process were carried out using observation sheets, field notes, cameras and assisted by observers. Observations made at this stage focused on the application of Problem Base Learning based on the Kahoot game, whether it was in accordance with what was planned or not. Furthermore, observers also observe the obstacles faced during learning to make improvements in the next cycle. Apart from observing the learning process, an assessment was also carried out on students' learning motivation after implementing Kahoot game-based learning. The findings of this observation will be used subsequently as evaluation and reflection material for the cycle's implementation which will then be used as a basis for corrective action in the learning process in the next cycle.

d. Analysis and Reflection

The final stage in Classroom Action Research is the analysis and reflection stage. At this stage, the data used to carry out analysis and evaluation is data from observations related to teaching and learning activities that implement problem-based learning based on the Kahoot game. The results of the observation data in Cycle I showed that learning was not optimal in accordance with the plan and indicators of success of the action. There were several improvements in Cycle I learning process, namely: students still had difficulty solving cases/problems given by lecturers related to Integral material because they were not used to problem solving-based learning.

Apart from that, students are still not used to using the Kahoot game which has limited time to work on questions related to Integral material. Apart from the results of observations of learning activities, data was also obtained regarding the learning motivation displayed by students during the learning process. Even though they are still not used to it, students are more motivated to understand the material because they are motivated to solve questions in the form of the Kahoot game. The reflection results from each cycle are used to plan and implement improvements in the next cycle.

Results of Classroom Action Research

The outcomes of putting Problem Based Learning into practice on the Kahoot game in the lecture process for the Calculus 2 course for Mathematics study program students showed the following results:

a. Learning Achievement

In this classroom action research, the researcher carried out three tests, once before the action and twice at the end of the cycle, namely cycle I and cycle II. Researchers conducted an end-of-cycle test to determine the results of student learning achievement after implementing problem-based learning based on the Kahoot game. The results of the average student scores based on the results of the pre-cycle test, final test of cycle I and final test of cycle II can be shown in Figure 2.

![Figure 2. Average Student Achievement Score Results](image-url)
Figure 2 shows that after implementing Problem-Based Learning based on the Kahoot game in cycles I and II, the test results in each cycle showed an improvement in student learning accomplishment. This is shown by the class average score which was initially 57.87. After actions were taken in cycle I, the class average score was 71.5. Furthermore, the average class score in cycle II was 80.25. This shows an increase in student learning achievement in the Calculus 2 course. Similar research results also showed that students' learning results who applied the Kahoot game-based problem-based learning method experienced a significant increase in learning outcomes (Muzeliati, Auliah, A., & Agustinawati 2022).

b. Student Learning Motivation

In this research, apart from seeing an improvement in learning outcomes for students, it was also to see an increase in student learning motivation where learning motivation data was obtained from data on students filling out the questionnaire on learning motivation. The questionnaire instrument used in this research consisted of 25 statements consisting of positive and negative statements. The results of students filling out the learning motivation questionnaire can be seen in Table 3.

<table>
<thead>
<tr>
<th>No</th>
<th>Score Intervals</th>
<th>Criteria</th>
<th>PreCycle Total</th>
<th>Presentation (%)</th>
<th>Post Cycle Total</th>
<th>Presentation (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>40 – 50</td>
<td>Very Good</td>
<td>-</td>
<td>-</td>
<td>4</td>
<td>33.33</td>
</tr>
<tr>
<td>2</td>
<td>35 – 39.5</td>
<td>Good</td>
<td>5</td>
<td>41.67</td>
<td>8</td>
<td>66.67</td>
</tr>
<tr>
<td>3</td>
<td>30 – 34.5</td>
<td>Currently</td>
<td>7</td>
<td>58.33</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>4</td>
<td>25 – 29.5</td>
<td>Not Good</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>5</td>
<td>&lt; 25</td>
<td>Very Not Good</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Based on Table 3, outcomes of students' learning motivation emerged following implementation of problem-based learning based on the Kahoot game, where students experienced an increase compared to before the research was carried out, initially 7 students (58.33%) were in the fairly good criteria and 5 students (41.67%) were in the good criteria. After conducting research for two cycles, the results obtained were an increase in student learning motivation with good criteria for 8 students (66.67%) and 4 students (33.33%) with the other criteria being very good. It is evident from the outcomes of these statistics that students’ learning motivation has grown with the Kahoot game media in learning the Calculus 2 course. Similar research results were also presented that the Kahoot game was effectively used in mathematical learning, as shown by the outcomes of surveys, motivation and student learning outcomes which showed interest in the application (Muzayanati et al., 2022).

Discussion

The data analysis revealed presented above, it was found that the implementation of Problem Based Learning based on the Kahoot game was able to provide many benefits to students, especially those taking the Calculus 2 course. Learning models, learning motivation and initial abilities play an important role in determining student learning outcomes. This is because the learning processes of problem based learning and conventional learning are very different. Problem base learning is appropriate to apply to the Calculus 2 course because students are invited to solve problems related to the material. This may improve students' comprehension of integral ideas in Calculus 2 class.

Problem-based learning provides new knowledge to students through problems in order to make it difficult for students to learn them, apart from that, problem-based learning also provides a fun learning process because in the problem-based learning process students work in groups, interact with each other, and teach each other (peer teaching). Therefore, if provided problem-based learning interventions, groups of students with low learning motivation and...
high initial skills or groups of students with high learning motivation and low initial abilities will achieve high learning results.

Furthermore, with the Kahoot game media, students become more inspired to carry out activities for teaching and learning, improving learning outcomes and learning motivation. This agrees with what (Arsyad, 2011) related to the advantages of using utilizing learning media in the classroom can help students become more motivated to learn by making lessons more exciting. After implementing the Kahoot game in learning, students became more enthusiastic about participating in learning because they felt that learning Calculus 2 was no longer boring and students found it easier to understand the material presented. The impact of using Kahoot in the learning process can increase student learning motivation. Where students are happy with the introduction of the educational game Kahoot. Apart from that, the Kahoot used can also be used on each Android cellphone. The use of the Kahoot educational game in learning evaluation is carried out to make the evaluation more interesting and not monotonous so that students will be more enthusiastic and motivated to carry out the learning evaluation.

So, from the application of Kahoot-based problem base learning that has been implemented by researchers, students become more motivated to learn integral material and are accustomed to solving problems given by lecturers in the Calculus 2 course, causing student achievement results to experience a significant increase from the average score. The student average was 57.78 to 80.25 after going through two cycles. This is in line with the results of previous research which concluded that there is a significant interaction between learning models, learning motivation, and initial abilities on student learning outcomes. This means that student learning outcomes depend on the learning model, learning motivation, and students' initial abilities (Anggraini et al., 2013). Apart from that, other research results also show that the Kahoot app can improve students' interest and drive in learning, which will make it simpler for them to comprehend the teacher's information (Hartanti, 2019). In research, (Wigati, 2019) stated that the use of Kahoot media in Mathematics learning can improve students' learning outcomes and interest. This is in line with this research where the Kahoot game can improve learning outcomes but the difference is in learning interest, where this research focuses on increasing learning motivation.

From the results of this research, consequently it may be said that there was an increase in achievement and learning motivation between before and after the implementation of problem base learning based on the Kahoot game in the Calculus 2 course which was carried out in two cycles in this research. There were time limitations in this research so this research was only carried out in 2 cycles. This is also a consideration for researchers because during the 2 cycles of implementing problem-based learning based on the Kahoot game, it has been able to increase student achievement and learning motivation.

CONCLUSION

Considering the findings of the study and discussion explained above, it can be concluded that the implementation of Problem Based Learning based on the Kahoot game can: 1) improve learning achievement results seen from the class average score from before the research, namely 57.87 and after the research the results obtained in cycle I was 71.5 while the result in cycle II was 80.25. 2) increase student learning motivation. This is shown by the results of data on student learning motivation criteria before the research. 7 students (58.33%) were in the good criteria and 5 students (41.67%) were in the good criteria. After taking action, 8 students (66.67%) fell into the good criteria and 4 students (33.33%) fell into the very good criteria. The results of this research are in accordance with the purpose of this study being to improve performance and learning motivation of students in the Calculus 2 course by implementing problem-based learning based on the Kahoot game.
Declaration

Author Contribution: NM: Conceptualization, Writing - Original Draft, Methodology, Editing and Visualization, Writing - Review & Editing, and Formal analysis; DLK: Writing - Review & Editing, Formal analysis, Validation and Supervision.

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