Journal of General Education and Humanities
Vol. 5, No. 1, February 2026, pp. 1629 – 1637, https://doi.org/10.58421/gehu.v5i1.1126
ISSN 2963-7147

The Effect of the Problem-Based Learning Model on Creativity and Collaboration Skills in Science Learning among Fifth-Grade Students of SD Negeri 4 Palu

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Article Info

Article history:

Received 2026-01-24
Revised 2026-02-22
Accepted 2026-02-22

Keywords:

Collaboration
Creativity
Problem-Based Learning
Science Learning

ABSTRACT

This study was conducted to address the low levels of creativity and collaboration skills among fifth-grade students at SD Negeri 4 Palu, which were attributed to the use of conventional teaching practices. The objective of this research was to examine the effect of the Problem-Based Learning (PBL) instructional model on students' creativity and collaboration skills in science learning. The study employed a pre-experimental design with a one-group pretest–posttest. The research subjects were 16 fifth-grade students selected through saturated sampling. Data were collected through questionnaires, observations, and documentation, and analyzed using a Paired-Samples T-Test in SPSS version 30. The results revealed a significant increase in students' creativity scores, with the mean rising from 19.38 in the pretest to 28.69 in the posttest. Similarly, the mean collaboration score increased from 21.13 to 31.88. Hypothesis testing showed a significance value of less than 0.001 (Sig. < 0.05), indicating that the Problem-Based Learning model had a statistically significant effect on improving students' creativity and collaboration skills. These findings suggest that implementing PBL effectively enhances essential 21st-century skills in elementary science learning.

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1. INTRODUCTION

Education plays a fundamental role in improving the quality of human resources and fostering meaningful changes in individual and societal life [1]. According to Law of the Republic of Indonesia Number 20 of 2003 concerning the National Education System, education is defined as a conscious and planned effort to create a learning atmosphere that enables students to actively develop their potential, including spiritual strength, self-control, intelligence, noble character, and necessary skills for society and the nation [2]. In the current era, education must also respond to global challenges and rapid technological development.

Twenty-first-century Learning emphasizes mastery of four essential skills, known as the 4Cs: critical thinking, creative thinking, communication, and collaboration [3]. These competencies are crucial because technological advancement continues to influence educational systems worldwide. Hoyles and Lagrange, as cited in Putrawangsa and Hasanah, explain that digital technology has become one of the most influential factors shaping modern education systems [4]. Therefore, learning processes must be designed to facilitate the development of higher-order thinking skills, particularly creativity and collaboration.

Science learning plays an important role in fostering these competencies. Science is a discipline that systematically studies natural phenomena through observation and inquiry processes [5]. In science learning, students are expected to apply higher-order thinking skills to understand concepts and solve contextual problems [6]. Creative thinking skills enable students to generate original ideas and develop innovative solutions to problems encountered during learning activities [7]. Furthermore, creative thinking supports students in strengthening their reasoning abilities and improving problem-solving performance [8].

Collaboration skills are equally important in 21st-century education. Collaboration refers to cooperative activities in which individuals support one another to achieve common goals [9]. Within the Merdeka Curriculum framework, collaboration is emphasized as a key competence that encourages students to express and defend their ideas logically [10]. Effective collaboration also involves exchanging ideas, organizing information, analyzing problems, and constructing a deeper understanding through interaction with peers [11].

However, preliminary observations conducted at SD Negeri 4 Palu revealed that the creativity and collaboration skills of fifth-grade students remain relatively low. Learning activities are still dominated by conventional teaching models, resulting in limited student participation and minimal engagement in group discussions. Students often struggle to express ideas confidently, complete group assignments effectively, seek learning resources independently, and present discussion results. This situation indicates a gap between the expected 21st-century competencies and the actual classroom practices.

To address this issue, teachers need to implement instructional models that actively engage students in meaningful and problem-oriented learning experiences. One instructional model that has been shown to foster creativity and collaboration is Problem-Based Learning (PBL). Problem-Based Learning is recognized as a model that enhances creative thinking and problem-solving through structured problem scenarios [12]. The model emphasizes student-centered discussion processes that stimulate creative idea generation through collaborative activities [13].

Problem-Based Learning is particularly appropriate for elementary school students in the concrete operational stage of cognitive development. At this stage, students develop logical thinking skills that are closely related to concrete and contextual experiences [14]. In addition to improving creative thinking, PBL has also been shown to enhance collaboration skills through cooperative problem-solving tasks [15]. Research indicates that PBL supports the development of higher-order thinking skills necessary to respond to rapid technological and social changes [16]. Moreover, implementing PBL encourages students to use information effectively, communicate knowledge, and work collaboratively to achieve optimal learning outcomes [17].

Although previous studies have demonstrated the effectiveness of Problem-Based Learning in improving creative thinking or collaboration skills, most research has been conducted at the secondary education level or has focused on only one variable. Limited studies examine the simultaneous effect of PBL on both creativity and collaboration skills in elementary science learning, particularly in the context of SD Negeri 4 Palu. This condition reveals a research gap that needs further investigation.

Based on this background, this study aims to examine the effect of the Problem-Based Learning model on creativity and collaboration skills in science learning among fifth-grade students at SD Negeri 4 Palu. The results of this research are expected to contribute theoretically to the development of innovative learning strategies in elementary education. Practically, the findings are expected to guide teachers in designing science learning activities that foster essential 21st-century skills, particularly creativity and collaboration.

2. METHOD

This study employed an experimental research approach using a quantitative method. An experimental design was selected because the study aimed to determine the effect of the Problem-Based Learning (PBL) model on students' creativity and collaboration skills in science learning. Quantitative methods were used to ensure that the data obtained could be measured objectively and analyzed statistically to produce verifiable conclusions [18]. The research design used was a one-group pretest–posttest design, which is categorized as pre-experimental research. In this design, a single group of participants was observed before and after treatment, without a control group. Students' creativity and collaboration skills were measured prior to the implementation of the PBL model (pretest) and again after the intervention (posttest). The difference between pretest and posttest scores indicated the effect of the PBL treatment on the observed variables [19].

Table 1. One-Group Pretest–Posttest Research Design

Group	***Pretest***	**Treatment**	***Posttest***
Experimental	O_1	X	O_2

The study was conducted at SD Negeri 4 Palu, located in Kamonji Village, West Palu District, Palu City. The research was carried out in December 2024. The study population consisted of all fifth-grade students at SD Negeri 4 Palu, totaling 16 students. Because the population was relatively small, a saturated sampling technique was used, in which all members of the population were included as research participants. Consequently, the sample size was equal to the population size, with 16 students participating in the study [20].

The independent variable in this study was the application of the Problem-Based Learning (PBL) model, while the dependent variables were students' creativity and collaboration skills in science learning. Creativity skills were defined as students' ability to generate original ideas, think flexibly, and elaborate solutions to problems, whereas collaboration skills referred to students' ability to work effectively with peers, participate actively, share responsibilities, and respect others' contributions during group activities [21], [22]. The relationship between the independent and dependent variables was examined as a

causal relationship, in which the implementation of the PBL model was expected to influence improvements in creativity and collaboration skills.

Data were collected using questionnaires, observations, and documentation. Questionnaires were used to measure students' creativity and collaboration skills based on predetermined indicators. Observations were conducted to examine students' learning activities and interactions during the implementation of the PBL model, while documentation was used to support and strengthen the primary data obtained from questionnaires and observations [23]. Data analysis was performed using descriptive statistics and inferential statistics. Prior to hypothesis testing, the data were examined for normality. Hypothesis testing was conducted using a Paired Sample T-Test with the assistance of SPSS version 30 to determine whether there were significant differences between pretest and posttest scores. A significance level of 0.05 was applied, with values below 0.05 indicating a statistically significant effect of the PBL model on students' creativity and collaboration skills [24].

3. RESULTS AND DISCUSSION

3.1 Descriptive Analysis of Students' Creativity and Collaboration Skills

This section presents descriptive results on the effect of the Problem-Based Learning (PBL) model on students' creativity and collaboration skills in science learning among fifth-grade students at SD Negeri 4 Palu. The descriptive analysis includes the highest, lowest, and mean scores from the pretest and posttest results for both observed skills.

Table 2. Descriptive Statistics of Pretest and Posttest Scores

Skill	Number of Students	Test	Highest Score	Lowest Score	Mean Score
Creativity	16	*Pretest*	24	15	19,38
		Posttest	32	25	28,69
Collaboration	16	*Pretest*	24	17	21,13
		Posttest	36	28	31,88

Based on the analysis presented in Table 2, the results can be described as follows. For creativity skills, the pretest scores ranged from 15 to 24, with a mean score of 19.38. After implementing the Problem-Based Learning model, posttest scores increased significantly, ranging from 25 to 32 (the maximum possible score), with an average of 28.69. This increase indicates a substantial improvement in students' creativity skills following the application of the PBL model.

For collaboration skills, the pretest results showed that students' scores ranged from 17 to 24, with a mean score of 21.13. After applying the Problem-Based Learning model, posttest scores ranged from 28 to 36, the maximum, with a mean of 31.88. The increase in both the score range and the average score demonstrates an improvement in students' collaboration skills after participating in learning activities based on the PBL model.

Overall, the descriptive data indicate a clear increase in both creativity and collaboration skills from the pretest to the posttest. These results suggest that implementing

the Problem-Based Learning model positively enhanced students' creativity and collaboration skills in science learning.

3.2 Normality Test Results

This study employed a normality test to ensure that the research data met the assumptions required for further statistical analysis. The normality test was conducted using the Shapiro–Wilk test in SPSS version 30, as the number of research participants was fewer than 50. The decision rule for this test stated that if the p-value was greater than 0.05, the data were considered normally distributed.

Table 3. Normality Test Results Using the Shapiro–Wilk Test

No.	Data	Statistik	df	*Sig.*	Description
1	*Pretest*	0.991	16	1,000	Normal
2	*Posttest*	0.973	16	0,882	Normal

Based on the results presented in Table 3, the significance value for the pretest data was 1.000, while the significance value for the posttest data was 0.882. Both values exceed the standard significance level of 0.05. Therefore, the pretest and posttest data were normally distributed.

Fulfillment of the normality assumption indicates that the data are suitable for further analysis using parametric statistical tests. Consequently, the hypothesis testing in this study could be conducted using the Paired Sample T-Test to examine the effect of the Problem-Based Learning model on students' creativity and collaboration skills.

3.3 Hypothesis Testing Results

The final stage of data analysis in this study was hypothesis testing, which aimed to answer the research question regarding the effect of the Problem-Based Learning (PBL) model on students' creativity and collaboration skills. Hypothesis testing was conducted to determine whether there was a statistically significant difference between students' pretest and posttest scores after the implementation of the PBL model. The statistical test used was the Paired Sample T-Test, a parametric test for comparing the means of two related samples.

The decision criteria used in this study were as follows. If the significance value (Sig.) were less than 0.05, the null hypothesis (Ho) would be rejected, and the alternative hypothesis (Ha) would be accepted. Conversely, if the significance value was greater than 0.05, the null hypothesis would be accepted, and the alternative hypothesis would be rejected.

Table 4. Paired Sample T-Test Results

Variabel	*Mean Difference*	t-hitung	*df*	*Sig.* (2-tailed)	Description
Pretest - Posttest	-20.875	-94.344	15	< 0,001	Signifikan

Based on the results presented in Table 4, the significance value (Sig. 2-tailed) obtained from the Paired Sample T-Test was < 0.001. According to the established decision criteria, because the p-value was less than 0.05, the null hypothesis (Ho) was rejected, and

the alternative hypothesis (Ha) was accepted. This result indicates a statistically significant difference between pretest and posttest scores following the implementation of the Problem-Based Learning model.

The mean difference value of -20.875 indicates a substantial increase in students' scores from the pretest to the posttest. The negative sign in the mean difference and t-value reflects that the posttest mean score was significantly higher than the pretest mean score. Therefore, the results of this hypothesis test statistically confirm that implementing the Problem-Based Learning model significantly improved students' creativity and collaboration skills in science learning.

3.4 Effect of Problem-Based Learning on Students' Creativity Skills

This study was conducted to address the problem of low creativity skills among fifth-grade students in science learning at SD Negeri 4 Palu. Based on initial observations, the low level of creativity skills was due to the use of conventional, teacher-centered learning models, which limited students' opportunities to explore ideas and engage actively in problem-solving. Therefore, the Problem-Based Learning (PBL) model was implemented as an instructional approach designed to actively involve students in investigating real-world problems.

Before implementing the PBL model, a pretest was administered to assess students' initial creativity skills. The descriptive analysis results showed that students' creativity skills were relatively low, with a mean pretest score of 19.38. These results indicate that students were not yet accustomed to learning activities that required them to generate original ideas or apply flexible thinking in solving problems. This condition reflects passive learning habits formed by limited variation in the instructional models used during previous learning activities.

After implementing the PBL model on the topic of properties of matter, students were actively involved in learning activities that followed the PBL model's syntax, including problem orientation, organizing learning activities, guided investigation, and presentation of results. During these activities, students were encouraged to observe phenomena, conduct simple experiments, and discuss findings within their groups. These learning experiences trained students to think creatively by analyzing problems, generating ideas, and concluding.

The effectiveness of the PBL model in enhancing creativity skills is evident from the significant increase in posttest scores, with the mean score rising from 19.38 to 28.69. This finding supports the theoretical perspective that Problem-Based Learning can enhance creative thinking skills by actively encouraging students to engage in problem-solving processes and collaborative discussions. According to Sanjaya, the PBL model can improve creative thinking skills by fostering initiative, independent Learning, and meaningful learning experiences through problem-solving activities [25].

3.5 Effect of Problem-Based Learning on Students' Collaboration Skills

In addition to creativity skills, this study also examined the effect of the Problem-Based Learning model on students' collaboration skills. Prior to implementing PBL, the pretest results showed that students' collaboration skills were relatively low, with a mean

score of 21.13. This condition was characterized by students' limited participation in group discussions, lack of responsibility in completing group tasks, and low confidence in expressing opinions during learning activities.

The PBL model required students to work in small groups to solve problems related to science concepts. Through collaborative activities such as group discussions, experiments, and joint presentations, students were encouraged to share responsibilities, exchange ideas, and respect differing viewpoints. These activities directly trained students to develop collaboration skills, including active participation, teamwork, and mutual support among group members.

The improvement in collaboration skills was clearly reflected in the posttest results, where the mean score increased significantly from 21.13 to 31.88. This increase demonstrates that students became more capable of working effectively with peers after participating in learning activities based on the PBL model. The findings of this study are consistent with the view that PBL actively involves students in collaborative problem-solving, thereby strengthening their ability to work together in achieving shared learning goals [26].

Furthermore, the results of this study align with previous research findings. A study conducted by Ishlahul and Yuyun Dwi Haryanti found that the PBL model positively affected students' creative thinking skills in science learning [27]. Similarly, research by Wahyu Hartina and Permana demonstrated that implementing PBL improved students' collaboration skills, as indicated by more intensive group discussions and more effective task distribution among students [28]. These findings reinforce the conclusion that the PBL model is effective in enhancing collaboration skills in elementary school learning contexts.

4. CONCLUSION

This study concludes that implementing the Problem-Based Learning (PBL) model positively contributes to the development of students' creativity and collaboration skills in elementary science learning. The findings confirm that student-centered, problem-oriented instructional approaches are effective in fostering active engagement, idea generation, teamwork, and shared responsibility among fifth-grade students. Thus, PBL can serve as an appropriate pedagogical strategy to support the development of essential 21st-century competencies at the elementary school level.

The implications of this research highlight the importance of shifting from conventional teacher-centered instruction to interactive and collaborative learning models. For teachers, the results provide practical guidance in designing science learning activities that integrate real-world problems to stimulate creativity and cooperative learning. For schools and curriculum developers, this study supports the integration of Problem-Based Learning within the Merdeka Curriculum framework to strengthen higher-order thinking skills and social competencies.

However, this research has several limitations. The study employed a pre-experimental design without a control group, which limits the ability to generalize the findings broadly. The sample size was relatively small and confined to a single elementary school, limiting the generalizability of the results to diverse student populations and

educational contexts. Additionally, the study focused only on creativity and collaboration skills within science learning, without examining other 21st-century competencies.

Future research is recommended to use a quasi-experimental or true-experimental design with larger, more diverse samples to strengthen the validity and generalizability of the findings. Further studies may also explore the long-term impact of PBL implementation, its effectiveness across different subjects, or its integration with digital learning technologies. This research contributes to the broader educational community by providing empirical evidence that supports the use of innovative learning models to enhance essential student competencies. Ultimately, the findings are expected to benefit educators, policymakers, and the general public by promoting instructional practices that prepare students to meet the challenges of the modern world.

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