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Wind Car Project to Integrate STEAM into the Elementary Education Curriculum

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ABSTRACT

Objective: *This study aims to describe the implementation of the Wind Car Project as a simple, contextual, and low-cost strategy for integrating STEAM (Science, Technology, Engineering, Arts, and Mathematics) into the Grade 4 elementary school curriculum.* ***Method:*** *The research employed a descriptive qualitative approach with a case study design conducted in one fourth-grade class. Data were collected through classroom observations, analysis of curriculum documents and STEAM learning modules, and teacher reflective notes.* ***Results:*** *The findings indicate that the Wind Car Project successfully integrates all STEAM components holistically through the Engineering Design Process (EDP). The project enhanced students' conceptual understanding of wind energy, promoted active and collaborative learning, and supported the implementation of project-based learning aligned with the Merdeka Curriculum. Teachers also perceived the project as feasible and adaptable within existing instructional constraints.* ***Novelty:*** *This study highlights the novelty of utilizing a simple, low-resource engineering project to operationalize STEAM integration at the elementary level, demonstrating that effective STEAM-based curriculum development does not necessarily require complex infrastructure or high financial investment, but can be achieved through well-designed, contextually relevant projects.*

INTRODUCTION

The development of science, technology, and sustainability issues requires the education sector to continuously adapt curricula to remain relevant to the demands of the 21st century [1]. Elementary education, as the foundation for students' competency development, needs to provide learning experiences that are not only oriented toward conceptual mastery but also toward critical thinking, creativity, collaboration, and problem-solving skills. These competencies are essential for preparing students to face complex global challenges in the future. Learning approaches that emphasize active participation and contextual understanding are therefore increasingly necessary. Consequently, curriculum innovation at the elementary level becomes a strategic priority [2], [3].

The STEAM (Science, Technology, Engineering, Arts, and Mathematics) approach has been widely recommended to address these challenges, as it promotes interdisciplinary integration and experiential, real-world learning. STEAM encourages students to connect concepts across disciplines through meaningful activities. In Indonesia, the Merdeka Curriculum provides broad opportunities for the implementation of project-based learning as a core instructional strategy. This

curriculum emphasizes flexibility, contextual learning, and student-centered instruction. As a result, STEAM aligns well with the philosophical and pedagogical foundations of the Merdeka Curriculum [3], [4].

However, the implementation of STEAM in elementary schools still faces several challenges. Many teachers perceive STEAM learning as complex, costly, and requiring special facilities or advanced technology. These perceptions often limit teachers' willingness to adopt STEAM-based learning models in their classrooms. Additionally, limited access to training and practical examples further constrains implementation. Therefore, there is a strong need for best-practice examples of STEAM learning that are simple, feasible, and curriculum-aligned.

One such example is the Wind Car Project included in the Grade 4 STEAM e-module for Semester 1 under the theme *Saving Energy*. This project utilizes simple and easily accessible materials such as cardboard, straws, and bottle caps to construct a wind-powered car. Through this activity, students learn scientific concepts related to wind energy, force, and motion in a hands-on manner. The project also integrates engineering design, creativity, and basic mathematical reasoning. Accordingly, this article focuses on analyzing the Wind Car Project as a means of integrating STEAM into the development of the elementary education curriculum.

Literature Review

STEAM in Elementary Education

STEAM is an integrated learning approach that combines science, technology, engineering, arts, and mathematics within a single learning context. This approach emphasizes interdisciplinary connections rather than isolated subject instruction. In elementary education, STEAM supports the development of scientific literacy and creativity at an early age. Learning experiences become more meaningful when students engage with real-world problems and tangible projects. Therefore, STEAM is considered highly relevant for fostering holistic student development in primary education [5].

Engineering Design Process (EDP)

The Engineering Design Process (EDP) is a systematic framework commonly used in engineering-based learning. It consists of six stages: Ask, Imagine, Plan, Create, Test, and Improve. These stages guide students in identifying problems, generating ideas, and developing solutions through iterative processes. EDP encourages logical thinking, experimentation, and reflection during learning activities. As a result, EDP supports the development of problem-solving and critical-thinking skills in elementary students.

STEAM and Curriculum Development

STEAM-based curriculum development does not necessarily require structural changes to existing subject frameworks. Instead, it can be implemented through the enrichment of learning strategies, instructional media, and authentic assessment methods. Project-based STEAM activities allow teachers to integrate multiple competencies within a single learning experience. Simple STEAM projects can function as micro-level curriculum innovations that enhance classroom practices. Thus, STEAM

contributes to curriculum flexibility while maintaining alignment with national education standards [6], [7].

RESEARCH METHOD

This study employed a descriptive qualitative approach with a case study design to gain an in-depth understanding of the implementation of the Wind Car Project. The research subjects were fourth-grade elementary school students who participated in learning activities using the Semester 1 STEAM e-module. The case study design was chosen to capture the contextual and process-oriented nature of STEAM integration in real classroom settings. This approach allowed the researchers to explore learning interactions, instructional strategies, and curriculum alignment in detail. Through this design, the study sought to provide a comprehensive description of how the Wind Car Project functions as a STEAM-based learning activity in elementary education.

Data Collection Techniques

Data were collected using multiple techniques to ensure a comprehensive understanding of the learning process. First, classroom observations were conducted to examine the integration of STEAM components and the level of student engagement during the Wind Car Project. These observations focused on student participation, collaboration, and problem-solving activities. Second, document analysis was carried out on the STEAM e-module, learning objectives, and the Wind Car project activities to identify curriculum alignment and instructional design. Third, teacher reflections were collected to explore perceived impacts of the project on student learning and curriculum development, providing valuable practitioner insights [8], [9].

Data Analysis Techniques

The collected data were analyzed using a systematic qualitative analysis procedure. This process included data reduction to select relevant information related to STEAM integration and project-based learning. The reduced data were then organized and presented in descriptive forms to identify emerging patterns and themes. Following data presentation, conclusions were drawn based on consistent findings across data sources. To enhance the validity of the findings, data triangulation was applied by comparing results from observations, document analysis, and teacher reflections [10], [11].

RESULTS AND DISCUSSION

Implementation of the Wind Car Project in the Curriculum

Based on the STEAM e-module, the Wind Car Project was implemented under the theme Saving Energy in the Grade 4 curriculum. The project integrates the Science component through the study of wind energy, air pressure, and propulsive force. The Technology aspect is reflected in the use of simple tools and the application of environmentally friendly technological principles [12], [13]. The Engineering component involves the process of designing and assembling a wind-powered car, while Arts is incorporated through creative design and decoration to enhance the visual appeal of the product. The Mathematics element is applied through calculating speed using the formula $v = s/t$, and the learning activities are compressed within one

semester of the STEAM module and conducted through the stages of the Engineering Design Process, ensuring active student participation throughout the learning process.

Impact on Curriculum Development

The findings of the case study indicate that the Wind Car Project effectively supports contextual project-based learning in elementary education. The project simplifies teachers' efforts to integrate STEAM components without requiring changes to the existing curriculum structure. It also encourages instructional flexibility by allowing teachers to adapt learning activities to classroom conditions and student needs. Furthermore, the project enhances curriculum relevance by promoting creativity, collaboration, and experiential learning. Therefore, the Wind Car Project serves as a practical model for curriculum development that aligns with the principles and objectives of the Merdeka Curriculum [14], [15].

CONCLUSION

Fundamental Finding : This study demonstrates that the Wind Car Project represents a simple, effective, and feasible model for integrating STEAM into the elementary education curriculum, enabling students to develop a meaningful understanding of wind energy concepts through hands-on, interdisciplinary learning. **Implication :** The project supports the implementation of project-based learning aligned with the Merdeka Curriculum and offers practical guidance for teachers to integrate STEAM without requiring complex infrastructure or major curricular restructuring, thereby contributing to adaptive and sustainable curriculum development at the elementary level. **Limitation :** This study is limited to a single case study conducted in one fourth-grade class, which may restrict the generalizability of the findings to broader educational contexts. **Future Research :** Further research is recommended to examine the implementation of the Wind Car Project across diverse school settings, grade levels, and regional contexts, as well as to investigate its long-term impact on students' STEAM competencies, critical thinking skills, and environmental awareness.

REFERENCES

[1] A. Asrifan and S. S. Ingilan, "Redesigning Doctoral Curricula: Integrating Sustainability in 21st-Century Research Skills," in *Improving Doctoral Education and Research Development for Sustainability*, IGI Global, 2025, pp. 177–210. doi: 10.4018/979-8-3373-0225-6.ch006.

[2] H. I. Y. Yim, "STEAM in practice and research in primary schools," *Int. J. Sci. Educ.*, vol. 46, no. 3, pp. 345–360, 2024.

[3] UNESCO, *STEM and STEAM education framework for primary learning*. UNESCO Publishing, 2021.

[4] K. Tan and A. Ng, "Authentic assessment in STEAM education," *STEM International Review*, vol. 9, no. 1, pp. 14–28, 2021.

[5] R. Sari, "Renewable energy projects in elementary science learning," *Journal of Primary Science Education*, vol. 7, no. 1, pp. 33–46, 2023.

[6] L. Rahmawati, "STEAM implementation challenges in Indonesian elementary schools," *Jurnal Inovasi Pendidikan*, vol. 14, no. 1, pp. 55–68, 2022.

[7] A. Nugroho, "Curriculum development and STEAM integration in primary schools," *Indonesian Journal of Curriculum Studies*, vol. 5, no. 2, pp. 89–102, 2020.
[8] M. Kim and S. Chae, "Effects of STEAM-based projects on problem-solving skills in elementary students," *Journal of STEAM Education*, vol. 6, no. 1, pp. 22–35, 2021.
[9] K. Manning, "Low-cost STEAM activities for primary schools," *STEM Education International*, vol. 10, no. 2, pp. 101–115, 2023.
[10] A. A. G. Ekayana, "Project-based STEAM learning to improve scientific literacy in elementary students," *J. Technol. Sci. Educ.*, vol. 15, no. 1, pp. 45–58, 2025.
[11] S. Han, "Engineering design process for young learners," *Early STEM Research Journal*, vol. 4, no. 2, pp. 67–79, 2020.
[12] N. Nurhidayah and A. Yahya, "IMPLEMENTATION OF THE MERDEKA CURRICULUM THROUGH THE APPLICATION OF THE PROJECT-BASED BLENDED LEARNING MODEL IN MATHEMATICS LEARNING: IMPLEMENTASI KURIKULUM MERDEKA MELALUI PENERAPAN MODEL PROJECT-BASED BLENDED LEARNING DALAM PEMBELAJARAN MATEMATIKA," *MaPan*, vol. 11, no. 2, pp. 273–284, Dec. 2023, doi: 10.24252/mapan.2023v11n2a5.
[13] U. Khairiyah, D. A. Pramudita, and M. B. T. Sampurno, "Enhancing Creative Thinking Through Project Based Learning: Study of Fourth-Grade Elementary Students," *Indonesian Journal of Islamic Elementary Education*, vol. 5, no. 2, pp. 220–230, Nov. 2025, doi: 10.28918/ijiee.v5i2.9655.
[14] M. Hess, "Saving the World," in *Social & Emotional Curriculum for Gifted Students Grade 5*, Routledge, 2021, pp. 65–90. doi: 10.4324/9781003238027-4.
[15] E. Bilir, C. Bilir, and D. Soybas, "Supporting the Self-Confidence of a Student with Mathematics Learning Disabilities through the Engineering Design Process," in *Generational Advances through STEM Education*, Purdue University Library Publishing, 2025. doi: 10.5703/1288284317837.

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