Jurnal Profesi Pendidikan (JPP)
Volume 4, Number 2, December 2025
P-ISSN: 2829-0828 E-ISSN: 2828-8831
Open Access: https://journal.ikipsiliwangi.ac.id/index.php/jpp

Improving Creative Thinking Skills with the STEM Learning Model for Fifth Grade Elementary School Students

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Article Info

Article history:

Received November 01, 2025
Accepted December 15, 2025
Available online December 20, 2025

Keywords:

Creative Thinking, STEM learning model, Elementary School

DOI:
https://doi.org/10.22460/jpp.v4i2.29951

Abstract

This study aimed to examine the improvement of creative thinking skills through the implementation of the STEM (Science, Technology, Engineering, and Mathematics) learning model. The research employed a pre-experimental design using a one-group pretest–posttest quantitative approach. The participants consisted of 29 fifth-grade elementary school students. Data were collected through creative thinking skill tests administered before and after the implementation of the STEM model and analyzed using SPSS software. The data analysis included descriptive statistics, normality testing, hypothesis testing, and N-gain analysis. The results of the descriptive analysis showed a significant increase in students' creative thinking skills, with a mean score difference of 37.07 between the pretest and posttest. The normality test indicated that both pretest (0.232) and posttest (0.093) data were normally distributed. The paired-sample t-test revealed a significance value of 0.000 ($p < 0.05$), indicating a statistically significant improvement after the application of the STEM model. Furthermore, the N-gain score of 0.58 categorized the effectiveness of the STEM model as moderately effective. Based on these findings, it can be concluded that the STEM learning model effectively enhances creative thinking skills among fifth-grade elementary school students and contributes positively to the learning process.

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INTRODUCTION

21st-century education is increasingly inseparable from the use of information technology, especially in the context of a rapidly changing global world. Every advancement in knowledge technology not only brings positive impacts but also contributes to shifts in people's perspectives, values, and lifestyles (Rosiani, 2023). Therefore, the primary goal of education is no longer limited to mastering basic

knowledge, but is also directed at developing higher-order thinking skills, creativity, problem-solving, scientific and technological literacy, and lifelong learning skills to prepare them for facing sustainability challenges (Santi et al., 2021). In this context, 21st-century skills, known as the 4Cs, critical thinking, creativity, communication, and collaboration, are essential competencies that must be instilled from elementary school so that students can respond to global challenges adaptively and reflectively (Didik, 2024).

One key skill within the 4Cs framework is creative thinking, which is the ability of individuals to calmly and constructively address real-life problems through new, original, and previously unthinkable ideas (Yuniar & Hadi, 2023). Creative thinking is not only about generating ideas, but also encompasses the ability to apply ideas in unconventional ways, build connections across unfamiliar concepts, and explore new possibilities to achieve specific goals (Murphy et al., 2024). Thus, creative thinking is an essential foundation for deeply understanding problems and generating innovative solutions in the form of ideas and concrete projects.

However, field findings indicate that the level of creative thinking among elementary school students remains relatively low. Many students struggle to solve problems independently and flexibly. This condition is inextricably linked to learning practices that are still dominated by conventional approaches, where students tend to be directed to imitate teacher examples without adequate space for exploration. Consequently, students are only able to solve problems procedurally and demonstrate less originality in their ideas. Low student creativity is also influenced by a lack of experimental activities, limited contextual learning experiences, and the use of learning methods that lack variety and do not optimally encourage students' creative activity (Prastiwi & Yulianto, 2024; Kelana, *et, al*, 2022).

Efforts to address these problems require learning support through the application of appropriate models relevant to the demands of the 21st century. One approach considered in line with developing creativity is the STEM (Science, Technology, Engineering, and Mathematics) learning model. The STEM model is an innovative approach that integrates four disciplines to build conceptual understanding and higher-order thinking skills through authentic problem-solving (Fadhilah et al., 2024). This approach not only emphasizes mastery of scientific concepts but also encourages students to think critically and creatively, and develop the technological and engineering skills necessary to face global competition (Rahmawati & Juandi, 2022; Susilawati, *et al*, 2025).

Various previous studies have demonstrated the effectiveness of STEM learning in improving students' creative thinking skills. Research by Eviota and Liangco (2020) at SDN 3 Singotrunan, Banyuwangi Regency, showed that the use of STEM-based e-modules in science lessons, focusing on natural resource management and conservation, improved students' creative thinking indicators. Another study conducted by Murdiasih and Wulandari (2022) on students at SMP Negeri 1 Candi showed that the

application of STEM learning to food additives was quite effective in improving students' creative thinking skills in the moderate category. Meanwhile, Yuniar and Hadi (2023) reported that the application of the PBL model combined with mind mapping techniques in seventh-grade students resulted in good learning outcomes with an average score of 3.7.

However, most previous research has focused on junior high school students and specific science topics, and has not specifically linked the application of STEM learning to the development of innovative products designed and produced directly by elementary school students. Furthermore, studies that explicitly place creative thinking skills as the primary outcome in the context of elementary school science learning are still relatively limited. Therefore, this study has novel value by examining the application of the STEM learning model in fifth-grade elementary school science learning, specifically on the topic of human respiratory organs, combined with innovative product creation activities. This approach is expected to not only improve conceptual understanding but also significantly encourage the development of students' creative thinking skills through contextual, integrative, and meaningful learning experiences.

METHOD

This research employed a mixed-methods approach to data collection and analysis, combining quantitative and qualitative data. Furthermore, a sequential design was employed, beginning with quantitative data collection and then qualitative data analysis to describe the situation.

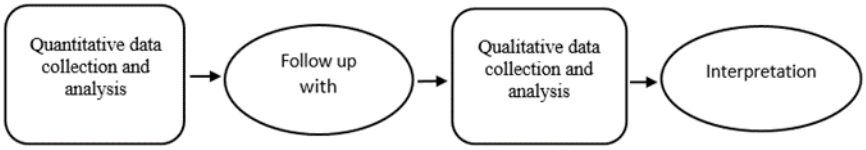

Figure 1. Sequential Explanatory Design
Source: Crewell & Clok 2018

This study used a pre-experimental approach conducted in one group. The following is the single-group pretest and posttest design:

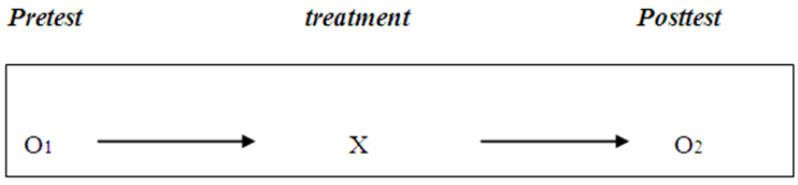

Figure 2. One-group pretest-posttest design

Based on the figure, O1 is the pretest on creative thinking skills before the treatment, X in the figure represents the treatment, namely the learning process using the STEM model, and O2 is the posttest on creative thinking skills after the treatment.

After the quantitative data were obtained, the data were analyzed using descriptive statistics. The subjects in this study were 29 fifth-grade students at SDN 2 Padasuka, Lembang District, with 16 female students and 13 male students. The instruments used were creative thinking skills test items, observation sheets, and interviews. The instruments were then validated by experts, tested for readability by teachers and students, and piloted. The data collected in this study consisted of quantitative and qualitative data. Quantitative data were obtained from the pretest and posttest results using SPSS, while qualitative data were obtained using observations and interviews. The data obtained were analyzed descriptively.

RESULT AND DISCUSSION

RESULT

The results of the research conducted revealed that the test questions distributed consisted of a pre-test and a post-test using the STEM model. The results of the pre-test and post-test can be seen in the following table:

Table 1. Results of Descriptive Analysis of Pretest and Posttest

Descriptive Statistics			
N	**Hasil**	**Rata-rata**	**Std.Deviation**
29	Pretest	34.9138	10.76292
29	posttest	71.9828	15.90119

Based on the table above, there was an improvement in the pretest assessment compared to the posttest assessment results. Based on the data analysis, there was a difference between the average pretest and posttest scores, with a difference of 37.07. The pretest and posttest results were administered to fifth-grade students to determine improvements in their creative thinking skills. The pretest was administered in the first meeting, which did not yet use the STEM model, while the posttest was administered after students had been exposed to learning using the STEM model. Each question contained indicators of creative thinking, indicating a significant improvement in students' creative thinking skills after the implementation of the STEM model.

This improvement was due to students' success in answering questions and their ability to work in teams. The study found that students strengthened teamwork, fostered team spirit, and evaluated and solved problems by developing collaborative solutions. In science learning, students were able to understand concepts, gather information, and develop ideas when needed (Hafiana, 2022).

Furthermore, the results were tested for normality using the Shapiro-Wilk T-test, which had a significance level of 0.05, which is the threshold for a value (sig). > 0.05 = the data can be said to be normally distributed, while if the significance value (sig.) < 0.05 = the data can be said to be non-normally distributed. The results of the normality test can be seen in the table below.

Table 2. Normality Test

	Sig.	Information
Pretest	.232	Normal
Posttest	.093	Normal

Based on the pretest and posttest results, the pretest result was 0.232 > 0.05, indicating a normal distribution. Meanwhile, the posttest result was 0.93 > 0.05, indicating a normal distribution. Therefore, it can be concluded that both data points are greater than 0.05, indicating that the fifth-grade students' creative thinking skills test results come from a normally distributed population.

A mean difference test was conducted to determine students' initial abilities before and after the treatment. Based on the hypothesis test requirements, if the sig (2-tailed) > 0.05, Ho is accepted and Ha is rejected. If the sig (2-tailed) < 0.05, H_o is rejected and H_a is accepted.

The proposed hypotheses are as follows:

H_o = There is no significant improvement in students' creative thinking skills after using the STEM learning model

H_a = There is a significant improvement in students' creative thinking skills after using the STEM learning model

Table 3. Hypothesis Testing

	Paired Sample Test		
	T	**df**	**Sig.(2-tailed)**
Pretest-Posttest	-18.455	28	0.000

Based on these results, the sig. (2-tailed) value is <0.05. Therefore, it can be concluded that based on the hypothesis that Ho is rejected and Ha is accepted. Therefore, the t-test results indicate a significant increase in the creative thinking skills of fifth-grade students after using the STEM learning model. The final step was to conduct an N-Gain test to determine the effectiveness of the STEM learning model in improving the creative thinking skills of fifth-grade students after using the STEM model. The following are the results of the N-Gain test.

Table 4. N-Gain Test

Cohen effect size	**Cohen effect size**
0.5888	Cukup

The N-Gain test results yielded a score of 0.5888. Therefore, the pretest and posttest results for the use of the STEM model on creative thinking skills in fifth-grade students fall within the sufficient category. Therefore, it can be concluded that the STEM learning model is quite effective in improving creative thinking skills in fifth-grade students. The improvement in students' creative thinking skills can be seen in the graph below.

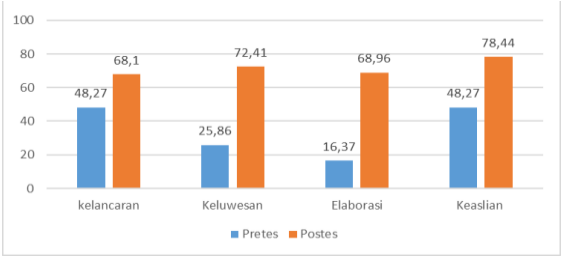

Figure 3. Graph of Average Creative Thinking Skills Indicators

From the average results of these indicators, the students' creative thinking skills that showed the highest increase were the originality indicator with an average difference between the pretest and posttest of 30.17, while the indicator with the lowest increase was the fluency indicator with an average difference between the pretest and posttest of 19.83.

DISCUSSION

Creative thinking skills in this learning activity are a skill every student must possess. Creative thinking skills are essential for generating ideas and arguments, asking questions, and enabling students to think openly and responsively in problem-solving (Isnaeni et al., 2021). Creative thinking skills also help students navigate daily life when faced with problems, generating new ideas for solving them. In line with Simanullang (2023), with creative thinking skills, students can understand problems through innovation and creativity. To determine the improvement in the creative thinking skills of fifth-grade elementary school students, a pretest and posttest were administered. The pretest was administered in the initial meeting before using the STEM model, with an average score of all students deemed incomplete, indicating low levels of creative thinking skills. Next, learning activities implemented the STEM model were conducted over four meetings.

After implementing the STEM model, a posttest was administered in the fourth meeting, with significant improvements in student achievement. The results are evident in the average score of 29 students, who achieved completion. This shows that the creative thinking skills of fifth grade students have increased. The above results align with previous research demonstrating that implementing the STEM model can improve creative thinking skills. Hany Hafiana (2022) stated that students strengthen teamwork, foster team spirit, and evaluate and solve problems by developing collaborative solutions. In science learning, students can understand concepts, gather information, and develop ideas when needed (Damayanti & Kelana, 2025). Therefore, the STEM model is an appropriate model for developing creative thinking skills through teamwork, sharing ideas, and developing collaborative solutions. Previous research indicates that STEM learning can enhance creativity because students participate and learn about their environment comprehensively (Nurjanah 2020).

To determine whether there is an improvement in creative thinking skills using the STEM model, several tests were conducted: a normality test, a paired sample t-test, and an n-gain test. Based on these analysis results, it can be seen that the use of the STEM model, according to the criteria, is quite effective in improving creative thinking skills in fifth-grade elementary school students. Steps that can improve creative thinking skills are seen in fluency, where students are able to generate multiple ideas and solutions to a problem. This technique helps students generate new ideas and opinions. The next step is flexibility in thinking, where students see problems not only from a single perspective but also from multiple perspectives. The next step is elaboration, where students can detail an idea to improve its quality. The next step is authenticity, where students can generate or develop new ideas in depth. These steps align with the characteristics of STEM, namely integrating disciplinary knowledge and skills into a learning experience, in student-centered learning, which includes project-based learning based on real-life situations.

Based on the description above, there is an increase in students' creative thinking skills using the STEM model through activities such as designing and making products. Teamwork to seek information and exchange ideas helps students enhance their creativity, which is related to everyday life.

CONCLUSION

Based on the research results, it can be concluded that the implementation of the STEM learning model can significantly improve the creative thinking skills of fifth-grade elementary school students. The results of the quantitative analysis showed a significant increase between the pretest and posttest scores, with an average difference of 37.07, and supported by the results of the paired sample t-test which showed a significance value <0.05, so that the alternative hypothesis was accepted. In addition, the results of the N-Gain test of 0.5888 indicated that the effectiveness of the STEM model was in the fairly effective category in improving students' creative thinking skills. This increase was especially seen in the originality indicator as the aspect that experienced the highest development, followed by fluency, flexibility, and elaboration. Qualitative findings from observations and interviews also supported the quantitative results, which showed that STEM learning encouraged students to work collaboratively, actively discuss, dare to express ideas, and be able to design and produce innovative products that are relevant to real-life contexts. Thus, STEM learning not only improves students' conceptual understanding of science materials, especially the human respiratory organs, but also provides a meaningful learning experience in developing creative thinking skills which are an important demand of 21st-century education.

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