

Effectiveness of STEAM-Integrated Project-Based Learning to Improve Creative and Collaborative Thinking Skills of Elementary School Students

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Abstract:

This study aims to describe the effectiveness of STEAM-integrated project-based learning in improving elementary school students' creative thinking and collaboration skills. The subjects of this study were at Babarsari State Elementary School, Depok Subdistrict, Sleman Regency, consisting of 14 grade V (five) students, with a composition of 8 male students and 6 female students, selected through purposive sampling technique. The type of research used was Classroom Action Research. Data were collected through interviews, observations, and tests. Data analysis was conducted using qualitative and quantitative techniques. The results showed that applying project-based learning models integrated with STEAM improved students' creative and collaborative thinking skills and learning outcomes. Students' creative and collaborative thinking skills increased from 26% and 28% to 78% and 80%, showing an increase of 52%. In addition, the average completeness of student learning outcomes increased from 21% to 79%, with a specific increase in the social studies learning outcomes of grade V students by 58%. This research highlights the effectiveness of the STEAM approach in improving students' skills and learning outcomes.

Keywords:

Creative and Collaborative Thinking; Project-Based Learning; STEAM

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Introduction

Every child in Indonesia has the right to a quality education. Proper guidance is necessary to ensure optimal understanding and avoid misconceptions. Cognitive development, including creative and collaborative thinking, is essential for effective learning ([Romlah et al., 2023](#); [Thangeda et al., 2019](#)). Education quality depends on improving the quality of learning, including collaborative skills, in achieving common goals ([Alifah, 2023](#); [Suyana et al., 2024](#)). Collaboration involves various skills and responsibilities to achieve positive outcomes. Collaborating individuals must have the same vision, mission, and resources to achieve a common goal ([Elvira, 2022](#); [Ni'mah & Noor, 2023](#)).

Quality education focuses on knowledge transfer and opens opportunities for creative thinking ([Fajari et al., 2023](#); [Riyad et al., 2023](#)). Creative thinking is an individual's ability to generate new ideas, innovative solutions, and original concepts not bound by conventional limitations. Creativity involves a flexible, courageous, and open-minded mental process that welcomes new experiences and alternative possibilities ([Muzaini, Rahayu et al., 2023](#); [Rati et al., 2021](#)). In addition, creativity includes the ability to connect and utilize existing knowledge, experiences, and thoughts in unique ways to produce something valuable and original ([Muzaini, Noptario, et al., 2023](#)). According to [Pinias et al. \(2023\)](#), creativity or creative thinking is the ability to see various possibilities in solving problems. Education that integrates creativity prepares students to be flexible and adaptive thinkers in an ever-changing environment. Creativity also encourages individual growth, allowing them to explore their potential more widely and deeply ([L. Sari & Shalihah, 2023](#); [Widiari & Astawan, 2021](#)).

The relationship between student creativity and collaboration is close because collaboration enables the exchange of diverse ideas, encourages interdisciplinary thinking, and broadens the scope of creative thinking. When students work together in teams or groups, they can inspire, support, and expand each other's ideas through discussion and joint reflection ([Silva et al., 2022](#)). Collaboration allows students to utilize individual expertise, creating innovative solutions to solve complex problems ([Lee, 2023](#)). Collaborative ability refers to an individual's capacity to work effectively to achieve a common goal ([Darmayanti, 2023](#)). Collaboration involves communicating, listening, and sharing responsibilities within a team or group. In addition, collaborative ability includes conflict resolution, building good relationships, and contributing productively in cooperative situations ([Amany et al., 2023](#); [Rudianto et al., 2022](#)).

Based on the discussion of creativity and collaboration above, it is clear that these two aspects should be the main focus of the learning process. However, data from the Program for International Student Assessment (PISA) shows that 56 countries have not optimized their education system to develop students' creative thinking. In comparison, 34 other countries have succeeded in this regard. Indicates that more than 50% of the countries participating in this survey have not paid enough attention to aspects of learning that develop students' creativity and innovation. In addition, based on initial observations, students' creative and collaborative thinking abilities are still less visible and not optimally facilitated. Students tend to be less active in conveying ideas and rely heavily on textbooks during learning. Therefore, creative and collaborative thinking skills must be developed from primary education onwards to improve students' understanding of learning materials and outcomes ([Nasucha et al., 2023](#); [Rudianto et al., 2022](#)).

Quality education directly impacts student learning outcomes by providing a strong foundation for understanding and applying learning concepts ([Nuri et al., 2023](#)). Through quality education, students are more likely to be actively involved in learning, increasing their motivation and interest in learning ([Utomo et al., 2023](#)). As

a result, they are likely to achieve higher academic performance and acquire relevant skills for success in various areas of life. Susanto (2016) states that student learning outcomes are the abilities obtained after undergoing learning activities. Learning outcomes refer to student achievement in understanding, mastering, and applying the subject matter taught. Includes understanding the concepts, skills, attitudes, and knowledge students acquire during the learning process ([Hidayah et al., 2023](#)). Learning outcomes should be the main focus in education as they are a concrete measure of the effectiveness of the learning process. A deep understanding of student achievement provides the basis for improving teaching content and methods. By considering learning outcomes, educators can identify the needs of individual students and design more effective learning strategies ([Hanum et al., 2022](#); [Muzaini, 2023](#)).

However, observations and interviews conducted in class V of SD Negeri Babarsari, Depok District, Sleman Regency, found that the number of students in one class is 14, consisting of 8 male and 6 female students. Currently, learning is conducted offline. Students use textbooks, and teacher guides for social science lessons, sometimes supplemented with video media from YouTube. This teaching method is teacher-centered, so students only receive material from books and videos without using props that can help them understand the material. Social science lessons for grade 5 SD require teaching aids that students can observe, hold, and practice directly. This teaching method does not stimulate students' creative and collaborative thinking skills. In addition, the learning outcomes of fifth-grade students show a lack of understanding, which can be seen from their assignment answers, which are almost the same as the textbook rather than the answers of their thinking.

According to [Annisa \(2023\)](#), Project Based Learning (PjBL) is a learning model that focuses on a discipline's main concepts and principles, involving students in problem-solving activities and other meaningful tasks. This model provides opportunities for students to work independently in building their knowledge and producing a final product. The PBL model can foster a disciplined attitude in learning and make students more active and creative in the learning process ([Rehman et al., 2023](#)). In addition, PBL has excellent potential to create a more enjoyable and meaningful learning experience. PBL also facilitates students in investigating and solving problems, being student-centered, and producing actual products in the form of project results ([Anggraini & Hardini, 2024](#)).

Project-based learning can be integrated into STEAM-based learning in the classroom. Applying PBL-based STEAM (Science, Technology, Engineering, Arts, and Mathematics) learning develops cognitive skills such as listening, solving problems, matching form with function, and making decisions ([Fitriyah & Ramadani, 2021](#)). The STEAM approach actively involves students in practical activities and is directed at real-world situations ([Allanta & Puspita, 2021](#)). Through STEAM, learning can be delivered interesting and fun, making it more meaningful for students ([Rini et al., 2022](#)). The STEAM approach can hone and develop students' skills to generate more creative ideas and concepts ([Hafsah & Veni, 2021](#)). In addition, STEAM learning can guide students in developing critical thinking skills, problem-solving skills, and collaboration. The STEAM approach is a multidisciplinary approach that evolved from the STEM approach by adding an element of art to its learning. The art component benefits students and teachers through expression, communication, creativity, imagination, observation, perception, and thinking ([Enggar et al., 2023](#)).

In another study conducted by [Dewi et al. \(2024\)](#), The results showed that the percentage of students' STEM literacy achievement was 70%, including in the moderate category. Other research conducted by [Qomatfian et al. \(2024\)](#) shows that the feasibility of STEAM learning media based on the game *gobak sodor* on the

material of the characteristics of living things for elementary schools obtained a value in the aspect of ideas with a percentage of 95.83% very feasible category, the aspect of usefulness with a percentage of 95.00% very feasible category, the aspect of creativity with a percentage of 92.50% very feasible category, and the display aspect with a percentage of 93.33% very feasible category. Similar research conducted by [Rohman et al. \(2021\)](#) also shows that applying the PjBL model integrated with STEAM effectively improves students' critical thinking and 21st-century skills. A similar study conducted by [Hafsah & Veni \(2021\)](#) showed that the application of the PjBL-STEAM model allows students to develop real-world skills, such as cooperation, decision-making, initiative, communication, problem-solving, and self-management, which in turn can improve students' critical thinking skills in the context of numeracy problems.

Previous research conducted by [Winarni et al. \(2024\)](#) found that VR integrated with STEAM using PjBL impacted all components of science literacy, with an influence value from the statistical analysis above 70%. [Yuberti et al. \(2024\)](#) also revealed that based on research that has been conducted, data obtained shows that there is an effect of the PjBL model with a STEAM approach on Computational Thinking ability; this is indicated by a sig value of 0.033, which means sig < 0.05 so that H1 is accepted. [Ayuningsih et al. \(2024\)](#) provide a statement that the average value of collaboration skills after 84.17 > 40.83 before using the math learning module, the average value of knowledge after 84.07 > 35.07 before using the math learning module, meaning that there is an increase in collaboration skills and student learning outcomes.

Previous research has discussed creative thinking, collaborative skills, learning outcomes, and the PjBL-STEAM model in elementary schools. However, no integrated research examines creative and collaborative thinking skills and the application of an integrated STEAM project-based learning model in elementary schools.

Based on these findings, it is evident that the social science learning process requires improvement to enhance fifth-grade students' creative thinking skills, collaboration, and learning outcomes. An integrated STEAM-based project-based learning model can be applied as this model supports students in making their props independently to ensure optimal learning understanding. This research is focused on improving creative and collaborative thinking skills and learning outcomes of fifth-grade students of SD Negeri Babarsari, Depok District, Sleman Regency, in Social Studies subjects, especially on the material of economic activities.

Research Method

The research method used in this study is Action Research. Collaborative action research facilitates the incorporation of perspectives and knowledge from various stakeholders. It encourages active participation and involvement of all parties in the change process and development of learning practices ([Ari & Ciftci, 2022](#)). In addition, this approach allows researchers to iterate and continually adjust the research variables according to student responses and needs in authentic learning contexts ([Semathong, 2023](#); [Tulung et al., 2022](#)). The Action Research method was chosen because it allows researchers to directly implement the STEAM-integrated project-based learning model in the classroom while observing real-time changes in students' creative and collaborative thinking skills.

This research was conducted at SD Negeri Babarsari, Depok District, Sleman Regency. The research subjects consisted of fifth-grade students of SD Negeri Babarsari, Depok District, Sleman Regency, with 14 students consisting of 8 boys and 6 girls. They were selected using purposive sampling, deliberately and selectively based on specific criteria to represent the desired population ([Huang et al., 2019](#)).

This method is selected to ensure that the researcher obtains relevant and representative information by the research objectives, although not using a random approach, to optimize the use of available resources ([Greenwood et al., 2022](#)).

Data were collected through interviews, observations, and tests. Interviews were conducted to evaluate students' initial abilities in creative and collaborative thinking and social studies learning outcomes. Observations were used to obtain data on students' creative and collaborative thinking skills, while tests were used to measure their learning outcomes. The instruments used included interview guidelines, observation sheets, and tests consisting of questions. The interview guideline included 10 questions about creative thinking ability, 10 questions about collaborative ability, and the achievement of social studies learning outcomes. The test consisted of 10 questions for each cycle, with a maximum score of 10 for each correct answer. The observation sheet contains indicators that evaluate students' creative and collaborative thinking criteria, with a check mark (√) indicating each criterion shown by the students.

Instrument validation is carried out through Content Validity Test, Instrument Trial, and Reliability Analysis. The systematic Data Analysis Method uses Data Collection. Data is collected through validated instruments, student test results, observation sheets, field notes, and interviews. Furthermore, in Quantitative analysis, numerical data is analyzed using descriptive statistics to measure student learning outcomes or skills improvement. Furthermore, Qualitative analysis, qualitative data, such as observation and interview results, are analyzed through the stages of data reduction, data presentation, and conclusion drawing to identify patterns or changes in student behavior. Next is data triangulation, which is done by comparing data from various sources of test results, observations, and interviews to increase the validity of the findings.

Data analysis in this Action Research followed the methodology recommended by [Miles et al. \(2014\)](#), which includes the stages of data collection, data presentation, data interpretation, and conclusion drawing. In Action Research, quantitative data analysis used descriptive and inferential statistics to measure creativity, collaboration, and learning outcomes. Meanwhile, qualitative data analysis focused on an in-depth understanding of the application of the integrated PjBL-STEAM model.

Results and Discussion

In this study, researchers conducted two research cycles, each consisting of two meetings. During the action research that applied the Project-based Learning (PjBL) model integrated with the STEAM (Science, Technology, Engineering, Arts, and Mathematics) approach in learning social science at SD Negeri Kalitengkek, there was a significant improvement from Cycle 1 to Cycle 2. In Cycle 1, the observation results showed that students were actively involved in project planning, group discussions, and information gathering related to the chosen topic. Despite facing challenges in understanding complex social science concepts, students were enthusiastic and willing to find creative solutions. In Cycle 2, the application of PjBL and the STEAM approach matured. The students demonstrated greater independence in planning and executing their projects and a deeper understanding of social science concepts. They confidently used STEAM skills, such as utilizing technology for research and applying scientific knowledge to design solutions. Collaboration among students was also more synergy, with a more diverse and in-depth exchange of ideas. The final project in Cycle 2 showed significant improvement in quality and complexity and more in-depth reflection on the learning process. Indicates that implementing PjBL integrated with the STEAM approach effectively improves students' understanding and skills in social science at the primary school level.

In interviews with teachers who implemented PjBL integrated with the STEAM approach in teaching social science at SD Negeri Kalitengkek, teachers highlighted the changes from Cycle 1 to Cycle 2. In Cycle 1, teachers noted that students showed high interest in the project but still needed intensive guidance in planning and implementation. Nonetheless, teachers observed increased students' motivation and engagement in learning. In Cycle 2, teachers noted significant progress in students' independence in planning and implementing the project and their ability to apply STEAM concepts more effectively. Teachers also observed improvements in the quality of the final project outcomes and students' ability to collaborate and think critically. Teachers expressed their belief that PjBL, integrated with the STEAM approach, has positively impacted students' understanding and skills in social studies and stimulated their interest and motivation to learn.

The indicators of creative thinking ability used in this study include three indicators with four criteria: (1) Generating many diverse ideas, with criteria not running out of ideas in solving problems, freely expressing opinions and feelings, being flexible in thinking and responding, and having broad interests; (2) Originality of thinking, with criteria: having original ideas, ideas that are different from the general, confident, independent, responsible, and committed to the task; (3) Ability to elaborate on the main idea, with criteria: full of initiative, interested in creative activities, having great curiosity, and critical of other people's opinions. In addition, indicators of collaborative ability in this study include group cooperation, adaptation with group members, responsibility in completing group tasks, discussing decision-making, and communicating well. Based on the test results of several indicators of creativity and collaboration, data analysis of students' creative thinking skills in social studies subjects can be seen in Table 1.

Table 1. Analysis of Data on Creative Thinking Skill

No.	Cycle II	Creative thinking skill	Collaborative skill
1	Precycle	26%	28%
2	Cycle 1	Meeting I	53%
		Meeting II	64%
3	Cycle 2	Meeting I	72%
		Meeting II	78%

The table above shows the creative and collaborative thinking skill scores from the pre-cycle stage to Cycle 2. In the pre-cycle stage, the average percentage of students' creative thinking ability was 26%, and collaborative ability was 28%. In Cycle 1, Meeting 1, the average percentage of students' creative thinking ability increased to 53%, and collaborative ability reached 55%. In Cycle 1, Meeting 2, the average percentage of students' creative thinking ability rose to 64%, and the collaborative ability was 66%. In Cycle 2, Meeting 1, the average percentage of students' creative thinking ability reached 72%, and the collaborative ability was 74%. In Cycle 2, Meeting 2, the average percentage of students' creative thinking ability increased to 78%, and the collaborative ability was 80%. The results of this creativity and collaboration data analysis can be visualized in Figure 1.

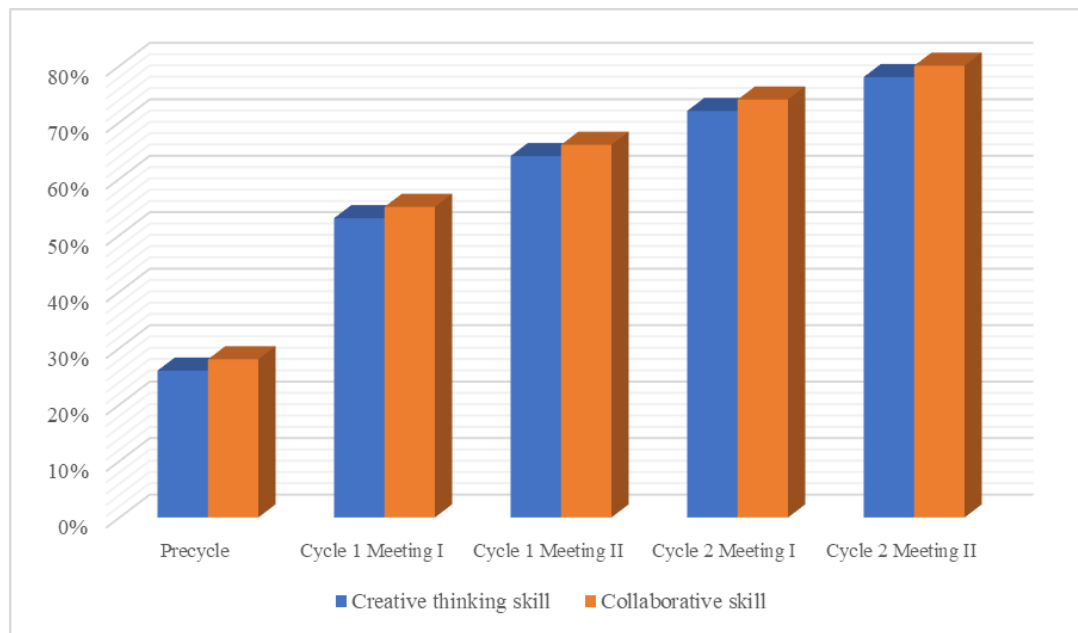


Figure 1. Analysis Result of Creative and Collaborative Thinking Skill Data

Figure 1 shows the comparison and increase in the percentage of students' creative and collaborative thinking skills from the pre-cycle stage to Cycle 2. From pre-cycle to Cycle 1, Meeting 1, there was an increase of 27%. From Cycle 1, Meeting 1 to Meeting 2, there was an increase of 11%. In Cycle 1, Meeting 2, an increase of 8% was recorded. From Cycle 2, Meeting 1 to Meeting 2, there was an increase of 6%. It indicates a significant positive change in students' creativity and collaboration in learning. In the context of PjBL-STEAM learning, this research focuses on social science learning outcomes as part of the implementation impact evaluation. The results of the data analysis show that implementing this integrated learning model has a significant positive impact on student achievement in social science subjects. The following table presents the learning outcomes influenced by STEAM-based PjBL.

Table 2. Learning Outcome

Category	Precycle		Cycle 1		Cycle 2	
	No. of students	%	No. of students	%	No. of students	%
Pass	3	21	8	57	11	79
Not Pass	11	79	6	43	3	21
Total	14	100	14	100	14	100

Table 2 shows the data analysis of social science learning outcomes from the pre-cycle stage to Cycle 2. The table provides information on the number of students and the percentage of students who passed. The determination of student graduation is based on the school's Minimum Completion Criteria (KKM) set at 75. At the pre-cycle stage, out of 14 students, three passed, or 21% of the total students. In Cycle 1, the number of students who passed increased to 8 or 57% of the total. In Cycle 2, the number of students who passed increased to 11 or 79% of the total. Data analysis of these social science learning outcomes is shown below in Figure 2.

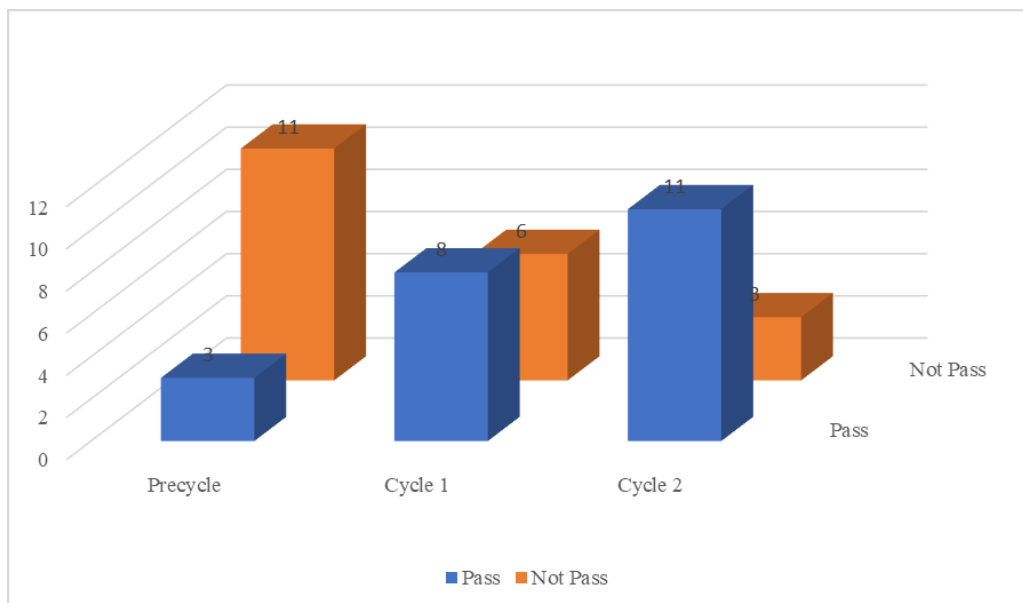


Figure 2. Learning Outcome on Social Science Subject

Figure 2 compares the percentage and average increase in social science learning outcomes from the pre-cycle stage to Cycle 2. From the pre-cycle stage to Cycle 1, the completeness of student learning outcomes in one class increased by 46%. From Cycle 1 to Cycle 2, the percentage increased by 22%. Indicates that PjBL-STEAM learning can improve students' learning outcomes in social studies.

Discussion

During the action research involving the application of the Project-based Learning (PjBL) model integrated with the STEAM (Science, Technology, Engineering, Arts, and Mathematics) approach in learning social science at SD Negeri Kalitengkek, there was a significant improvement from Cycle 1 to Cycle 2. In Cycle 1, observations showed that students were actively involved in project planning, group discussions, and information gathering related to the chosen topic. In Cycle 2, the implementation of PjBL and the STEAM approach became more mature. Students showed greater independence in planning and executing their projects and a deeper understanding of social science concepts. In addition, the final project outcomes in Cycle 2 showed significant improvement in quality and complexity and more in-depth reflection on the learning process.

In a learning environment that encourages project-based learning, students can plan their projects, which involves identifying goals, determining the necessary steps, and deciding the solutions to be implemented (Amalia et al., 2024; Lilis et al., 2021). allows students to develop independence in planning and managing their time and available resources (Hindun et al., 2024). In addition, by incorporating elements of science, technology, engineering, art, and math, students are encouraged to apply various skills and knowledge across disciplines (Tran et al., 2021). is evident when students use technology for research, apply mathematical principles in design, or appreciate artistic aspects in the presentation of their projects. This process allows students to develop a more thorough and integrated understanding of the studied subject (Anisimova et al., 2020).

Based on data on creative and collaborative thinking skills, it was found that students' creative thinking skills improved at each stage by using project-based learning integrated with the STEAM model. This learning model trains students to find solutions to problems faced independently and in groups, thus improving their creative thinking skills (Chafidah et al., 2024). Supported by Rasmini (2023), who

states that in project-based learning, learning activities occur collaboratively in heterogeneous groups. In the project-based learning model, students design problems and find their solutions. The project-based learning model has the advantage of its characteristics: helping students design processes to achieve results, training students to manage information carried out in a project, and producing actual products due to their work ([Novrita et al., 2024](#)). Implementing PjBL-STEAM in elementary schools enhances student creativity through challenging projects that integrate STEAM elements and strengthen student collaboration through exchanging ideas and using technology. This model improves understanding or mastery of subject matter and prepares students with relevant skills for the future ([R. P. Sari et al., 2024](#)).

In addition, data from implementing the PjBL-STEAM model showed a positive and significant effect on student learning outcomes in elementary schools. This finding is in line with several studies showing that PjBL-STEAM has a positive impact on student learning achievement ([Atmojo, Ardiansyah et al., 2022](#); [Atmojo, Saputri et al., 2022](#); [Chen et al., 2023](#); [Julio et al., 2024](#)). By integrating STEAM elements in learning, this model provides varied and challenging learning experiences for students, thus strengthening their understanding of the material ([Prahani et al., 2023](#)). Through this approach, students learn concepts theoretically and apply them in a real-world context through creative projects that they design and implement ([Sutrisno & Syukur, 2023](#)). In addition, PjBL and STEAM-based learning provide important support in the learning process by increasing opportunities for the effective exchange of ideas, exploration, and application of knowledge ([Karta & Rasmini, 2022](#)). This view is supported by several experts who state that in project-based learning, students not only receive information from the teacher but are also directly involved in investigating, planning, and implementing learning activities, which in turn improves their understanding of the material and learning outcomes ([Prajoko et al., 2023](#); [Syafuddin et al., 2023](#)).

Previous research conducted by [Ananda et al. \(2024\)](#) showed that VR integrated with STEAM using PjBL impacted all components of science literacy, with an influence value from statistical analysis above 70%. [Suryanti et al. \(2024\)](#) also revealed that based on research that has been conducted, data obtained shows that there is an effect of the PjBL model with a STEAM approach on Computational Thinking ability; this is indicated by a sig value of 0.033, which means sig < 0.05 so that H1 is accepted. [Reswara et al. \(2024\)](#) showed that implementing SSI-integrated PjBL-STEAM positively affects students' science literacy skills. Responses from students will then be divided into five categories, namely scientific argumentation levels 1-5. [Rachmawati et al. \(2024\)](#) define the N-gain value as 0.37 (medium) and the effect size as 0.87 (large) on the data, which supports the idea that students' scientific argumentation is greatly improved. Through learning activities, students' argumentation can increase from level 3 in the pre-test to level 5 in the post-test.

This research reveals that implementing a project-based learning model combined with the STEAM (Science, Technology, Engineering, Arts, and Mathematics) approach can significantly improve elementary school students' creative and collaborative thinking skills. This model demonstrates how integrating various disciplines can broaden students' learning experiences and assist them in developing more complex skills. This research also emphasizes the need for cooperation between teachers from different fields to create comprehensive learning. The implications of the results of this study are the need for appropriate assessments to measure students' creative and collaborative thinking skills, and one of the main limitations is the limited sample size. The number of students and schools involved may not reflect enough diversity to make strong conclusions about the effectiveness

of this learning model, and the short research time may not be adequate for the significant development of creative and collaborative thinking skills.

Based on the research findings, some recommendations are as follows: Teachers need to get support and access to resources needed to implement this learning model effectively. Educational practitioners can take inspiration from the findings of this study to develop a more integrated curriculum with the STEAM approach. It can help prepare students for the increasingly complex and multidisciplinary demands of the real world. Policymakers must provide adequate financial support and infrastructure for teacher training in implementing project-based learning models integrated with the STEAM approach. Future researchers can focus on evaluating the long-term impact of this learning model on students' creative and collaborative thinking skills or current variables relevant to other elementary school students. First, the sample was limited to one school, making it difficult to generalize the results to a broader population. Secondly, the study's relatively short duration may not be sufficient to observe long-term changes in students' creative and collaborative thinking skills. Third, external factors such as family support and access to adequate STEAM resources may also affect the results.

Conclusion

Implementing the project-based learning (PjBL) model integrated with the STEAM (Science, Technology, Engineering, Arts, and Mathematics) approach effectively improves students' creative thinking, collaborative skills, and learning outcomes. Through this approach, students are more actively involved in the learning process, able to find innovative solutions and work effectively in teams. In addition, learning outcomes show significant improvement, indicating that this method strengthens concept understanding and prepares students with relevant 21st-century skills. This approach provides a fun, meaningful, and applicable learning experience, making it a potential learning model that can be widely applied in education.

The PjBL-STEAM approach encourages students to develop creative thinking, collaboration, problem-solving, communication, and critical thinking skills essential in the modern era. The findings underscore the importance of developing an integrative curriculum incorporating STEAM elements to create more applicable and less theoretical learning. Further research is needed to evaluate the long-term impact of PjBL-STEAM on students. Policymakers must also provide infrastructure, training, and funding support to ensure sustainable school implementation.

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