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Developing Elementary School Students' Creativity through the Implementation of a STEAM-Based Waste Recycling Project in Integrated Science and Social Studies (IPAS)

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Abstract: This study aims to describe the implementation of a Science, Technology, Engineering, Arts, and Mathematics (STEAM) based waste recycling project in Integrated Science and Social Studies (IPAS) learning to foster the creativity of fifth grade students at SD Negeri 106/1 Pelayangan. This research employed a qualitative approach using a descriptive research design. The research participants consisted of the school principal, the fifth grade teacher, and fifth grade students. Data were collected through classroom observations, semi structured interviews, and documentation, and were analyzed using the stages of data reduction, data display, and conclusion drawing. The trustworthiness of the data was ensured through source triangulation and technique triangulation. The findings revealed that the implementation of the STEAM-based waste recycling project was carried out in three stages: planning, implementation, and evaluation. The project successfully fostered students' creativity, as demonstrated by their ability to generate original ideas, elaborate on concepts, solve problems, produce diverse creative products, and collaborate effectively in groups. The successful implementation was supported by students' enthusiasm, the teacher's role as a facilitator, collaborative teamwork among students, and the availability of recyclable materials. However, several challenges were identified, including limited instructional time, differences in students' abilities, and technical difficulties encountered during product development. Therefore, the STEAM based waste recycling project can serve as an alternative instructional approach in Integrated Science and Social Studies (IPAS), promoting active, contextual, and meaningful learning while enhancing elementary school students' creativity.

Keywords: *STEAM, waste recycling project, students' creativity, integrated science and social studies (IPAS), elementary school*

INTRODUCTION

Creativity is one of the essential competencies that should be developed in 21st-century education. Through creativity, students are not only able to generate new ideas but also to develop solutions to various problems encountered in their daily lives (Dilekçi & Karatay, 2023; Thornhill-Miller et al., 2023). At the elementary school level, fostering creativity is particularly important because it serves as a foundation for critical thinking, problem-solving, communication, and collaboration skills required in the future. Science and Social Studies (IPAS) learning in the Merdeka Curriculum emphasizes the importance of contextual, meaningful, and student-centered learning experiences (Rosmiati et al., 2022; Syamsidar et al., 2025). Therefore, teachers are expected not only to deliver subject matter but also to design learning activities that provide opportunities for students to observe, explore, discuss, design, and produce meaningful work. Through active learning, students are expected to construct knowledge based on their own learning experiences.

However, classroom practices indicate that IPAS instruction in elementary schools is still largely dominated by teacher-centered approaches. Students tend to receive information passively rather than actively construct knowledge. Consequently, opportunities for students to develop creativity, express ideas, and produce original work remain limited. This condition was also observed at SD Negeri 106/1 Pelayangan, where project-based learning has been implemented but has not yet fully integrated the Science, Technology, Engineering, Arts, and Mathematics (STEAM) approach throughout the learning process.

One approach that can be employed to foster students' creativity is implementing a STEAM-based waste recycling project. The STEAM approach integrates five disciplines science, technology, engineering, arts, and mathematics into a unified learning experience, enabling students to engage in contextual and authentic learning (Baidal-Bustamante et al., 2023; Perales & Aróstegui, 2024). This integration encourages students to identify problems, design solutions, utilize available materials, and create products with practical value. A waste recycling project was selected because it is closely related to students' everyday lives. Through this project, students are encouraged to transform recyclable waste materials into useful products while simultaneously developing environmental awareness. Throughout the process, students not only learn IPAS concepts but also develop their ability to express ideas, collaborate with peers, modify designs, and produce creative and innovative products.

Previous studies have demonstrated that implementing project-based learning integrated with the STEAM approach can enhance students' creativity through active, experience-based learning activities. However, most of these studies have employed quantitative approaches to measure improvements in creativity or have focused on different types of learning projects (Chang et al., 2023; Kuo, 2025; Wahyudi et al., 2024). Qualitative studies specifically describing the implementation of STEAM-based waste recycling projects in elementary school IPAS learning remain relatively limited (Laeli et al., 2024; Muntazah et al., 2025). Therefore, this study contributes to the existing literature by providing an in-depth description of how a STEAM-based waste recycling project is implemented to foster students' creativity.

Based on the foregoing discussion, this study aims to describe the implementation of a STEAM-based waste recycling project in elementary school IPAS learning, to explore the development of students' creativity throughout the project, and to identify the supporting and inhibiting factors

influencing its implementation. The findings are expected to serve as a reference for elementary school teachers in designing more innovative, contextual, and creativity-oriented IPAS learning experiences

METHOD

Research Design

This study employed a qualitative descriptive research design. A qualitative approach was selected to obtain an in-depth understanding of the implementation of a STEAM-based waste recycling project in IPAS learning and to explore how the project contributed to the development of students' creativity (Creswell & Creswell, 2022). The descriptive design was used to systematically describe the learning process, the forms of creativity demonstrated by students during the project, and the factors that supported and hindered the implementation of the learning activities.

Research Site and Participants

The study was conducted at SD Negeri 106/1 Pelayangan. This site was selected because the school had implemented project-based learning but had not yet fully integrated the STEAM approach into classroom instruction. The participants included the fifth-grade classroom teacher, who facilitated the learning activities, and fifth-grade students who participated in the STEAM-based waste recycling project. In addition, the school principal served as a key informant to provide supporting information regarding the implementation of project-based learning at the school.

Data Collection

Data were collected through observation, interviews, and documentation. Classroom observations were conducted throughout the learning process to examine the implementation of the STEAM-based waste recycling project and students' learning activities. In-depth interviews were conducted with the fifth-grade teacher, the school principal, and selected students to obtain detailed information regarding the implementation process, the development of students' creativity, and the supporting and inhibiting factors encountered during the project. Documentation, including photographs of learning activities, lesson plans, students' project products, and other relevant documents, was collected to complement and strengthen the findings obtained through observations and interviews.

Data Analysis

Data were analyzed using the interactive model of qualitative data analysis consisting of three stages: data reduction, data display, and conclusion drawing. Data reduction involved selecting, organizing, and simplifying the information obtained from observations, interviews, and documentation. The reduced data were then presented in a narrative form to facilitate interpretation and identify relationships among the findings. Finally, conclusions were drawn and continuously verified throughout the research process to ensure the validity of the findings. Data trustworthiness was established through methodological triangulation and source triangulation by comparing information obtained from observations, interviews, and documentation across different participants

RESULTS

The findings indicate that the implementation of the STEAM-based waste recycling project in fifth-grade IPAS learning at SD Negeri 106/1 Pelayangan was carried out through three main stages: planning, implementation, and evaluation. These stages were conducted systematically, providing students with active, contextual, and student-centered learning experiences.

During the planning stage, the teacher prepared the teaching module, formulated the learning objectives, organized the required tools and materials, and designed a project involving the construction of a simple toy car using recyclable materials in accordance with the IPAS learning objectives. At this stage, the elements of Science, Technology, Engineering, Arts, and Mathematics were integrated into the learning activities, ensuring that the project emphasized not only the final product but also the learning process.

The implementation stage demonstrated students' active engagement throughout the project, as explained in Table 1. Working collaboratively in groups, students observed, discussed, designed, constructed, tested, and presented their projects. Throughout the activities, the teacher acted as a facilitator, providing guidance whenever students encountered difficulties. These learning experiences encouraged students to exchange ideas, collaborate effectively, solve problems, and develop their creativity during the learning process. During the evaluation stage, the teacher assessed both the learning process and the final products. The assessment focused not only on the quality of the completed products but also on students' participation, collaboration, confidence in expressing ideas, problem-solving abilities, and creativity in designing products from recyclable materials. The evaluation provided comprehensive evidence of the development of students' creativity throughout the implementation of the STEAM-based learning project.

Table 1. Implementation stages of the STEAM-based waste recycling project.

Stage	Main Activities	Findings
Planning	Preparing the teaching module and organizing the required tools and materials.	The learning process was designed using the STEAM (Science, Technology, Engineering, Arts, and Mathematics) approach.
Implementation	Conducting a waste recycling project, facilitating group discussions, and presenting project outcomes.	Students actively collaborated, demonstrated creativity, and successfully integrated STEAM elements into their projects.
Evaluation	Assessing both the learning process and project outcomes through observations, interviews, and documentation.	Students' creativity improved throughout the learning process, and the project was successfully completed.

The findings also revealed that implementing the STEAM-based waste recycling project effectively fostered students' creativity. The development of creativity was reflected in students' ability to generate ideas (fluency), explore various alternative solutions (flexibility), elaborate and refine their ideas (elaboration), produce unique and engaging products (originality), and collaborate effectively within groups. In addition to enhancing creativity, the project activities also increased students' self-confidence when presenting their work in front of the class.

The successful implementation of the project was supported by several factors, including students' high level of enthusiasm, the availability of easily accessible recyclable materials, effective collaboration

among students, and continuous teacher guidance throughout the learning process. On the other hand, the study also identified several challenges, including limited time for project implementation, differences in students' ability to understand instructions, and technical difficulties encountered during product assembly, as presented in Table 2. Nevertheless, these challenges were addressed through group collaboration and teacher facilitation, enabling the learning objectives to be successfully achieved.

Table 2. Summary of research findings

Research Focus	Key Findings
Implementation of the STEAM-based project	The project was implemented through three stages: planning, implementation, and evaluation.
Development of students' creativity	The indicators of fluency, flexibility, originality, elaboration, and collaboration demonstrated noticeable improvement throughout the project implementation.
Supporting factors	Students' enthusiasm, teacher guidance, effective group collaboration, and the availability of recyclable materials contributed to the successful implementation of the project.
Challenges	Limited implementation time, differences in students' abilities, and technical difficulties during project construction were identified as the main challenges.

DISCUSSION

The findings of this study indicate that the implementation of a STEAM-based waste recycling project in elementary school science education (IPAS) was carried out systematically through the stages of planning, implementation, and evaluation. Careful planning provided a clear framework for both teachers and students throughout the project. The preparation of teaching modules, the formulation of learning objectives, and the selection of project activities aligned with the characteristics of the IPAS curriculum were key factors contributing to the successful implementation of STEAM-based learning. During the implementation stage, students actively participated in every phase of the learning process, including identifying problems, designing products, utilizing recyclable materials, revising their designs, and presenting the final outcomes. These activities demonstrate that STEAM-based learning creates a student-centered learning environment. Through authentic learning experiences, students not only developed a deeper understanding of IPAS concepts but also strengthened their critical thinking, collaboration, communication, and problem-solving skills while addressing challenges encountered during product development (Bertrand & Namukasa, 2020; Ekayana et al., 2025).

The findings further reveal that the STEAM-based waste recycling project effectively fostered students' creativity. This was reflected in their ability to generate multiple ideas, develop and refine those ideas into more innovative products, explore alternative solutions when facing challenges, and produce unique products that differed across groups. Furthermore, project presentations provided students with opportunities to express their ideas, explain the product development process, and enhance their self-confidence in public speaking. These findings are consistent with the principles of STEAM education, which emphasize the integration of science, technology, engineering, arts, and mathematics to solve authentic, real-world problems. Such an interdisciplinary approach enables students to learn through hands-on experiences, making learning more meaningful and relevant (Arango-Caro et al., 2025; Belbase et al., 2022). Beyond improving academic competencies, the waste recycling project also

promoted environmental awareness by encouraging students to transform recyclable materials into useful and value-added products.

The study also identified several factors that contributed to the successful implementation of the project, including students' enthusiasm, continuous teacher support throughout the learning process, the availability of recyclable materials, and effective collaboration among group members. These factors encouraged active student participation throughout the project activities. Nevertheless, several challenges were encountered, including limited instructional time, differences in students' learning abilities, and technical difficulties during product construction. These challenges were mitigated through teacher facilitation, clear task allocation within groups, and more effective time management.

Overall, the implementation of the STEAM-based waste recycling project had a positive impact on IPAS learning in elementary schools. The learning process shifted from a teacher-centered approach to a student-centered approach, allowing students to construct knowledge through authentic experiences, collaborate with peers, think creatively, and develop products that addressed real environmental issues. These findings reinforce the potential of the STEAM approach as an effective instructional alternative for supporting the implementation of the Merdeka Curriculum, particularly in fostering creativity among elementary school students.

CONCLUSION

The implementation of the STEAM-based waste recycling project in Grade V IPAS learning at SD Negeri 106/1 Pelayangan was successfully conducted through the systematic stages of planning, implementation, and evaluation. The integration of Science, Technology, Engineering, Arts, and Mathematics into project-based learning provided students with contextual, active, and student-centered learning experiences. The project effectively enhanced students' creativity, as demonstrated by their ability to generate ideas, explore multiple problem-solving strategies, elaborate and refine their ideas into improved products, produce diverse and original work, and collaborate effectively within groups. In addition, participation in project presentations increased students' confidence in communicating and presenting their work before the class.

The successful implementation of the project was supported by students' enthusiasm, the active role of teachers as facilitators, effective collaboration among students, and the availability of easily accessible recyclable materials. However, several challenges were identified, including limited instructional time, differences in students' abilities, and technical difficulties encountered during product construction. Despite these challenges, they were effectively addressed through teacher guidance and collaborative teamwork, enabling the learning objectives to be successfully achieved. The findings suggest that STEAM-based waste recycling projects represent an effective alternative for IPAS instruction in elementary schools by creating meaningful learning experiences while simultaneously fostering students' creativity.
ability.

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Authors' Contributions NAL: conceptualization; methodology; validation; writing—review and editing and supervision; project administration; funding acquisition. MY: methodology; visualization; data curation; formal analysis. All authors read and approved the final manuscript.

Data Availability The data supporting the findings of this study are available from the corresponding author upon reasonable request.

Ethical approval All procedures performed in the study followed the ethical standards.

Consent for publication All authors have read and agreed to the published version of the manuscript.

Consent to participate Consent to participate was obtained from all individual participants included in the study.

Informed consent Informed consent was obtained from all individual participants included in the study. Data were reported anonymously in the study.

Conflict of interest The authors declare no competing interests

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