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Optimizing Student Learning Engagement through the Project-Based Learning Approach in the Sensor and Transducer Practicum

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A R T I C L E I N F O

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A B S T R A C T

The purpose of this study is to determine the level of student engagement in the Sensor and Transducer Practicum class using the Project-Based Learning (PBL) instructional model. This research employs Classroom Action Research (CAR), also known as Classroom Action Research (PTK). The subjects of the study are 27 students enrolled in the Mechatronics Vocational Education program at the Faculty of Engineering, Universitas Negeri Makassar (FT UNM), during the 2023–2024 academic year. The study is organized into three cycles, with two meetings in each cycle. Data were collected through documentation, learning outcomes, and observations. A qualitative descriptive analysis method was used to analyze the data. The findings show that the average student engagement in the first cycle was 72.0% based on observation data and 71.0% based on questionnaire data, resulting in an overall average of 71.01%. The second cycle was conducted to improve upon the results of the first cycle. In the second cycle, the average student engagement increased to 74.00% based on observations and yielded an overall average of 75.01%. To further enhance learning outcomes and validate the effectiveness of the PBL approach, a third cycle was implemented. In this cycle, the average student engagement reached 76.50% based on observation data and 77.00% based on questionnaire data, resulting in an overall average of 76.60%. These results demonstrate that the application of the Project-Based Learning model positively impacts student engagement in the classroom.

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INTRODUCTION

One of the key efforts to improve the quality of education is through the enhancement of the learning process, where every educator is required to implement appropriate and innovative teaching strategies to strengthen students' mastery of the subject matter. The improvement of educational quality is a crucial factor in fostering an intelligent and capable generation, and it largely depends on the competence and professionalism of educators. As the central figures in the learning process, educators play a vital role in driving the success of students. Their ability to design and facilitate effective learning experiences significantly influences students' academic achievement and overall development.

One of the main challenges faced by students in higher education is the difficulty in mastering course material effectively. To address this issue, educators are continuously seeking to improve instructional quality through the development of new paradigms and the implementation of various teaching models. However, without applying the appropriate instructional approach, students often become disengaged and experience boredom due to monotonous and repetitive teaching methods. Project-Based Learning (PBL) has emerged as an effective strategy to overcome such challenges. According to Krajcik and Shin (2019), PBL provides a meaningful learning experience where students engage in problem-solving and investigation through real-world projects that are aligned with course objectives. Bell (2010) also emphasizes that PjBL promotes the development of critical 21st-century skills such as collaboration, creativity, and self-directed learning.

Key characteristics of PjBL include student autonomy in managing projects from planning to presentation, a high level of personal responsibility, collaborative engagement with peers, teachers, and even the broader community, as well as the promotion of creative thinking. The classroom environment under PBL is typically more flexible, allowing students to explore and develop ideas in a tolerant and supportive atmosphere (Lee & Hannafin, 2016). Learning, as defined by Kolb (1984), is the process whereby knowledge is created through the transformation of experience. This view is supported by Darling-Hammond et al. (2020), who argue that learning environments that are emotionally safe, student-centered, and intellectually challenging are more effective in fostering deep understanding and engagement. In line with this, Biggs and Tang (2011) argue that meaningful learning occurs when students are actively involved in both the physical and cognitive aspects of learning, underscoring the importance of active participation. Without student activity and engagement, learning becomes superficial and ineffective. Therefore, the implementation of Project-Based Learning is crucial in enhancing the overall learning experience and ensuring students' active involvement in the classroom

The essence of the learning process is to develop students' activities and creativity through various interactions and learning experiences. Student engagement is a fundamental element that significantly influences the success of the learning process. Engagement involves both physical and mental activities, such as doing and thinking, which cannot be separated (Fredricks,

Blumenfeld, & Paris, 2004). According to Schunk, Pintrich, and Meece (2008), indicators of student engagement can be observed in several aspects: participation in completing learning tasks, involvement in problem-solving, asking questions when facing difficulties, seeking additional information for problem-solving, engaging in group discussions, and assessing their own abilities and outcomes. Based on the descriptions provided by experts regarding engagement, it can be concluded that student engagement refers to active involvement in the learning process.

Project-Based Learning (PBL) is a teaching method that has been widely adopted and developed in many advanced countries, particularly in the United States. In this approach, educators play a crucial role in determining the quality of instruction delivered during the learning process. As noted by Krajcik and Shin (2019), PjBL is both curriculum-driven and aligned with educational standards, encouraging students to engage in meaningful, standards-based learning activities.

PBL can be viewed as an extension or refinement of Problem-Based Learning (PBL), with a stronger focus on contextual and experiential learning. According to Thomas (2020), PBL supports a contextual teaching and learning (CTL) framework by immersing students in real-world problems that require practical and collaborative solutions. Larmer, Mergendoller, and Boss (2015) explain that PBL emphasizes the application of knowledge through the creation of tangible products or outcomes, making learning more relevant and authentic to students' lives. Furthermore, project-based learning is rooted in the idea of experiential education, where students construct knowledge through active engagement with real-life issues. This method not only fosters critical thinking and problem-solving skills but also enhances motivation and long-term retention (Condliffe et al., 2017). As a result, PBL is seen as an effective strategy to connect classroom learning with real-world contexts and prepare students for future challenges

In Project-Based Learning, the role of the educator is to facilitate and guide the learning process. The teacher acts as a timekeeper, a mediator in resolving student conflicts, and a promoter of collaboration and group dynamics. Additionally, the teacher observes group behavior throughout the learning process. Educators are responsible for encouraging student interaction, fostering open communication, and helping students develop the confidence to express their opinions. They also support learners in discovering and internalizing their strengths while recognizing their areas for improvement. Through this approach, students are encouraged to actively engage with the subject matter and develop critical thinking skills by practicing investigation and inquiry (Levin, 2016).

LITERATURE REVIEW

Several factors influence learning achievement, including student engagement and learning motivation. Selecting an appropriate teaching method that aligns with the learning material can encourage active student participation and foster both engagement and motivation. Traditional educator-centered

approaches, which have often dominated the learning process, tend to involve students minimally, leading to a lack of active participation and reduced motivation—particularly among students in the Vocational Mechatronics Education Program at the Faculty of Engineering, Universitas Negeri Makassar, in the Sensor and Transducer Practice course. To address this issue, the implementation of the Project-Based Learning (PBL) model is proposed as an effective solution.

METHODOLOGY

This study employs Classroom Action Research (CAR), which focuses on efforts to transform current classroom conditions toward the desired outcomes. The research was conducted over two cycles: Cycle I and Cycle II. Each cycle consisted of one meeting and followed four key stages-planning, implementation, observation, and reflection. Data collection was carried out by a collaborative team consisting of the researcher, three observers, and the course instructor. If the expected outcomes are not achieved by the end of Cycle I and Cycle II, additional cycles may be conducted as necessary to reach the intended goals.

Pre-cycle activities are carried out to obtain information about the condition of students before being given action. This action is a planning of the implementation of the Project Based Learning model in an effort to increase the activeness and motivation to learn in the Sensor and Transducer Practice course. Cycle I is carried out using the Project Based Learning model. After Cycle I is carried out and the results of the reflection are obtained, the results of the reflection are used as a determinant in carrying out activities in this cycle II. Cycle II is carried out by applying the Project Based Learning model in class. Students will be formed into groups in working on projects given by the lecturer.

In educational research, the subjects of study may include both individuals involved in education and the products or outcomes of their educational activities (Cohen, Manion, & Morrison, 2018). The data collection techniques used in this study followed a triangulation approach, which involves the integration of multiple instruments to enhance the validity of the data. Observation was employed as a primary technique, particularly effective when the research focuses on human behavior, learning processes, or phenomena in natural settings, especially when the number of participants is limited (Creswell & Poth, 2018). Questionnaires were also utilized, defined as a set of written questions to be completed by respondents in writing, and were distributed to students to gather responses regarding the implementation of the Project-Based Learning model. The data were analyzed using descriptive quantitative methods to interpret patterns and trends in student responses.

RESULT AND DISCUSSION

Based on the research conducted with students of the Vocational Mechatronics Education Program at the Faculty of Engineering, Universitas Negeri Makassar, in the Sensor and Transducer Practice course, it was found that student engagement and learning motivation increased across Cycle I,

Cycle II, and Cycle III through the implementation of the Project-Based Learning (PBL) model. The following section provides a detailed discussion of the research findings and how the PBL approach contributed to these improvements.

One of the key observable aspects in the implementation of the Project-Based Learning (PBL) model is student engagement. The research findings indicate that in Cycle I, the average percentage of student engagement based on observational data was 72.00%, while the questionnaire data showed 71.01%. Thus, the overall average for Cycle I was 71.01%. The process was continued to Cycle II in an effort to improve the outcomes based on reflections from Cycle I and to optimize the learning process further. In Cycle II, the average percentage of student engagement observed increased to 74.00%, and the overall result, including questionnaire data, reached 75.01%. The research was extended to Cycle III to verify that the increase in engagement was a result of the PjBL model implementation. In Cycle III, the average engagement score based on observation rose to 76.50%, while the questionnaire data showed 77.00%. Therefore, the overall average for Cycle III was 76.60%. These progressive increases across cycles provide strong evidence that the application of Project-Based Learning positively impacted student engagement.

The first aspect of student engagement observed was paying attention to the lecturer's explanation. In Cycle I, the percentage of students who actively paid attention was 65.71%. Some students in this aspect were already prepared to listen attentively, as indicated by their silence and visual focus on the lecturer. In Cycle II, this percentage increased to 74.69% due to the lecturer incorporating animated examples at the front of the class to stimulate student interest and attention. This upward trend continued in Cycle III, maintaining the engagement rate at 74.69%.

The second aspect of student engagement was active participation in discussions during the learning process. In Cycle I, 75.31% of students were observed to participate in discussions. However, some students had not yet joined their groups because they were seated far apart. To address this issue in Cycle II, the “connecting with the problem” phase was modified: the lecturer reorganized the classroom layout by assigning seats and tables to ensure group proximity. Students were divided into groups based on their attendance numbers for example, students with numbers 1 to 6 formed Group 1, and so on. Each group was arranged to sit close together to encourage better interaction and group cohesion. As a result, student participation in discussions increased to 76.37% in Cycle II. This trend continued in Cycle III, where the percentage rose to 77.37%

The third aspect of student engagement was the willingness to ask questions within the group. In Cycle I, 76.72% of students were observed to ask questions within their groups. Some students felt encouraged to ask questions when they encountered issues, particularly with the placement of scene descriptions in the animation. In Cycle II, this percentage increased to 78.07%, as students were further motivated to ask questions when they identified

problems during the learning process. However, in Cycle III, there was a slight decrease, with the percentage reaching 73.59%

The fourth aspect of student engagement was the willingness to respond to questions. In Cycle I, 67.03% of students were observed to respond to questions within their groups. Some students were hesitant to answer questions as they were unable to find solutions to the problems provided and felt too shy to ask. In Cycle II, this percentage increased to 68.34%, as some students became more willing to respond after the lecturer actively visited each group and inquired about any difficulties they were facing. This trend continued in Cycle III, where the percentage rose to 74.59%. This improvement was attributed to the lecturer's increased presence in each group and the additional strategy of providing students with paper to submit written questions anonymously, encouraging more students to participate.

The fifth aspect of student engagement was the ability to solve problems. In Cycle I, 70.43% of students were able to solve the problems within their groups. This was largely because each student had access to a learning module. In Cycle II, this percentage increased to 71.82%, as students began to supplement the information from the modules with internet research. In Cycle III, the percentage further increased to 76.08%, demonstrating continued improvement in problem-solving abilities.

The increase in student engagement from Cycle I to Cycle II was 4.8%. The increase from Cycle II to Cycle III was 1.9%. In Cycle I, the highest engagement indicator was in the problem-solving aspect, with a percentage of 72.05%. In Cycle II, the highest engagement indicator remained in problem-solving, reaching 75.17%. In Cycle III, the highest engagement indicator continued to be problem-solving, with a percentage of 77.14%.

Cycle III the average percentage of activity obtained has reached the expected success criteria. Students in cycle III have begun to adapt to the learning model used, students are also accustomed to discussing and exchanging information with their group members. Student activity is also seen when students pay attention to the explanations of educators and other students when speaking in class, students have begun to dare to ask and express their opinions when given questions. In solving the problems given, student enthusiasm increases at each meeting. Each group tries faster and better in solving the cases given than other groups. The following is a graph of the increase in student activity in each cycle.

CONCLUSIONS AND RECOMMENDATIONS

Based on the results of this study, it can be concluded that the implementation of learning in the Sensor and Transducer Practice course using the Project Based Learning model in the Mechatronics Vocational Education Study Program, FT UNM can increase student activity. This is based on observation data from all predetermined indicators, obtaining results in cycle I of 57.65%, increasing in cycle II to 74.25%, and increasing in cycle III to 75.67%. The increase in student activity in cycle I to cycle II was 4.8% and in cycle II to cycle III an increase of 1.9%. Based on the results of the research that has been

carried out, learning using the Project Based Learning model has proven to be effective in increasing the activity of PVM Study Program students, FT UNM. This is evident from the data obtained showing an increase in student activity in each cycle. Therefore, learning using the Project Based Learning model needs to be applied as a variation of learning in lectures.

FURTHER STUDY

This research still has limitations so further research is still needed on this topic.

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