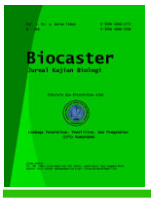

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THE EFFECT OF THE PROBLEM BASED LEARNING MODEL ON STUDENTS' COMMUNICATION SKILLS AND LEARNING OUTCOMES IN ECOSYSTEM MATERIAL

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ABSTRACT: This study aims to determine the effect of the problem-based learning model on students' communication skills and cognitive learning outcomes regarding the topic of ecosystems at SMA Negeri 1 Kualuh Leidong. A quasi-experimental design specifically a pretest-posttest non-equivalent control group design was employed, involving 72 students from two classes selected via random sampling. The experimental class utilized the problem-based learning model, while the control class underwent conventional instruction. Communication skills were measured using observation sheets, and cognitive learning outcomes were assessed through multiple-choice tests. The results indicate that the experimental class achieved an average communication skill score of 87.67% (categorized as highly skilled), which was significantly higher than the control class's score of 55.44% (categorized as skilled). Cognitive learning outcomes also showed significant improvement; the experimental class achieved an N-gain score of 0.75 (high category), compared to 0.47 (medium category) for the control class. Mann-Whitney U test results indicate that the problem-based learning model significantly influences communication skills, while Independent Sample t-test results show that problem-based learning significantly affects biology learning outcomes regarding the topic of ecosystems. This study demonstrates that problem-based learning is an effective instructional model for developing students' communication skills and enhancing their biology learning outcomes, particularly concerning the ecosystem topic.

Keywords: Communication Skills, Learning Outcomes, Problem Based Learning.

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INTRODUCTION

Education is a structured process designed to make learning interactive and to enable students to achieve their full potential (Aminah et al., 2021). Compared to other fields of study, biology is a relatively complex discipline. Biology is often perceived as a subject that relies heavily on memorization, making learning a challenge for students. Based on a descriptive study, students in schools are able to receive and process information at a moderate level, exert only a small amount of mental effort when studying biology in class, and achieve learning outcomes that fall within a relatively low range (Safnowandi, 2016; Setiawan, 2019). Connecting lesson content with the surrounding environment will make learning more meaningful because what students learn in class becomes useful in their

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daily lives. Learning biology is not only about dealing with theories and concepts, but also about taking action, gaining understanding, and solving problems related to biology.

Innovation is needed to improve the quality of education, and one of these innovations is curriculum reform. The Merdeka Curriculum is the current curriculum implemented as an effort to address the demands of the 21st century. It provides opportunities for students to actively solve the problems they encounter during the teaching and learning process. Learning is carried out using various challenging strategies and techniques that encourage students to think critically, explore, create, and experiment by utilizing diverse resources. The skills required to face the 21st century include critical thinking, collaboration, communication, creativity, and innovation. One of the most essential skills needed in the 21st century is communication ability (Mufidah, 2023).

When examined more deeply, the goals of national education are aligned with the objectives of biology learning, one of which is to develop students' experience in conducting experiments and to train them to communicate their learning outcomes orally. Oral communication is a process of conveying messages verbally from a source to a receiver with the intention of influencing the recipient. Oral communication is highly essential in the learning process. In classroom learning, oral communication occurs, among other situations, during group discussions, as discussions involve processes of social interaction. Each group member interacts directly within the group (Sari, 2018).

One of the learning models that can be used to improve students' biology learning outcomes is Problem Based Learning. Problem Based Learning is an instructional model that focuses on solving real-life problems. This model encourages students to acquire new knowledge through problem-solving, critical thinking, teamwork, communication, and the development of information in a positive manner. Problem Based Learning provides students with opportunities to exchange ideas with their peers and teachers, analyze problems scientifically, and consider various possible solutions to a given problem. The Problem Based Learning model is expected to improve students' learning outcomes because students construct their own knowledge through the learning process (Trianto et al., 2021).

This is relevant to the study conducted by Astuti (2019) on the effect of the Problem Based Learning model on the communication skills of Grade X students at SMA Negeri 02 Padang Cermin, which stated that there was an influence of problem-based learning on students' communication skills. In the second stage, students are organized for learning, and in the third stage, guidance and investigation are provided through heterogeneous group work that emphasizes active and collaborative student participation. It is therefore expected that at these stages, students' communication skills can be developed and their learning outcomes improved.

Indrawan et al. (2022) state that selecting the problem-based learning model to improve student learning outcomes regarding ecosystems is a compelling subject for research; this is because many sub-topics within the ecosystem unit can be directly linked to issues in the students' immediate

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environment, thereby fostering a contextual learning process. Consequently, problem-based learning serves as a solution to enhance learning outcomes in this topic while helping students understand the material by connecting it to real-life events. Previous studies have shown that problem-based learning improves learning outcomes; however, research simultaneously examining its impact on communication skills and learning outcomes regarding the topic of ecosystems remains limited.

Based on observations conducted by the researcher in February 2025 alongside teachers at SMA Negeri 1 Kualuh Leidong, several issues were identified, including poor communication skills, suboptimal student learning outcomes, and a lack of questioning and passivity during the learning process. These conditions made it difficult for students to comprehend the material presented by the teacher. In light of these issues, this study aims to determine the effect of the problem-based learning model on students' communication skills and learning outcomes regarding the topic of ecosystems at SMA Negeri 1 Kualuh Leidong.

METHOD

This study employs a quasi-experimental research method. The research design used is the pre-test/post-test control group design. Both sample groups will undergo the same pre-test (initial test) and post-test (final test). The pre-test is administered prior to the intervention to establish a baseline for measuring change. Following the intervention, both groups will take the post-test to assess the outcomes resulting from the treatment. The study involves two variables: the independent variable (the problem-based learning model) and the dependent variables (communication skills and learning outcomes).

This study was conducted at SMA Negeri 1 Kualuh Leidong. The sample consisted of 72 students divided into two groups an experimental class and a control class selected using a random sampling technique. The research instruments included a test to measure cognitive learning outcomes and an observation sheet to assess students' communication skills. Class X-1 was selected as the experimental class and received instruction using the problem-based learning model, while Class X-4 was designated as the control class and taught using conventional methods.

Table 1. Quasi-Experimental Research Design.

Class	Pre-test	Treatment	Post-test
Experimental class	O1	X1	O3
Control class	O2	X2	O4

(**Source:** Sugiyono, 2019).
Information:
O1 = Pre-test measurement in the experimental class;
O2 = Pre-test measurement in the control class;
X1 = Treatment of the experimental class using the PBL model;
X2 = Treatment of the control class using a conventional learning model;
O3 = Final test (post-test) measurement in the experimental class; and
O4 = Final test (post-test) measurement in the control class.

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The following is the index of communication skill criteria presented in Table 2.

Table 2. Criteria for the Level of Students' Communication Skills.

Score	Criteria
87.50 – 100	Very Good
75.00 – 87.49	Good
50.00 – 74.99	Enough
0 – 49.99	Not Enough

(**Source:** Sari, 2018).

The Shapiro-Wilk test was used to assess normality, and the results indicated that the data for communication skills were not normally distributed, whereas cognitive learning outcomes were normally distributed. Levene's test was used to evaluate homogeneity and ensure that the variances in both classes were similar. The non-parametric Mann-Whitney U test was used for hypothesis testing at a significance level of $\alpha = 0.05$ because the normality assumption was not met, whereas the parametric Independent Samples t-test was used for hypothesis testing at a significance level of $\alpha = 0.05$ because the normality assumption was met. The average pretest, posttest, and N-gain scores of the experimental and control groups were compared to conduct a quantitative analysis. To measure the improvement in learning outcomes in both classes, the N-gain score was calculated using the following formula:

$$N\text{-}Gain = \frac{Skor\ Posttest - Skor\ Pretest}{Skor\ Ideal - Skor\ Pretest}$$

(**Source:** Arikunto, 2016).

N-gain scores are interpreted based on a set of classification criteria to determine the category of improvement achieved by each class. The criteria used to classify the N-gain scores in this study are presented in Table 3.

Table 3. N-Gain Level Criteria.

N-Gain Value	Category
G>0.7	High
0.3≤ G ≤ 0.7	Medium
G>0.3	Low

(**Source:** Arikunto, 2016).

RESULTS AND DISCUSSION

Results

This study examines the effect of problem-based learning on students' communication skills and cognitive learning outcomes regarding the topic of ecosystems. The research findings are presented in two sections: communication skills and cognitive learning outcomes.

Communication Skills

An observation sheet based on the four indicators proposed by Pertiwi & Nindiasari (2022) was used to evaluate communication skills. Observations were conducted twice for both the experimental and control groups: once before the

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treatment (baseline data) and once after the treatment (final data). Table 4 presents data from the initial observation, while Table 5 presents data from the final observation. The results of the collaboration skill assessment for both the experimental and control classes are presented in Table 4 below. The data reflect the students' overall performance based on the indicators observed during the learning process.

Table 4. Initial Data on Communication Skills.

No.	Indicator	Experimental Class		Control Class	
		Indicator (%)	Category	Indicator (%)	Category
1	Able to express ideas and thoughts effectively	31.71%	Not Enough	30.32%	Not Enough
2	Able to listen effectively	34.49%	Not Enough	36.11%	Not Enough
3	Able to convey information effectively	30.78%	Not Enough	31.71%	Not Enough
4	Using good and effective language	34.02%	Not Enough	34.49%	Not Enough
	Average	32.75%	Not Enough	33.16%	Not Enough

Based on Table 4, the average communication skills for the experimental and control classes were 32.75% and 33.16%, respectively, placing both in the "Poor" category. The initial levels of communication skills in both classes were similar prior to the intervention, as indicated by a mean difference of 0.41%. This finding suggests that both groups had comparable baseline communication skills, providing a fair basis for evaluating the effects of the intervention.

Table 5. Final Data on Communication Skills.

No.	Indicator	Experimental Class		Control Class	
		Indicator (%)	Category	Indicator (%)	Category
1	Able to express ideas and thoughts effectively	86.34%	Good	53.24%	Enough
2	Able to listen effectively	88.42%	Very Good	58.56%	Enough
3	Able to convey information effectively	88.88%	Very Good	55.55%	Enough
4	Using good and effective language	87.03%	Good	54.39%	Enough
	Average	87.67%	Very Good	55.44%	Enough

Based on Table 5, the initial average communication skill level in the experimental class was 32.75%, rising to 87.67% after the treatment a difference of 54.92%. In the control class, the initial communication skill level was 33.16%, increasing to 55.44% after the treatment a difference of 22.28%. The final communication skill results showed the experimental class reaching an average of 87.67% (categorized as "very good"), while the control class reached 55.44% (categorized as "fair"). This 32.23% difference indicates a greater improvement in communication skills in the experimental class compared to the control class. Based on the students' pretest and posttest scores, the mean and standard deviation of their cognitive learning outcomes were calculated for each class. The average cognitive learning outcomes derived from these scores are more clearly illustrated in Figure 1.

Biocaster : Jurnal Kajian Biologi
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Volume 6, Issue 3, July 2026; Page, 1651-1660
Email: biocasterjournal@gmail.com

Cognitive Learning Outcomes

Cognitive learning outcomes were measured using a 20-item multiple-choice test administered as both a pretest and a posttest to both classes. The test items were designed to assess students' understanding across various cognitive levels, including comprehension, application, and analysis. The average pretest, posttest, and N-gain scores for each class are summarized in Table 6 and presented in Figure 1.

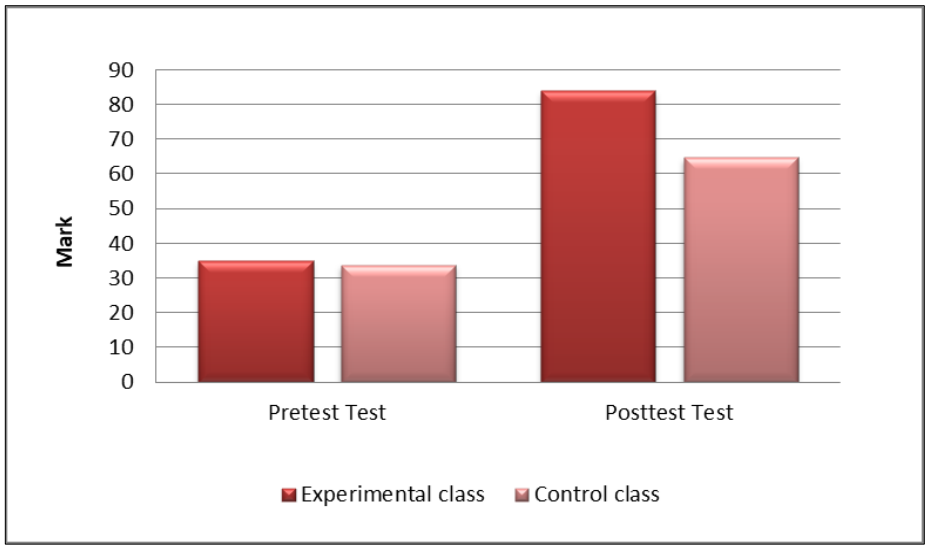

Figure 1. Bar Chart of Average Pre-test and Post-test Scores for Experimental and Control Classes.

The standard deviation, independent sample t-test results and N-gain of the experimental and control classes in this study are presented in Table 6.

Table 6. Standard Deviation, Independent Sample t-test Results and N-Gain.

Class	N	Standard Deviation		Independent Sample t-test		N-Gain
		Pre-test	Post-test	Pre-test	Post-test	
Experimental Class	36	8.106	7.053	0.624	0.001	0.75
Control Class	36	12.894	10.138			0.47

Based on Figure 1 and Table 6, the mean pretest score for the experimental class was 35 (SD = 8.106), while that of the control class was 33.75 (SD = 12.894). This indicates a mean difference of 1.25 points between the experimental and control classes. The hypothesis test results using an Independent Sample T-test on the pretest data yielded a Sig. (2-tailed) value of 0.624. Since 0.624 > α (0.05), there is no significant difference between the mean pretest scores of the experimental and control classes. This implies that the experimental and control classes possessed equivalent initial cognitive abilities.

The experimental class achieved an average pretest score of 35, which rose to 84.03 on the posttest, reflecting an increase of 49.03 points (102.15%). The control class showed an average pretest score of 33.75 and an average posttest score of 64.72, reflecting an increase of 15.69 points (32.69%). Although both classes showed improvement, the experimental class demonstrated significantly

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Volume 6, Issue 3, July 2026; Page, 1651-1660
Email: biocasterjournal@gmail.com

greater progress than the control class. The difference in average posttest scores between the two classes was 19.31 points (40.23%), with the experimental class consistently outperforming the control class.

Based on the N-gain results derived from pretest and posttest data, the experimental class achieved a score of 0.75, while the control class achieved 0.47. Hypothesis testing using the independent sample t-test (via SPSS 31 software) yielded a Sig. (2-tailed) value of 0.001. Since the obtained Sig. (2-tailed) value of 0.001 is less than 0.05, the null hypothesis (H_0) is rejected and the alternative hypothesis (H_a) is accepted; this indicates that the problem-based learning model has an effect on student learning outcomes regarding the topic of ecosystems at SMA Negeri 1 Kualuh Leidong.

Discussion

This study examines the effect of problem-based learning on students' communication skills and cognitive learning outcomes in biology, specifically regarding the topic of ecosystems. The discussion is structured around two main findings: the improvement of communication skills and the improvement of cognitive learning outcomes.

Communication Skills

The research results indicate that students in the experimental class taught using the problem-based learning method achieved significantly higher communication skill scores compared to students in the control class. This improvement can be attributed to the characteristics of proplem based learning, which require students to actively engage in group work through five stages: orienting students to the problem, organizing students for learning, guiding individual and group investigations, developing and presenting work products, and analyzing and evaluating the problem-solving process and outcomes. Throughout these stages, students were consistently required to contribute ideas, share tasks, negotiate decisions, and support one another, thereby directly practicing the four communication skill indicators assessed in this study. In contrast, students in the control class merely listened to the teacher's explanations, resulting in lower levels of active participation and student cohesiveness.

These findings align with previous research. Suswanti (2021) found that problem-based learning transforms students from passive participants into active ones. Students' communication skills are honed through group discussions, fostering enthusiasm as they seek solutions to the problems presented. In this learning process, students are not merely objects of instruction but individuals whose potential is actively developed. This is consistent with the findings of Astuti & Purwanto (2021), which indicate that group presentations build public speaking skills and self-confidence, equipping students with versatile skills applicable to daily life. Furthermore, Hotimah (2020) notes that the problem-based learning model is characterized by the use of real-life problems as the subject matter for student learning.

Cognitive Learning Outcomes

Student learning outcomes were determined based on scores obtained after instruction; the experimental class utilized the Problem-Based Learning (PBL) model, while the control class used a conventional model. The initial pretest

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E-ISSN 2808-277X; P-ISSN 2808-3598
Volume 6, Issue 3, July 2026; Page, 1651-1660
Email: biocasterjournal@gmail.com

scores were generally low, contrasting with the posttest results, which demonstrated that the students had successfully grasped the material. These findings indicate that the instructional process contributed to a significant improvement in students' understanding of the learning material, with the PBL model showing greater effectiveness in enhancing learning outcomes compared to the conventional approach.

This finding is supported by Rohmah & Setiani (2022), whose research indicates that classes taught using the problem-based learning model outperform those taught using conventional methods; this is because the problem-based learning model guides students to solve problems and actively seek information to address the issues presented thereby fostering more meaningful and memorable knowledge acquisition whereas in classes taught via conventional methods, students tend to be passive, as the source of knowledge remains teacher-centered and students rely solely on the teacher's explanations for information.

Despite promising results, this study has several limitations. First, it employed a quasi-experimental design without random assignment, as it involved pre-existing classes; this creates a potential for selection bias, even though the baseline scores of both groups were similar. Second, communication skills were assessed using a rubric, but the presence of observers may have influenced student behavior (the Hawthorne effect), and the absence of reported inter-rater reliability could affect assessment consistency. Third, the study was conducted at a single school, limiting the generalizability of the findings to different educational contexts. Future research should employ a more robust experimental design, ensure inter-rater reliability, and replicate the study across diverse settings.

CONCLUSION

The Problem-Based Learning (PBL) model had a significant effect on students' communication skills regarding the topic of ecosystems in Grade X at SMA Negeri 1 Kualuh Leidong ($\alpha < 0.05$); the experimental class achieved an average score of 87.67% (very good category), whereas the control class averaged 55.44% (fair category). The PBL model also significantly influenced the improvement of students' cognitive learning outcomes regarding the ecosystem topic in Grade X at SMA Negeri 1 Kualuh Leidong ($\alpha < 0.05$). The experimental class demonstrated an improvement in learning outcomes with an N-gain of 0.75 (high category), which was higher than that of the control class, which had an N-gain of 0.47 (medium category).

RECOMMENDATION

Future research is recommended to investigate the implementation of the Problem-Based Learning (PBL) model across different biology topics, educational levels, and school settings with larger and more diverse samples to strengthen the generalizability of the findings, as well as to examine its long-term effects on students' communication skills and cognitive learning outcomes. In conducting future studies, researchers should consider potential challenges such as variations in students' prior knowledge and learning motivation, limited instructional time, differences in teacher expertise in implementing PBL, and the availability of

learning resources, as these factors may influence the effectiveness of the model and the research outcomes.

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