



# The Influence of Phenomenon-Based Learning on Students' Critical Thinking and Communication Skills

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**Abstract:** This study was conducted in relation to the phenomenon-based learning approach, which aimed to determine the effect of phenomenon-based learning on students' critical thinking and communication skills. This study was a quantitative study with a multi-group pretest-posttest quasi-experimental design. In this study, there were four classes used, consisting of three classes taught using PhBL (phenomenon-based learning) with different variations, namely direct, mediated, and integrated PhBL, and one control class taught using STAD (student teams achievement division) learning. The results showed that phenomenon-based learning had a significant effect on critical thinking skills with a value of  $f=21.93$   $p<.05$  and communication skills  $f=12.65$   $p<.05$ . Based on the three variations in PhBL learning, integrated PhBL learning showed the highest significant results in improving critical thinking skills with an average of 91.57 and communication skills of students with an average of 90.22. followed by direct PhBL learning with an average critical thinking skill of 89.48 and communication skill of 90.00, and finally mediated PhBL with an average critical thinking skill of 88.96 and communication skill of 88.45. The results of this study indicate that phenomenon-based learning is effective in improving students' critical thinking and communication skills.

**Keywords:** Biology; Communication skills; Critical thinking; PhBL; Quasi-experiments

## Introduction

The education system in Indonesia as a whole currently still faces significant challenges (Adnan et al., 2025). Data from the 2020 PISA assessment indicates that Indonesia's average science literacy score stands at 396, which is far below the OECD average of 498, with Indonesia ranking 62nd out of 81 participating countries (OECD, 2023). Education is vital in daily life as a means to empower students in navigating the many global dynamics. Through the educational process, students can further explore the full range of potential and skills within themselves that can be shaped and directed (Adnan et al., 2025). Education exerts a significant influence on improving the quality of human resources, which is crucial for a nation's progress. Effective human resource management in the field of education focuses on developing capabilities that lead to an overall improvement in educational quality and enhance

competitive capacity at the global level (Tiara et al., 2023).

Education today demands a learning system focused on developing 21st-century skills, which are the primary expectation of the education system to produce high-quality human resources capable of competing on a global scale (Jarrah & Aminatun, 2022; Susilawati et al., 2020). The enhancement of 21st-century skills, particularly critical thinking and communication skills, is crucial for students because these skills enable them to analyze information more deeply, make rational decisions, and solve problems logically (Susilawati et al., 2020). As stated by Ufairiah et al. (2020), students' critical thinking skills are currently relatively low. The low level of students' critical thinking skills is reflected in their tendency to accept information at face value without further questioning or analysis (Sundari & Sarkity, 2021). A study emphasizes that critical thinking skills contribute to the development of scientific literacy, creativity, and innovation, which are also key elements

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in 21st-century education (Hutsalo et al., 2024; Primasari et al., 2020). Furthermore, improving critical thinking skills can have a positive impact on students' academic achievement, particularly in mastering complex and applied biological concepts (Ratnasari et al., 2025; Lukitasari et al., 2019). Developing these critical thinking skills is crucial so that students become more accustomed to solving problems using logical and reflective reasoning. These critical thinking skills are becoming increasingly important in today's era, characterized by rapid changes and intense competition driven by technological advancements (Doyan et al., 2022).

Not only critical thinking skills, but communication skills are also crucial in 21st-century education because with communication skills, students are able to convey ideas or information clearly (Mulyadi et al., 2026). Putri et al. (2020) expressed the view that with communication skills, students are provided with the means to convey messages, express themselves, and influence others in the learning process. Furthermore, communication skills can encourage students to express ideas and understand information conveyed by teachers during lessons (Marfuah, 2017). Currently, students' communication skills remain relatively low, as evidenced by their inability to explain what is in their minds clearly and systematically (Oktaviani & Nugroho, 2015). Students' communication skills still need to be improved, given that many students are still unable to demonstrate fluency in communication (Khoiriah et al., 2023). Other studies also indicate that students' communication skills fall into a category with a percentage below 50% (Nurlaelah et al., 2020). Additional research suggests that communication skills are categorized as moderate. However, the implementation of these skills in classroom practice has not yet been fully optimized (Cici Mayani et al., 2023).

Findings from observations and interviews with 11th-grade MIPA students and biology teachers at SMA Negeri 18 Bone indicate that, to date, the teaching methods implemented at the school remain ineffective in enhancing students' critical thinking and communication skills. This situation highlights a gap with the demands of 21st-century learning, which emphasizes active learning to enhance students' critical thinking and communication skills. This is compounded by the fact that the current biology learning process remains teacher-centered. Students' critical thinking and communication skills can be improved through various methods, one of which is the implementation of phenomenon-based learning.

As revealed by Saberi et al. (2024), in phenomenon-based learning, students are required to think and act like scientists and engineers, engaging them in exploring natural phenomena and solving real-world problems,

which leads to a deeper understanding of scientific content and improved critical thinking skills (Kubat, 2020; Saberi & Nouri., 2025; Bendici, 2019) while providing a context for explicitly and reflectively communicating about the nature of science.

In phenomenon-based learning, students take center stage as they investigate and understand various real-world events through the lens of relevant phenomena (Riadh, 2022). To enhance the quality of learning activities, phenomenon-based learning places students in real-world contexts where they can apply what they have learned (Mattila & Silander., 2015). Phenomenon-based learning is a branch of constructivism. According to Wakil et al. (2019), students construct their knowledge by observing the world around them, then integrating this new information with what they already know to form a comprehensive understanding.

To date, research on the phenomenon-based learning approach indicates that it can support the development of 21st-century skills such as critical thinking and communication. However, most existing research still discusses the general application of phenomenon-based learning in education broadly. Research specifically examining the application of phenomenon-based learning at the high school level (SMA), particularly focusing on enhancing students' critical thinking and communication skills in biology education, remains relatively limited. Yet, biology education often faces significant challenges, such as abstract concepts and a learning approach that remains overly focused on rote memorization. In response to this, the phenomenon-based learning approach is a relevant solution to these issues because it emphasizes the connection between scientific concepts and real-world phenomena. Consequently, it better helps students understand concepts in a more scientific and contextual manner, thereby fostering their critical thinking and communication skills. For this reason, this study aims to examine the impact of implementing phenomenon-based learning on students' critical thinking and communication skills.

## Method

This study is a quantitative study using a multi-group pretest-posttest quasi-experimental experimental design. In this study, there are four classes, consisting of three treatment classes for phenomenon-based learning with different variations and one control class with STAD (student teams achievement division) learning. Each group will be given a pretest and posttest with the same questions for each class. The following is an overview of the research design, which can be seen in Table 1.

**Table 1.** Research Design Table

Class	Pretest	Experiment	Posttest
Experiment I	O <sub>1</sub>	X <sub>1</sub>	O <sub>2</sub>
Experiment II	O <sub>3</sub>	X <sub>2</sub>	O <sub>4</sub>
Experiment III	O <sub>5</sub>	X <sub>3</sub>	O <sub>6</sub>
Control	O <sub>7</sub>	X <sub>0</sub>	O <sub>8</sub>

Description: X<sub>1</sub>: Phenomenon-Based Learning (PhBL), X<sub>2</sub>: Phenomenon-Based Learning (PhBL), X<sub>3</sub>: Phenomenon-Based Learning (PhBL), X<sub>0</sub>: Student Teams Achievement Division (STAD), O<sub>1</sub>: Pre-test scores for experimental class I, O<sub>2</sub>: Post-test scores for experimental class I, O<sub>3</sub>: Pre-test scores for experimental class II, O<sub>4</sub>: Post-test scores for experimental class II, O<sub>5</sub>: Pre-test scores for experimental class III, O<sub>6</sub>: Post-test scores for experimental class III, O<sub>7</sub>: Pre-test scores for control class, O<sub>8</sub>: Post-test scores for control class

This study applied a phenomenon-based learning approach with different variations. These three variations aim to compare the effectiveness of different modes of presenting phenomena between direct, mediated, and integrated PhBL. Experimental class I applied direct PhBL (structured exploration), which is learning that uses real phenomena through direct observation so that students carry out activities such as observing, recording, formulating problems, and analysing observation results systematically. Experimental class II applied mediated PhBL (analysis of phenomena through media), which is learning that presents phenomena through media such as videos or animations so that students analyse phenomena based on information obtained from the media. Experimental class III applied integrated PhBL (reflective comparison), which is learning that combines direct

observation with supporting media so that students compare real phenomena with media representations to produce a more comprehensive analysis. The difference between the three treatments lies in the source of the phenomena used and the form of exploration and analysis activities carried out during learning. In its application, the three experimental classes and one control class were given the same material in each class with the same learning duration in each class.

## Result and Discussion

The results of this study were presented through several stages of analysis, including descriptive statistical analysis, prerequisite analysis tests (normality and homogeneity), and hypothesis testing using Analysis of Covariance (ANCOVA) followed by Least Significant Difference (LSD) testing to determine the differences between treatment groups. Descriptive analysis was conducted first to provide an overview of the distribution of students' critical thinking skills in each research group before and after the treatment.

### Critical Thinking Skills

The descriptive analysis was conducted to provide an initial overview of the critical thinking skills of students in each research group before and after the treatment. The values analysed included the mean, standard deviation, maximum value, minimum value, range and variance. The results of the descriptive analysis of critical thinking skills are presented in Table 2.

**Table 2.** Results of Descriptive Analysis of Critical Thinking Skills for Each Treatment

Type of learning	Type of test	Number of student	Average	Deviation standard	N-Max	N-Min	Range	Variance
STAD	Pretest	31	43.16	6.09	54	33	21	37.14
	Posttest	31	80.77	6.12	92	67	25	37.51
PhBL direct	Pretest	31	38.39	7.65	54	25	29	58.64
	Posttest	31	89.71	5.57	100	79	21	31.08
PhBL mediated	Pretest	31	44.94	7.39	54	33	21	54.72
	Posttest	31	88.87	5.44	100	79	21	29.64
PhBL integrated	Pretest	31	45.58	7.46	67	33	34	55.65
	Posttest	31	91.45	5.35	100	17	25	28.65

According to Table 2, the average critical thinking ability pretest score for the control class was 43.16, for experiment 1 it was 38.39, for experiment 2 it was 44.94, and for experiment 3 it was 45.58. These numbers show that before the therapy, the pupils in both groups had comparable skill levels. The average post-treatment score for the control group was 80.77, while the experimental classes showed higher scores, namely 91.45 in experiment 3, 89.71 in experiment 1, and 88.87 in experiment 2. This difference in the mean indicates that students who participated in Phenomenon Based

Learning (PhBL) tended to obtain higher critical thinking skill scores compared to students who participated in conventional learning.

This improvement can be explained by the characteristics of phenomenon-based learning, which places real phenomena as the context for learning so that students are encouraged to analyse, evaluate, and draw conclusions based on the information obtained. This approach enables students to develop higher-order thinking skills through the process of investigating the phenomena being studied. These findings are in line

with the research by Wakil et al. (2019), which shows that phenomenon-based learning can improve critical thinking skills because students are actively involved in problem-solving and analysing real phenomena.

The next result of the study was a normality test conducted to determine whether the research data was

normally distributed, thereby fulfilling the assumptions of parametric statistical analysis. Data on critical thinking abilities were tested for normalcy using the Kolmogorov-Smirnov test, and the findings are shown in Table 3.

**Table 3.** Normality Test of Critical Thinking Skills Research Data

Type of learning	Kolmogorov-Smirnov <sup>a</sup>		
	Statistic	df	Sig.
Pretest Control	.134	31	.165
Pretest direct	.146	31	.090
Pretest mediated	.148	31	.082
Pretest integrated	.136	31	.152
Posttest Control	.132	31	.178
Posttest direct	.154	31	.060
Posttest mediated	.150	31	.074
Posttest integrated	.154	31	.060

Description: df : Degree of freedom; Sig. : Significance

A normalcy test was run on the research data to make sure it fit the parameters of parametric statistical analysis before the hypothesis was tested. All of the significant values in Table 2's Kolmogorov-Smirnov test findings are larger than 0.05, indicating that the data on critical thinking abilities follow a normal distribution.

Then, to find out how comparable the variances were among the study groups, a test of variance homogeneity was run. A significant value of 0.52 was shown for the pretest and 0.87 for the posttest of critical thinking abilities in the Levene test findings shown in Table 4. We may infer that the variances across groups are homogenous since these values are bigger than 0.05.

**Table 4.** Homogeneity Test of Research Data on Critical Thinking Skills

	Levene Statistic	df1	df2	Sig.
Critical Thinking Skills Pre-test	Based on Mean .752	3	120	.523
Critical Thinking Skills Post-test	Based on Mean .228	3	120	.877

Description: df1: Degree of freedom of the numerator; df2: Degree of freedom of the denominator; Sig: Significance

Next, hypothesis testing was conducted using analysis of covariance (ANCOVA). The results of the analysis in Table 5 show that the group factor has an f value of 21.93 with a significance of  $p=0.000$  ( $p < 0.05$ ). This value indicates that the learning model has a

significant effect on students' critical thinking skills after controlling for the influence of initial skills. The  $R^2$  value of 0.35 indicates that the learning model contributes 35.7% to the variation in students' critical thinking skills scores.

**Table 5.** ANCOVA Test of Critical Thinking Skills

Tests of Between-Subjects Effects					
Dependent Variable: Posttest					
Source	Type III Sum of Squares	df	Mean Square	f	Sig.
Corrected Model	2105.716a	4	526.429	16.519	.000
Intercept	26247.014	1	26247.014	823.627	.000
Group	2096.758	3	698.919	21.932	.000
Error	3792.244	119	31.868		
Total	959653.000	124			

Description: R Squared = .357 (Adjusted R Squared = .335), df: Degree of freedom; F: f-value; Sig: Significance

These results indicate that the improvement in critical thinking skills is not solely due to differences in the initial abilities of the students, but is more influenced by the learning approach applied. Phenomenon-based learning allows students to connect concepts with real phenomena, making the learning process more

meaningful and encouraging the use of critical thinking skills because in this learning approach, students are encouraged to be able to ask questions. Furthermore, Jongyung (2025) states that this question-based approach encourages critical thinking and deepens students' understanding of the subject. These findings

are also in line with Rahman's (2023) research, which shows that phenomenon-based learning can improve students' analytical and evaluative abilities through the process of investigating contextual phenomena.

After conducting the ANCOVA test, it can be seen that the phenomenon-based learning approach has a significant effect on critical thinking skills. Next, an LSD (least significant difference) test was conducted to see which variation of the phenomenon-based learning approach provided the most significant improvement. The results in Table 6 show that the PhBL direct learning approach had the most significant effect on improving critical thinking skills with an average score of 91.57, followed by PhBL direct with an average score of 89.48 and then PhBL mediated with an average score of 88.96.

The phenomenon-based learning (phenomenon-based learning) approach, with variations in the three integrated PhBL experiments, can have the greatest significant impact on students' critical thinking skills. The teaching process through phenomenon-based learning (phenomenon-based learning integrated) has the most significant impact on improving critical thinking skills because, during the learning process, students not only observe and compare real phenomena

resulting from direct observation but also real phenomena through media; thus, in their analysis, phenomena through media also play an important role in the formulation of their analysis. The combination of direct observation and observation via media provides a broader perspective, allowing students the freedom to seek out various sources of information; this, in turn, encourages students to engage more actively in comparing evidence from direct observation and media, analysing data, and formulating explanations in a more scientific and in-depth manner.

The direct and mediated approaches to phenomenon-based learning also have a significant impact on the improvement of critical thinking skills, although direct and mediated phenomenon-based learning are not significantly superior to integrated PhBL. However, these two variations have a similar impact on the improvement of critical thinking skills; that is, both direct and mediated PhBL lead to improvements, but these are not significantly different from those achieved by integrated PhBL, which yields the greatest improvement. The LSD test results are presented in Table 6.

**Table 6.** LSD (Least Significant Difference) Test of Critical Thinking Skills

	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
STAD	80.781 <sup>a</sup>	1.014	78.774	82.789
PhBL direct	89.484 <sup>a</sup>	1.067	87.371	91.596
PhBL mediated	88.965 <sup>a</sup>	1.023	86.939	90.991
PhBL integrated	91.577 <sup>a</sup>	1.030	89.536	93.617

These results indicate that students who participated in phenomenon-based learning obtained significantly higher critical thinking scores than students who participated in conventional learning. Students' analytical abilities were better enhanced by involvement in the learning process using the phenomenon-based learning method compared to traditional learning, according to other research (Pareken et al., 2015).

Pratiwi et al. (2021) and Pareken et al. (2015) found that students' metacognitive awareness, creativity, critical thinking, and ability to explain scientific concepts were all enhanced by phenomenon-based learning. Furthermore, this method of learning is based on phenomena has been used in different contexts for basic knowledge acquisition (Islakhiyah et al., 2017; Wakil et al., 2019). Tongsoong et al. (2021) suggest that it can be even enhanced by combining it with other learning models.

*Communication Skills*

The next descriptive analysis was conducted on the students' communication skills data with the aim of

obtaining an overview of the students' initial abilities in each treatment group. The results of the descriptive analysis of the students' communication skills based on the pretest and posttest scores are presented in Table 7.

Descriptive analysis of students' communication skills is shown in Table 7. The average pre-test score for communication skills in the control class was 45.68, in experiment 1 it was 51.35, in experiment 2 it was 44.74, and in experiment 3 it was 47.55. After the treatment was given, the average post-test score increased in all groups. The control class obtained an average score of 83.52, while the experimental classes obtained higher scores, namely 90.23 in experiment 3, 90.00 in experiment 1, and 84.88 in experiment 2.

The improvement seen in the descriptive test table of communication skills shows that the phenomenon-based learning approach provides more space for students to convey ideas, explain concepts, and present analysis results systematically. The learning process in PhBL involves group discussions, presentations of investigation results, and exchanges of arguments so that students are trained to convey information

scientifically. These findings are also supported by Adipat's (2024) research, which explains that phenomenon-based learning can increase student

engagement in the learning process and develop various important competencies such as critical thinking, problem solving, and scientific communication.

**Table 7.** Results of Descriptive Analysis of Communication Skills for Each Treatment

Type of learning	Type of test	Number of student	Average	Deviation standard	N-Max	N-Min	Range	Variance
STAD	Pretest	31	45.68	6.35	57	37	20	40.26
	Posttest	31	83.52	4.90	90	75	15	24.05
PhBL direct	Pretest	31	51.35	5.98	59	37	22	35.77
	Posttest	31	90.00	3.87	96	79	17	15.00
PhBL mediated	Pretest	31	44.74	5.95	59	37	22	35.39
	Posttest	31	84.88	5.15	95	78	17	26.58
PhBL integrated	Pretest	31	47.55	6.20	57	39	18	38.52
	Posttest	31	90.23	4.99	99	79	20	24.98

The study data had to be checked for normality using a normality test before hypothesis testing could be done. This was to make sure the data was consistent with the assumptions of parametric statistics. All significant values in Table 8's Kolmogorov-Smirnov test

are larger than 0.05, indicating that the data on critical thinking abilities follow a normal distribution. Table 8 displays the results of the communication skills normalcy test.

**Table 8.** Normality Test of Research Data on Communication Skills

Type of learning	Kolmogorov-Smirnov <sup>a</sup>		
	Statistic	df	Sig.
Pretest Control	.144	31	.104
Pretest direct	.154	31	.060
Pretest mediated	.128	31	.200*
Pretest integrated	.143	31	.106
Posttest Control	.148	31	.080
Posttest direct	.140	31	.126
Posttest mediated	.141	31	.117
Posttest integrated	.145	31	.095

Description: df : Degree of freedom; Sig. : Significance

Table 8 shows that all significant values are more than 0.05 according to the findings of the communication skills normalcy test. Parametric statistical analysis may proceed to the next step since this proves the study data fits the normalcy assumption.

The next step was to compare the treatment groups using a test of homogeneity of variance on the data collected from students' communication abilities. You can see the outcomes of the homogeneity test, which was conducted using Levene's test, in Table 9.

**Table 9.** Homogeneity Test of Research Data on Communication Skills

	Levene Statistic	df1	df2	Sig.	
Critical Thinking Skills Pre-test	Based on Mean	.586	3	120	.625
Critical Thinking Skills Post-test	Based on Mean	1.920	3	120	.130

Description: df1: Degree of freedom of the numerator; df2: Degree of freedom of the denominator; Sig: Significance

The results of the homogeneity test on communication skills shown in Table 9 indicate that the significance value was 0.62 in the pretest and 0.13 in the posttest. These values indicate that the variance between research groups was homogeneous, thus fulfilling the assumptions of parametric analysis.

After the descriptive testing was completed, inferential testing was carried out, beginning with hypothesis testing using analysis of covariance (ANCOVA). The analysis findings in Table 9 demonstrate that the group factor had a significant f

value of 12.65 ( $p < 0.05$ ). This result shows that after accounting for the impact of starting abilities, the phenomenon-based learning method significantly affects students' critical thinking abilities. Data from the analysis of covariance (ANCOVA) test for communication abilities are shown in Table 10.

Also showing a substantial influence are the findings of the communication skills study (Table 10). With a significance level of  $p = 0.000$  ( $p < 0.05$ ), the group factor has an f value of 12.65. Students' improved communication abilities are a direct result of the

learning approach, as shown by this value. A correlation coefficient of 0.25 suggests that the learning model

explains 25% of the variance in students' verbal and written expression abilities.

**Table 10.** ANCOVA Test of Communication Skills

Tests of Between-Subjects Effects					
Dependent Variable: Communication Skills Posttest					
Source	Type III Sum of Squares	df	Mean Square	f	Sig.
Corrected Model	906.871 <sup>a</sup>	4	226.718	9.923	.000
Intercept	15336.592	1	15336.592	671.262	.000
Group	867.286	3	289.095	12.653	.000
Error	2718.839	119	22.847		
Total	964938.000	124			
Corrected Total	3625.710	123			

Description: a. R Squared = .250 (Adjusted R Squared = .225), df: Degree of freedom; F: f-value; Sig: Significance

LSD follow up tests were also conducted on the students' communication skills data to determine the differences between treatment groups. The results of the comparison between groups are shown in Table 11.

The LSD test results related to communication skills show that among the three variations in PhBL learning, namely direct, mediated, and integrated PhBL, the

results are similar to the LSD test results for critical thinking skills. The results show that the direct PhBL learning approach had the most significant effect on improving critical thinking skills, with an average score of 90.22, followed by direct PhBL with an average score of 90.00, and then mediated PhBL with an average score of 88.45.

**Table 11.** LSD Test of Communication Skills

	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
STAD	83.516 <sup>a</sup>	.867	81.800	85.232
PhBL direct	90.000 <sup>a</sup>	.905	88.208	91.792
PhBL mediated	88.452 <sup>a</sup>	.878	86.713	90.190
PhBL integrated	90.226 <sup>a</sup>	.859	88.526	91.926

The findings of the research conducted indicate that the phenomenon-based learning approach has a significant impact on improving students' communication skills. Among the three variations of the phenomenon-based learning approach applied, it was observed that the integrated PhBL approach was the most effective in significantly improving students' communication skills. This is because the process of presenting phenomena involved a combination of direct observation of phenomena and observation of phenomena through video media. The process of analysing phenomena, formulating questions and compiling findings involves two sources: direct observation and video media, which also serves as a source for analysis, formulation and compilation of findings regarding the phenomena. This combination further liberates students to explore the results of their findings regarding the observation of phenomena both directly and through media.

The significant difference that occurred in classes taught using the phenomenon-based learning approach was due to the application of PhBL, in which the phenomenon that became the starting point for learning provided a presentation of the phenomenon that gave students the opportunity to observe, discuss, ask

questions, and express their opinions. The process of group discussion and investigation activities while observing phenomena indirectly trains students to express and convey their ideas more broadly and systematically. Jongyung (2025) also stated that PhBL supports communication development because students often work in teams to explore phenomena.

Overall, the integration of descriptive analysis results, ANCOVA tests, and LSD follow-up tests shows that Phenomenon Based Learning has a significant effect on improving students' critical thinking and communication skills. This approach also provides a more contextual learning experience through the exploration of real phenomena so that students not only understand concepts theoretically but are also able to develop scientific thinking and communication skills.

### Conclusion

Based on the research results, it can be concluded that the phenomenon-based learning approach has a significant effect on improving critical thinking skills with a value of  $f=21.93$   $p<.05$  and communication skills  $f=12.65$   $p<.05$ . In the application of the three variations in the three experimental classes, it was found that the

integrated phenomenon-based learning approach showed the highest significant results in improving critical thinking skills with an average of 91.57 and student communication skills with an average of 90.22. followed by direct PhBL learning with an average critical thinking skill of 89.48 and communication skill of 90.00, and finally mediated PhBL with an average critical thinking skill of 88.96 and communication skill of 88.45.

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#### Author Contributions

Conceptualization, methodology, formal analysis, investigation, resources, writing –preparation of original draft, A.A.O., A., and A.M; writing –reviewing and editing, visualization, supervision, project administration, F.D. and A.A.Z All authors have read and approved the published version of the manuscript.

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#### Conflicts of Interest

The authors declare no conflict of interest.

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