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The Influence of Phenomenon Based Learning on Creative Thinking and Collaboration Skills

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ABSTRACT

Purpose – This study aimed to investigate the effect of PhBL learning applied with three variations of PhBL (direct phenomenon, indirect phenomenon, and combined phenomenon) on students' creative thinking and collaboration skills.

Methodology – This study used a quasi-experimental, pretest–posttest control-group design. Participants were drawn from all Grade XI students, with four classes serving as the research sample. Creative thinking skills were measured through open-ended questions, while collaboration skills were assessed via observation sheets administered before and after PhBL. The collected data were then analyzed using both descriptive and inferential statistical methods.

Findings – Results revealed that PhBL affected creative thinking and collaboration skills. Although no significant differences were observed among the three experimental groups in creative thinking, each experimental group differed significantly from the control group. Similarly, for collaboration skills, experimental groups did not differ significantly from one another. However, significant differences from the control group were observed only in experimental groups 1 and 2, whereas experimental group 3 showed no significant differences.

Contribution – This study shows that PhBL can be applied in the learning process to improve students' creative thinking and collaboration skills.

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INTRODUCTION

The 21st century has ushered in an era of dynamism and complexity, marked by rapid technological advances, digitalization, and globalization (Cokgungor, 2023). Essential competencies for the 21st century include critical thinking, creativity, communication, and collaboration, collectively termed the 4Cs, have become a major focus due to their strategic role in supporting individuals' readiness in various areas of life (Stanikzai, 2023; Thornhill-Miller et al., 2023). However, this global demand for 21st-century competencies is not yet fully reflected in classroom practices, particularly in Indonesia. Findings from the 2022 PISA indicate that Indonesia's overall educational quality remains comparatively low (Alfaruqi & Nurwahidah, 2025). Causes of low-quality education include learning activities that remain teacher-centered and memorization-oriented, and evaluations that emphasize only low-level cognitive aspects (Adnan et al., 2025). One-way learning patterns limit students' exploration of possible answers, leading them to avoid challenges that require divergent thinking and ultimately hindering the development of creativity (Mercan & Koseuglu, 2022).

Field-based data additionally demonstrate that students continue to exhibit relatively low creative thinking skills. These findings are supported by studies across several regions in Indonesia showing that learners struggle to generate original ideas, communicate them flexibly, and develop appropriate solutions to the problems they face (Putri et al., 2023). Results of research by Purwati & Alberida (2022) show that 44,8% of students have very low creative thinking skills and 35,4% have low skills. This data indicates the need to improve creative thinking skills through learning that encourages creativity and expands students' capacity for deep thinking. In addition to creative thinking, another important aspect that has not yet been fully developed is the ability to collaborate, which is closely related to students' social-emotional skills, such as communication, empathy, and responsibility in group interactions. Group work is often applied in learning activities, but in reality, many are only formalities. The cooperation that forms is limited to task division, without any interaction, in-depth discussion, or joint decision-making (Meulen & Aivaloglou, 2021). In line with this, Le et al. (2018) revealed that student collaboration is often ineffective due to a lack of cooperation, the presence of passive members (free-riders), the dominance of certain students in completing tasks, and the formation of groups based on friendships, which makes time management and concentration difficult.

This phenomenon indicates that frequent use of group work does not necessarily reflect learning that fosters collaboration. Findings by Mahlianurrahman et al. (2025) reinforce this, showing that low student collaboration is closely associated with limited effective group learning. Research by Khasanah et al. (2023) demonstrates that students continue to exhibit low levels of collaboration skills, with 62% in the low category and 17% in the very low category, whereas only 4% are in the high category and 17% in the very high category. These results emphasize the need for learning efforts that can train students to work together more effectively in groups. These findings further emphasize that current learning practices have not yet successfully integrated cognitive and social-emotional aspects in a balanced manner.

Ideally, the learning process should involve students as active participants whilst fostering development of their creative thinking and collaborative skills. Implementing a learning approach that places students at the center is a strategic step towards creating meaningful learning experiences, thereby fostering deeper and more relevant understanding. Conversely, teacher dominance in the learning process risks hindering students' intellectual and social development. Therefore, engaging, enjoyable, and student-centered learning must be prioritized (Adnan et al., 2021). In this context, the teacher's role is crucial as a mentor who provides consistent feedback to help students build a comprehensive understanding (Sugiarti et al., 2021). Furthermore, teachers, as facilitators, play a role in fostering positive interactions that support students' understanding and collaboration (Mulbar et al., 2021). These challenges become more critical when examined within the context of science education, where learning ideally integrates both cognitive and social processes through active inquiry and collaboration.

Biology, as a subject that integrates conceptual understanding with real-life phenomena, should provide ample opportunities for students to explore and construct their own knowledge. However, these ideal conditions have not yet been fully realized in actual teaching practice. Azizah et al. (2025) suggest that biology teaching has not yet been fully effective in encouraging students to think creatively. In line with this, Cahya et al. (2023) state that students' collaborative skills have also not developed optimally. In fact, biology learning should develop thinking skills whilst facilitating a shift from passive to active engagement (Adnan & Bahri, 2018). This issue highlights the importance of designing a learning process that actively involves students and integrates cognitive and social aspects in a balanced manner.

Therefore, an instructional approach is needed that not only engages students actively but also integrates cognitive and social-emotional aspects simultaneously. Foster creative thinking and collaboration skills. Phenomenon-Based Learning (PhBL) may be applied as a potential solution. Adipat (2024) explains that PhBL provides students with the opportunity to explore real phenomena in depth through teamwork. Supriyadi et al. (2024) add that PhBL can be integrated into the learning process because it can train and improve students' thinking skills. PhBL is an innovative learning method that originated in Finland, a country known for its world-class education system (Schaffar & Wolff, 2024). In this learning method, students learn through real-life phenomena. They are encouraged to work together and utilize creative thinking to develop effective solutions to identified problems. Material studied is closely related to everyday experiences or current social issues, making learning more contextual and meaningful for students (Kangas & Rasi, 2021).

By incorporating constructivist approaches, teachers can make classroom learning more active and engaging (Adnan et al., 2019). PhBL reflects constructivist principles, especially when students are directly involved in investigating phenomena (Schaffar & Wolff, 2024). From a constructivist perspective, learning is an active endeavor in which learners construct knowledge from their experiences and reflective processes. Knowledge is not acquired through memorization or direct transfer from the teacher but is constructed personally by linking new information to prior understanding and experience (Adnan et al., 2021). PhBL provides students with space to explore, interpret, and construct meaning in contexts relevant to their lives.

The implementation of PhBL is highly relevant for addressing twenty-first-century challenges and aligns with Indonesia's curriculum. Prasetyo et al. (2023) state that the era of Merdeka Belajar (Freedom of Learning) demands the creation of a dynamic, contextually relevant learning environment that emphasizes the development of higher-order thinking skills rather than the passive reception of information. Results of Tongsoong & Jermtaisong's (2021) research show that applying PhBL significantly improves students' creative thinking skills, as evidenced by higher post-learning scores than pre-learning scores. Wongnil & Bongkotphet (2023) assert that the adoption of PhBL in educational settings has empirically improved students' collaboration skills. Meechandee & Meekaew (2025) emphasize that PhBL directly encourages students' social engagement. PhBL not only places students in group work situations but also requires meaningful interaction, open discussion, and joint decision-making.

This study aims to analyze the impact of Phenomenon-Based Learning (PhBL) on students' creative thinking abilities and collaborative skills in biology lessons. The findings of this study are expected to contribute to the development of teaching practices that integrate cognitive and social aspects, as well as support the creation of a learning environment that fosters creativity and collaboration as key 21st-century competencies.

METHODOLOGY

Research Design

This study employed a quasi-experimental research design. This approach was selected because the researcher was unable to exercise full control over external variables that might influence experimental procedures. Moreover, individual random assignment was not feasible, as the study was conducted within pre-existing classroom groups in the school setting. Research used a pretest–posttest control-group design. This design enabled assessment of students' baseline abilities prior to the intervention through a pretest and evaluation of their performance after the intervention through a posttest. An inclusion control group allowed for comparison of creative thinking and collaboration outcomes between students who received the instructional treatment and those who did not. Consequently, the impact of the implemented learning approach could be examined with greater precision and validity.

The experimental group was divided into three types: (1) PhBL type I (Direct Phenomenon), where students directly observed phenomena presented by the teacher in class (5 students per group); (2) PhBL type II (Indirect Phenomenon), where students observed phenomena through media, specifically videos (7 students per group); and (3) PhBL type III (Combined Phenomenon), where students observed phenomena both directly in class and through videos (9 students per group).

It should be noted that each experimental class consisted of 32 students, as described in the participant section. The numbers five, seven, and nine refer to the number of members in each discussion group within the class, not the total number of students in each experimental group.

Participant

The study population comprised all eleventh-grade students at SMA Negeri 3 Majene, totaling 5 classes. The sample was selected using a cluster random sampling technique, in which whole classes were randomly assigned to study groups to maintain a natural classroom setting. In this process, each class had an equal chance of being selected without changing the existing class composition. After randomization, four classes were selected as the study sample, comprising three experimental classes and one control class. Each class, both in the experimental and control groups, consisted of 32 students. Participants were generally 16-17 years old and had relatively similar academic backgrounds, as they were enrolled in the same grade and followed the same curriculum. These relatively homogeneous participant characteristics were considered important to minimize variability and ensure comparability between the experimental and control groups.

Instrument

The instrument was developed using Treffinger's creative thinking framework, which includes four indicators: fluency, flexibility, originality, and elaboration. Each indicator was assessed with a 1-to-4 scoring rubric; higher scores indicate stronger creative thinking. Before use, experts validated the instrument, confirming acceptable content validity. Table 1 presents the summary instrument grid.

Table 1. Creative Thinking Skills Instrument Grid

Indicator	Description (Aspect Assessed)	Score Criteria (1–4)
Fluency	Ability to generate multiple relevant ideas or solutions	4 = many relevant ideas with clear purpose; 3 = several ideas but less clear; 2 = one idea; 1 = no relevant idea
Flexibility	Ability to produce ideas from different perspectives	4 = ≥4 varied ideas; 3 = 2–3 ideas; 2 = 1 idea; 1 = no idea
Originality	Ability to generate unique or novel ideas	4 = highly unique ideas; 3 = somewhat unique; 2 = common ideas; 1 = irrelevant
Elaboration	Ability to develop and detail ideas	4 = very detailed with supporting facts; 3 = detailed; 2 = limited detail; 1 = unclear

Students' collaboration skills were assessed using an observation sheet based on Greenstein collaboration indicators, including responsibility, respect, contribution, work management, and teamwork. Each indicator was scored on four-point scale (1–4), with higher scores reflecting better collaboration skills. This instrument has been validated by experts and has been shown to meet the criteria for acceptance. Summary of collaboration instrument grid is presented in table 2.

Table 2. Collaboration Skill Instrument Grid

Indicator	Description (Aspect Assessed)	Score Criteria (1–4)
Responsibility	Commitment to completing tasks on time	4 = always responsible; 3 = often; 2 = rarely; 1 = not responsible
Respect	Respect for others' ideas and perspectives	4 = consistently respectful; 3 = mostly; 2 = sometimes; 1 = disrespectful
Contribution	Active participation and idea sharing	4 = very active; 3 = active when needed; 2 = limited; 1 = none
Work Management	Ability to plan, organize, and manage tasks	4 = well-organized; 3 = fairly organized; 2 = poorly organized; 1 = disorganized
Teamwork	Ability to collaborate and utilize team members' strengths	4 = highly collaborative; 3 = moderately; 2 = limited; 1 = no collaboration

Validity creative thinking and collaboration skills instrument was assessed by two academic experts. Both validators provided evaluations, feedback and suggestions for improvement to ensure the clarity, appropriateness and suitability of the instrument used. Results validity assessment are then presented in detail in table 3 and table 4.

Data Collection

Data collection techniques in this study consisted of written tests and observations. Creative thinking skills were measured using a written test, as this technique is effective in revealing students' ability to generate diverse, original, and detailed ideas in response to a given problem. The test consisted of four open-ended essay questions designed to assess various indicators of creative thinking. Students were given 90 minutes to complete the test.

Collaborative skills were measured through observation, as collaboration is a social skill shown in students' behavior during group activities. Observers assigned to each group monitored and recorded collaborative behaviors during learning activities, so the number of observers matched the number of groups.

Before data collection, all observers received training to ensure consistent and reliable observations. The training covered the observation instrument, assessment indicators, and objective recording of student behavior. Observers also conducted a brief simulation to align understanding and minimize interpretive differences. This procedure aimed to increase the validity and reliability of the data. Creative thinking was measured with a variable test to reveal students' ability to generate diverse, unique, and detailed ideas. Students were given questions to express their creative potential in writing. Collaboration skills were assessed through observation, as collaboration is best evidenced by actual social behavior in group work. Observers noted how students worked productively with peers, respected opinions, compromised, and fulfilled roles. Observation provided an authentic picture of students' interactions and contributions during learning activities.

Data Analysis

Once the research data have been collected, they will be analyzed using both descriptive and inferential statistical methods. Inferential analysis will be conducted to test the research hypotheses. Prior to hypothesis testing, normality and homogeneity tests will be carried out. If data satisfy the assumptions of normality and homogeneity, hypothesis testing will proceed using parametric (ANCOVA). To identify specific differences in students' creative thinking and collaboration skills among the learning groups, a post-hoc analysis will be performed using the Least Significant Difference (LSD) test.

FINDINGS

Validity Test of the Students' Creative Thinking and Collaboration Skills Instruments

The validity of the instrument designed to measure students' creative thinking and collaboration skills was rigorously examined to ensure that it accurately captures the intended constructs. Establishing instrument validity is a crucial step in educational research, as it determines the extent to which the items represent the theoretical dimensions of creative thinking and collaborative competencies. In this study, validity testing was conducted through a series of statistical procedures to evaluate the quality and appropriateness of each item within the instrument. The results of the validity analysis provide empirical evidence regarding the degree to which the instrument items align with the underlying constructs. These findings are essential for confirming that the instrument can be reliably used to assess students' creative thinking and collaboration skills in a meaningful and interpretable manner. The detailed results of the validity testing are presented in the following section.

Table 3. Validity of the Creative Thinking Skills Instrument

Assessment Aspect	Assessment Score	Category
Content Suitability	5.00	Very Valid
Structural Feasibility	4.50	Very Valid
Language Appropriateness	4.66	Very Valid
Average	4.72	Very Valid

Validity test results for creative thinking and collaboration skills instruments indicate that developed instruments are classified as highly valid and are appropriate for use. Subsequent stage involves conducting data analysis, encompassing both descriptive and inferential statistical analyses. Inferential analysis includes tests of normality, homogeneity, hypothesis testing, and post-hoc analysis using LSD method.

Table 4. Validity of the Collaboration Skills Instrument

Assessment Aspect	Assessment Score	Category
Content Suitability	5.00	Very Valid
Structural Feasibility	4.62	Very Valid
Language Appropriateness	4.83	Very Valid
Average	4.81	Very Valid

Creative Thinking Skills

Descriptive Statistical Analysis

Descriptive statistics were used to analyze creative thinking skills of students in the experimental and control groups, both prior to (pre-test) and following (post-test) implementation of the intervention. Findings are summarized in table 5 below:

Table 5. Descriptive Statistics of Creative Thinking Skills

Treatment Group	Test Type	Average	Median	Standard Deviation	Lowest Score	Highest Score
Experiment 1	Pre-test	21.63	21.00	5.55	12	30
	Post-test	72.19	74.00	9.43	56	84
Experiment 2	Pre-test	23.22	23.00	4.64	16	34
	Post-test	70.19	70.00	7.67	53	86
Experiment 3	Pre-test	22.13	21.00	5.92	12	33
	Post-test	73.63	74.00	8.84	58	89
Control	Pre-test	22.91	22.50	5.59	14	33
	Post-test	66.09	67.00	10.83	46	84

Based on table 5, results for creative thinking skills prior to instruction using PhBL Type I (Direct Phenomenon) in Experimental Group 1 yielded an average of 21.63. After instruction using PhBL Type I (Direct Phenomenon), the mean was 72.19. Results of creative thinking skills prior to instruction using PhBL Type II (Indirect Phenomenon) in experimental group 2 were 23.22. After being taught using PhBL Type II (Indirect Phenomenon), the average was 70.19. Results of creative thinking skills before teaching PhBL Type III (Combined Phenomenon) in experimental group 3 yielded an average of 22.13. After being taught using PhBL type III (Combined Phenomenon), the average was 73.63. Results of creative thinking skills before being taught using STAD in the control group yielded an average of 22.91. After being taught using STAD, the average score was 66.09. Overall, these descriptive statistics indicate that the teaching methods applied to the experimental group led to greater improvement in creative thinking skills than those in the control group.

Normality Test

Determine whether data were normally distributed, Kolmogorov–Smirnov test was applied. Findings of the normality test for impact of PhBL on the creative thinking skills of Grade XI students at State Senior High School 3 Majene are summarized in table 6.

Table 6. Results of Normality Test for Creative Thinking Skills

	Class	Sig.	Description
Pre-test	Experiment 1	0.150	Normal
	Experiment 2	0.091	Normal
	Experiment 3	0.113	Normal
	Control	0.141	Normal
Post-test	Experiment 1	0.113	Normal
	Experiment 2	0.200	Normal
	Experiment 3	0.200	Normal
	Control	0.200	Normal

Results of the Kolmogorov–Smirnov test indicated that the significance values for students' creative thinking skills before and after the intervention were greater than 0.05. This suggests that data are normally distributed and suitable for further parametric analysis.

Homogeneity Test

Data homogeneity was assessed to determine equality of variances. Results of the Levene's test conducted using SPSS are shown in table 7.

Table 7. Results of the Homogeneity Test for Creative Thinking Skills

	Levene Statistic	Sig.	Description
Pre-test	1.457	0.230	Homogeneous
Post-test	1.735	0.163	Homogeneous

Based on decision made following the homogeneity test of data for the variable 'students' creative thinking skills' before and after intervention, significance value was > 0.05 (significance level of more than 0.05) it can therefore be concluded that scores for variable 'creative thinking skills' are homogeneous.

Hypothesis Test

After meeting the prerequisite tests, namely normality and homogeneity, the next step was to perform hypothesis testing using Analysis of Covariance (ANCOVA). ANCOVA is used to examine whether there is a treatment effect on the dependent variable while controlling for the influence of covariates. Results of the ANCOVA test on creative thinking skills are presented in table 8.

Table 8. Results of the Hypothesis Test for Creative Thinking Skills

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	1784.063[a]	3	594.688	6.186	0.001
Intercept	625521.125	1	625521.125	6506.655	0.000
Group	1784.063	3	594.688	6.186	0.001

Table 8 presents results of ANCOVA test based on tests of between-subject effects for treatment group, showing an F-value of 6.186 and significance level below 0.05 (0.001 < 0.05). This indicates that Phenomenon Based Learning has effect on students' creative thinking skills.

Least Significant Difference (LSD) Test

Table 9 illustrates the results of the LSD test performed to evaluate differences in students' creative thinking skills.

Table 9. LSD Test Results for Creative Thinking Skills

Group Comparison	Difference in Mean	Sig.	Description
Experiment 1 – Control	7.719*	0.002	Significantly different
Experiment 2 – Control	7.219*	0.004	Significantly different
Experiment 3 – Control	9.938*	0.000	Significantly different
Experiment 1 – Experiment 2	0.500	0.839	Not significant
Experiment 1 – Experiment 3	-2.219	0.367	Not significant
Experiment 2 – Experiment 3	-2.719	0.270	Not significant

Based on results of the LSD post hoc test, differences in mean scores between groups regarding creative thinking skills were identified. Decisions were based on mean differences and significance values. Significant differences are indicated by an asterisk (*) next to the mean difference and significance value of less than 0.05, whilst non-significant differences are indicated by the absence of an asterisk and significance value exceeding 0.05. Results of LSD test indicate that all experimental groups differed significantly from the control group. This suggests that implementation of Phenomenon Based Learning (PhBL), regardless of its type, is more effective in enhancing students' creative thinking skills compared to learning using STAD. However, no significant differences were found among experimental groups. This suggests that the three types of PhBL (Direct, Indirect, and Combined) have relatively similar levels of effectiveness in enhancing students' creative thinking skills. In other words, although each type of PhBL involves different approaches, they all provide comparable learning experiences that equally support the development of creative thinking skills.

Collaboration Skills

Descriptive Statistical Analysis

Descriptive statistics were used to examine students' collaboration skills in the experimental and control groups, both prior to (pre-test) and following (post-test) intervention. Results are summarized in table 10 as follows:

Table 10. Descriptive Statistics of Collaboration Skills

Treatment Group	Test Type	Average	Median	Standard Deviation	Lowest Score	Highest Score
Experiment 1	Pre-test	47.51	46.59	10.49	29.54	68.18
	Post-test	79.19	79.54	9.23	63.63	93.18
Experiment 2	Pre-test	54.75	55.68	8.64	38.63	70.45
	Post-test	78.55	78.40	7.34	65.90	90.90
Experiment 3	Pre-test	53.62	53.40	10.42	36.36	70.45
	Post-test	76.63	76.13	8.16	63.63	90.90
	Pre-test	53.26	53.40	10.84	36.36	70.45
	Post-test	73.72	72.72	7.43	59.09	90.90

Based on table 10, results for collaboration skills prior to instruction using PhBL Type I (Direct Phenomenon) in Experimental Group 1 showed an average of 47.51. After instruction using PhBL Type I (Direct Phenomenon), the mean was 79.19. Results for collaboration skills prior to instruction using PhBL Type II (Indirect Phenomenon) in experimental group 2 yielded an average of 54.75. After instruction using PhBL Type II (Indirect Phenomenon), the average score was 78.55. Results for collaboration skills prior to being taught PhBL Type III (Combined Phenomenon) in experimental group 3 yielded an average of 53.62. After being taught using PhBL Type III (Combined Phenomenon), the average score was 76.63. Collaborative skills results prior to instruction using STAD in the control group yielded an average of 53.26. After being taught using STAD, the average score was 73.72. Overall, all groups showed an increase in their average collaborative skills scores following the intervention. The experimental group had a higher post-test average than the control group, with varying degrees of improvement across the different types of PhBL.

Normality Test

Determine whether data were normally distributed, Kolmogorov–Smirnov test was applied. Results of this analysis, focusing on effect of PhBL on collaboration skills of Grade XI students at State Senior High School 3 Majene, are presented in the table 11 below.

Table 11. Results of the Normality Test for Collaboration Skills

	Class	Sig.	Description
Pre-test	Experiment 1	0.200	Normal
	Experiment 2	0.188	Normal
	Experiment 3	0.128	Normal
	Control	0.950	Normal
Post-test	Experiment 1	0.200	Normal
	Experiment 2	0.200	Normal
	Experiment 3	0.200	Normal
	Control	0.200	Normal

Based on Kolmogorov–Smirnov test, all collaboration skills data, both prior to and following the intervention, showed significance values above 0.05. This indicates that the data satisfy the assumption of normality.

Homogeneity Test

Homogeneity test was performed to assess equality of variances in data, using Levene's test through SPSS. Findings of this test, particularly in relation to effect of PhBL on students' collaborative skills, are presented as follows.

Table 12. Results of the Homogeneity Test for Collaboration Skills

	Levene Statistic	Sig.	Description
Pre-test	1.457	0.230	Homogeneous
Post-test	1.209	0.309	Homogeneous

Findings of homogeneity test revealed that significance values for students' collaborative skills, both before and after the treatment, were above 0.05. This indicates that data meet assumption of homogeneity of variances.

Hypothesis Test

Data met normality and homogeneity assumptions. Hypothesis test was then conducted using Analysis of Covariance (ANCOVA) to determine effect of treatment on dependent variable after controlling for influence of the covariates.

Table 13. Results of the Hypothesis Test for Collaboration Skills

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	578.674[a]	3	192.891	2.952	0.035
Intercept	759388.075	1	759388.075	11623.143	0.000
Group	578.674	3	192.891	2.952	0.035

As shown in table 13, results of ANCOVA based on between-subjects effects test yielded an F-value of 2.952 with significance level of 0.035 ($p < 0.05$). These findings indicate that PhBL has an effect on students' collaboration skills.

LSD (Least Significant Difference) Test

Table 14 illustrates the results of the LSD test performed to evaluate differences in students' collaboration skills.

Table 14. LSD Test Results for Collaboration Skills

Group Comparison	Difference in Mean	Sig.	Description
Experiment 1 – Control	5.468*	0.008	Significantly different
Experiment 2 – Control	4.829*	0.018	Significantly different
Experiment 3 – Control	2.911	0.152	Not significant
Experiment 1 – Experiment 2	0.639	0.752	Not significant
Experiment 1 – Experiment 3	2.556	0.208	Not significant
Experiment 2 – Experiment 3	1.917	0.344	Not significant

Based on results of post hoc tests, differences in collaborative skills were identified among groups. This conclusion is based on mean differences and significance levels, where significance value of less than 0.05 indicates statistically significant difference. Analysis showed that there were no significant differences amongst experimental groups (Experimental Groups 1, 2, and 3). This suggests that all types of Phenomenon Based Learning (PhBL) applied to experimental groups had relatively similar effectiveness in improving students' collaborative skills. Furthermore, Experimental Groups 1 and 2 showed significant differences compared to control group, indicating that PhBL Type I (Direct Phenomena) and Type II (Indirect Phenomena) are more effective than STAD learning in enhancing students' collaborative skills. Conversely, Experimental Group 3 did not show significant difference from the control group, suggesting that PhBL Type III (Combined Phenomenon) did not yield significant improvement in collaborative skills compared to the control condition. These findings imply that whilst PhBL generally supports the development of collaborative skills, not all variations of its implementation produce significantly different results when compared to STAD learning.

DISCUSSION

The Effect of Phenomenon Based Learning on Creative Thinking Skills

Results descriptive analysis indicate an improvement in students' creative thinking skills, as evidenced by the pre-test and post-test scores for each group. Based on the post-test averages, the experimental groups achieved higher scores compared to control group. Inferential analysis further shows implementation PhBL learning significantly influenced students' creative thinking skills, as demonstrated by significance value below established threshold. LSD post hoc test reveals that there are no significant differences among experimental groups 1, 2, and 3, suggesting that improvement creative thinking skills across these groups was relatively similar. In contrast, all experimental groups exhibited significant differences from the control group, indicating that intervention provided experimental groups was more effective than conventional learning experienced by the control group.

Results align with findings reported by Asahid & Lomibao (2020), showing that the PhBL approach contributes to the development of students' creative thinking skills by encouraging them to produce variety of solutions throughout the learning process. Impact of PhBL on students' creative thinking skills can be attributed to its use of real-life phenomena as the starting point of learning, which encourages learners to actively observe, pose questions, and construct their own understanding. In biology learning, these phenomena function not only as stimuli but also as bridge connecting scientific concepts with everyday experiences. Such conditions promote deeper cognitive engagement, motivating students to generate diverse ideas, explore alternative solutions, and develop more comprehensive and flexible understanding. From a constructivist perspective, this process occurs because students are actively involved in restructuring their prior knowledge through interaction with phenomena, which stimulates thinking processes such as analysis, synthesis, and idea generation. As result, creative thinking skills are enhanced because students are not merely passive recipients of information but actively participate in the process of constructing and refining knowledge.

These outcomes are corroborated by previous research conducted by Tongsoong & Jermtaisong (2021), which shows that PhBL can improve creative thinking skills. Adipat (2023) similarly emphasises that the integration of PhBL significantly contributes to improving student creativity. These advantages are in line with the characteristics of PhBL, which is holistic, authentic, contextual, and inquiry based, as stated by Akkas & Eker (2021) & Jongyung (2025). These characteristics create learning environment that supports divergent thinking, where students are encouraged to explore multiple perspectives and generate varied solutions rather than focusing on a single correct answer.

The increase in creativity in this study developed through the PhBL learning stages. Presenting phenomena as the initial context encouraged students to formulate interdisciplinary questions, which trained their flexibility. This is in line with Walker & Nouri's (2025) view that phenomena as the starting point of learning stimulate multidisciplinary thinking activities. The aspect of fluency developed through open-ended questions on the worksheet that encouraged students to develop diverse ideas and potential solutions, as explained by Narvaza & Manla (2024) fluency reflected number relevant ideas generated by students. Context of this study, fluency was evident when students were able to identify various types of nutrients, explain their effects, and propose alternative solutions in a variety of ways.

Elaboration develops through students' ability to provide more in-depth explanations, both through written answers on worksheets and through verbal explanations during group discussions. These outcomes align with the findings of previous research conducted by Oktavia et al. (2025), which shows that the aspect of elaboration in creative thinking skills analysed through the quality explanations and development of ideas produced by students. In line with these findings, Fauzi & Wuryandani (2025) also found that learning activities that require students to provide detailed explanations and develop in-depth responses, both through writing and group discussions, contribute to strengthening students' thinking skills, including elaboration as one of the main indicators. Meanwhile, the aspect of originality emerges through creative tasks that give students the freedom to choose the form of their work (PPT, video, poster, or infographic), which, according to Kim & Dumas (2025), can increase the emergence of unique and diverse ideas. Providing autonomy in task representation allows students to express their understanding in novel ways, thereby fostering originality as core component of creative thinking.

Subsequent analysis revealed no significant differences between PhBL types. Average experiment group 3 tended to be higher than the other types, followed by experiment group 1, then experiment group 2. Theoretically, direct phenomena provide authentic experiences and real interactions Regarding the learning process, as noted by Adipat (2024); Siri et al. (2024) stated that presenting phenomena directly in PhBL learning provides situations allowing students to interact directly with learning materials or items to facilitate the learning process becomes realistic and contextually meaningful, encouraging students to produce a variety of ideas and more in-depth explanations. Shao et al. (2024); Ramish et al. (2024) state that direct experience in learning has a unique role in constructing meaning through physical interaction and real observation, allowing students to relate concepts to their concrete experiences. This condition helps strengthen understanding while increasing students' active involvement in the creative thinking process, including in generating new ideas and developing more complex ideas.

Indirect phenomena through video can provide visual stimuli that enrich observation and generate ideas, as stated by Santhalia & Yuliati (2021); Cano et al. (2023) that video presentation allows enabling students to investigate phenomena that cannot be seen firsthand, thereby broadening their perspective in analysing phenomena. The combination of direct and indirect phenomena, as applied in experimental group 3, provides a more comprehensive learning experience, enabling students to compare, analyse, and synthesise information from various sources, which ultimately promotes the cultivation of flexible and fluent thinking. This integration of multiple representations supports cognitive flexibility, allowing students to shift between different perspectives and develop more varied and creative solutions.

The study shows that the stages and characteristics PhBL systematically facilitate the development of all indicators of creative thinking skills. Although variations in PhBL types did not show statistically significant differences, the phenomenon-based approach was generally proven to be more effective than STAD learning in developing students' creativity.

The Effect of Phenomenon Based Learning on Collaboration Skills

Results descriptive analysis indicate that during the pre-test phase, highest average collaboration skill score was observed in experimental group 2, followed by experimental group 3 and the control group, while experimental group 1 had lowest average score. In the post-test phase, all groups showed an increase in their average collaboration skill scores compared to pre-test. Experimental group 1 achieved highest average score, followed by experimental groups 2 and 3, with the control group having the lowest average. Inferential analysis further revealed implementation of PhBL learning had effect on students' collaboration skills. LSD post hoc test indicated that there were no significant differences among experimental groups 1, 2, and 3. However, experimental groups 1 and 2 demonstrated significant differences compared to control group, while experimental group 3 did not show significant difference from the control group.

Results of this study align with Jongyung (2025) view that PhBL is intended to foster various skills, including students' ability to collaborate. In this approach, students are guided to engage in teamwork, distribute responsibilities, share their findings, and build shared understanding. In biology education, particularly in studying the digestive system, this approach is highly meaningful because conceptual understanding involves not only theory but also examining the processes that occur within the human body. Through PhBL, students explore phenomena related to digestion, such as how food breaks down, the function of enzymes, and various digestive disorders. Each group member contributes through specific role, for example by gathering information, analyzing function of digestive organs, or linking eating habits to digestive health. These interactions encourage exchange of ideas, help clarify misunderstandings, and support development of shared arguments. This process can be explained through social constructivist perspective, which emphasises that knowledge is actively constructed through interaction and dialogue among learners. When students discuss and negotiate their understanding of digestive processes, cognitive conflict may arise, prompting them to reorganise their prior knowledge into more scientifically accurate concepts. As result, collaborative activities not only deepen students' understanding of digestive process but also enhance their ability to work together to address contextual problems.

Findings are also supported byWongnil & Bongkotphet (2023), who state that PhBL contributes to improving students' collaboration skills in the context of 21st-century competencies. Lack of statistically significant differences among the experimental groups, can be explained by fact that all three applied the same learning stages, as stated by Sizemore et al. (2024) that the use of uniform materials and stages has the potential to produce relatively equivalent outcomes. The PhBL stages used refer to Akkas & Eker (2021), which include 1) the learning teacher begins by asking questions or posing problems, (2) group discussion, (3) collaborative information search, (4) discovery of facts, (5) the use of the 'know-want-learn' (K W-L) strategy, and (6) planning and knowledge development. These stages systematically create opportunities for interaction, shared responsibility, and joint problem solving, which are essential elements in development of collaborative skills.

Responsibility indicators as part of collaboration skill indicators are reflected in students' ability to complete tasks according to their roles and manage time effectively. This is in line with the findings of Zhou; Colomer & Kusumaningsih & Sun (2025) that group learning can develop responsibility. Valente et al. (2024); Smith (2025) added that clear task completion targets also strengthen collaboration within groups. Respect indicators are evident through polite interactions, mutual listening, and respect for differences of opinion. This is in line with the research by Nzuza & Chitiyo (2024); Dilor (2025), which states that respect improves the quality of group interactions. In the context of biology learning, especially when discussing complex topics such as digestive disorders, differences in understanding often emerge, requiring students to regulate their emotions and respond constructively to peers' perspectives.

Contribution indicator is reflected in the enthusiasm of students in expressing ideas, responding to friends' opinions, and actively participating in information exchange, feedback, and collaborative problem solving. These activities show that students are not only present in the group but also play an active role in building a common understanding. These findings are supported by Ciuciulkiene et al. (2024); Jongyung (2025), who point out that PhBL encourages students to actively participate in collaborative inquiry by sharing ideas, gathering information, offering feedback, and solving problems as group. Such active engagement is closely related to the concept of positive interdependence, where students realise that group success depends on the active participation of all members, thereby motivating them to contribute more meaningfully.

Indicators of task management are reflected in the group's agreement on task distribution, time management, and workflow organisation so that group activities run smoothly. This management process helps students understand their respective roles and adjust their work steps to the objectives to be achieved. PhBL learning can train work management skills, as supported by Walker & Nouri (2025) and Thammaratthara, Boonlue, Maneewan, & Thamwipat (2025), who state that PhBL can develop students' abilities to plan task completion and develop time management strategies together.

Teamwork is formed through the involvement of all group members in solving the problems given. Students work together and combine their work through discussion until they reach a common understanding. In this way, students will be trained to improve one of their collaboration skills, namely teamwork. The outcomes of this study align with the research carried out by Utami et al. (2024), which states that PhBL can improve students' teamwork competencies because PhBL requires students to actively collaborate in groups and supports the formation of solid teamwork in the learning process.

Significant variations exist between experimental groups 1 and 2 and the control group may be due type of task, level of cognitive demand, and patterns of interaction that developed during the learning process. Thus, the quality of collaborative interaction that occurred was a major factor influencing these differences in results. This is in line with the statements by Hsu (2020) and Zabolotna et al. (2025), who mentioned that the type of task can influence how students interact and organise their work in groups, thereby impacting the process of building knowledge together. In STAD learning, discussions serve more as reinforcement of the material after the teacher's explanation, as explained by Pinem et al. (2025) that in STAD learning, questions are given after the teacher delivers the material and serve to reinforce learners' understanding of the instructional content delivered.

Insignificant difference between experiment 3 and the control group may be influenced by the number of group members. Experimental group 1 consisted of 5 students, experimental group 2 had 7 students, and experimental group 3 included 9 students per group. Research by Wang et al. (2023); Chen et al., (2024) shows that smaller groups tend to produce more intense interactions than larger groups. The ideal range of group members according to Shih & Chang (2020) is 2–7 students, and according to Zuhriyah (2021) is 3–5 students. Thus, the number of members in experiment 3, which exceeded the ideal range, is suspected to have reduced the even distribution of participation, resulting in suboptimal collaboration development.

Larger group sizes may lead to unequal participation, where some students become passive observers rather than active contributors, thereby weakening the collaborative learning process.

Implementation PhBL learning demonstrates positive effect on students' collaboration skills. However, not all experimental groups differed significantly from the control group. PhBL stages consistently facilitate the development of responsibility, respect, contribution, work management skills, and teamwork in the learning process. Overall, these findings highlight that the effectiveness of PhBL in enhancing collaboration skills is not only determined by its instructional design but also by quality of interaction, group structure, and the extent to which students actively engage in the learning process.

CONCLUSION

Study found that implementing Phenomenon Based Learning enhanced both creative thinking and collaboration skills of Grade XI students at Majene State Senior High School 3. All experimental groups showed higher post-test scores than the control group, with significant improvements in creative thinking, while no significant differences were found among the different PhBL types. Collaboration skills also improved, especially in experimental groups 1 and 2, though group 3 showed no significant difference, likely due to its larger size affecting interactions. These findings suggest that the effectiveness of PhBL is influenced more by the quality of interaction and group dynamics than by variations in its implementation.

This study contributes to science education by demonstrating that PhBL can effectively support the simultaneous development of students' creative thinking and collaboration skills in biology learning, particularly when engaging with conceptually complex topics such as the digestive system. Overall, PhBL promotes both the generation of diverse and meaningful ideas as well as the development of responsibility, respect, contribution, work management, and teamwork as essential 21st-century competencies.

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