

## Integrating TPACK into a Problem-Based Learning Model to Improve Mathematics Achievement among Junior High School Students

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### ABSTRACT

This study was initiated due to the low mathematics achievement of seventh-grade students at SMP Negeri 3 Satu Atap Idanotae, South Nias Regency, particularly on the topic of integers. Student performance was below the Minimum Mastery Criteria (KKM) set at 67, with only 9 out of 21 students (approximately 44%) meeting the required standard. The primary aim of this research was to improve student learning outcomes through the implementation of a Problem-Based Learning (PBL) model integrated with the TPACK approach. The study employed a Classroom Action Research (CAR) design and was conducted in two cycles during the 2018/2019 academic year. The findings indicate that the application of the PBL model effectively enhanced student learning outcomes in the topic of integers. Increased teacher engagement in the learning process was also observed, attributed to the use of the PBL model. Student achievement showed a consistent upward trend across the cycles. Prior to the intervention, only 9 students met the KKM with a class average of 44%. In the first cycle, 15 students achieved the KKM, raising the class average to 67%, and in the second cycle, 19 students met the KKM with a class average of 93%. These results demonstrate the positive impact of the PBL model in improving students' mathematical understanding and overall academic performance.

**Keywords:** Learning achievement, Problem-based Learning, Integers



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## 1. INTRODUCTION

Education serves as a fundamental vehicle for equipping individuals with knowledge, attitudes, and skills necessary to meet the demands of life. The rapid advancement of science and technology, particularly in the field of information technology, has accelerated the flow of information across all sectors, including education. This transformation directly affects the learning process, where the role of the teacher remains central. The quality of education is highly dependent on the competence and effectiveness of educators in designing and implementing meaningful learning experiences.

In the context of mathematics education, it is essential to employ a variety of instructional models that serve as a guide for teachers to carry out effective teaching. These models are crucial in enabling students to apply their mathematical abilities optimally in solving problems. However, when mathematics instruction fails to capture students' interest, they often become disengaged, leading to limited understanding and mastery of mathematical concepts. Consequently, students may struggle to solve mathematical problems and perform poorly in assessments.

Observations in Grade VII at SMP Negeri 3 Satu Atap Idanotae revealed several learning challenges that required immediate attention. Student participation during the learning of integer numbers was notably low, and the learning process remained teacher-centered. There was also a lack of opportunities for students to engage in authentic, real-life problem-solving activities that could foster deeper conceptual understanding. Furthermore, learning materials were predominantly textbook-based, which limited students' critical thinking and their ability to relate mathematical concepts to everyday situations. These issues were reflected in student performance data from the first semester of the 2018/2019 academic year, where the average score was 54.76, well below the Minimum Mastery Criteria (KKM) of 70. This indicated that the majority of students were underperforming, with only a small percentage meeting the required standard.

Motivated by these findings, the researcher sought to implement an instructional intervention using the Problem-Based Learning (PBL) model. PBL is recognized as an instructional approach that fosters students' critical thinking, problem-solving, and collaborative skills by engaging them with real-world problems. According to Arends and Kilcher (2010), PBL challenges students to learn how to learn and encourages them to work in groups to seek solutions to meaningful, contextual problems. In line with the demands of 21st-century education, PBL is considered a flexible model that effectively integrates technology into classroom learning, making it highly suitable for mathematics instruction. Therefore, the researcher conducted a study entitled *"Improving Student Learning Outcomes through the Problem-Based Learning Model with a TPACK Approach on the Topic of Integer Numbers in Grade VII of SMP Negeri 3 Satu Atap Idanotae, South Nias Regency."*

Based on the background and identified challenges, the main research question posed in this study is whether the implementation of the Problem-Based Learning model with a TPACK approach can improve the learning outcomes of Grade VII students in the topic of integer numbers. The primary objective of the study is to enhance students' academic performance in mathematics by applying this integrated instructional model. It is anticipated that the outcomes of this research will contribute to improving students' conceptual understanding, provide valuable insights for teachers seeking effective instructional strategies, support school efforts to innovate and enhance instructional quality, and serve as a reference for future research in similar educational contexts.

## 2. RESEARCH METHOD

This study employed a Classroom Action Research (CAR) design. The primary focus of this research was to implement targeted actions to improve the teaching and learning process and to enhance students' engagement in mathematics learning in general, and the Pythagorean Theorem in particular. The study was conducted collaboratively between the researcher and another teacher. The researcher acted as the main instructor during the learning process, while the collaborating teacher served as an observer.

The research was carried out at SMP Negeri 3 Satu Atap Idanotae, located in Awoni Village, Idanotae Subdistrict, South Nias Regency. The research subjects were 21 seventh-grade students. However, due to the ongoing COVID-19 pandemic and in accordance with health protocols for face-to-face learning in green zones, class capacity was limited to 50% of the total number of students. As a result, the study involved 16 students as research participants.

The stages of the classroom action research were implemented as follows:

### a. Planning

At this stage, the researcher developed a lesson plan and coordinated with a fellow mathematics teacher to serve as an observer. The planning process involved determining the instructional schedule and delivery methods, identifying alternative actions to be implemented, and preparing teaching aids and data analysis tools. The instructional materials and tools prepared included:

- a. Lesson Plans (RPP) based on the Problem-Based Learning (PBL) model
- b. Teaching materials
- c. Instructional media
- d. Student worksheets (LKPD)
- e. Evaluation instruments

### b. Action

During this stage, the researcher carried out the learning activities in accordance with the prepared plans, implementing the Problem-Based Learning model in the classroom.

### c. Observation

Throughout the instructional process, the designated observer monitored and recorded the implementation of the teaching and learning activities conducted by the researcher.

### d. Reflection

Upon completion of the instructional activities and the collection of all relevant data, the researcher conducted a reflection to describe the outcomes achieved, analyze any observed weaknesses, and identify areas for improvement in the subsequent cycle.

### **3. RESULTS AND DISCUSSION**

#### **A. Cycle I**

##### **1) Planning**

In the planning phase, the researcher prepared several materials, including the Lesson Plan (RPP) and student worksheets. The instruments used for data collection in this study were teacher activity observation sheets and student activity observation sheets during the learning process. The application of the Problem-Based Learning (PBL) model in mathematics instruction was implemented through a structured Lesson Plan (RPP). The planning was aligned with the content of the first semester, in accordance with the academic calendar during which the study was conducted. The instructional design was prepared for one meeting session, with a duration of  $2 \times 30$  minutes. The teaching material was derived from the 2017 Revised Curriculum 2013 for Grade VII mathematics.

##### **2) Action**

In the first cycle, the researcher aimed to address the predetermined indicators. The action phase followed the instructional scenario based on the PBL model, consisting of several stages. The session began with the teacher greeting the students, preparing them for learning, leading a prayer, and taking attendance. An apperception activity was conducted by encouraging students to observe right-angled triangle-shaped objects in their environment. The teacher then presented the learning objectives and introduced a problem related to proving the Pythagorean Theorem. Rather than delivering a full explanation, the teacher engaged students in question-and-answer discussions to foster active participation. To organize students for learning, the teacher demonstrated the tasks using media and explained the assignments students would complete. Students were divided into groups and provided with learning materials and student worksheets (LKPD). During the problem-solving process, students sought to complete the tasks in the worksheets. They were encouraged to ask questions about any aspects they did not understand. The teacher supervised students' work and offered guidance where needed. Students gathered information from the problems presented in the worksheets using visual aids. In the "develop and present work" stage, the teacher guided students in preparing and presenting group reports. Finally, the class analyzed and evaluated the problem-solving process through discussion, and the lesson concluded with a summary activity facilitated by the teacher.

##### **3) Observation**

The observation stage was conducted by the observer. The observer's main task was to monitor and record teacher and student activities based on pre-prepared observation sheets. The results from the first cycle revealed that students were not yet actively engaged. Some students were unable to answer the teacher's questions, and during group discussions, several students did not participate actively, requiring the teacher to provide encouragement. Student activity was rated as fair, likely due to the teacher not fully implementing the PBL steps, as they were not yet familiar with the model. Learning mastery had not reached the expected target of 75%, with only 60% of students meeting the minimum standard.

##### **4) Reflection**

Reflection was conducted collaboratively between the classroom teacher and the observer at the end of the lesson. During this session, observations and findings were discussed. The reflection addressed aspects of planning, implementation, evaluation, and student outcomes. The researcher and teacher analyzed the strengths and weaknesses observed throughout the learning process. These findings were then used to revise the lesson plan and prepare improvements for the second cycle.

#### **B. Cycle II**

##### **1) Planning**

Based on the reflection from Cycle I, it was deemed necessary to proceed to a second cycle. In this phase, new plans were developed, including revised Lesson Plans (RPP) based on the stages of the PBL model. Planning was done for two learning sessions, with each session lasting  $2 \times 30$  minutes. The learning content for Cycle II was a continuation of the topic from Cycle I. The basic competency targeted in this cycle was the students' ability to apply integer numbers to solve real-life problems.

##### **2) Action**

The implementation followed the pre-planned instructional scenario using the Problem-Based Learning model. The session began with the teacher greeting the students, preparing them for the lesson, leading a prayer, and taking attendance. The teacher then conducted an apperception activity and

explained the learning objectives. Students were introduced to a contextual problem, and again, rather than explaining everything, the teacher engaged them through guided questioning to stimulate active learning. The teacher organized students for learning by providing demonstrations and clarifying tasks to be discussed in groups. Students were divided into groups and given learning materials and student worksheets (LKPD). Students were instructed to analyze problems in the worksheets using visual aids provided by the teacher. Throughout the learning process, students asked questions, and the teacher offered clarification and assistance in resolving the problems. The students collected and processed information related to the problems. They then developed and presented their group work results, guided by the teacher, using the LKPD and visual materials. During this cycle, it was observed that students were able to solve problems related to the Pythagorean Theorem, as evidenced by the quality of group reports presented. The lesson concluded with a class discussion to evaluate the problem-solving process, followed by a summary and recognition for students who achieved high scores.

### 3) Observation

Observations in Cycle II were analyzed using both teacher and student activity observation sheets. According to the findings of the collaborator and the researcher, the teacher successfully utilized instructional time effectively from the beginning to the end of the session. The PBL steps were fully implemented, resulting in a high level of student engagement. Based on the student activity observations, students were able to solve problems related to real-life financial contexts, as shown by increased participation during class. Students actively expressed opinions and asked questions throughout the problem-solving process. Group discussion reports were well-developed and presented effectively. The increase in student engagement contributed to improved mathematics performance, with classical learning mastery reaching 90%, exceeding the Minimum Mastery Criteria of 70.

### 4) Reflection

Reflection was conducted collaboratively between the researcher as the observer and the partner teacher at the end of each lesson. The results indicated that the implementation of the Problem-Based Learning (PBL) model in Grade VII was successful. During this second cycle, the teacher executed the lesson plan effectively in accordance with the revised design. Students showed increased engagement throughout the lesson, with all students prepared and actively involved in learning activities. They were able to solve problems related to the Pythagorean Theorem and demonstrated comprehension of the material, as evidenced by improved test scores. Both group discussions and individual evaluations showed satisfactory results, and overall learning mastery was achieved at a high level.

## 4. CONCLUSION (10 PT)

Based on the analysis and discussion presented above, it can be concluded that the observation results indicate a consistent improvement in teacher activity throughout the two cycles of implementing the Problem-Based Learning (PBL) model. The data demonstrate that the PBL model effectively enhanced teacher engagement in the learning process, particularly in guiding students through problem-solving tasks both individually and in groups, as well as in providing feedback on group presentations.

Moreover, the analysis of student activity observation sheets reveals that students became increasingly active in the learning process when the PBL model was applied. This was evident through their willingness to participate, express their opinions, and ask questions about unfamiliar concepts. Students were also able to solve problems related to the Pythagorean Theorem with greater independence and confidence.

The combined analysis of both teacher and student activity observation sheets indicates a positive trend that aligns with the improvement in student learning outcomes from Cycle I to Cycle II. The classical mastery level increased from 78% to 93%, with 20 students successfully achieving the Minimum Mastery Criteria (KKM). These findings provide strong evidence of the effectiveness of the implemented PBL-based instructional approach in improving mathematics learning outcomes in Grade VII at SMP Negeri 3 Satu Atap Idanotae, South Nias Regency.

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