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Implementation of the Problem-Based Learning (PBL) Model to Improve Conceptual Understanding and Student Activeness in Grade X

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Abstract
This study aimed to improve students' conceptual understanding and learning activeness in Biology in a Grade X class at SMAN 3 Pamekasan by implementing the Problem-Based Learning (PBL) model on the topic of environmental change. Classroom action research was employed to examine improvements in conceptual understanding and students' active participation during instruction. Data were collected through observation and written tests administered within the PBL implementation. Essay test scores and observation sheets were presented in tables and graphs to facilitate analysis. In Cycle I, the mean score for students' conceptual understanding reached 86.33 and increased in Cycle II to 92.39, indicating a high level of mastery. Meanwhile, student activeness in Cycle I was 64% (categorized as "adequate"), and it increased substantially in Cycle II to 91% (classified as "very active"). These findings suggest that the PBL model is effective in enhancing conceptual understanding and student engagement in Biology learning.

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Problem-Based Learning; Conceptual Understanding; Student Activeness.

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Introduction

Biology is a discipline that teaches systematic ways of understanding the surrounding environment and is inextricably linked to modern life (Rindawan et al., 2021). Studying biology is not limited to theoretical understanding; it also involves practical actions and problem-solving related to biological phenomena (Arumsari et al., 2023). In educational contexts, learning biology is not sufficiently achieved through independent study alone; guidance is necessary to maximize students' conceptual understanding of biology. Accordingly, teachers play a critical role in the learning process by ensuring that learning objectives are achieved and by presenting materials that stimulate students' curiosity and encourage their active engagement in learning (Febrianti et al., 2024; Trang & Hansen, 2021; Wiens et al., 2021).

Learning attainment is influenced by several factors, including the predominant use of teacher-centered instructional models, limited variation in instructional approaches, and inadequate teacher skills in facilitating student-centered learning (Togatorop & Dito, 2023). The continued use of conventional models can lead to boredom as well as low levels of understanding and student engagement. Student activeness refers to processes within learning activities that involve both action and thinking, physically and mentally (Febrianti et al., 2024; Wahyuni et al., 2022).

Based on the problems identified in the school, students' participation and activeness were still relatively low. This was because the instructional model used was not sufficiently

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varied and was dominated by group discussions and lecture-based delivery that made students bored (Juanda et al., 2024). Therefore, the implementation of innovative and relevant learning models is needed to encourage student activeness and participation. Engaging learning models can increase students' enthusiasm and promote their active involvement in the learning process (Sulasiawati & Indrayani, 2023).

The researchers selected PBL as an approach considered effective in supporting teachers' roles as learning facilitators and in stimulating students to engage in critical thinking and problem-solving based on real-life cases from students' surroundings (Hanifah & Indarini, 2021). This model supports students in developing independent learning, inquiry, and the ability to understand concepts (Hasthiolivia & Prijowuntato, 2023). In PBL, problems are introduced by the teacher before learning activities begin to encourage active student engagement, foster student independence, and strengthen students' thinking capacity in addressing problems that require in-depth analysis (Masrinah et al., 2023; Maulidya et al., 2021). PBL offers several advantages: (1) students can deepen their understanding independently through learning activities; (2) learning is problem-centered and therefore relevant to current issues; and (3) students are encouraged to develop the ability to solve challenges in real situations (Farwati et al., 2024). In practice, PBL is implemented through a sequence of steps: first, the teacher presents the problem to students; second, students conduct investigations and gather information; third, students analyze data and draw conclusions; and fourth, students present their results (Mareti & Hadiyanti, 2021).

To improve Grade X students' engagement in Biology learning, PBL was implemented. Prior studies have demonstrated that implementing a problem-based learning model can significantly enhance student participation during instruction. For example, improvements were observed in indicators of cooperation and social relations, reaching a maximum score of 83.3% (Kartikasari et al., 2023). In addition, a study in class X-12 at SMAN 15 Surabaya found that PBL was effective in fostering student activeness in Biology learning (Abdul Rochim, 2024). These findings suggest that PBL effectively facilitates increased student engagement in Biology instruction and represents a viable approach to address challenges encountered in teaching and learning.

In this study, PBL was implemented to cultivate student activeness, enabling students to independently explore concepts in learning materials through their own lines of reasoning, which in turn would directly influence their conceptual understanding. This aligns with research indicating that PBL facilitates students' skill development and makes students more active during learning (Handayani & Koeswanti, 2021). PBL can also support authentic understanding because learning can be derived from students' daily lives (Putri & Fitri, 2022). This finding is consistent with previous work, which has shown that PBL encourages students to be actively involved in their learning (As'ad et al., 2024). Moreover, PBL has been reported to improve students' conceptual understanding and increase student activeness in Biology subjects (Ekasari, 2023; Kurniawan et al., 2020). Therefore, research implementing PBL to support deeper understanding and active engagement on the topic of environmental change had not yet been conducted in senior high schools in Pamekasan Regency. This study is expected to contribute to improving conceptual understanding and activeness among Grade X students through innovative PBL-based Biology learning.

Research Method

This study was conducted from 10 April to 22 May 2025 at SMAN 3 Pamekasan in the 2024/2025 academic year. The research employed Classroom Action Research (CAR), a practical approach focused on improving the quality of classroom instruction (Rosalina, 2023). The study consisted of two cycles comprising four stages: planning, implementation, observation, and reflection (see Figure 1) (D. Harahap et al., 2024).

Data on conceptual understanding were collected using an essay-based written test, while student activeness data were gathered through observations conducted before and after learning, as part of the data collection process. The data included pretest and posttest scores as well as observed student activities recorded on observation sheets during PBL-based instruction. The participants were students from Class X-J at State Senior High School 3, Pamekasan. The PBL syntax is presented in Table 1.

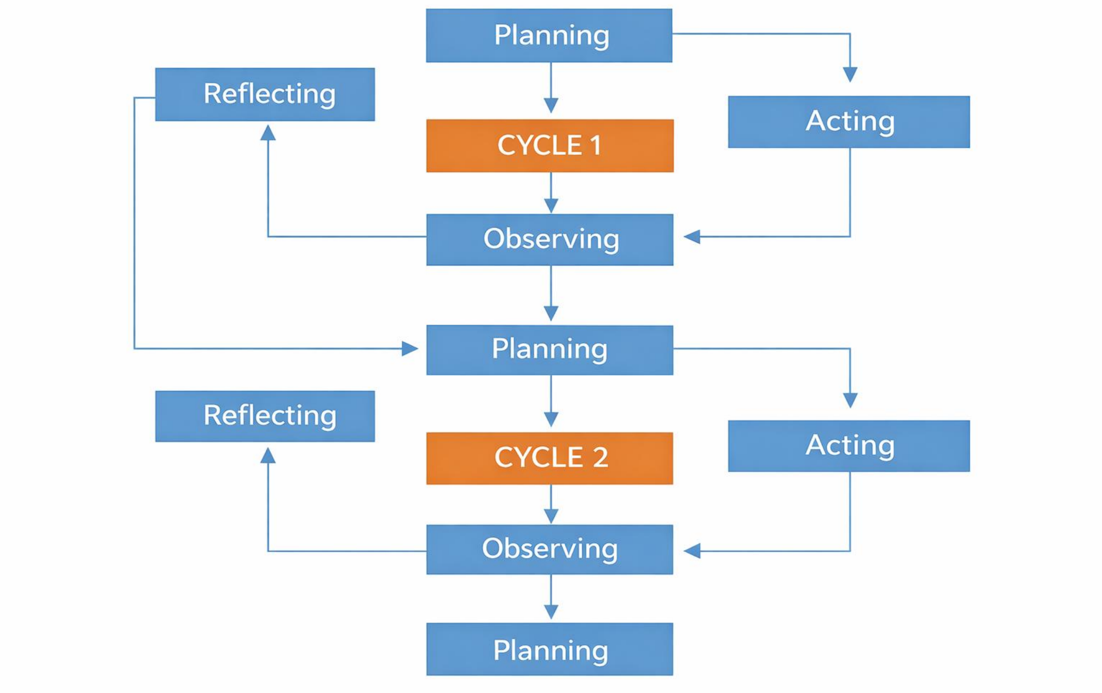

Figure 1. CAR activity cycle (Harahap, 2021)

Table 1. PBL Syntax

Stage	Syntax	Learning Activities
1	Orienting students to a real-world problem	The teacher explains the learning objectives and presents a problem for students to explore.
2	Organizing students for learning	The teacher facilitates the formation of student groups to support collaborative learning.
3	Guiding investigation	The teacher provides guidance and assistance while students investigate to address the presented problem.
4	Developing and presenting students' findings	The teacher supports students in developing their products and encourages them to present their findings.
5	Critically reviewing and evaluating the methods used during the problem-solving process.	The teacher directs students to analyze and evaluate the strategies and processes they used to solve the problem.

Source: Corebima (2009).

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The data were analyzed using two approaches: quantitative and qualitative. The quantitative approach was used to determine students' conceptual understanding through tests administered during the learning process by comparing results between Cycle I and Cycle II to assess improvements in Biology conceptual understanding after PBL implementation. Meanwhile, qualitative analysis was employed to describe the classroom learning processes in accordance with the PBL framework (Harahap et al., 2021). This approach was used to present data systematically based on the results obtained, without the intention of drawing general conclusions (Sugiyono, 2013, as cited in Arningsih Nainggolan et al., 2023). The school's minimum mastery criterion was 75. To determine conceptual understanding scores and evaluate individual learning activeness, the study used the formula shown in the original manuscript (commonly expressed as: Score (%) = (obtained score / maximum score) × 100). The following standards were used to evaluate student activity:

Table 2. Student Activity Assessment Categories

Assessment Category	Symbol	Score
Less active	K	1
Moderately active	C	2
Very active	B	3

Source: Aqib (2016).

Data on students' conceptual understanding were obtained through evaluations conducted at the end of each learning cycle using questions developed based on indicators of concept mastery in Biology (see Table 3).

Table 3. Indicators of Students' Conceptual Understanding Ability

Percentage	Conceptual Understanding Qualification
$66.67\% \leq p \leq 100\%$	High
$33.33\% \leq p < 66.67\%$	Moderate
$0\% \leq p < 33.33\%$	Low

Source: Mawaddah (2016).

Student activeness data were obtained from observation results conducted during the learning process. The activity data were analyzed by calculating the average observation score to determine the category of student involvement during learning, based on the score ranges, aspects, and indicators presented in Table 4, so that the level of student participation could be clearly identified.

Table 4. Aspects and Indicators of Student Learning Activeness

Aspect	Indicator
Learning activities	A. Student attention B. Willingness to express opinions C. Respecting others' opinions D. Task completion E. Willingness to answer

Source: Dimyati (2009).

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Table 5. Scoring Rubric

Option	Score
Often	1
Sometimes	2
Rarely	3
Never	4

Source: Sasmita et al. (2023).

Under this assessment procedure, the observer completes the student activity observation sheet based on observations of the student's involvement during the learning process, referring to the indicators listed in the instrument. Each indicator is scored according to the frequency or intensity of the observed behavior. Student activeness in each Cycle is calculated as a percentage and then compared to identify increases or decreases in learning activity from one Cycle to the next. The total activeness percentage is then interpreted to determine whether activeness is categorized as poor, adequate, good, or very good according to the criteria below (Table 6).

Table 6. Activeness Criteria

Learning activeness percentage	Criteria
80–100%	Very good
66–79%	Good
56–65%	Adequate
< 55%	Poor

Research Findings and Discussion

The observation results for Grade X students at SMAN 3 Pamekasan during learning using the PBL model are presented in Table 7.

Table 7. Observation Results of Student Activity

Cycle	Mean Score	Criterion	Description
1	86.33	2	Moderately active
2	92.39	3	Active

Student activity increased from Cycle I to Cycle II, as indicated by higher student involvement during discussions and problem-solving. In Cycle I, students still required guidance in applying the PBL approach, whereas in Cycle II, they were more independent and active throughout the lessons. The PBL implementation was also shown to encourage students to learn independently while collaborating effectively.

The data from Cycles I and II indicate a meaningful improvement in students' conceptual understanding. In Cycle I, the mean concept mastery score reached 86.33 and increased to 92.39 in Cycle II, representing a 6.6% increase. These results indicate that implementing PBL had a positive impact on students' depth of conceptual understanding. In addition, this approach enabled students to apply their knowledge to solve problems related to real-life situations.

Beyond the increase in mean scores, overall mastery learning achievement also improved substantially. In Cycle I, 86.1% of students met the mastery criterion, with seven students categorized as excellent and 24 students categorized as good. In Cycle II, all 36 students achieved mastery learning with results classified as excellent. This finding indicates that PBL is highly effective in strengthening overall concept mastery. The approach also increased students' active engagement during learning and helped them connect the material to real-world problems in daily life.

The improvement in Biology conceptual understanding in this study can be linked to several factors. PBL provides opportunities for students to learn concepts through meaningful contexts, so they do not merely receive information unidirectionally but are actively involved in problem solving. Group discussions and collaboration enable students to clarify their understanding, exchange ideas, and reinforce the material they have studied. Continuous learning processes also supported improvements in understanding, as reflected in the substantial difference between Cycle I and Cycle II.

Overall, the findings indicate that the problem-based learning (PBL) model has a positive impact on strengthening students' conceptual understanding in Biology. With mastery learning approaching 100% in Cycle II and a mean score of 92.39, the implemented learning model helped students effectively master the concepts studied. Improvements in mean scores and active participation suggest that PBL can be used as a strategy to strengthen Biology concept mastery while enhancing students' critical thinking skills.

Findings regarding students' activeness during the learning process in Grade X at SMAN 3 Pamekasan are presented in Table 8.

Table 8. Student Activeness Percentage Results in Cycle I

No.	Category	Number of students	Percentage
1	Very active	19	53%
2	Active	6	11%
3	Less active	11	36%

Table 8 shows student activeness categories in Cycle I, indicating that 52% of students were categorized as very active, 11% as active, and 36% as less active. These data indicate that student involvement increased, but it has not yet met the predetermined success indicator. Based on observations, student activity patterns in Grade X at SMAN 3 Pamekasan in Cycle II are presented in Table 9.

Table 9. Student Activeness Percentage Results in Cycle II

No.	Category	Number of students	Percentage
1	Very active	26	72%
2	Active	7	19%
3	Less active	3	8%

Based on Table 9, 72% of students were categorized as very active, 19% as active, and 8% as less active. In Cycle II, student activity showed a positive change and was satisfactory. This achievement met the target expectation for student activeness, namely, more than 91%. Based on the observation results and analysis of student activeness, a graph was generated (presented in Figure 3).

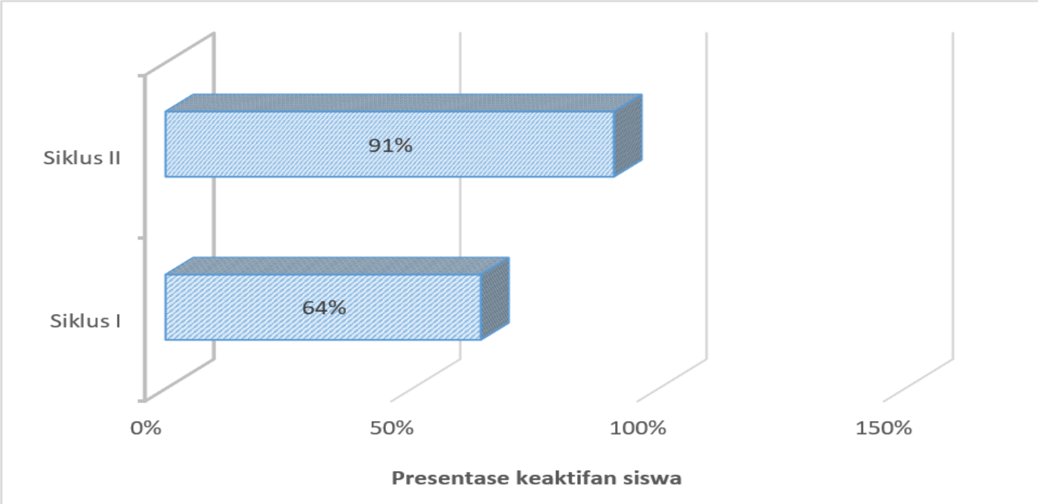

Figure 3. Student activity development

Based on the chart in Figure 3, observation and data analysis indicate that in Cycle I, student activeness was 64%, placing it in the "adequate" category. In Cycle II, the activeness percentage increased to 91%, which falls into the "very good" category. The comparison between the two cycles reveals a 27% increase. Student activeness in both cycles was calculated based on observations of five activity aspects formulated as indicators.

In Cycle I, the percentage of student involvement in learning activities reached 64% and was classified as adequate. The minimum success threshold for the activeness indicator was set at 70%. Student activeness in Cycle I had not met the target; therefore, the study continued to Cycle II. In this subsequent Cycle, activeness increased to 91% and was categorized as very good, exceeding the 70% minimum success threshold.

Several factors supported achieving the activeness success indicator, including question-and-answer sessions that increased student participation in responding to questions. In addition, structured and well-managed discussions contributed to a conducive classroom atmosphere in which students actively engaged in discussions based on the provided Student Worksheets (Lembar Kerja Peserta Didik; LKPD). This condition encouraged increased student activity in expressing opinions, both in group discussions and during class presentations. These results are consistent with previous findings, which show that appropriate instructional methods—such as active learning supported by LKPD—can increase students' curiosity. LKPD typically involves problems that must be analyzed and solved collaboratively, thereby motivating students to seek information and feel challenged during the learning process (Sasmita et al., 2023). Through the use of LKPD, students become more active and understand the flow of learning activities; accordingly, LKPD-based PBL has been shown to improve students' conceptual understanding (Afridiani et al., 2020). Other studies have also reported that integrating LKPD within PBL can significantly develop students' thinking skills (Khovivah et al., 2022).

Conclusion

The implementation of the Problem-Based Learning (PBL) model was effective in improving conceptual understanding and student activeness on the topic of environmental change. This was confirmed by the increase in the mean conceptual understanding score to

92.39 in Cycle II, indicating that nearly all students achieved mastery learning. In addition, student activeness increased significantly, reaching 91%, which was classified as very good.

Recommendations

Problem-based learning is important for teachers to enhance students' skills, activity, and understanding because it offers learning that directly engages with real events. Given its substantial benefits for students, it is recommended that this model continue to be used—particularly in Biology learning—because it can contribute to the curriculum and to 21st-century learning demands. Additionally, teacher training is necessary to implement interactive and innovative learning methods, thereby preventing student boredom. Support from parents and community leaders is also necessary to support every child's education, ensuring that each child is motivated and can participate more easily in each learning activity.

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