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The Improvement of Students' Creative and Collaborative Thinking Skills by Applying STEAM-Integrated Project-Based Learning

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ABSTRACT

This research introduced a new method by integrating STEAM-based project learning to effectively enhance students' creative and collaborative thinking skills, which has not been widely explored in the educational context. The subjects were 14 students consisting of 8 male students and 6 female fifth grade students who were selected using purposive sampling techniques. The type of research used Classroom Action Research. Data collection was carried out by interviews, observations and tests. The data analysis techniques used qualitative and quantitative. The study results showed that The average creative thinking skill of students was increase; the average collaborative thinking skill of students was increase; and learning outcomes also increased. The the result showed that STEAM integrated project-based learning can improve creative and collaborative thinking skills as well as students' social science learning outcomes. The research also contributed by showing that the implementation of STEAM-integrated project-based learning effectively enhances students' creative and collaborative thinking skills, providing a robust framework for educators to foster innovation, teamwork, and problem-solving abilities in the classroom, ultimately preparing students for complex real-world challenges.

Keywords: *Creative and Collaborative Thinking, Learning Outcomes, Project-Based Learning*

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INTRODUCTION

Quality education is the right of every child in Indonesia. Appropriate guidance is necessary to ensure maximal understanding and prevent misconceptions. Support for cognitive development, including creative and collaborative thinking, is essential for optimal learning (Thangeda et al., 2016). The improvement of education quality depends on enhancing the quality of learning, including collaborative abilities in achieving common goals (Alifah, 2021). Collaboration involves various skills and responsibilities to achieve positive outcomes. Individuals in collaboration must share vision, mission, and resources to attain shared goals (Elvira, 2021).

Quality education is not only about knowledge transfer but also about opening doors to creative thinking (Riyad et al., 2021). Creative thinking refers to an individual's ability to generate new ideas, innovative solutions, and original concepts unrestricted

by conventional boundaries. Creativity involves a flexible, courageous, and open-minded mental process that embraces new experiences and alternative possibilities (Rati et al., 2017). It also entails the ability to connect and leverage existing knowledge, experiences, and thoughts uniquely to create something valuable and original (Fajari et al., 2023). According to Munandar (Harisudin, 2019), creativity or creative thinking is the ability to see various possibilities for solving a problem. Education that integrates creativity prepares students to become flexible and adaptive thinkers in the face of continuously changing environments. Moreover, creativity fosters individual growth, enabling them to explore their potentials more broadly and deeply (Harahap, 2020; Sukamti, 2017).

The relationship between students' creativity and collaboration is closely intertwined because collaboration enables interaction among diverse ideas, promotes interdisciplinary thinking, and broadens the scope of creative thought. When students work together in teams or groups, they have the opportunity to inspire, support, and expand their ideas through collective discussions and reflections (Fauzi & Roza Linda, 2021). Collaboration also allows students to leverage individual expertise and create more innovative solutions to solve complex problems (Wardhani et al., 2022). Collaborative ability refers to an individual's capacity to effectively work with others in achieving common goals (Partono et al., 2021). Collaboration involves the ability to communicate clearly, listen, and share responsibilities within a team or group. Additionally, collaborative skills encompass conflict resolution, building good relationships, and contributing productively in cooperative situations (Fauzi & Roza Linda, 2021; Wardhani et al., 2022).

Based on the discussion of creativity and collaboration above, it is evident that both aspects should be the primary focus in the implementation of the learning process. However, field observations indicate that based on data from the Program for International Student Assessment (PISA), 56 countries have not yet optimized their education systems in developing students' creative thinking, while 34 other countries can be categorized as having optimized their education systems for developing students' creative thinking. This implies that more than 50% of all participating countries in this survey have not focused on learning aspects that develop students' creativity and innovation. Furthermore, based on initial observations, it can be seen that students' abilities in creative and collaborative thinking are not clearly evident and are not maximally facilitated. This is evident during learning sessions when students are less active in conveying ideas and still rely heavily on textbooks. Therefore, creative and collaborative thinking skills need to be developed from elementary education onwards to enhance students' understanding of learning materials and improve learning outcomes (Partono et al., 2021; Riyad et al., 2021).

Quality education also directly impacts students' learning outcomes by providing a strong foundation for understanding and applying learning concepts (Rati et al., 2017). Through quality education, students are more likely to actively engage in the learning process, enhancing their motivation and interest in learning (Chamdani et al., 2022). As a result, they tend to achieve higher academic accomplishments and acquire relevant skills for success in various life domains. Susanto (2016) stated that students' learning outcomes are the abilities acquired by children after undergoing learning activities. Learning outcomes refer to students' achievements in understanding, mastering, and applying the taught subject matter. Learning outcomes encompass the understanding of concepts, skills, attitudes, and knowledge acquired by students during the learning process (Setyawan et al., 2019). Learning outcomes should be the primary focus in

education as they serve as a concrete measure of the effectiveness of the learning process. A profound understanding of students' achievements provides a basis for improving content and teaching methods. By considering learning outcomes, educators can identify individual students' needs and design more effective learning strategies (Juniarti & Renda, 2019; Sinaga & Silaban, 2020).

However, based on observations and interviews conducted in the fifth-grade class of SD Negeri Kalitengkek, Gebang District, Purworejo Regency, it is known that the number of students in one class is 14, consisting of 8 boys and 6 girls. Currently, learning is conducted offline. For social science lessons, students use textbooks and teacher's guides, occasionally supplemented with video media from YouTube. This teaching method mainly centers around the teacher, and students are limited to receiving material from books and videos without any tangible teaching aids to enhance their understanding of the material. Social science lessons for fifth grade require teaching aids that students can observe, handle, and practice directly. This method of teaching lacks in stimulating students' creative and collaborative thinking skills. Additionally, the learning outcomes of fifth-grade students indicate a lack of understanding. This is evident from their assignment responses, which tend to be almost identical to the textbook rather than the students' own answers.

Project Based Learning (PBL), according to Bie (Ngalimun, 2013), is a learning model that focuses on the central concepts and principles of a discipline, involving students in problem-solving activities and other meaningful tasks, providing opportunities for students to work autonomously in constructing their own learning, and culminating in the creation of a product. The PBL model can cultivate students' disciplined learning attitudes and make them more active and creative in their learning (Kusuma & Artama, 2023). Additionally, the PBL model has great potential to create more engaging and meaningful learning experiences. Furthermore, PBL also facilitates learners to investigate, problem-solve, be student-centered, and produce tangible products in the form of project outcomes (Permatasari et al., 2023).

Project Based Learning can be integrated into STEAM-based learning in the classroom. The implementation of STEAM (Science, Technology, Engineering, Arts, and Mathematics) learning based on PBL develops cognitive skills such as listening, problem-solving, matching form with function, and decision-making (Fitriyah & Ramadani, 2021). Learning with the STEAM approach actively involves students, engages in practical activities, and is directed towards real-world situations (Permana et al., 2023). Through STEAM, teaching can be delivered in an interesting and enjoyable manner, making it more meaningful for students (Rini et al., 2022). The STEAM approach can sharpen and develop students' skills to generate ideas and concepts to become more creative (Diana & Saputri, 2021). Additionally, STEAM learning can guide students in developing critical thinking skills, problem-solving skills, and collaboration. The STEAM approach is a multidisciplinary approach that evolves from the STEM approach by adding the element of Art in its learning. The art component is beneficial for both students and teachers through forms of expression, communication, creativity, imagination, observation, perception, and thinking (Triprani et al., 2023).

Previous studies have addressed creative thinking skills (Fajari et al., 2023; Harahap, 2020; Rati et al., 2017), collaborative skills (Fauzi & Roza Linda, 2021; Wardhani et al., 2022), learning outcomes (Chamdani et al., 2022; Saptono et al., 2020), PjBL-STEAM models (Permana et al., 2023; Diana & Saputri, 2021; Fitriyah & Ramadani, 2021; Putu et al., 2021; Triprani et al., 2023) in elementary schools. However, there has been no integrated study examining both creative and collaborative thinking skills along with

the application of integrated STEAM-based project-based learning models in elementary schools.

Based on these findings, it is evident that the social science learning process needs improvement to enhance the creative and collaborative thinking skills as well as the learning outcomes of fifth-grade students. The use of integrated STEAM-based project-based learning models can be applied because they support students in creating their own teaching aids independently to ensure optimal learning comprehension. This study focuses on enhancing the creative and collaborative thinking skills and learning outcomes of fifth-grade students at SD Negeri Kalitengkek in social science lessons, specifically focusing on economic activities.

METHOD

The research method employed in this study was Action Research (AR). Collaborative action research enables the incorporation of various perspectives and knowledge from various stakeholders, as well as encourages active participation and involvement of all parties in the process of change and development of learning practices (Ari & Ciftci, 2022). Additionally, this method allows researchers to iterate and continuously adjust the research variables according to students' responses and needs in the actual learning context (Semathong, 2023; Tulung et al., 2022). The AR method was chosen because it enables researchers to directly engage in the implementation of the STEAM-integrated project-based learning model in the classroom environment while observing real-time changes in students' creative and collaborative thinking skills.

The study was conducted at SD Negeri Kalitengkek, Gebang District, Purworejo Regency. The subjects of this research were fifth-grade students of SD Negeri Kalitengkek, Gebang District, Purworejo Regency, totaling 14 students consisting of 8 male and 6 female students selected through purposive sampling technique. Purposive sampling technique is a deliberate and selective sampling technique based on specific criteria to represent the desired population (Suen et al., 2014). This method was chosen because it allows researchers to obtain relevant and representative information according to the research objectives, albeit not randomly, thus optimizing the available resources (Campbell et al., 2020).

Data collection was carried out through interviews, observations, and tests. Interviews were conducted to assess students' initial conditions regarding creative and collaborative thinking skills and learning outcomes in social studies. Observations were conducted to obtain data on creative and collaborative thinking skills, while tests were conducted to obtain data on students' learning outcomes. The instruments used by the researcher were interview guidelines, observation sheets, and test instruments consisting of questions. The interview guide consisted of 10 questions related to creative thinking skills, 10 questions related to collaborative abilities, and learning outcomes in social studies. The test instrument used was a test consisting of 10 questions for each cycle, with each correct answer receiving a score of 10. The observation sheet consisted of several indicators containing several criteria for creative and collaborative thinking. The observation sheet was filled by marking (√) the criteria for creative and collaborative thinking displayed by the students.

The data analysis in this Action Research (AR) was done following the technique proposed by Miles et al. (2014), involving the process of data collection, data presentation, data interpretation, and drawing conclusions. In Action Research (AR), quantitative data analysis techniques involve the use of descriptive and inferential statistics to measure creativity, collaboration, and learning outcomes. Meanwhile,

qualitative data analysis focuses on a deep understanding of the application of the integrated PjBL-STEAM model.

RESULT AND DISCUSSION

In this study, the researcher conducted a total of 2 research cycles, each consisting of 2 sessions. Throughout the action research involving the implementation of the Project Based Learning (PjBL) model integrated with the STEAM (Science, Technology, Engineering, Arts, and Mathematics) approach in teaching social science at SD Negeri Kalitengkek, significant improvements were observed from Cycle 1 to Cycle 2. During Cycle 1, observations indicated that students were actively involved in project planning, group discussions, and gathering information related to the chosen topic. Despite facing challenges in understanding complex social science concepts, students showed high enthusiasm and a willingness to seek creative solutions. In Cycle 2, the implementation of PjBL and the STEAM approach became more mature. Students demonstrated greater independence in planning and executing their projects, as well as a deeper understanding of social science concepts. They confidently utilized STEAM skills, such as leveraging technology for research and applying scientific knowledge to design solutions. Collaboration among students also appeared more synergistic, with more diverse and in-depth exchange of ideas. The final project outcomes in Cycle 2 showed significant improvements in quality and complexity, along with deeper reflections on the learning process. This indicates that the implementation of integrated PjBL with the STEAM approach is effective in enhancing students' understanding and skills in social science at the elementary school level.

In interviews with teachers implementing the integrated PjBL with the STEAM approach in teaching social science at SD Negeri Kalitengkek, teachers highlighted changes from Cycle 1 to Cycle 2. In Cycle 1, teachers noted that students showed high interest in the project but still required more intensive guidance in planning and executing it. Nevertheless, teachers observed increased motivation and student engagement in learning. In Cycle 2, teachers noted significant developments in students' independence in project planning and execution, as well as their ability to apply STEAM concepts more effectively. Teachers also observed improvements in the quality of final project outcomes, as well as students' abilities to collaborate and think critically. Teachers expressed their confidence that the integrated PjBL with the STEAM approach has had a positive impact on enhancing students' understanding and skills in social studies, while also stimulating their interest and motivation to learn.

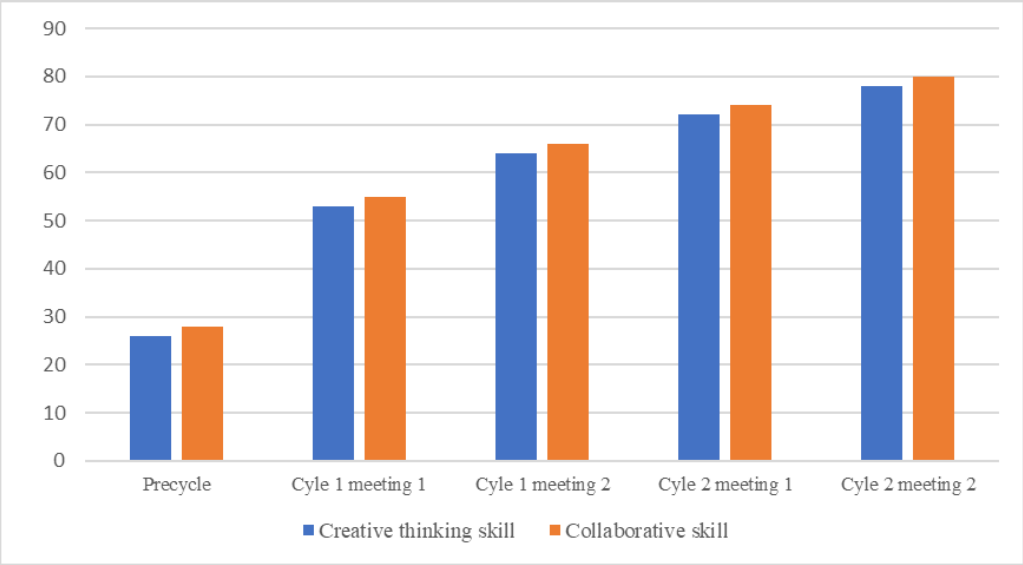
As for the indicators of creative thinking skills used in this study, there were 3 indicators, each with 4 criteria: (1) Generating many and varied ideas with criteria: not running out of ideas in problem solving, freely expressing opinions and feelings, flexible in thinking and responding, having broad interests; (2) Originality of thinking, with criteria: having original ideas, having thoughts different from common ideas, confidence, independence, responsibility, and commitment to tasks; (3) Ability to elaborate main ideas with criteria: rich in initiative, interested in creative activities, having a great curiosity, critical of others' opinions. Furthermore, the indicators of collaborative abilities used in this study include group cooperation, adapting to group members, responsibility in completing group tasks, discussing decision-making, and communicating well within the group. Based on the test results of several creativity and collaboration indicators, the data analysis of students' creative thinking skills in social science 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%	55%
		Meeting II	64%	66%
3	Cycle 2	Meeting I	72%	74%
		Meeting II	78%	80%

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

Figure 1. Analysis result of creative and collaborative thinking skill data



In Figure 1, the comparison and increase in the percentage of students' creative and collaborative thinking skills from the pre-cycle stage to cycle 2 can be observed. From the pre-cycle stage towards Cycle 1, Meeting 1, there was an increase of 27%. From Cycle 1, Meeting 1 to Meeting 2, there was an 11% increase. In Cycle 1, Meeting 2, there was an 8% increase. From Cycle 2, Meeting 1 to Meeting 2, there was a 6% increase. This 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 an integral part of evaluating the impact of this implementation. Data analysis results reveal that the implementation of this integrated learning model has a significant positive impact on students' achievement in social science subjects. The following table presents the learning outcome affected 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

In Table 2, the analysis of the social science learning outcomes data from the pre-cycle stage to cycle 2 can be observed. The table provides information on the number of students and the percentage of students who passed. Student proficiency determination is based on the school's Minimum Mastery Criteria (KKM), set at a score of 75. In the pre-cycle stage, out of 14 students, there were 3 students who passed, or 21% of the students. In cycle 1, there were 8 students who passed, or 57% of the students, and in cycle 2, there were 11 students who passed, or 79% of the students. The analysis of the social science learning outcomes data is shown below in Figure 2.

Figure 2. Learning outcome on social science subject

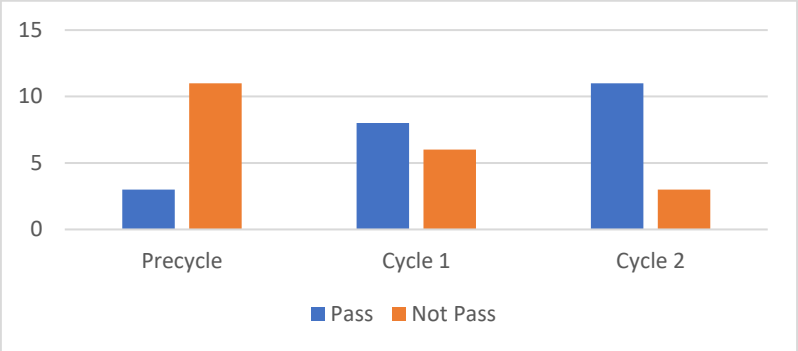


Figure 2 presents the comparison of the percentage and average increase in social science learning outcomes from the pre-cycle stage to cycle 2. From the pre-cycle stage to cycle 1, the student learning outcomes proficiency in one class increased by 46%. From cycle 1 to cycle 2, the percentage increased by 22%. This indicates that PjBL-STEAM learning can improve students' social science learning outcomes.

DISCUSSION

Throughout the action research involving the implementation of the Project Based Learning (PjBL) model integrated with the STEAM (Science, Technology, Engineering, Arts, and Mathematics) approach in teaching social science at SD Negeri Kalitengkek, significant improvements were observed from Cycle 1 to Cycle 2. During Cycle 1, observations showed that students were actively involved in project planning, group discussions, and gathering information related to the chosen topic. In Cycle 2, the implementation of PjBL and the STEAM approach becomes more mature. Students demonstrate greater independence in planning and implementing their projects, as well as a deeper understanding of social science concepts. Additionally, the final project results in Cycle 2 showed significant improvements in quality and complexity, along with deeper reflection on the learning process. In a learning environment that promotes project-based learning, students have the opportunity to plan their own projects, which

involves identifying goals, determining the necessary steps, and making decisions related to the solutions they will implement (Kusuma & Artama, 2023; Setiawan et al., 2021). This allows students to develop their independence in planning and managing their time and available resources (Ahmad, 2021). Furthermore, by including elements of science, technology, engineering, art, and mathematics, students are encouraged to apply various cross-disciplinary skills and know (Kim & Lee, 2019). This is apparent when students need to 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 subject being studied (Shatunova et al., 2019; Sigit et al., 2022; Wahyuningsih et al., 2020).

Based on the data on creative and collaborative thinking skills, it is found that students' creative thinking skills increased at each stage using the project-based learning integrated with STEAM model. Through this learning model, students are trained to find solutions to encountered problems independently or in groups, thus enhancing their creative thinking skills (Firmansyah, 2019; Putu et al., 2021). This is supported by Putu et al. (2021), stating that in project-based learning, learning activities occur collaboratively in heterogeneous groups. In the project-based learning model, students design a problem and find their own solutions. The project-based learning model has the advantage of its characteristics: assisting students in designing a process to determine an outcome, training students to be responsible for managing information conducted in a project, and finally, students produce tangible products as a result of their own work (Sa'diyah et al., 2023). The implementation of PjBL-STEAM in elementary schools enhances students' creativity through challenging projects that integrate STEAM elements and strengthens student collaboration through idea exchange and technology use. This model not only improves understanding or mastery of the subject matter but also prepares students with relevant skills for the future (Permana et al., 2023; Fitriyah & Ramadani, 2021).

The results of this research are in line with several studies which state that there is an influence of PjBL STEAM on students' creative and collaborative thinking skills (Firmansyah, 2019; Fitriyah & Ramadani, 2021; Putu et al., 2021; Triprani et al., 2023). On the other hand, the findings of this research contradict several studies which state that there is no significant influence between the PjBL or STEAM learning model on students' creative or collaborative thinking skills due to many other influencing factors (Fatmawati, 2018; Lee & Shin, 2014; Sumarni & Kadarwati, 2020).

Also, based on the data of the implementation of the PjBL-STEAM model has shown a positive and significant influence on the learning outcomes of elementary school students. The results of this research are in line with several studies which state that there is an influence of PjBL STEAM on student learning achievement (Atmojo et al., 2022; Iyakrus & Ramadhan, 2021; Kim & Lee, 2019; Muntamah et al., 2023; Setiawan et al., 2021; Utari & Afendi, 2022). By incorporating STEAM elements into learning, this model can provide diverse and challenging learning experiences for students, strengthening their understanding of the material (Diana & Saputri, 2021). Students not only learn concepts theoretically but also see how these concepts can be applied in real-world contexts through creative projects they design and execute (Putu et al., 2021). Furthermore, PjBL and STEAM learning can provide crucial support in the learning process by increasing opportunities for idea exchange, exploration, and effective knowledge application (Firmansyah, 2019). This is in line with several experts' opinions stating that in project-based learning, students are not only receiving information from the teacher but are also directly involved in investigating, planning, and implementing

learning activities, making students who learn through projects tend to have a better understanding of the material and experience improved learning outcomes (Fitriyah & Ramadani, 2021; Putu et al., 2021).

This research shows that the use of a project-based learning model integrated with the STEAM (Science, Technology, Engineering, Arts, and Mathematics) approach can significantly improve creative and collaborative thinking skills in elementary school students. This learning model shows that collaboration between various disciplines can enrich students' learning experiences and help them develop broader skills, and it emphasizes the importance of collaboration between teachers from various fields to design holistic learning. The implications of this research include the need for adequate assessments to measure students' creative and collaborative thinking skills. One of the main limitations is the limited sample size. This is because the number of students and schools involved may not include enough diversity to make strong generalizations about the effectiveness of the learning models tested. Additionally, research is conducted over a relatively short period of time, whereas creative and collaborative thinking skills may require a longer time to develop significantly.

Based on research findings, several things can be recommended, as follows: For teachers, it is necessary to get support and access to the resources needed to implement this learning model effectively. Education practitioners can take inspiration from the findings of this research to develop a curriculum that is more integrated with the STEAM approach. This can help prepare students to face real world demands that are increasingly complex and connected in a multidisciplinary manner. For policymakers, it is necessary to provide adequate financial and infrastructure support for teacher training in implementing a project-based learning model that is integrated with the STEAM approach. For future researchers, they could focus on evaluating the long-term impact of this learning model on students' creative and collaborative thinking skills or current variables that are relevant for other elementary school students. This study has several limitations. First, the sample is limited to one school, making it difficult to generalize the results to a broader population. Second, the relatively short duration of the study 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 influence the outcomes of the research.

CONCLUSION

Based on the research findings, it can be concluded that the implementation of the STEAM-integrated project-based learning model can enhance students' creative and collaborative thinking skills as well as their learning outcomes. This is evident from the data analysis and discussions presented in this study. There was an improvement in students' creative and collaborative thinking skills from the pre-cycle stage to cycle 2, where the average percentage increased from 26% and 28% to 78% and 80%, respectively. On average, students' creative and collaborative thinking skills increased by 52%. Furthermore, students' learning outcomes also showed improvement. Based on the initial data from the pre-cycle to cycle 2, the average completion rate of students' learning outcomes increased from 21% to 79%. Specifically, the average completion rate of students' social science learning outcomes in grade V increased by 58%. This research highlights the effectiveness of project-based learning models integrated with the STEAM approach in enhancing students' creative and collaborative thinking skills as well as their learning outcomes.

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AUTHOR CONTRIBUTION STATEMENT

ABEW was responsible for writing, analysis, and conceptualization of the study. MS contributed to the analysis and provided supervision throughout the project. RH played a crucial role in the analysis and offered valuable supervision. HZ was involved in the analysis and also provided essential supervision. LEWF contributed by editing the manuscript and supervising the overall progress of the research.

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