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Application of Problem-Based Learning (PBL) Model and Project-Based Learning (PJBL) in Learning Mathematics in Elementary Schools

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Abstract This study aims to develop and implement Problem-Based Learning (PBL) and Project-Based Learning (PJBL) learning models in mathematics learning at SD Negeri No. 18 Bababulo, Majene Regency. The main objective of implementing these two models is to increase student involvement, as well as critical, analytical, and creative thinking skills in solving mathematical problems. The implementation procedure began with an introduction to the theme of the impact of plastic waste on the environment. Students were divided into six groups to discuss problems, develop project plans, and conduct observations. The results showed that students were actively involved, with significant increases in motivation and critical thinking skills. Enthusiasm was seen during discussions and presentations, although there were challenges related to self-confidence during presentations, which were overcome through practice from the teacher. The conclusion of this study states that the implementation of PBL and PJBL is effective in improving students' understanding of mathematical concepts and social skills. Suggested follow-ups include consistent implementation of both models and periodic evaluation to improve the quality of learning.

Keywords: PBL, PJBL, Mathematics, Learning

1. INTRODUCTION

Mathematics learning at the elementary school level faces various obstacles, especially in creating meaningful and enjoyable learning experiences. In many remote areas, teaching methods that are still focused on teachers are often one-way, so that students are less motivated and have difficulty understanding abstract mathematical concepts. This low interest in learning is further exacerbated by the lack of interactive learning media and technology. According to Sari (2022), monotonous learning methods can cause gaps in understanding and reduce critical thinking skills.

The assessment results show that many students have difficulty in solving mathematical problems that require critical thinking skills. Rahmat's (2022) research revealed that non-problem-based learning makes students less trained to face contextual challenges, which has an impact on their learning outcomes. Therefore, it is necessary to develop innovative and interactive learning models.

One way to increase student engagement is through the Problem-Based Learning (PBL) and Project-Based Learning (PjBL) models. According to Wijaya &

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Permana (2024), PBL can improve critical thinking skills, while PjBL encourages student creativity and independence. Both models focus not only on cognitive outcomes but also on student engagement in solving real problems.

The PBL model involves students in identifying and analyzing problems, while PjBL emphasizes projects that are relevant to the subject matter. Yulia & Santoso (2021) showed that PjBL can increase students' motivation and creativity because they have greater control over the learning process.

The purpose of implementing PBL and PjBL is to increase student engagement and critical, analytical, and creative thinking skills. This approach is expected to facilitate understanding of abstract mathematical concepts and build social skills through group work (Setiawan & Wibowo, 2023). In addition, the implementation of these two models is expected to create a more dynamic and interesting learning atmosphere, thereby increasing students' interest in learning.

Thus, PBL and PjBL not only help students achieve optimal learning outcomes, but also prepare them to face future challenges that require high-level thinking skills.

2. LITERATURE REVIEW

Theory of Problem-Based Learning (PBL) Model

Problem-Based Learning (PBL) is a learning approach that places students in an active role as problem solvers. According to Barrows (1986), the main goal of PBL is to improve students' critical and analytical thinking skills through solving problems that are relevant to real contexts. This approach provides an authentic learning experience, where students are faced with situations that require complex problem solving. In the context of education, PBL focuses not only on the transfer of knowledge, but also on the development of critical thinking skills and collaboration skills.

The characteristics of PBL involve several main aspects. PBL starts from real problems that are relevant to students' daily lives, aims to make students feel connected to the material being studied and increase their motivation. In the process, students are actively involved, conducting research, analyzing, and evaluating the information collected to find solutions to problems. This learning also emphasizes cooperation in groups, which allows students to share ideas and discuss different approaches, as well as develop social skills. Teachers in PBL act as facilitators who guide students during the learning process. In this role, teachers help students formulate questions, find sources of information, and provide constructive feedback.

The advantages of PBL include improving critical thinking skills that train students to think analytically, higher learning motivation due to involvement in real problems, and the development of important social skills through group collaboration.

Theory of Project-Based Learning (PjBL) Learning Model

Project-Based Learning (PjBL) is a learning model that emphasizes project completion as the main method in the learning process. Thomas (2000) explains that PjBL encourages students to develop knowledge and skills through projects that are relevant to real life. Through this approach, students conduct research, collaborate, and create final products as a result of the projects they work on.

The main characteristics of PjBL include several key aspects. Project-based learning in PjBL engages students in projects that require time and effort to complete, allowing for in-depth exploration of the concepts being taught. The process places a premium on the end product, allowing students to demonstrate their understanding through work that can be shared with others. Assessment in PjBL is often done through performance-based assessments, which allow students to receive feedback on their skills and understanding. PjBL also encourages collaboration in groups, promoting social interaction and the development of teamwork skills.

PjBL has several advantages, such as high student engagement through interesting projects, development of 21st century skills, and deeper understanding of concepts thanks to practical and relevant learning.

Relevant Research on Problem-Based Learning (PBL) and Project-Based Learning (PjBL) Learning Models

There are several previous studies that are relevant to this research.
The research includes:

First, Wijaya and Santoso (2020) in the journal Innovation Education. This study focuses on the impact of PJBL on creativity and critical thinking skills of high school students. The results of the study indicate that students involved in PJBL-based projects experienced a significant increase in creativity. This is due to the freedom given to students to design innovative solutions or products in their projects. In addition, PJBL also improves students' critical thinking skills because they are required to analyze information and solve complex problems, so that they can make decisions that affect the final results of the project.

Second, Haryanto and Rahman (2021) in the Journal of Mathematics Education explored the application of PBL in elementary school Mathematics learning. This study shows that the use of PBL can improve students' understanding of mathematical concepts. Students who learn with the PBL approach show better abilities in applying mathematical concepts in real situations. This study emphasizes that the problems faced by students must be relevant to everyday life so that students can be more involved and motivated in learning.

Third, Sari and Hasanah (2022) in the Journal of Education investigated the combined effect of PBL and PJBL in increasing students' learning motivation in grade IV of elementary school. The results of the study showed that students who participated in learning with a combination of these two models had a higher level of motivation compared to students who only participated in conventional learning. The researchers found that the combination of PBL and PJBL made students more active in participating and more enthusiastic in learning, which in turn had a positive impact on their learning outcomes.

The above studies show that both PBL and PJBL have great potential in improving the quality of education. Both not only help students develop critical thinking skills and creativity, but also increase motivation and conceptual understanding in learning. Therefore, it is important for educators to apply this learning model effectively in the context of education, especially in Mathematics learning in Elementary Schools.

Implementation Method

In the implementation of the Problem-Based Learning (PBL) and Project-Based Learning (PjBL) models in elementary school mathematics classes, activities are designed and implemented systematically to achieve optimal results for the development of student understanding. This method involves direct application in the classroom environment, with details of time, place, student characteristics, and learning stages that support both models.

Time and Place of Implementation

a. Execution time

The implementation of the problem-based learning (PBL) and project-based learning (PjBL) learning models was carried out on Tuesday, October 22, 2024, with a time allocation of 2 lesson hours, namely 08.00 - 09.45, during the second and third lesson hours.

b. Venue of Implementation

Learning activities were carried out at SD Negeri No. 18 Bababulo, Majene Regency, West Sulawesi. Focusing on class III as the object of research allows the application of PBL and PjBL methods that are interactive and collaborative.

Student characteristics

Class III consists of 7 male students and 8 female students with a total of 15 students. The average age of students ranges from 8 to 9 years, which is an important cognitive development phase for active learning. Learning is carried out in the classroom.

Stages of Learning Implementation

- Introduction (10 minutes): The teacher opens the class by explaining the purpose and theme of the impact of plastic waste on the environment, and invites students to discuss their experiences related to this theme.
- Group Division (5 minutes): Students are divided into 6 groups considering their abilities and learning styles.
- Problem Identification (15 minutes): Each group identifies problems related to the impact of plastic waste with guidance from the teacher.
- Project Plan Preparation (20 minutes): Groups prepare project steps, including data collection and how to deliver results.
- Project Implementation (25 minutes): Students carry out projects according to plan, such as observing the school environment and group discussions.
- Presentation and Discussion (20 minutes): Each group presents the project results, followed by discussion and input from other groups.
- Reflection (5 minutes): Students share their opinions about the learning they have done, challenges, and lessons learned.

- Evaluation

  Evaluation is carried out through:

  - Group performance assessment and presentation.
  - Observation of student participation and collaboration.

3. RESULTS OF IMPLEMENTATION AND DISCUSSION

Implementation Results

Use of Learning Resources and Multimedia

In the implementation of mathematics learning using the Problem-Based Learning (PBL) and Project-Based Learning (PJBL) models, the use of learning resources and multimedia plays an important role. The learning resources used include textbooks, educational videos, and various online sources that are relevant to the material being taught. The success of using these sources is clearly seen from the enthusiasm and positive responses of students. For example, educational videos that explain mathematical concepts visually are able to attract students' attention and improve their understanding.

However, challenges arise regarding the accessibility of learning resources, especially for students who do not have digital devices at home. This has the potential to reduce student engagement in the learning process outside of school hours. To overcome this problem, teachers provide printed materials as an alternative and organize additional sessions at school to use devices together. In this way, all students, including those with limited access, can still be actively involved in learning.

Implementation of Learning Strategies/Methods/Models

The PBL and PJBL models are applied systematically in the classroom, where students are divided into small groups to discuss relevant problems and plan their projects. The success of implementing this model can be seen from the increase in student participation in group discussions and their ability to solve complex problems. Students show high interest and creativity in finding solutions.

However, not all students feel comfortable participating, especially during group presentations. Some students feel anxious and lack confidence when they have to speak in front of the class. As a solution, teachers conduct presentation exercises in small groups before the main presentation, provide constructive feedback, and create a more supportive atmosphere. This has proven effective in increasing students' self-confidence, so that they are more courageous in sharing their ideas and group work results in front of their friends.

Implementation of Assessment and Evaluation

Formative assessments are conducted continuously throughout the learning process, allowing teachers to observe student engagement and progress. Summative evaluations are conducted after the project is completed, with performance-based assessments allowing students to demonstrate their understanding in practical terms. The success of this evaluation system is evident from the positive feedback received by students regarding the transparency and clarity of the assessment criteria used.

However, some students felt that the assessment did not fully reflect their efforts, especially when the results of group projects were assessed collectively. To address this, teachers developed clear assessment rubrics, covering aspects such as teamwork, creativity, and conceptual understanding. In addition, students were involved in the assessment process by providing opportunities to reflect on their own and their group mates' contributions, so that they better understood the criteria used in the assessment.

Syntax/Procedure/Learning Scenario

The implementation of the learning syntax follows the steps that have been designed, starting from identifying problems, preparing project plans, to presenting results. In each stage, the teacher's efforts to create a class that supports student motivation are clearly visible. Interactive discussion techniques and educational games are used to maintain student engagement.

However, some students had difficulty collaborating, especially in groups consisting of students with different abilities. To overcome this challenge, the teacher implemented an ice-breaking activity at the beginning of the lesson, which aimed to create a friendly atmosphere and support interaction between students. In addition, the teacher provided more detailed instructions on how to collaborate effectively, including the division of roles within the group to ensure that all students felt involved.

Creating Motivation, Creativity, and Interaction

The success of teachers' efforts in creating classes that build learning motivation is very visible from the increase in student involvement in discussions and projects. Students who previously tended to be passive began to show initiative and willingness to actively participate. However, differences in student characteristics, especially in terms of self-confidence and ability, are a challenge in themselves.

To address this, teachers divide students into groups based on their abilities and learning styles. This way, each student can contribute in a way that works best for them, creating an inclusive and supportive learning environment. In addition, teachers also reward groups that demonstrate good cooperation and creativity, further motivating students to be active in learning.

Implementation of Local Culture and Wisdom

The application of local culture and wisdom in learning is very important to make the material more relevant to students. In this learning, teachers relate mathematics material to situations and problems in the surrounding environment, such as plastic waste management. The success of this approach can be seen from the enthusiasm of students when discussing local issues that they face every day.

However, challenges arise when some abstract concepts are difficult to explain in the context of local culture. To overcome this difficulty, teachers provide concrete examples and relevant case studies, so that students can more easily understand the material. In addition, teachers also invite students to find solutions to local problems, so that they feel more involved and have responsibility for the surrounding environment.

Discussion

The implementation of the Problem-Based Learning (PBL) and Project-Based Learning (PJBL) models in mathematics learning has shown a number of significant successes. One of the main achievements is the increased involvement of students in the learning process. Research by Rahmat (2022) confirms that PBL can increase student motivation by involving them in solving real problems. In this implementation, students actively discuss and collaborate to identify and analyze the impact of plastic waste on the environment. This not only helps them understand mathematical concepts but also provides a more meaningful learning experience.

However, obstacles also emerged during the implementation. Some students felt less confident when they had to present the results of their group work. Kurniawan (2021) showed that self-confidence is an important factor in project-based learning. To overcome this problem, teachers provide guidance and presentation practice in small groups before presenting in front of the class. This strategy has been shown to help students feel more comfortable and prepared, so they can better convey their ideas.

Furthermore, in terms of evaluation, the implementation of formative and summative assessments showed positive results. Performance assessments during the project provided direct feedback to students regarding their understanding. This is in accordance with Aditya's (2020) suggestion which emphasized the importance of feedback in improving the learning process. However, there were some students who had difficulty understanding the assessment criteria. To overcome this, the teacher explained in more detail about the assessment rubric and provided relevant examples.

In the context of implementing local culture and wisdom, success is seen when students relate mathematics learning to their daily reality. As explained by Hasan (2019), integrating local wisdom can increase the relevance of the material. However, some students still have difficulty applying abstract concepts in local contexts. To help them, teachers use concrete examples and visualizations, in accordance with the recommendations of Setiawan (2021), who emphasizes the importance of real depictions to understand difficult concepts.

Although there were various challenges during the implementation of the PBL and PJBL models, the solutions applied showed that with the right approach, these obstacles can be overcome. The success in increasing student motivation and understanding shows that both learning models are effective in the context of mathematics education, while also equipping students with better social skills and environmental awareness.

The planning process for implementing PBL and PJBL begins with identifying relevant themes and selecting problems that are close to students' lives.In this planning, the teacher sets clear learning objectives and designs activities that involve exploration and collaboration. During the implementation, the teacher act as facilitators, supporting students in the research process and providing necessary guidance. At the end of the project, students are expected to be able to present their findings in a creative way. The results of this learning are seen in improving understanding of mathematical concepts, developing social skills, and environmental awareness. The success in improving student motivation and understanding shows that both learning models are effective in the context of mathematics education, as well as equipping students with the skills to face real-world challenges.

4. CONCLUSION AND FOLLOW-UP

Conclusion

The implementation of the Problem-Based Learning (PBL) and Project-Based Learning (PJBL) learning models in mathematics learning at SD Negeri No. 18 Bababulo has succeeded in achieving the expected goals. Students are actively involved in the process learning by identifying and analyzing the impact of plastic waste on the environment. Through this method, they not only understand mathematical concepts, but also learn to work together in groups. In the process, there are several adjustments made, such as providing presentation exercises to increase student confidence and explaining the assessment criteria in more detail so that all students understand the teacher's expectations.

The results of the formative assessment showed an increase in student engagement and understanding, while the summative evaluation showed positive results. However, some obstacles emerged, such as students' difficulty in connecting abstract concepts to real contexts. To overcome this problem, the teacher used concrete examples and relevant visualizations, which were proven to help students understand the material better.

Follow-up

The follow-up of the implementation of this learning includes several suggestions for improving the learning model in the future. First, teachers are expected to continue to use the PBL and PJBL methods consistently, paying attention to the necessary adjustments based on feedback from students. For example, providing more presentation practice sessions before evaluation activities can help students who are less confident.

In addition, it is important to increase the integration of culture and local wisdom in teaching materials, so that students can more easily relate mathematics learning to their daily lives. Teachers are also advised to collaborate with colleagues to share best practices and develop more varied learning resources.

Regular monitoring and evaluation of this learning model is essential to assess its effectiveness. By involving students in the evaluation process, teachers can gain valuable input for continuous improvement. It is hoped that these steps can improve the quality of mathematics learning and equip students with the skills needed to face future challenges.

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