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The Effect of Implementing the *Problem Based Learning* Model on Student Learning Outcomes at SMA Negeri 13 Semarang on the Topic of Environmental Changes

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Abstract

The quality of education is greatly influenced by innovations in the learning process. Teacher-centered learning models often cause students to be passive and lose motivation, thus requiring models that actively involve students. This study aims to analyze the effect of implementing the Problem Based Learning (PBL) model on student learning outcomes, particularly in the cognitive, affective, and psychomotor aspects, on the topic of Environmental Changes at SMA Negeri 13 Semarang. This study uses a quasi-experimental method with a nonequivalent pretest-posttest design involving two classes: the experimental class used the PBL model, while the control class used a conventional model. Learning outcome data were collected through tests, observations, and interviews, then analyzed quantitatively and descriptively. The results show a significant improvement in the learning outcomes of students in the experimental class compared to the control class, in cognitive, affective, and psychomotor aspects. The conclusion of this study is that the implementation of the PBL model affects student learning outcomes on the topic of environmental changes. This is supported by hypothesis testing, including t-tests, n-gain tests, classical learning completeness tests, and analysis of learning outcomes in affective and psychomotor aspects. The contribution of this research to science is providing empirical evidence on the effectiveness of the PBL model in learning, as well as offering innovative solutions to improve student learning outcomes comprehensively.

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INTRODUCTION

The quality of education is very important for a country. Education is one of the main capitals in development to improve the quality of human resources in the country. One of the educational institutions is the school. Schools must be capable of carrying out the processes of transformation, education, and socialization. In this context, transformation means that schools must be able to serve as places for students to develop better and more advanced behavior; education means that schools must be places where the teaching and learning process takes place for educators and students; and socialization means that schools must be places where students learn to interact with others and socialize. In accordance with the Indonesian Law No. 20 of 2003 concerning the National Education System, Article 1, Paragraph (20), "Learning is the process of interaction between learners and educators and learning resources in a learning environment." The quality of education is influenced by several factors, namely the quality of educators, curriculum, staff, facilities and infrastructure, and learning resources.

Educators play an important role in improving the quality of learning. Educators must be able to enhance the quality of education because they are the key figures who directly interact with students. According to Purba (2022), in the Merdeka Curriculum, educators act as facilitators based on professional, pedagogical, personality, and social competencies. One of the abilities that educators must master is the capability to apply appropriate, active, and effective learning models. The quality of educators can be seen from how innovative the learning they conduct with students is. According to Sani (2022), a great teacher is one who produces creative students through innovative and creative learning. Innovative learning tends to make students enthusiastic about the learning process. The role and quality of educators are the keys to achieving satisfactory student learning outcomes.

Innovative educators as facilitators are expected to implement an appropriate learning process. The first step that educators can take to create innovative learning is to shift the perspective from teacher-centered learning to student-centered learning. This aligns with the statement by Jayawardana & Gita (2020), that good quality education occurs when the learning process is student-centered rather than teacher-centered, because in the latter, students tend to be passive, bored, and lose motivation to learn. The implementation of this method will make students more active in learning and more motivated.

The learning model implemented by educators will influence students' learning achievement. According to Dakhi (2020), learning outcomes are achievements attained by students academically through assignments and exams, as well as students' activeness in asking questions to the teacher and answering questions from the teacher to support students in achieving these learning outcomes. Based on interviews conducted by the researcher with a biology teacher at SMA Negeri 13 Semarang on March 14, 2024, it was found that in biology lessons, the PBL (Problem-Based Learning) model has been implemented, but not in all classes. This is because each class has different student characteristics, so teachers must adjust to the conditions of each class. In classes where the PBL model was not applied, teachers still used the conventional model with the lecture method. In these classes, there were some students who fell asleep or engaged in activities unrelated to the lesson. This resulted in students in those classes having learning outcomes categorized as poor.

One of the factors that influence students' learning outcomes is the learning model applied by educators during the learning process. The learning model implemented by educators will affect the students' learning achievements. According to Alwinda & Wiguna (2022), selecting an appropriate learning model is an important aspect of the teaching and learning process. In line with the statement by Sari et al (2019), the conventional model using the lecture method causes students to have less interest in taking notes, resulting in poor understanding of the material delivered. As teachers, it is essential to be able to apply a learning model that encourages students to be active and think critically for better understanding of biology, by relating students' comprehension to everyday life (contextual). One solution that teachers can implement is by applying the Problem-Based Learning (PBL) model.

According to Hotimah (2020), PBL is a learning model that encourages students to solve real problems and find solutions by working in groups. The syntax of PBL according to Arends (2012) includes: orienting the problem to the students, organizing students for learning, guiding individual or group investigations, developing and presenting the results, and analyzing and evaluating the problem-solving outcomes. Educators who implement the PBL learning model are expected to be able to improve students' learning outcomes on the material delivered. The PBL model has several advantages, including training students to always think critically and be skilled in solving problems, stimulating student activity through learning by doing, and making the learning process effective and conducive because students are required to be actively involved in the learning process. However, this model also has some drawbacks, such as not all materials being suitable for PBL, the time required to complete the learning process being relatively long, difficulties for teachers in managing task distribution when there are too many students in the class, and if

students are not accustomed to analyzing problems, they may lack the motivation to complete the tasks (Magdalena et al., 2024).

In line with the research conducted by Dewi et al (2019), the implementation of PBL on the topic of environmental pollution can increase students' activity in learning biology in terms of affective aspects (attitude) and psychomotor aspects (skills), as well as improve cognitive aspects, namely the learning outcomes of students in class X MIPA 3 at SMA Negeri 1 Jatisrono. Another study by Mardiyanti (2020) found that the application of PBL on the topic of environmental change significantly improved students' critical thinking skills in class X MIPA 2 at SMA Negeri 1 Mataram. Additionally, research by Lonita & Simatupang (2020) showed that the implementation of the PBL model had a positive and significant effect on students' ability to solve biology problems related to environmental pollution in class X MIA 7 at SMA Negeri 13 Medan. Based on the issues above, this study aims to analyze the effect of applying the PBL model on learning outcomes in the cognitive, affective, and psychomotor aspects, particularly on the topic of Environmental Change.

RESEARCH METHOD

This research was conducted at SMA N 13 Semarang, located at Jl. Rowosemanding, Wonolopo Village, Mijen District, Semarang City. This study uses a quasi-experimental research design. The research was carried out from February 19 to February 26 during the even semester of the 2024/2025 academic year. The research design employed is the Nonequivalent Pretest-Posttest Design. According to Rukminingsih et al (2020), the Nonequivalent Pretest-Posttest Design involves administering a pretest to each class, then applying treatment to the experimental class, followed by a posttest to each class. The population in this study consists of all tenth-grade students or phase E at SMA N 13 Semarang, ranging from X-E1 to X-E8. The sampling technique used is purposive sampling. The sample consists of 2 classes, namely X-E4 and X-E7, with each class having 32 students.

This study was conducted on two classes, namely class X-E4 as the control class and class X-E7 as the experimental class. The experimental class was given treatment by applying the PBL model, while the control class used the conventional model. The research procedure in the experimental class refers to the syntax of Arends (2012), whereas the control class follows the syntax of the conventional model by Purnomo et al (2022), which includes: the teacher administering a pretest, presenting the learning objectives, delivering information about the Environmental Change material to students step by step using the lecture method, checking students' understanding and providing feedback by distributing Environmental Change worksheets (LKPD) for students to work on, giving opportunities for further practice by assigning homework, and finally administering a posttest. In the experimental class, students were given worksheets and problem-based questions related to real-life issues around them. The control class used a conventional learning model implemented by the teacher. The teaching material in the first meeting focused on environmental change. Before the learning process, both the control and experimental classes were given a pretest to measure students' initial knowledge. Learning was then conducted according to the syntax of each applied model. After the learning process was completed, both classes were given a posttest to measure students' final knowledge of the environmental change material. Data were collected through tests (pretest and posttest), observations, documentation, and interviews. The data analysis employed quantitative descriptive and inferential methods. Prerequisite tests included normality and homogeneity tests, while hypothesis testing consisted of t-tests, N-gain analysis, classical learning completeness tests, and analyses of affective and psychomotor learning outcomes.

1. T-test

   The t-test used in this study is the independent sample t-test. This test aims to determine the difference between two means originating from the same population. The formula for the t-test used for independent samples is:

$$t = \frac{\overline{X_1} - \overline{X_2}}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}}$$

(Widiyanto, 2013)

Information :

t = t coefficient

X_1 = Mean of sample distribution 1

X_2 = Mean of sample distribution 2

S_1 = Standard deviation of sample distribution 1
S_2 = Standard deviation of sample distribution 2
n_1 = Number of data in sample 1
n_2 = Number of data in sample 2

2. N-gain test

The normalized gain test (n-gain) is conducted to determine the improvement in students' cognitive learning outcomes after being given treatment. The increase in students' cognitive learning outcomes is derived from the pretest and posttest scores. The calculation of the n-gain score can be determined using the following formula:

$$N - Gain = \frac{(x_2) - (x_1)}{(maximum\ score) - (x_1)}$$

Information :
x_2 = Average pretest score
x_1 = Average posttest score

The normalized N-Gain score levels are grouped in Table 1.

Table 1. *n-gain* (Meltzer & David, 2002)

N-Gain	***Interpretasi***
g > 0,70	High
0,70 < *g* < 0,30	Medium
g < 0,30	Low

3. Classical Completeness Test

The classical completeness test used in this study aims to determine the completeness of students' learning outcomes after the learning process takes place. Students' learning completeness can be seen from the scores or grades obtained during the pretest and posttest. The completeness criterion applied at SMA N 13 Semarang is a score of ≥ 75, which is considered complete. The classical completeness applied at SMA N 13 Semarang states that if the number of students who achieve completeness is more than 85%, then it is categorized as successful.

4. Affective Learning Outcome Analysis

The affective learning outcome analysis is used to determine the attitude scores or values obtained in each class. The affective learning outcome data is obtained through observation conducted by the researcher while students are engaged in discussions. The observation of students' attitudes during group discussions in problem-solving is aligned with the P5 element (Project to Strengthen the Profile of Pancasila Students).

5. Psychomotor Learning Outcome Analysis

The psychomotor learning outcome analysis is used to determine the skills scores or values obtained in each class. The psychomotor learning outcome data is obtained through observation conducted by the researcher when students present the results of their discussions.

The data from the analysis of affective and psychomotor learning outcomes can be adjusted according to the criteria in Table 2.

Table 2. Criteria for student learning outcomes (Ainun et al., 2025).

Percentage	Student Learning Outcome Criteria
90-100	Very good
80-89	Good
65-79	Moderate
55-64	Low
<54	Very low

RESULTS AND DISCUSSION

RESULTS

The description of the research data will present the data on student learning outcomes (cognitive, affective, and psychomotor) of Grade X (Phase E) students at SMA Negeri 13 Semarang. This research was conducted over two meetings in each class for the Biology subject on the topic of Environmental Changes. The implementation of this research obtained data from pretest and posttest results as the cognitive learning outcomes of students, which were conducted in both the experimental and control classes. Meanwhile, data on affective and psychomotor learning outcomes were obtained through observations made by the researcher during the learning process. The pretest is a test that measures students' abilities before the treatment is given, while the posttest measures students' abilities after the treatment. Both tests serve to measure or assess the effectiveness of the implementation of the PBL model. The following are the research results obtained by the researcher.

Before conducting the t-test, prerequisite tests (normality and homogeneity tests) were performed. The normality test in this study used the Shapiro-Wilk test due to the small sample size. Normality tests were conducted on four data groups: pretest and posttest results from both control and experimental classes. All groups showed results >0.05, indicating normally distributed data. The homogeneity test results also showed >0.05, meaning the variances between two or more groups were equal (homogeneous). After completing these prerequisite tests, subsequent analyses were conducted including the t-test, n-gain test, and classical completeness test, as detailed in Table 3, Table 4, and Figure 1.

1. T-test

Table 3. T-test

Class	Score & Mean	t	df	Sig. (2-tailed)
Control Class	*Pretest* (63,82) *Posttest* (70,54)	9,27	62	0,000
Experimental Class	*Pretest* (72,34) *Posttest* (82,73)	9,27	61,76	0,000

Based on Table 3, the t-test results for the control and experimental classes show that the significance values for both classes are <0.05. This indicates a statistically significant difference between pretest and posttest scores in both groups.

2. N-gain Test

Table 4. N-gain Test

Kel.	Score & Mean	Mean Difference	N-gain	N-Gain Criteria
Control Class	*Pretest* (63,82) *Posttest* (70,54)	6,72	0,1881	Low
Experimental Class	*Pretest* (72,34) *Posttest* (82,73)	10,39	0,3856	Medium

Based on Table 4, the n-gain test results for the control and experimental classes show that the n-gain value obtained in the control class is 0.1881, which falls into the low category, while in the experimental class it is 0.3856, which falls into the moderate category.

3. Classical Completeness Test

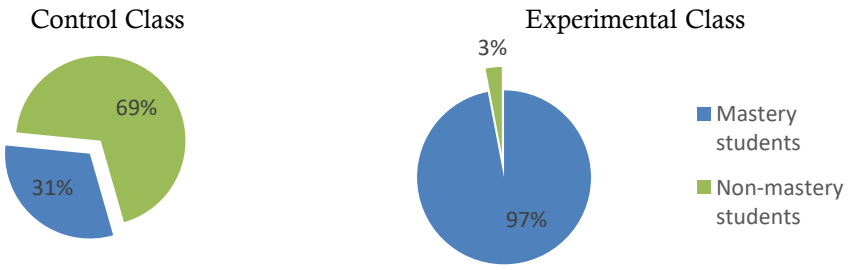

Figure 1. Classical Completeness Test

Based on Figure 1, the classical completeness test shows that the control class achieved 31%, while

the experimental class achieved 97%. This indicates that the experimental class falls into the successful category.

4. Analysis of Affective Learning Outcomes

The average scores of affective learning outcomes are listed in Table 5, and the affective learning outcomes by element are shown in Figure 2.

Table 5. Analysis of Affective Learning Outcomes

Class	Average score	Description
Control class	51%	Low
Experimental class	68%	Moderate

Based on Table 5, the affective learning outcomes of students in the control class reached 51%, which falls into the low category, while the experimental class achieved 68%, which is categorized as moderate.

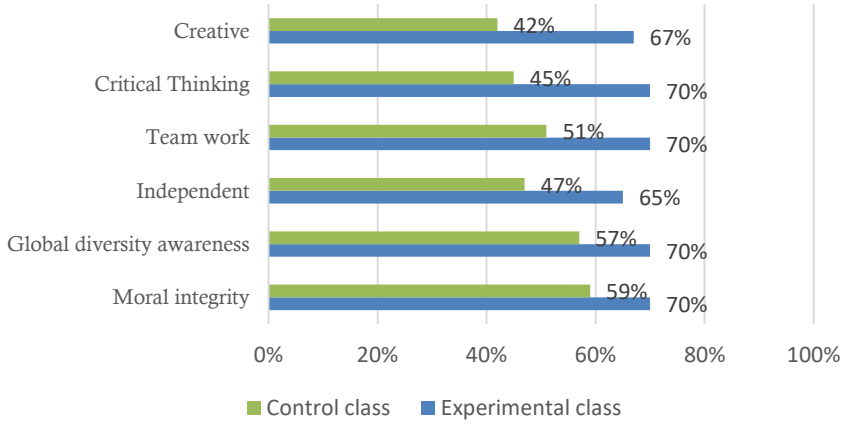

Figure 2. Affective Learning Outcomes (by Aspect)

Based on Figure 2, the highest affective learning outcome score in the control class was found in the noble character element, at 59%, while the lowest score was in the creative aspect, at 42%. In the experimental class, the highest scores were found in five aspects simultaneously: critical thinking, cooperation, independence, global diversity, and noble character, all at 70%, while the lowest score was in the independence aspect, at 65%.

5. Analysis of Psychomotor Learning Outcomes

The average scores of psychomotor learning outcomes are listed in Table 6, and the psychomotor learning outcomes by indicator are shown in Figure 3.

Table 6. Analysis of Psychomotor Learning Outcomes

Class	Percentage	Description
Control class	75%	Moderate
Experimental class	92%	Very good

Based on Table 6, the psychomotor learning outcomes of students in the control class reached 75%, which falls into the moderate category, while the experimental class achieved 92%, which is categorized as very good. The psychomotor learning outcomes by aspect will be shown in Figure 3.

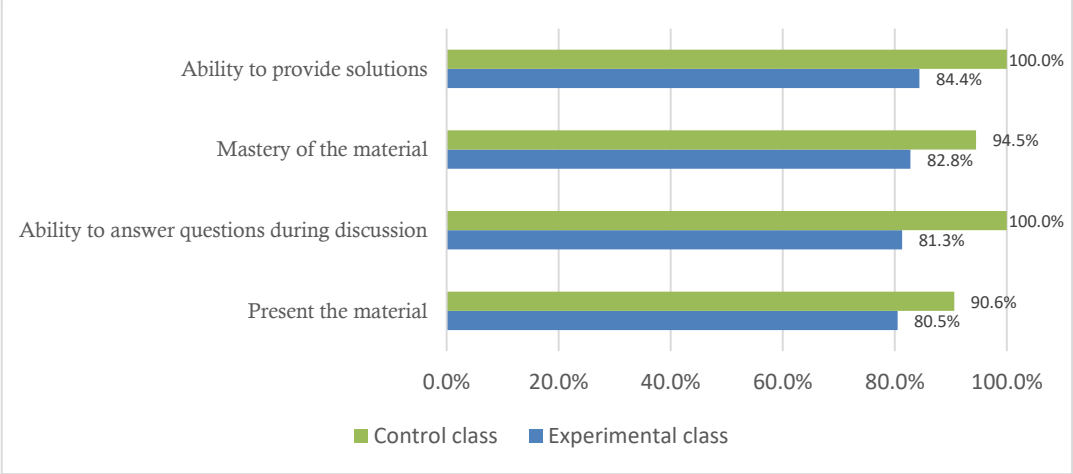

Figure 3. Psychomotor Learning Outcomes (by Aspect)

Based on Figure 3, the highest psychomotor learning outcome scores in the control class were found in the indicators of the ability to provide solutions and the ability to answer questions during discussions, both at 100%, while the lowest score was in the indicator of the ability to deliver material, at 90.6%. In the experimental class, the highest score was in the indicator of the ability to provide solutions, at 84.4%, while the lowest score was in the indicator of the ability to deliver material, at 80.5%.

DISCUSSION

The research results show that the implementation of the Problem-Based Learning (PBL) model is able to improve and have a significant impact on students' learning outcomes in the cognitive, affective, and psychomotor aspects on the topic of environmental changes. The improvement is evidenced by the pretest and posttest results, which show a significant difference in scores between the experimental class and the control class. The n-gain test results conclude that the average score in the experimental class is higher than that of the control class. This indicates that the PBL model applied in the experimental class can enhance students' cognitive learning outcomes more effectively than the conventional model used in the control class. Therefore, it can be concluded that the implementation of the PBL model has a more effective influence on cognitive learning outcomes.

The improvement in cognitive learning outcomes aligns with the characteristics of the PBL model, which emphasizes the process of solving real problems provided by the researcher. Students actively engage in the learning process by examining, analyzing, and determining solutions to these real problems. This is consistent with Emor et al (2024), who stated that activities in this learning encourage students to connect the problems in the questions and worksheets (LKPD) with issues in everyday life. The implementation of the PBL model in learning enhances students' competence in critical thinking and effectively improves their cognitive learning outcomes. Other research by Juliyanti & Nopriyeni (2023) found that the PBL model has a significant effect on the cognitive learning outcomes of high school biology students, evidenced by higher average scores in the experimental class using PBL compared to the control class using conventional methods. This aligns with Djonomiarjo (2019), who reported that the application of the PBL model significantly improved cognitive learning outcomes compared to the conventional model in the control class. Research by Paradina et al (2019) also demonstrated that the PBL model applied in the experimental class increased students' learning outcomes more than the conventional model used in the control class. The implementation of the PBL model has been proven to improve students' learning outcomes in the cognitive, affective, and psychomotor domains (Agustina et al., 2025).

The results of the classical learning completeness test in the experimental class using the PBL model were more effective in improving learning outcomes by helping students achieve the Learning Achievement Criteria (KKTP). Based on the results of this classical completeness test, it was categorized as successful because it reached 97% completeness of the total students, exceeding the standard set by the school. The PBL model provides opportunities for students to explore concepts through collaborative activities and group discussions, allowing them to freely express their opinions. This aligns with the statement by Souwakil et al (2024) that the PBL model in biology significantly increases classical learning completeness.

The implementation of the PBL model in the experimental class has been proven to improve students' affective learning outcomes, with an average score of 68%, compared to the control class using the

conventional model. The PBL model plays an important role in fostering positive attitudes in students during the learning process and in their discussion behavior. During the learning activities, students are able to collaborate and discuss in groups to solve real problems related to environmental changes around them. The PBL model allows students to practice empathy, responsibility, cooperation, and openness to various perspectives. The assessment of affective learning outcomes is aligned with the P5 elements (Strengthening the Profile of Pancasila Students), which include noble character, mutual cooperation, critical thinking, independence, creativity, and global diversity. Each element contains several attitude indicators. For example, in the noble character element, students are expected to use polite language, avoid interrupting friends during discussions, and accept criticism and suggestions graciously. In the global diversity element, students respect differing opinions, avoid language that offends diversity such as religion, ethnicity, and culture, and remain open to other viewpoints during discussions. The independence element involves students reading and completing the Environmental Change worksheets according to group discussions, not relying on friends to finish tasks, and taking responsibility for assigned group work. In the mutual cooperation element, students help friends facing difficulties during discussions, actively listen and respond to opinions, and fulfill their roles within the group properly. The critical thinking element encourages students to ask in-depth questions related to the problems discussed, provide logical arguments based on facts, and analyze the strengths and weaknesses of proposed solutions. Lastly, the creativity element motivates students to propose innovative ideas, express opinions in unique and engaging ways, and develop alternative solutions that had not been previously considered.

The implementation of the PBL model can improve students' attitudes in the noble character element because students tend to discuss with their group members and enhance their social awareness. This aligns with the statement by Muliana et al (2024) that the application of the PBL model fosters mutual respect and students' social skills. This statement is related to the increased student attitudes in the global diversity element. The PBL model encourages students to be tolerant and accepting when sharing opinions during discussions. The discussions conducted by students stimulate group members to be open to each other's perspectives. The PBL model is effective in developing students' tolerance character (Kurnia & Mukhlis, 2023).

In the independence element, students are encouraged to collaborate responsibly in completing the Environmental Change worksheets. Group cooperation makes the learning process more student-centered. This aligns with the research conducted by Murdani et al (2022), which found that the PBL model increases students' learning motivation by promoting a learning process that is more focused on students, contextual, engaging, and effective. As a result, students become more active in asking and answering questions related to the subject matter being studied.

The problem-solving activities in the Environmental Change worksheets support students' collaborative attitudes. Group discussions encourage students to work together to find solutions to problems. This aligns with the mutual cooperation element, which shows improvement in students' affective learning outcomes. Fitri et al (2023) similarly stated that the implementation of the PBL model effectively enhances the spirit of mutual cooperation, marked by increased collaboration, care, and sharing of solutions in problem-solving. According to Asmiyunda & Hardeli (2023), besides improving students' collaborative attitudes, the PBL model also corrects misconceptions and stimulates higher-order thinking. This is evident from students' behavior during group discussions, which fosters a sense of responsibility, helps solve problems in the Environmental Change worksheets, and achieves solutions together.

The critical thinking element has been proven to improve through the implementation of the PBL model. The PBL model significantly enhances students' critical thinking skills. This occurs because, in the PBL approach, students are faced with various problems that are relevant and directly related to their daily lives. Research conducted by Nurbayti et al (2025) supports this view, stating that the PBL model improves students' critical thinking by focusing them on identifying problems and creating solutions. Students do not merely receive information passively but are actively encouraged to analyze, explore information, and critically evaluate all learning materials related to real-world problems. According to Ilmi & Lagiono (2019), this process encourages students to think more critically, creatively, and independently in seeking solutions, thereby optimally developing their critical thinking abilities. Lutfiah et al (2021) argue that the PBL model motivates students to actively construct their knowledge by searching for various information to solve the problems they face. Supported by Hartati & Hong (2024), the PBL model also significantly improves critical thinking skills and facilitates active engagement and collaborative attitudes among students. With this active involvement, the knowledge gained becomes more meaningful and easier to remember. This supports students in understanding and retaining the learning material, so when given a posttest, they can answer questions more easily and effectively.

The PBL model provides opportunities for students to explore various approaches to solving the

problems they face. With these opportunities, students are encouraged to think creatively and produce innovative solutions. This aligns with the improvement in affective learning outcomes in the P5 element of creativity. Diverse problems and exchanging opinions stimulate students to creatively seek solutions. The PBL model offers space for students to express opinions, innovate, and develop creative thinking in solving problems studied within a real-world context (Handayani et al., 2025).

Psychomotor learning outcomes are reviewed by aspect, namely the ability to deliver material, answer questions during discussions, mastery of the material, and provide solutions to problems. According to the assessment instrument for students' presentation skills of discussion results, there are several indicators: the ability to deliver material, the ability to answer questions during discussions, mastery of the material, and the ability to provide solutions. In the indicator of the ability to deliver material, the sub-indicators include loud volume, clear pronunciation, clear voice intonation, and the voices of all group members being audible in the classroom. For the indicator of the ability to answer questions during discussions, the sub-indicators are the ability to answer with logical reasons, accept input from others well, politely remind when questions are off-topic, and respond using language that is not offensive. In the indicator of mastery of the material, the sub-indicators include the ability to relate results to supporting theories, the ability to present arguments, the ability to correctly summarize the material, and answer the problem's objectives. For the indicator of the ability to provide solutions, the sub-indicators are that the solutions given correspond to the problem, the solutions achieve the problem's objectives, and the solutions provided are logical.

The implementation of the PBL model in the experimental class has been proven to improve students' psychomotor learning outcomes, with an average score of 92%, compared to the control class using the conventional model. Psychomotor analysis shows that the experimental class outperformed the control class in every aspect. In the experimental class, students were given the opportunity to present their discussion results using PowerPoint media created collaboratively in groups. This stimulated an increase in students' psychomotor learning outcomes. This aligns with the research by Harahap et al (2025), which found that the implementation of the PBL model using PowerPoint significantly improves critical thinking skills, conceptual understanding, and memory retention. The use of PowerPoint allows students to obtain a clear visual representation of the concepts being studied, thereby enhancing understanding and long-term retention of the material. This supports the improvement in students' skills in delivering material. Another study by Saragi & Dalimunthe (2022) also found that learning outcomes using the PBL model with PowerPoint were higher than those using the conventional model.

The PBL model provides space for students to develop higher-order thinking skills, including expressing ideas, answering questions during discussions, and designing and presenting solutions to problems. Practical activities in the learning process have been proven to strengthen and enhance students' psychomotor skills, especially in presentations when solving problems. According to Emor et al (2024), the PBL model strongly supports the development of skills in expressing ideas and answering scientific questions within the context of biology learning. Strengthening the psychomotor aspect is very important to prepare students to face the challenges of the 21st century. This statement supports that the PBL model improves students' psychomotor outcomes, particularly in the indicator of the ability to answer questions during discussions.

The teaching model applied by the teacher greatly influences students' mastery of the material. The PBL model has been proven to significantly improve students' skills in mastering the material on environmental change. Students can easily grasp the material because this model presents content in the form of real problems around them, which stimulates critical thinking and enhances memory retention. This is supported by research conducted by Risna et al (2025), which found that the implementation of the PBL model has a very significant contribution to students' understanding of the material being studied, thereby improving learning outcomes. This aligns with research by Yulizar (2025), which states that the PBL model not only improves students' cognitive learning outcomes but is also effective in increasing students' motivation to learn the material.

The problems listed in the Environmental Change worksheets include local, national, and international issues. Problem-solving carried out by students will improve their psychomotor learning outcomes, particularly in the indicator of the ability to provide solutions. This is evidenced by discussions and exchanges of opinions among group members. Such discussions encourage students to seek solutions to the problems they are addressing. This aligns with research by Thesalonika (2024), which found that the PBL model enhances problem-solving skills, promotes active involvement in group learning, and improves students' presentation abilities. The PBL model can improve students' skills in problem-solving and encourage active participation in learning (Cahyana & Widodo, 2024).

CONCLUSION

Based on the research results, it can be concluded that the implementation of the PBL model has an

effect on students' cognitive, affective, and psychomotor learning outcomes in the environmental change material at SMA Negeri 13 Semarang. Therefore, the PBL model can be used as an effective alternative learning method for environmental change material as well as other subjects that require students to think critically and solve problems. Teachers can develop PBL models relevant to the context and other related materials to make learning more applicable. Thus, the PBL model can shape attitudes and skills that are important for students in the modern era.

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