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Enhancing Science Learning Outcomes through Problem-Based Learning with Edform Worksheets

Putri Anjani[1*], Achmad Ramadhan[1], Yuniasih Yuniasih [2]

[1] Teacher Professional Education Program, Tadulako University, Indonesia
[2] SMA Negeri 2 Palu, Palu Indonesia

*Corresponding author: putrianjani@gmail.com

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ABSTRACT

Low learning outcomes in biology are often linked to teacher-centered instructional approaches and the lack of interactive digital learning media. This study aims to investigate the effectiveness of implementing the Problem-Based Learning (PBL) model assisted by Edform-based electronic student worksheets (E-LKPD) in improving students' learning outcomes. The research was conducted as Classroom Action Research (CAR) involving 34 students of class XI K at SMA Negeri 2 Palu during the even semester of the 2024/2025 academic year. The study consisted of two cycles, each comprising four stages: planning, implementation, observation, and reflection. Data were collected through learning outcome tests, observation sheets of teacher and student activities, and student response questionnaires. Quantitative data were analyzed descriptively, while qualitative data were obtained through classroom observations and student responses. The results showed that the average student score in Cycle I was 64.92%, categorized as moderate, and increased to 82.53% in Cycle II, categorized as high. This improvement of 27.12% indicates that the implementation of PBL assisted by Edform-based E-LKPD is effective in enhancing students' biology learning outcomes. In addition, students demonstrated more active participation, improved collaboration, and greater motivation during learning activities. Therefore, PBL supported by interactive digital worksheets can be considered an alternative instructional strategy to promote meaningful and engaging biology learning.

INTRODUCTION

Information and communication technology (ICT) has permeated almost all aspects of human life, including education (Tarmo et al., 2022). In the field of education, technology serves as an essential source of knowledge and reference in the learning process (Luckin et al., 2019). The rapid advancement of technology has increased the demands placed on

teachers. In the digital era, teachers are required to master and utilize technology to design innovative and creative learning experiences (Sadriani et al., 2023).

However, in practice, the results often do not meet expectations, as evidenced by students' low conceptual understanding, limited engagement in learning activities, and unsatisfactory evaluation outcomes. Low learning outcomes can be attributed to several factors, one of which is the predominance of teacher-centered instructional models that provide insufficient opportunities for students to explore and construct their own understanding. Additionally, the lack of variety in the presentation of materials and the use of unappealing learning media can reduce students' motivation and enthusiasm, leading to less effective information retention. This aligns with the view of Beeth (1998, in Lin, Yen, Liang, & Chiu, 2016), who emphasized that teaching methods are one of the most critical factors in conceptual change and a primary concern for teachers and science educators when fostering students' scientific understanding through the learning process.

To address these challenges, in the 21st century, also known as the digital era, teachers are increasingly required to be more active, critical, innovative, creative, and collaborative in keeping up with contemporary teaching trends by leveraging technology (Akrim, 2018). The use of technology in learning offers various potentials to enhance the effectiveness and efficiency of the teaching and learning process. One form of technology integration in education is through the use of Edform-based electronic student worksheets (E-LKPD). Edform is an online educational platform that enables teachers to easily create and distribute interactive E-LKPD. In line with this, constructivist theory, as one of the foundational learning theories, supports the use of scientifically based E-LKPD (Indah, N. K., 2024).

In addition to learning media, instructional models also play a crucial role in enhancing the quality of learning. One such model is Problem-Based Learning (PBL), which aims to improve students' problem-solving abilities, investigative skills, critical thinking, collaboration, and argumentation skills during discussions, while simultaneously enhancing their conceptual understanding through the construction of knowledge based on the problems they encounter (Hermanto et al., 2023). Furthermore, the integrated stages within the PBL method are known to assist students in developing their creative thinking skills (Khoiriyah & Husamah, 2018). The implementation of PBL is expected to foster deeper understanding, cultivate critical thinking and collaborative skills, and thereby improve students' learning outcomes. As emphasized by Suwidagdho et al. (2021), the selection of an appropriate instructional model significantly affects the learning process; engaging learning activities tend to make students more motivated and enthusiastic in participating, whereas unengaging methods can have the opposite effect.

Based on observations during the biology learning process in class XI K at SMA Negeri 2 Palu, it was found that students' biology learning outcomes were still relatively low. This was evident from their limited participation in discussions, low enthusiasm and motivation for learning, and the fact that, even with the facilitation of worksheets, only a few students were able to complete group assignments effectively. To enhance both knowledge and learning enthusiasm, the researcher implemented a student-centered instructional model, namely Problem-Based Learning (PBL). According to Wulandari et al. (2023), learning media serve as an effective tool to assist teachers in delivering content and stimulating students' interest and engagement. To support the implementation of this model, the researcher utilized technology-based interactive learning media, specifically Edform-based electronic student worksheets (E-LKPD).

The biology topic focused on in this study was the human reproductive system. This topic was selected due to its complexity, which requires a deep conceptual understanding and has strong relevance to students' daily lives. Conventional teaching methods often make it difficult for students to grasp the concepts and actively engage in the learning process. Electronic student worksheets represent an innovative learning tool that can facilitate

students' learning process (Lessy et al., 2021). Through the implementation of PBL and interactive E-LKPD media, students are expected to improve their learning outcomes, enhance conceptual understanding, actively participate in discussions, and be able to relate theoretical knowledge to real-world phenomena.

METHOD

Research Design

This study employed the Classroom Action Research (CAR) method, implemented across two cycles. The first cycle consisted of two teaching sessions followed by an evaluation session, and the second cycle repeated the same procedure using the same material on the human reproductive system. Each cycle encompassed four stages: planning, action implementation, observation, and reflection.

Population and Samples

The subjects of this study were the students of class XI K at SMA Negeri 2 Palu in the 2025/2026 academic year, consisting of 34 students. The researcher acted as both the instructor and the observer during the learning activities.

Instrument

The research instruments used in this study included learning outcome tests in the form of multiple-choice and short-answer questions to assess students' mastery of the material concepts, observation sheets to record the engagement of both teachers and students during the learning process, and student response questionnaires to determine their perceptions of using Edform-based electronic student worksheets (E-LKPD).

Procedure

The Classroom Action Research (CAR) procedures employed in this study followed four stages in accordance with the model proposed by Kemmis and McTaggart (1988, in Machali, 2022). The first stage was planning, which involved developing a set of research instruments, including teaching modules, observation sheets, questionnaires, and post-test items. The second stage was action implementation, where the researcher applied the Problem-Based Learning (PBL) model using Edform-based electronic student worksheets (E-LKPD). The third stage was observation, which focused on recording students' engagement and participation during the learning process. Finally, the fourth stage was reflection, which entailed analyzing the results of observations and tests to identify strengths and weaknesses and to improve the implementation in the subsequent cycle.

Data Analysis Techniques

The data in this study consisted of both qualitative and quantitative types. Qualitative data were collected through observations of learning activities and student questionnaires, and were analyzed using descriptive techniques. Quantitative data were derived from the students' learning outcome tests administered across two cycles

RESULT AND DISCUSSION

RESULT

This section presents the findings from the implementation of the Problem-Based Learning (PBL) model assisted by Edform-based electronic student worksheets (E-LKPD) over two research cycles. The results include descriptive statistics of students' learning outcomes, observations of teacher and student activities, and student responses to the learning process. To begin with, the descriptive statistics of students' learning outcome tests in Cycle I are presented in Table 1.

Table 1
Descriptive Statistics of Learning Outcome Tests in Cycle I.

Descriptive Statistics	Learning Outcomes Scores
Lowest Score	30
Highest Score	90
Mean	64,92
Standard Deviation	19,04

The descriptive statistical analysis of students' learning outcome tests in Cycle I, as presented in Table 1, showed that scores ranged from 30 to 90. The mean score was 64,92, indicating that, overall, students' learning achievement fell into the moderate category. The standard deviation was 19.04, suggesting a considerable variation or dispersion of scores among students. Based on these results, improvements were deemed necessary for the subsequent cycle.

In addition to the descriptive statistics, the distribution of students' learning outcomes in Cycle I was further analyzed based on score intervals and their corresponding categories. The frequency and percentage distribution of students across these categories are presented in Table 2.

Table 2
Frequency Distribution and Percentage of Learning Outcome Categories in Cycle I.

Score Interval	Category	Learning Outcomes	
		F	%
81-100	Very Good	6	21,42
70-80	Good	5	17,85
60-69	Moderate	6	21,42
40-59	Low	6	21,42
< 39	Very Low	5	17,85
	Total	28	100

As shown in Table 2, only 11 students (39,27%) fell into the Very Good (21,42%) and Good (17,85%) categories. Meanwhile, 17 students (60,73%) were classified into the Moderate to Very Low categories, with proportions of 21,42% (Moderate), 21,42% (Low), and 17,85% (Very Low). These results indicate that the majority of students had not yet achieved the expected learning outcomes, thereby reinforcing the need for improvements in the subsequent cycle.

Following the implementation of improvements in the second cycle, the descriptive statistics of students' learning outcomes were analyzed to evaluate progress compared to Cycle I. The results of this analysis are presented in Table 3.

Table 3
Descriptive Statistics of Learning Outcome Tests in Cycle II.

Descriptive Statistics	Learning Outcomes Scores
Lowest Score	40
Highest Score	99
Mean	82,53
Standard Deviation	15,22

The descriptive statistical analysis of students' learning outcome tests in Cycle II showed that scores ranged from 40 to 99. The mean score was 82.53, indicating that, overall, students' learning achievement fell into the high category. The standard deviation was 15.22, suggesting a considerable variation of scores among students.

Table 4
Frequency Distribution and Percentage of Learning Outcome Categories in Cycle II.

Score Interval	Category	Learning Outcomes	
		F	%
81-100	Very Good	16	57,14
70-80	Good	8	28,57
60-69	Moderate	1	3,57
40-59	Low	3	10,71
< 39	Very Low	0	0
	Total	28	100

As shown in the table, 24 students (85.71%) achieved learning outcomes in the Good and Very Good categories, while 4 students (14.28%) remained below the standard, falling into the Moderate and Low categories. The results indicate that students' learning outcomes improved from Cycle I to Cycle II.

DISCUSSION

Based on the data analysis, the mean score of students in Cycle I was 64.92%, indicating that learning outcomes were still in the moderate category. After reflecting on the weaknesses identified in Cycle I, improvements were implemented in Cycle II through enhanced application of the Problem-Based Learning (PBL) model and the development of Edform-based electronic student worksheets (E-LKPD). As a result, the mean score of students in Cycle II increased to 82.53%, representing a 27.12% improvement. This increase indicates that the corrective actions implemented after the reflection in Cycle I had a positive impact on students' learning achievement, although some students still required further guidance.

Media is an integral part of the learning process, and its role cannot be separated from or underestimated in influencing the course of learning. Therefore, instructional methods that promote the development of students' thinking skills are essential (Astuti et al., 2023), one of which is problem-based learning supported by appropriate media. Improvements in Cycle II involved presenting more contextualized materials and assignments, linking them to students' daily lives. This effort aimed to create more meaningful learning while facilitating the understanding of the concepts being studied. This aligns with Erwin (2018, in Handayani & Koeswanti, 2021), who stated that Problem-Based Learning (PBL) is a series of teaching and learning activities focused on solving real-life problems. PBL can serve as an alternative approach for more innovative, engaging, and challenging learning experiences for students (Permatasari et al., 2019). In line with this, conceptual understanding is a crucial aspect of learning because it emphasizes not only memorization of theoretical knowledge but also its meaning and application in daily life (Kristidhika et al., 2020).

Thus, the knowledge acquired by students is not solely dependent on the teacher's explanations but is also the result of an active learning process. Furthermore, the Problem-Based Learning (PBL) model exposes students to cases that are relevant to the learning material and guides them in seeking solutions. This process makes the material easier to understand and ultimately enhances students' learning outcomes (Darmayanti Ifva et al., 2022).

In addition, the development of E-LKPD design to be more visually appealing and interactive aims to increase students' learning motivation. Kus Rochman & Yuliani (2021) emphasized that E-LKPD with attractive visual displays and interactive features has been proven to enhance students' interest and argumentative skills. Additional features, such as automatic deadlines, were also implemented in the E-LKPD to encourage discipline and punctuality in completing assignments. Although direct research on automatic deadline

features in E-LKPD is still limited, Daryanto et al. (2022) indicated that the application of time limits in digital media can promote students' discipline and timeliness in task completion. By utilizing this platform, educators can also provide learning experiences that are relevant to real-world challenges while training students to collaborate, communicate, and solve problems collectively (Rasyida et al., 2024). However, continuous improvement is still necessary, especially for students who are below the average, through more adaptive learning tailored to their needs.

CONCLUSION

The findings of this study indicate that the implementation of the Problem-Based Learning (PBL) model, supported by Edform-based electronic student worksheets (E-LKPD), is effective in improving the learning outcomes of Class XI K students at SMA Negeri 2 Palu. The average student achievement increased from 64.92% in Cycle I to 82.53% in Cycle II. This demonstrates that PBL facilitated by E-LKPD promotes learning that is both meaningful and contextual, while enhancing students' motivation and active participation in the learning process. For future studies, it is recommended to extend the number of research cycles to achieve more optimal outcomes and to gain a more comprehensive understanding of the effectiveness of the interventions implemented.

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