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A Comparison of Problem-Based Learning and Inquiry Learning Models Using a Deep Learning Approach on the Topic of Environmental Change and Its Impact on Critical Thinking Skills

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Abstract
Critical thinking is the process of thinking clearly and logically when evaluating information. It involves using cognitive abilities to identify, analyse and evaluate information in order to solve problems and draw the right conclusions. This study aims to analyse the impact of implementing Problem-Based Learning (PBL) and Inquiry Learning models alongside a deep learning approach on critical thinking skills in environmental studies. The research used a quasi-experimental design with a non-randomised control group pretest-posttest. The study's participants were 61 pupils selected through purposive sampling. Critical thinking skills were measured using an essay test based on the following six Ennis indicators: Focus, Reason, Inference, Situation, Clarity, and Overview. The data were analysed using One Way ANOVA. The results showed no significant difference in critical thinking skills ($F(1, 29) = 0.022$, $p = 0.883$, $\eta_p^2 = 0.001$). Therefore, it can be concluded that implementing the PBL and Inquiry Learning models with a deep learning approach has the same impact on students' critical thinking skills.

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1. INTRODUCTION

Critical thinking skills are one of the key competencies in 21st-century learning because they enable students to interpret information, assess the reliability of evidence, construct logical arguments, and make reflective decisions. This competency is not only related to academic ability but also to students' readiness to tackle real-world problems that are complex, open-ended, and require evidence-based problem-solving (Facione, 2011; Ariadila et al., 2023). In science education, critical thinking is essential because students are expected to understand phenomena, connect concepts with data, evaluate the causes of events, and draw scientifically sound conclusions (Ennis, 2011).

The topic of environmental change is a relevant area of biology for developing critical thinking skills because it is directly related to environmental issues in students' surroundings, such as pollution, changes in ecosystem quality, habitat destruction, and the impact of human activities on environmental balance. The nature of this subject requires students not only to memorize concepts but also to analyze cause-and-effect relationships, interpret information, compare various alternative solutions, and make decisions based on data and evidence. Therefore, instruction on environmental change must be designed through activities that encourage students to observe phenomena, ask questions, discuss, conduct investigations, and reflect deeply on their learning outcomes (Pursitasari et al., 2020; Antonio & Prudente, 2024).

Based on preliminary observations at Batanghari State High School 8, students' critical thinking skills, as assessed using the FRISCO indicators, have not yet developed optimally. Students still struggle to identify the focus of a problem, provide evidence-based reasoning, draw inferences, relate information to context, articulate explanations clearly, and thoroughly review their answers. This situation indicates that the learning process still requires strategies capable of facilitating students to actively engage in constructing knowledge, solving problems, and evaluating information independently. Thus, a learning model is needed that places greater emphasis on higher-order thinking activities, collaboration, and the use of evidence in the decision-making process.

One learning model suitable for developing critical thinking skills is Problem-Based Learning (PBL). PBL uses contextual problems as a starting point for learning, encouraging students to identify problems, formulate learning needs, seek relevant information, test alternative solutions, and present the results of their problem-solving. This process aligns with the characteristics of critical thinking because students are trained to analyze information, evaluate evidence, construct arguments, and reflect on the chosen solution (Hmelo-Silver et al., 2007). Several studies have also shown that PBL has the potential to improve critical thinking skills because it provides students with opportunities to learn through authentic problems, group discussions, and collaborative decision-making (Nastiti et al., 2021).

In addition to PBL, Inquiry-Based Learning is also relevant to science education because it positions students as discoverers of knowledge through the scientific inquiry process. This model involves activities such as formulating questions, developing tentative hypotheses, collecting and analyzing data, drawing conclusions, and communicating the results of the inquiry. These steps help students build conceptual understanding while developing critical thinking skills through the use of evidence and scientific reasoning (Yang et al., 2019). Inquiry-based learning can also increase student engagement because it does not rely solely on the teacher's explanations, but gives students the opportunity to explore phenomena, test information, and draw conclusions based on the results of their investigations (Ramdhayani et al., 2023).

The implementation of PBL and inquiry-based learning in this study was integrated with a deep learning approach. The deep learning approach emphasizes meaningful, reflective learning that is connected to real-life contexts, so that students do not merely memorize information but gain a deep understanding of concepts and are able to apply their knowledge to solve new problems (Marton & Saljo, 1976;Andayanie et al., 2025). Through this integration, learning is expected to foster a more active, conscious, and enjoyable learning experience, as students are engaged in the process of understanding problems, seeking evidence, constructing arguments, and reflecting on their learning outcomes.

Although PBL and Inquiry Learning have been extensively studied in relation to critical thinking skills, research comparing these two models with the deep learning approach in the context of environmental change still needs to be developed. This comparison is important for obtaining empirical information regarding learning models that teachers can use to develop students' critical thinking skills in the context of biology education. Based on this description, this study aims to analyze a comparison of the application of the Problem-Based Learning and Inquiry Learning models with the deep learning approach on students' critical thinking skills regarding environmental change material at State Senior High School 8 Batanghari.

2. RESEARCH METHODS

Research Type and Design

This study employs a quantitative approach using a quasi-experimental research design. The specific design used is a non-randomized control-group pretest–posttest design. This design was chosen because the research subjects were drawn from pre-existing classes, so the researcher did not randomly assign individual students to the treatment group. A quasi-experimental design is appropriate for educational research when full randomization is difficult to achieve, but the researcher still wishes to compare the effects of two different instructional treatments (Shadish et al., 2002).

This study involved two sample classes: an experimental class that implemented a Problem-Based Learning (PBL) model with a deep learning approach, and a control class that implemented an Inquiry Learning model with a deep learning approach. Both classes took a pretest before the intervention and a posttest after the intervention to assess the students' critical thinking skills.

Table 1. *Non-randomized Control-Group Pretest Posttest Design*

Class	*Pretest*	Treatment	*Posttest*
Experiment	A1	PBL with a deep learning approach	B1
Control	A2	Inquiry-Based Learning with a Deep Learning Approach	B2

Notes:
A1: Critical thinking skills pretest
A2: Critical thinking skills pretest
B1: Critical thinking skills posttest
B2: Critical thinking skills posttest

Population and Sample

The population in this study consists of all 10th-grade students at Batanghari State High School 8 during the second semester of the 2025/2026 academic year. The population comprises five classes with a total of 150 students, including 74 male students and 76 female students.

Table 2. Class Student Population X SMA Negeri 8 Batanghari

No	Kelas	Jumlah Murid	Total
1.	X1	31	
2.	X2	30	
3.	X3	30	150
4.	X4	31	
5.	X5	28	

The research sample was selected using purposive sampling, a technique in which the sample is selected based on specific criteria aligned with the research objectives. The sample selection criteria were based on the results of normality and homogeneity tests of students' daily test scores. The normality test was conducted using the Shapiro–Wilk test, while the homogeneity test was conducted using Levene's test. A class was deemed to meet the criteria if the significance level was greater than 0.05. Based on these results, Class X1 was designated as the experimental class and Class X2 as the control class.

Table 3. Research Sample

No.	Treatment	Class	Total
1.	Experiment	X1	31
2.	Control	X2	30

Research Procedures

This study began with 1) a preliminary study to obtain an overview of students' critical thinking skills; 2) observations to identify issues related to critical thinking skills; and 3) a literature review to gain an initial understanding of critical thinking skills and the theoretical basis for applying learning models. It consisted of three main stages: 1) the preparation stage, which involved preparing the teaching materials and instruments to be used; 2) the implementation stage, which involved applying the learning interventions in each class—specifically the Problem-Based Learning model based on Arens and the Inquiry Learning model based on [source], using a deep learning approach—as well as administering pretests and posttests to students to collect data on their critical thinking skills; and 3) the final stage, which involved analyzing and reporting the results.

Table 4. Research Procedure Problem Based Learning

Problem Based Learning	
Syntax	**Teacher Activities**
Step 1: Introduce students to the problem	The teacher explains the learning objectives and outlines the necessary supplies and materials, then encourages students to actively participate in problem-solving activities.
Step 2: Organizing students for learning	Teachers help students define and organize learning tasks related to the given problems.
Step 3: Guiding individual and group investigations	Teachers encourage students to seek out relevant information, conduct experiments, find explanations, and make decisions or come up with solutions as part of the problem-solving process.
Step 4: Developing and presenting the final project	Teachers help students plan and prepare their work, such as written reports, videos, or models, and prepare for presentations.
Step 5: Analyzing and evaluating the problem-solving process	The teacher guides students in reflecting on and evaluating the results of their investigation and the learning process they have undergone.

(Arends, 2015)

Table 5. Research Procedure Inquiry Learning

Inquiry Learning	
Syntax	**Kegiatan Guru**
Problem Orientation	Focus on sparking students' curiosity about the subject matter to be studied, such as by providing an introduction in the form of a phenomenon
Formulating the Problem	Guiding students in formulating problems that correspond to the given phenomena
Formulating a Hypothesis	Guide students to write a hypothesis based on the problem statement
Data collection	Guiding students in conducting, collecting, or gathering data/information

Inquiry Learning	
Syntax	**Kegiatan Guru**
Testing a hypothesis	Guide students to compare the results of the activity with the hypothesis they have formulated
Drawing conclusions	Guiding students to draw conclusions from the results of the activity

(Trianto, 2007 dalam Noviwati dkk., 2023)

Data Collection Methods and Research Instruments

The data in this study were collected through pre- and post-tests of students' critical thinking skills. The pre-test was administered before the intervention to assess students' initial abilities, while the post-test was administered after the intervention to assess their critical thinking skills following the implementation of the learning model.

The instrument used was a critical thinking skills essay test. An essay test was chosen because it can measure students' ability to explain reasons, analyze information, construct arguments, and draw conclusions in writing. The instrument was designed based on the FRISCO critical thinking indicators, which include Focus, Reason, Inference, Situation, Clarity, and Overview. The FRISCO indicators refer to Ennis's concept of critical thinking, which is the ability to think rationally and reflectively to determine what to believe or do (Ennis, 2011).

The critical thinking skills instrument consists of 12 items that have been validated using Pearson's product-moment correlation and found to be reliable using Cronbach's Alpha. An item is considered valid if the significance level is less than 0.05, and the instrument is considered reliable if the Cronbach's Alpha value is ≥ 0.70.

Data Analysis Techniques

Data on critical thinking skills were collected through essay tests. The data were analyzed using parametric statistics with a one-way ANOVA. Before conducting the one-way ANOVA, the data had to meet the specified prerequisites. If any of these prerequisites were not met, the data analysis proceeded using nonparametric statistics. The assumptions for the one-way ANOVA are as follows:

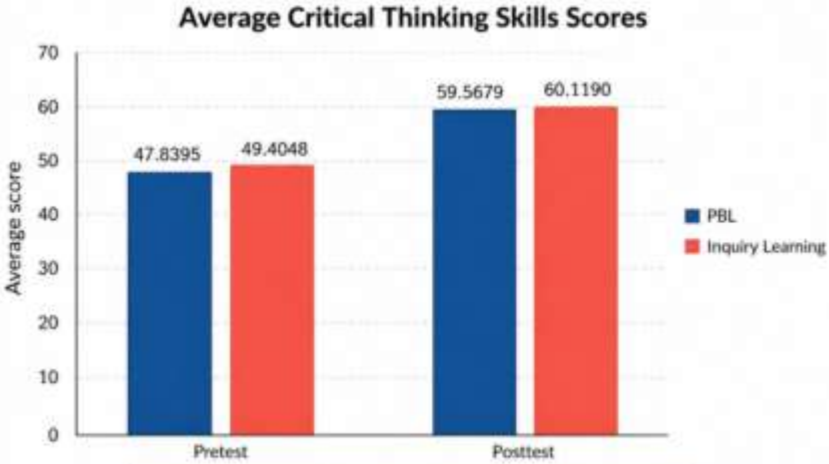
1. The dependent variable data is on an interval or ratio scale.
2. The independent variable consists of categorical data that divides the data into at least two mutually exclusive groups.
3. Independence of observations (observations are made independently of one another).
4. There are no significant outliers.
5. The residuals are normally distributed.
6. The variance within and between groups is homogeneous.
7. The covariates are linearly related to the dependent variable.
8. Homogeneity of regression slopes is required.

The decision regarding hypothesis testing was based on a significance level of 0.05. If the p-value is less than 0.05, there is a significant difference between the PBL class and the Inquiry Learning class. Conversely, if the p-value is greater than 0.05, there is no significant difference between the two classes. In addition to the significance value, the analysis results are also examined through the effect size in the form of partial eta squared (ηp^2) to determine the magnitude of the learning model's influence on critical thinking skills. If the test results are significant, the interpretation proceeds by examining the effect size value. However, if the test results are not significant, the interpretation focuses on the trend of changes in pretest–posttest scores and the magnitude of the effect size as supporting information.

3. RESULTS AND DISCUSSION

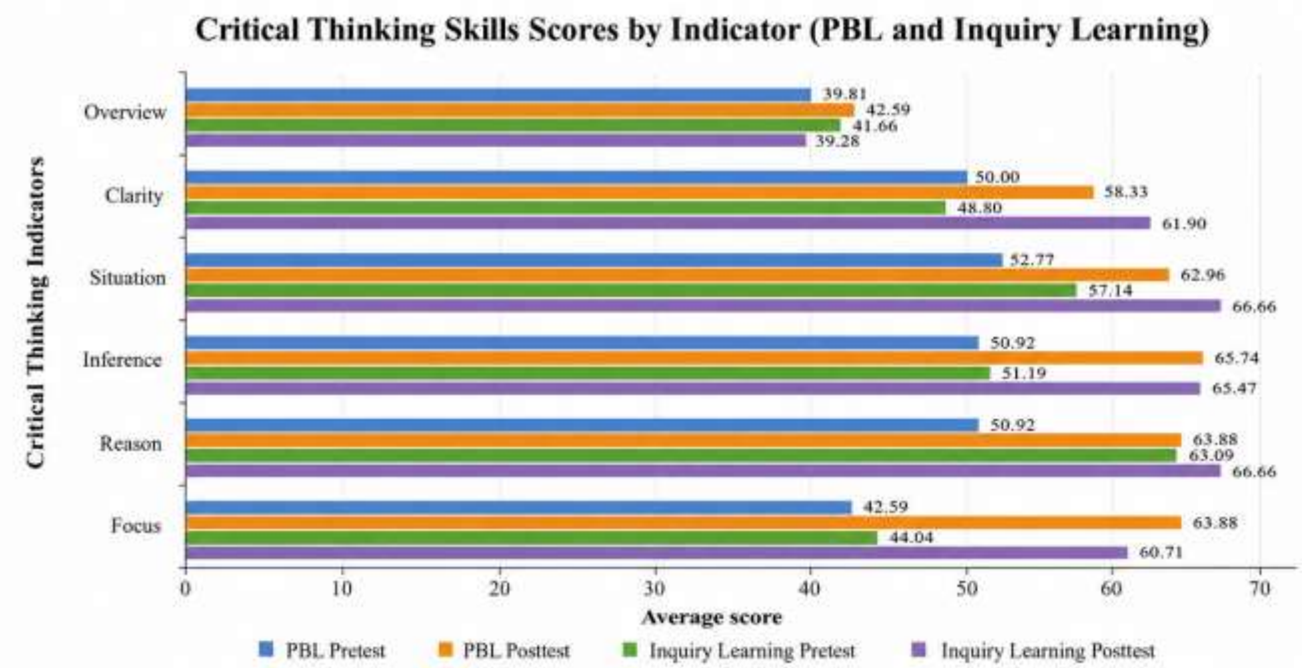
3.1. Research Results

The results of the analysis of students' critical thinking skills in the Problem-Based Learning (PBL) class and the Inquiry Learning class before and after the intervention are presented in Figure 1. Based on the figure, the average critical thinking skill score in the PBL class increased from 47.83 on the pretest to 59.56 on the posttest. Meanwhile, in the Inquiry Learning class, the average critical thinking skills score increased from 49.40 on the pretest to 60.11 on the posttest. These results indicate that both learning models were effective in developing students' critical thinking skills following the learning process.



Group	Pretest	Posttest
PBL	47.8395	59.5679
Inquiry Learning	49.4048	60.1190

Figure 1. Comparison of critical thinking skills scores between the PBL class and the Inquiry Learning class



Indicator	PBL Pretest	PBL Posttest	Inquiry Learning Pretest	Inquiry Learning Posttest
Overview	39.81	42.59	41.66	39.28
Clarity	50.00	58.33	48.80	61.90
Situation	52.77	62.96	57.14	66.66
Inference	50.92	65.74	51.19	65.47
Reason	50.92	63.88	63.09	66.66
Focus	42.59	63.88	44.04	60.71

Figure 2. Scores for the Critical Thinking Skills Indicator in the PBL Class and the Inquiry Learning Class

Figure 2 shows that in the PBL model, the greatest improvement was observed in the indicators of focus, reason, and inference. Meanwhile, in the Inquiry Learning model, the greatest improvement was observed in the indicators of focus, inference, and clarity. The smallest improvement was observed in the overview indicator. These results indicate that both the PBL and Inquiry Learning models are capable of improving several indicators of students' critical thinking skills during the learning process.

Before conducting a one-way ANCOVA parametric test, several assumptions must be met, including: 1) the dependent variable consists of interval or ratio data; 2) the independent variable consists of categorical data that divides the data into at least two mutually exclusive groups; 3) independence of observations; 4) no significant outliers; 5) the residual data is normally distributed; 6) the variance is homogeneous across groups; 7) the covariates must be linearly related to the dependent variable; and 8) there must be homogeneity of regression slopes.

The dependent variable in this study is critical thinking skills, which are measured as interval data (critical thinking skill scores), while the independent variables are nominal/categorical data (PBL classes and Inquiry Learning classes). This study was also conducted through independent observations, and no student critical thinking skill scores were found to be extremely low or extremely high; thus, the first, second, third, and fourth requirements have been met. Next is the fifth requirement, namely the normality of the residual data for the critical thinking skills variable. The normality of the residual data for critical thinking skills can be seen in Table 1.

Table 6. Results of the Normality Test for the Distribution of Residuals in Critical Thinking Skills Data

Tests of Normality				
	Shapiro-Wilk			Description
	Statistic	df	Sig.	
Residual for Critical Thinking Posttest	.982	32	.856	Normal

The results of the normality test using the Shapiro-Wilk test indicate that the posttest residuals for critical thinking skills [W(32) = 0.982, p = 0.856] are normally distributed, thus fulfilling the fifth requirement for the one-way ANOVA. The next requirement, the test of data homogeneity, is presented in Table 2.

Table 7. Results of the Homogeneity Test for the Distribution of Residuals in Critical Thinking Skills Data

Levene's Test of Equality of Error Variance[a]				
Dependent Variable: Posttest Berpikir Kritis				Description
F	df1	df2	Sig.	
3.014	1	30	.093	Homogeneous

The results of Levene's test in Table 2 indicate that the variances of the critical thinking skills data between the control class and the experimental class are homogeneous [F(1,30) = 3.143, p = 0.093], thus fulfilling the sixth requirement for the one-way ANOVA. Next is the test of linearity of the covariates with the dependent variable, as shown in Figures 3 and 4.

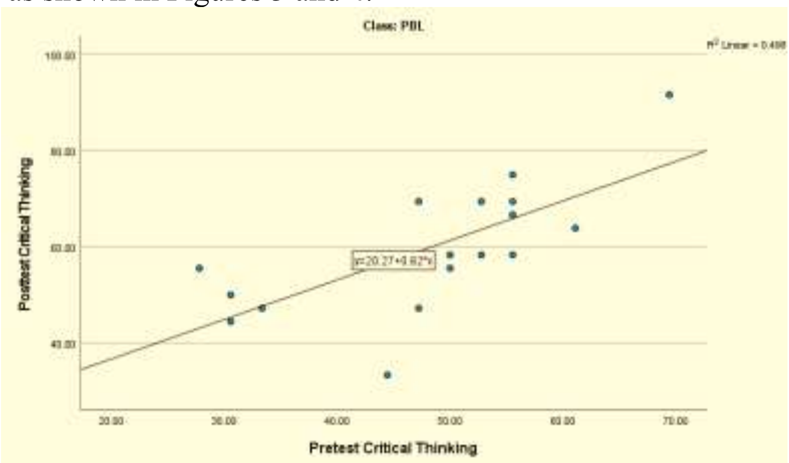


Figure 3. Linearity between the pretest and posttest scores for critical thinking skills in the PBL class

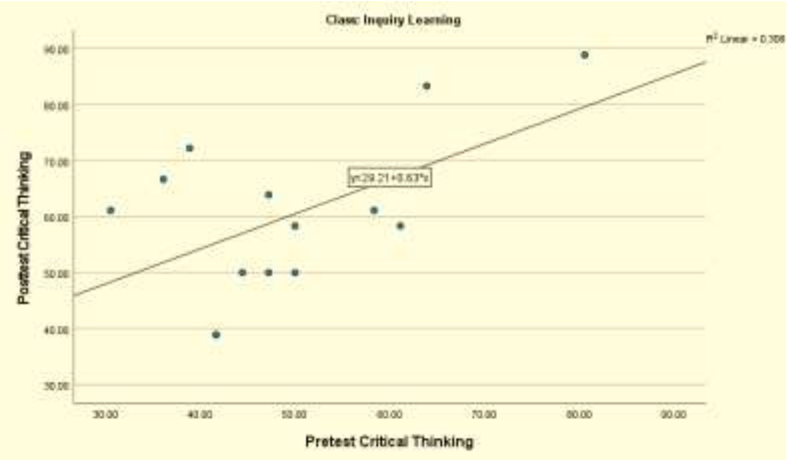


Figure 4. Linearity between the pretest and posttest scores for critical thinking skills in the Inquiry Learning class

The results of the linearity test shown in Figures 3 and 4 can be seen from the distribution of points on the scatter plot, which exhibits a linear trend. The scatter plot indicates that the pretest and posttest data for critical thinking skills in both the experimental and control classes are linear. Thus, the seventh prerequisite is met. Next is the test for homogeneity of regression slopes, which can be seen in Table 3.

Table 8. Results of the Homogeneity of Regression Slope Test

Tests of Between-Subjects Effects

Dependent Variable: Posttest Critical Thinking

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Description
Kelas * PretestCriticalThinking	42.110	1	42.110	.344	.562	.012	Homogeneous
Error	3425.220	28	122.329				

Table 3 indicates that the test of homogeneity of regression slopes for the pretest and posttest data on critical thinking skills between one class and another is homogeneous [F(1,28) = 0.344, p = 0.562, ŋp2 = 0.012]. The assumption is met if Sig > 0.05. Thus, the eighth assumption is met, so the analysis can proceed to the hypothesis test using One-Way ANOVA, as shown in Table 4.

Table 9. Results of the One-Way ANCOVA Test

Tests of Between-Subjects Effects

Dependent Variable: Posttest Critical Thinking

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	2304.034[a]	2	1152.017	9.635	.001	.399
Intercept	1066.721	1	1066.721	8.922	.006	.235
Pretest Critical Thinking	2301.642	1	2301.642	19.250	.000	.399
Clas	2.653	1	2.653	.022	.883	.001
Error	3467.330	29	119.563			
Total	120239.198	32				

Corrected Total	5771.364	31
a. R Squared = .399 (Adjusted R Squared = .358)		

Based on Table 4, the results of the one-way ANCOVA indicate that there is no difference in students' critical thinking skills between the PBL class and the Inquiry Learning class [$F(1,29) = 0.022$, $p = 0.883$, $F^2 = 0.001$], suggesting that the model applied does not have a significant effect on students' critical thinking skills.

3.2. Discussion

Critical thinking is one of the 21st-century skills that serves as a vital foundation in the learning process, as this ability helps students understand information in depth, analyze problems, evaluate evidence, and make logical and responsible decisions. In the context of learning, critical thinking skills not only play a role in enhancing conceptual understanding but also train students to tackle complex real-world issues, including environmental problems. Therefore, learning should be designed to encourage students to actively ask questions, engage in discussions, construct arguments, solve problems, and draw conclusions based on evidence so that critical thinking skills can develop as a primary tool for facing 21st-century challenges.

In this study, critical thinking skills are understood as students' ability to think rationally, reflectively, and evidence-based when determining what to believe or do. These skills are measured using the FRISCO indicators, which include Focus, Reason, Inference, Situation, Clarity, and Overview (Ennis, 2011). These six indicators are relevant to the demands of science learning because students must not only memorize concepts but also understand problems, provide reasoning, draw conclusions, consider context, communicate ideas clearly, and review the decisions they have made (Rivas et al., 2022).

The results of the study show that the average score for critical thinking skills in the Problem-Based Learning (PBL) class increased from 47.83 on the pretest to 59.56 on the posttest. In the Inquiry Learning class, the average score also increased from 49.40 to 60.11. The improvement in both classes indicates that learning that engages students in problem-solving, inquiry, discussion, and reflection can foster the development of critical thinking skills. This finding aligns with the characteristics of active learning, which positions students as the primary agents in constructing understanding, rather than as passive recipients of information (Wiratama et al., 2025).

Although there was an increase in the average scores in both classes, the results of the One-Way ANCOVA test showed that there was no significant difference between the critical thinking skills of students in the PBL class and the Inquiry Learning class after controlling for pretest scores, $F(1,29) = 0.022$, $p = 0.883$, ŋp2 = 0.001. The very small partial eta-squared value indicates that differences in learning models do not contribute meaningfully to the variation in posttest scores. Thus, the results of this study do not indicate the superiority of one model over another but rather show that PBL and Inquiry Learning with a deep learning approach produce relatively equivalent critical thinking skills in this study.

The similarity in outcomes can be explained by the shared pedagogical foundations of the two models. Both PBL and Inquiry Learning are oriented toward student-centered learning, emphasizing investigative activities, the use of evidence, collaboration, and reflection. In PBL, students begin with a contextual problem that prompts them to identify key information, formulate learning needs, seek and evaluate evidence, and propose solutions. In Inquiry Learning, students follow the scientific process through activities such as asking questions, formulating hypotheses, collecting data, analyzing findings, and drawing conclusions. Since both models require processes of analysis, evaluation, and inference, the relatively similar final outcomes are a logical finding (Hmelo-Silver et al., 2007).

In PBL classes, the development of critical thinking skills is primarily linked to the processes of problem orientation, group investigation, solution development, presentation, and evaluation. Contextual problems related to environmental change can help students connect biological concepts to real-world phenomena such as pollution, ecosystem degradation, land-use changes, and the impact of human activities on the environment. When students are asked to explain the causes, impacts, and alternative solutions to a problem, they practice using reasoning, assessing the relevance of information, and constructing evidence-based arguments. This aligns with research Hmelo-Silver et al., (2007) which emphasizes that PBL fosters flexible knowledge, problem-solving skills, independent learning, collaboration, and motivation to learn.

Active student engagement in the learning process plays a crucial role in developing students' critical thinking skills. In PBL-based learning, activities such as identifying problems, formulating alternative solutions, discussing, and presenting problem-solving outcomes can help students develop analytical and systematic thinking skills. This is supported by Marviany et al., (2025) which indicates that the implementation of the PBL model in biology instruction can improve students' problem-solving skills, thereby contributing to the development of critical thinking skills.

In Inquiry Learning classes, improvements in critical thinking skills are evident through students' engagement in the scientific inquiry process. Activities such as formulating problems, developing hypotheses, collecting data, testing information, and drawing conclusions allow students to practice connecting data to concepts and assessing whether the evidence obtained is sufficient to support their conclusions. Inquiry Learning also provides students with the opportunity to communicate their findings and reflect on the results of their investigations. Pedaste et al., (2015) explains that the inquiry phase includes orientation, conceptualization, investigation, conclusion, and discussion; this sequence of phases is closely aligned with indicators of critical thinking because it requires processes of analysis, interpretation, inference, evaluation, communication, and reflection.

The findings of this study can also be understood from the perspective of the deep learning approach. This approach emphasizes meaningful, conscious, and enjoyable learning, so that students are guided to understand the relationships between concepts, connect the material to real-world experiences, and reflect on their learning process. In the topic of environmental change, meaningful learning occurs when students not only memorize the definition of environmental change but also analyze causes, predict impacts, and consider evidence-based solutions. This principle aligns with the deep approach to learning, which emphasizes a deep understanding of the meaning, relationships, and structure of knowledge, rather than merely reproducing information (Marton & Saljo, 1976; Andayanie et al., 2025).

Based on the analysis of the indicators, the PBL model showed a notable improvement in the indicators of focus, reasoning, and inference. This indicates that problem-solving activities in PBL help students identify the focus of the problem, formulate reasons, and draw conclusions based on the available information. Meanwhile, in the Inquiry Learning class, notable improvements were observed in the focus, inference, and clarity indicators. This suggests that the inquiry process helps students understand the focus of the question, develop conclusions, and explain their findings more clearly. Thus, both models contribute to overlapping indicators, particularly focus and inference, as both require students to understand the problem and draw conclusions based on evidence.

The lowest improvement in both classes was observed in the overview indicator. This indicator relates to students' ability to review their thought processes, check the consistency of their answers, and thoroughly re-evaluate their conclusions. The low achievement on this indicator suggests that students still tend to stop once they have arrived at an answer, and thus are not yet accustomed to re-examining the quality of their arguments and conclusions. This situation indicates the need to strengthen reflection activities, peer review, and metacognitive questions at the end of the learning session, for example, through questions such as "Is the evidence used sufficient?", "Are there any alternative explanations?", and "Which parts of the answer still need improvement?".

The lack of a significant difference between PBL and Inquiry Learning may also be attributed to the relatively short duration of the intervention, the limited sample size, and the heterogeneous prior abilities of the students. Critical thinking skills are complex abilities that develop gradually through repeated practice, teacher guidance, feedback, and opportunities to revise ideas. Meta-analysis Liu & Pásztor, (2022) shows that PBL is generally effective in developing critical thinking, but its effectiveness is influenced by the duration of the intervention, student characteristics, group size, assessment tools, and the form of instruction. A similar pattern is observed in inquiry-based learning; a meta-analysis Antonio & Prudente, (2024) demonstrates the positive impact of the inquiry-based approach on higher-order thinking skills, but its effectiveness remains dependent on the instructional design and supporting strategies employed.

The teacher's role is a key factor in ensuring that PBL and Inquiry Learning truly lead to the development of critical thinking. Teachers need to provide scaffolding through guiding questions, examples of how to evaluate evidence, guidelines for data analysis, argumentation rubrics, and feedback on students' responses. Without adequate scaffolding, problem-based or inquiry-based learning risks becoming an unfocused exploratory activity, especially for students who lack a strong prior knowledge base. Therefore, the implementation of PBL and Inquiry Learning must strike a balance between student autonomy and teacher guidance so that the critical thinking process can develop optimally (Hmelo-Silver et al., 2007; Seibert, 2020; Andayanie et al., 2025).

Overall, the results of this study indicate that PBL and Inquiry Learning, when combined with a deep learning approach, both have the potential to develop students' critical thinking skills regarding environmental change. Both approaches enhance student engagement in understanding problems, processing information, using evidence, constructing arguments, and drawing conclusions. However, since the posttest results between the two classes were not significantly different, the choice of learning model can be adjusted based on the characteristics of the material, student readiness, time availability, and the teacher's ability to manage the learning process. For future research, it is recommended to use a longer treatment duration, a larger sample size, strengthen reflection activities on the overview indicator, and combine quantitative and qualitative data so that the development of students' critical thinking can be explained in greater depth.

4. CONCLUSION

Based on the research findings, it can be concluded that the Problem-Based Learning (PBL) and Inquiry Learning models, when combined with a deep learning approach, have a relatively similar impact on students' critical thinking skills regarding environmental change. Both models were equally effective in increasing the average critical thinking skill scores from the pretest to the posttest; however, the results of the One-Way ANCOVA test indicated that the difference in achievement between the two classes was not significant. Therefore, PBL and Inquiry Learning can be used as active learning alternatives to develop critical thinking skills, especially when supported by scaffolding, reflective activities, and evidence-based evaluation.

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