Implementation of The Problem Based Learning Model with Wordwall-Based Learning Media on Ecosystem Materials to Improve Student Activity and Learning Outcomes

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Abstract: This study aims to determine the effectiveness of the application of the Problem Based Learning (PBL) model assisted by Wordwall-based learning media in improving student activity and learning outcomes in ecosystem material in class X of SMA Negeri 5 Pematangsiantar. The background of this study is based on the low activity and learning outcomes of students and the lack of innovation of the learning media used. The method used in this study is classroom action research (CAR). This study was conducted in two cycles consisting of four main stages: planning, action implementation, observation, and reflection. The subjects of this study were 36 students of class X-10 of SMA Negeri 5 Pematangsiantar. The results showed a significant increase in student learning outcomes from cycle I (60.94) to cycle II (84.56), with an increase of 23.6 points. Likewise, there was an increase in the percentage of learning completion, namely in cycle I of 27.78% (10 people) to 100% (36 people), in cycle II. From the observation results of student activity in cycle I obtained 60.15%, included in the less category and in cycle II 92.38%, included in the very good category thus there was an increase in student activity by 32.23%. The average N-Gain score of 0.83 shows that learning using the Problem Based Learning model with Wordwall-based learning media is very effective in increasing the activity and learning outcomes of class X-10 students of SMA Negeri 5 Pematangsiantar. The results of this study show an increase in student activity and learning outcomes in ecosystem material using the Problem Based Learning model with Wordwall-based learning media for class X-10 SMA Negeri 5 Pematangsiantar.

Keywords: Ecosystem; Learning outcomes; Problem Based Learning; Wordwall; Student activity

Introduction

Education is an effort to enable humans to develop their potential through the learning process or other methods recognized and recognized by society (Rahman et al., 2025; Shavkidinova et al., 2023). Nowadays, science is taught at all levels of school, from elementary school to university. Several definitions of science have been put forward by experts, including Chambers et al.

(2021), who argue that science is a process for producing knowledge.

Natural science has high educational value, namely its potential to foster a child's overall personality (Botha, 2021). When taught appropriately, science becomes a subject that provides opportunities for critical thinking. For example, if science is taught using the Wordwall or discovery method, students will be confronted with a problem (Ariyani et al., 2025; Bariyah & Prastowo, 2024; Nuha et al., 2025; Syaifi & Murwitaningsih, 2022). If

science is taught through experiments conducted by students themselves, science becomes more than just a subject for memorization (Russell & Martin, 2023).

The environment is everything surrounding living things that influences their lives. The environment consists of biotic and abiotic components (Ehis-Eriakha & Akemu, 2022; Singh, 2024). Biotic components are all living things, such as plants, animals, humans, and microorganisms (Deshmukh, 2024). Meanwhile, abiotic components are all non-living things, such as soil, air, water, climate, humidity, light, and sound (Prabhu, 2021; Sumuki, 2023). An ecosystem is an ecological system formed by the reciprocal relationship between living things and their environment. An ecosystem consists of both the physical environment and the organisms that live there. Numerous interactions occur within an ecosystem. Interactions between species within an ecosystem can change the condition of a population. These interactions can have positive or negative impacts, or even have no effect on the interacting species.

The quality of learning is determined, in part, by the level of student participation in interactive teaching and learning activities (Sinaga, 2024). Therefore, educators need to utilize various methods, including the methods and media used in teaching and learning activities (Tuma, 2021). Understanding teaching methods and being able to use them in the classroom is a competency that teachers must possess. This means that the success or failure of achieving teaching objectives after the teaching and learning process depends, in part, on how the teaching and learning activities are conducted by the teacher and the learning process undertaken by the students in the classroom, by PBL, it is hoped that there will be improvements in student learning outcomes and creativity, thus motivating them to learn (Arfani et al., 2024). As stated by Koschmann et al. (2012); Taufik (2024), PBL is a curriculum and learning process that design problems that require students to acquire essential knowledge, develop problem-solving skills, develop their own learning strategies, and develop teamwork skills. The learning process uses a systemic approach to solving problems or facing challenges that will be needed in their careers and daily lives. Dutch's opinion, as cited in Taufik (2024), states that PBL is an instructional method that challenges students to "learn to learn," working together in groups to find solutions to real-world problems.

Therefore, to improve student learning outcomes in science, particularly on the topic of ecosystems, appropriate strategies and media are necessary. Wordwall is an engaging application related to the program. This application is explicitly intended to be a fun learning asset, media, and assessment tool for

students. The Wordwall page also provides examples of instructor manifestations so that new clients understand the types of creations to be made (Azura & Khairuna, 2025). Wordwall is a web application that can be used to create engaging education for students and can also be used as a learning medium that engages students (Rahma et al., 2023). This website is suitable for planning and exploring active learning evaluations (Irham, 2020).

Method

This study used a classroom action research (CAR) method aimed at improving student engagement and learning outcomes in the classroom through a cyclical approach. This study was conducted in two cycles consisting of four main stages: planning, action implementation, observation, and reflection. Each cycle was conducted over two meetings. If the expected results were not achieved in the second cycle, a third cycle was conducted to improve learning outcomes.

In this study, the stages followed the steps of classroom action research (CAR), which included planning, action, observation, and reflection (Arikunto, 2013). In the planning stage, the researcher developed an action plan based on problems identified in the learning process, which included the selection of methods, techniques, and learning media to address these problems (Mertler, 2024). Next, in the action stage, the researcher implemented learning according to the plan with the aim of improving and enhancing the quality of the learning process. In the observation stage, the researcher observed and recorded the learning process and outcomes to determine the extent to which the implementation of the action had an impact on student learning. Finally, in the reflection stage, the researcher analyzed the data obtained from the observations to evaluate the effectiveness of the actions that had been implemented. The results of this reflection are then used to plan improvements or adjustments needed in the next cycle, and this cycle will be repeated if the desired results have not been achieved.
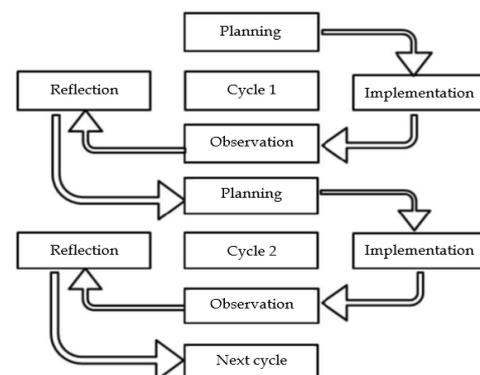

Figure 1. Classroom Action Research Cycle

From the data obtained through the research instrument, the results will then be analyzed using descriptive statistical analysis techniques. Descriptive statistics are used to process data characteristics related to summations, averages, midpoints, percentages, and to present data in an interesting, easy-to-read, and understandable way (graphs, tables, and charts). Based on the research instrument described previously, the following data analysis techniques were used:

Observation

Based on the observation sheet instrument, there are two types of observations: student activity observations and teacher activity observations. The data analysis technique for the results of these two observations uses the Formula 1.

$$Percentage\ of\ Activities\ = \frac{A}{B}x100\% \qquad (1)$$

With assessment categories:
1 = Poor
2 = Less than Good
3 = Fair
4 = Good
5 = Very Good

Test

Test results will be obtained from students' formative assessment data for each session, namely from the post-test results. These results will be in the form of a score and will be calculated using the Formula 2.

$$\bar{x} = \frac{\sum X}{N} \qquad (2)$$

Description:
$\bar{x}$ = Average student score
$\sum X$ = Total score obtained
N = Maximum score

Based on the scores obtained, the conversion of the question mastery level can be seen in the Table 1.

Table 1. Categories of score

Range score	Categories
90 – 100	Excellent
80 – 89	Good
75 – 79	Enough
< 75	Low

$$Classical\ Completion = \frac{\sum Student\ completed}{\sum Total\ of\ student}x100\% \qquad (3)$$

Learning is considered complete if students' scores meet the Minimum Completion Criteria (KKM) standard, namely a score of 75 or higher, and classical completion reaches at least 75%.

Indicators of Success

The indicator of success in this research is an increase in student learning outcomes in Biology on ecosystems from Cycle I to Cycle II. This is reflected in an increase in student learning outcomes in biology from Cycle I to Cycle II. The target achieved in this success indicator is an increase in student activity and learning outcomes, indicated by the achievement of the KKM with a score of 75 for all students. Therefore, the research is considered complete.

Result and Discussion

The purpose of this study was to determine the effectiveness of implementing a problem-based learning model with wordwall-based learning media on ecosystems material to improve student engagement and learning outcomes in grade 10 students at SMA Negeri 5 Pematangsiantar in the 2024/2025 academic year. The research used in this study was Classroom Action Research (CAR). Classroom Action Research (CAR), as a part of action research aimed at improving the quality of classroom learning practices, is gaining popularity. Recycling within Classroom Action Research (CAR) itself includes action planning, action implementation, observation and evaluation, and reflection.

The classroom action research conducted utilized the Problem-Based Learning (PBL) model with the aid of wordwall-based learning media to improve student engagement and learning outcomes in ecosystems material in grade 10 students at SMA Negeri 5 Pematangsiantar.

Validity and Reliability Test Results

The validity of the questions was calculated using the product-moment correlation formula using raw numbers. The instrument used to measure the questions was a test containing 20 multiple-choice items and an essay. The highest score is 8 and the lowest score is 1. Before the questions were administered to the sample class, they were first validated on 36 grade X students of SMA Negeri 5 Pematangsiantar. Therefore, the students used for the validation test were students outside the sample. Based on the validity test results, all 20 questions were valid. This is evident from the calculated r value > table r value, resulting in 20 valid questions.

Similarly, the reliability test was used to measure the consistency of the questions in the research used to measure the questions. Before conducting the reliability test, a decision must be made, namely an alpha of 0.60.

The variables are considered reliable. The results of the reliability test on the questions show that the Cronbach's Alpha for this variable is higher than the baseline value, at 0.82 > 0.60. This result proves that the questions in the questions are reliable.

Analysis of Student Learning Outcomes

The data obtained in this study are student learning outcomes in Cycles I and II, using a problem-based learning model using word walls to improve student engagement and learning outcomes in ecosystems material in grade 10 at SMA Negeri 5 Pematangsiantar in the 2024/2025 academic year.

Based on Figure 2, the average value of cycle I was 60.94. This result shows that students' mastery of ecosystem material was still lacking in cycle I. With a KKM of 75 at SMA Negeri 5 Pematangsiantar, out of 36 students, 10 (27.78%) of class X-10 students achieved the KKM, and 26 students (72.22%) did not achieve the KKM.

Observations of student activity using a questionnaire revealed an average activity score of 60.15% for class X-10 students at SMA Negeri 5 Pematangsiantar. This indicates that student activity was still low in Cycle I. This indicates that class X-10 students were less active in learning using the problem-based learning model using wordwall media, resulting in a low average learning outcome of only 60.94%. Based on Cycle I data, where classical learning completion was only 27.78%, not reaching the minimum classical completion of 75%. Therefore, this research was deemed unsuccessful, and continued in Cycle II.

Figure 2 shows that the average learning outcome score for grade X students at SMA Negeri 5 Pematangsiantar in Cycle II was 84.56, categorized as good. With a Minimum Competency (KKM) of 75 at

SMA Negeri 5 Pematangsiantar, all 36 students in grade X-10 achieved the KKM (100%). Because completion was achieved both individually and as a class, the study was discontinued at Cycle II.
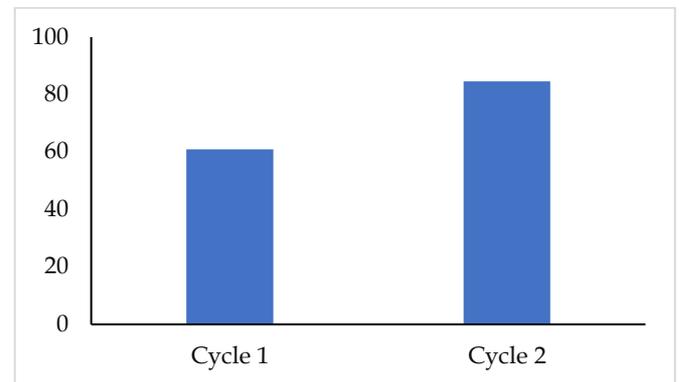

Figure 2. Comparison of Student Learning Outcomes in Cycle I and Cycle II

Based on the result in Figure 2, it can be seen that of the 36 students in grade X-10 at SMA Negeri 5 Pematangsiantar, 6 (16.7%) obtained a score of 76, 11 (30.6%) obtained a score of 80, 10 (27.8%) obtained a score of 84, 4 (11.1%) obtained a score of 92, and 5 (13.9%) obtained a score of 100. The cumulative total percentage is 100%.

Based on observations of the activeness of class X-10 students at SMA Negeri 5 Pematangsiantar in Cycle II, the average score was 92.38%, categorized as very good. Therefore, in Cycle II, class X-10 students at SMA Negeri 5 Pematangsiantar were very active in learning using the problem-based learning model combined with word wall media, resulting in good average student learning outcomes (84.56).

Table 2. Descriptive Statistics N-gain score

Parameter	N	Minimum	Maximum	Mean	Std. Deviation
N-gain	36	73.88	99.33	83.4629	7.73511
Valid N (listwise)	36				

The N-Gain Score results showed an average value of 0.83, which is considered good. This indicates that the learning implemented was quite effective in improving student understanding. Overall, these data demonstrate that the application of the problem-based learning model combined with word wall learning media effectively increased student engagement and learning outcomes in class X-10 of SMA Negeri 5 Pematangsiantar by 83%.

The data in Table 2 shows a significant increase in student understanding after implementing problem-based learning combined with word wall learning media, from cycle I (60.9) to cycle II (84.5), representing

a 23.6-point increase. Furthermore, there was an increase in student completion percentage, from 27.272% (10 students) in cycle I to 100% (36 students) in cycle II. This indicates that all 36 students in grade X-10 of SMA Negeri 5 Pematangsiantar had achieved the established competency standards. Therefore, the learning process was successful, and the study was stopped until cycle II.

A questionnaire was then used to measure student understanding of ecosystems. This questionnaire was designed to assess the extent to which students understood the concepts taught, connected the material to real-world phenomena, and applied their knowledge in problem-solving. The questionnaire data revealed

that the total score for all students was 2,047.5, representing 93.06% of the students, and categorized as very good (effective). Thus, the application of the problem-based learning model with wordwall-based learning media on ecosystems material was very effective in improving the activeness and learning outcomes of grade X students at SMA Negeri 5 Pematangsiantar in the 2024/2025 academic year.

Based on direct observations during learning activities, namely in Cycles I and II, observations covered student activities in understanding the material, discussing, and participating in problem-solving. At this stage, observations were made of student activities using an instrument in the form of a student observation sheet. Student activities were observed by the researcher. The results of observations of student activeness in Cycle I were obtained at 60.15%, categorized as poor. This means that in Cycle I, grade X students of SMA Negeri 5 Pematangsiantar were less active in learning, resulting in poor (low) learning outcomes, at only 60.9%. In Cycle II, student activeness was obtained at 92.38%, categorized as very good. This means that in Cycle II, grade X students of SMA Negeri 5 Pematangsiantar were very active in learning using the Problem-Based Learning model with Wordwall-based learning media, resulting in high (good) learning outcomes.

The N-Gain Score of 0.83 indicates a high level of effectiveness, meaning that the problem-based learning model combined with wordwall learning media effectively increased student engagement and learning outcomes by 83% in class X-10 of SMA Negeri 5 Pematangsiantar. The N-Gain Score results showed an average value of 0.83, indicating that the learning implemented was quite effective in improving student understanding. Overall, these data demonstrate that the application of the problem-based learning model combined with wordwall learning media is effective in increasing student engagement and learning outcomes in class X-10 of SMA Negeri 5 Pematangsiantar (Agustin et al., 2025; Puspita & Setiawan, 2025).

Based on the results achieved in cycles I and II, both in terms of improved grades, method efficacy, and positive feedback from students, it can be concluded that cycle II successfully met the research objectives. Therefore, this research was terminated in cycle II, as the results obtained in cycle II had achieved the expected success standard.

Conclusion

There was a significant increase in student learning outcomes from cycle I (60.94) to cycle II (84.56) with an increase of 23.6 points. Likewise, there was an increase

in the percentage of learning completion, namely in cycle I of 27.27% (10 people) to 100% (36 people), in cycle II. From the results of observations of student activity in cycle I obtained 60.15%, including the less category and in cycle II of 92.38%, included in the very good category thus there was an increase in student activity of 32.23%. The average N-Gain score of 0.83 indicates that learning using the Problem Based Learning model with Wordwall-based learning media is very effective in increasing the activity and learning outcomes of class X-10 students of SMA Negeri 5 Pematangsiantar. The results of this study show an increase in student activity and learning outcomes in ecosystem material using the Problem Based Learning model with Wordwall-based learning media for class X-10 SMA Negeri 5 Pematangsiantar.

Author Contributions
DPS: formulates research ideas, prepares designs, and revision of manuscript content. S.R: performs data analysis, interpretation of results, and writes the main manuscript. H.A.S: interpretation of results and revision of manuscript content.

Conflicts of Interest
The authors declare no conflict of interest.

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