Journal of Indonesian Elementary Education
Vol. 2, No. 1, Desember 2024, pp 102-109
E-ISSN: 3032-6222
https://ejournal.intelektualedu.com/index.php/JIEE/index

STEM and the Storm: Investigating Problem-Solving Skills in Water Cycle Lessons Among Young Learners

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ABSTRACT. Problem-solving ability is an essential skill for elementary school students to meaningfully understand science concepts, including the water cycle, which is closely related to everyday life phenomena. However, conventional teaching methods often do not provide sufficient opportunities for students to develop this skill optimally. This study aims to investigate the effect of implementing the STEM learning model on students' problem-solving ability in the context of the water cycle in a fifth-grade elementary school classroom. The study employed a pre-experimental method with a one-group pretest-posttest design. The sample consisted of 30 fifth-grade students selected through convenience sampling. The research instrument used was a problem-solving ability test, and the data were analyzed quantitatively using a paired sample t-test. The results showed that the implementation of the STEM model had a significant positive effect on enhancing students' problem-solving ability, categorized as high. These findings indicate that integrating STEM into science learning can be an effective approach to foster critical thinking and problem-solving skills from an early age.

Keywords: *STEM, problem solving, water cycle, elementary school, science learning*

INTRODUCTION

Problem-solving ability is a complex cognitive skill that involves a systematic process of identifying and processing information to generate solutions for well-structured problems or constraints (Arianto & Hanif, 2024). For students, this ability is not only essential for understanding academic content but also for navigating real-life situations that require decision-making (Nasution, 2021) and critical thinking (Rosjanuardi & Juandi, 2023). In the context of science education, this skill becomes increasingly important, as students are expected to analyze, comprehend, and logically explain various natural phenomena (Magaji, 2021).

When students possess adequate problem-solving skills, they are able to transfer and apply these skills to different problem-solving contexts, thereby enhancing their analytical abilities (Armiati et al., 2018). Such capabilities contribute to improved conceptual understanding and the development of higher-order thinking processes (Rismawati et al., 2022), ultimately leading to better learning outcomes. These strengths also play a crucial role in preparing students to face future challenges that demand 21st-century competencies (Kurniawati et al., 2019).

One of the strategies that can be implemented to foster students' problem-solving abilities is the use of instructional models that promote exploration, collaboration, and active engagement (Limbong, 2024). Effective learning models can guide students in constructing knowledge through direct experience and reflective thinking. Therefore, selecting an appropriate instructional model is key to designing a meaningful and cognitively challenging learning process (Aji et al, 2024).

A learning model that aligns well with these goals is the STEM (Science, Technology, Engineering, and Mathematics) education model. This model not only cultivates essential skills such as critical, collaborative, and creative thinking (Sutinah et al., 2024),, but also corresponds to the characteristics of science subjects, which include conceptual understanding (product), scientific process skills, and scientific attitudes. STEM approaches allow students to learn science in an integrated and contextualized manner (Wahono et al, 2021).

STEM-based learning is closely related to the development of problem-solving skills. Through the integration of concepts from various disciplines and the resolution of real-world, project-based or

challenge-based problems, students are encouraged to formulate problems, design solutions, and reflect on the outcomes. Several previous studies, such as those conducted by researcher, have shown that STEM has a significant impact on critical thinking skills. Subsequent research indicates that STEM can enhance students' problem-solving abilities.STEM-based instruction is closely related to the development of problem-solving skills. Through the integration of concepts from multiple disciplines and the application of project-based or real-world problem-solving activities, students are encouraged to formulate problems, design solutions, and reflect on the outcomes (Jolly, 2017). Previous studies, such as those conducted by (Patras et al., 2024), have shown that STEM influences critical thinking skills. Subsequent research has indicated that STEM can also enhance students' problem-solving abilities (Lathiifah & Kurniasi, 2020; Sarican & Akgunduz, 2018).

Based on this background, the present study aims to investigate the effect of implementing the STEM learning model on fifth-grade students' problem-solving abilities in the topic of the water cycle in elementary school. This research is expected to contribute to improving the quality of science education at the elementary level, particularly in fostering problem-solving competence, which is essential for the sustainable mastery of scientific concepts and skills.

METHOD

This study employed a pre-experimental method using a one-group pretest–posttest design (Sugiyono, 2019), selected to measure the effect of implementing the STEM learning model on students' problem-solving abilities. The research subjects consisted of 30 fifth-grade elementary school students selected using convenience sampling (Creswell, 2010). The learning process was conducted using a STEM-based approach designed to actively engage students through the integration of science, technology, engineering, and mathematics within the context of the water cycle topic.

The instrument used was a problem-solving ability test in the form of open-ended questions based on Polya's indicators: understanding the problem, devising a plan, carrying out the plan, and evaluating the solution. Data were collected through pretests and

posttests, and then analyzed quantitatively using a paired sample t-test with a significance level of 0.05 to determine the effectiveness of the STEM model in improving students' problem-solving abilities.

RESULT AND DISCUSSION

This study aimed to investigate the effect of the STEM learning model on students' problem-solving abilities in the topic of the water cycle. To measure this effect, a pretest and posttest were administered to 30 students. The test results were analyzed to assess the improvement in scores and the statistical significance of the difference.

Table 1. Problem-Solving Ability Data

Data	Pretest	Postest
Jumlah siswa	30	30
Average	52	90
Normality Test	Sig. = 0,094 (normal)	Sig. = 0,133 (normal)
Paired sample t-test	Sig. = 0,000	
n-gain	0,77 (high)	

The analysis results indicate a significant improvement in students' problem-solving abilities after the implementation of the STEM learning model. The average score increased from 52 (before the treatment) to 90 (after the treatment). The paired sample t-test yielded a significance value of 0.000, which is smaller than 0.05, indicating that the difference is statistically significant. Additionally, the N-gain value of 0.77 falls within the high category, suggesting a substantial improvement in students' abilities.

This improvement in problem-solving skills can be explained by several factors. First, STEM learning emphasizes active student engagement in the learning process through contextual problem-solving and challenge-based projects. This aligns with the view that STEM approaches encourage the integration of knowledge and skills in real-world contexts (Sirakaya et al., 2020), thereby enhancing students' critical thinking and problem-solving abilities (Duodu et al., 2017).

Second, the interdisciplinary nature of STEM allows students to see the connections between concepts and apply them in new situations. Students not only memorize the concept of the water

cycle but also use it to design solutions for real-world problems such as drought or flooding. This supports the view that integrated learning is essential for developing deep and flexible conceptual understanding (Siegel & Giamellaro, 2020).

Third, the STEM model provides opportunities for students to work collaboratively in groups and explore solutions together. This collaborative activity fosters scientific communication skills, idea-sharing, and joint reflection (Lesseig et al., 2019). Collaboration in STEM learning significantly enhances higher-order thinking skills (Baker & Galanti, 2017; Ratnasari, 2023).

Fourth, hands-on experiences through experiments and simple engineering activities make learning more meaningful and enjoyable for students (Johnson et al., 2020). Through this approach, students learn by experiencing rather than merely receiving information. Real-world learning experiences in STEM (Galanti & Holincheck, 2022) offer opportunities to interact with physical objects in the real world (Ching et al., 2019).

Therefore, the results of this study reinforce previous findings that the STEM approach is effective in improving students' problem-solving abilities. This model has been proven to bridge theoretical and practical learning in a balanced manner while promoting relevant 21st-century skills. These findings have important implications for teachers to begin integrating STEM-based learning into the elementary school science curriculum.

CONCLUSION

Based on the research conducted, it can be concluded that the implementation of the STEM learning model contributes positively to the development of elementary school students' problem-solving abilities. This model enables active, contextual, and integrative learning, thereby encouraging students to think critically, creatively, and reflectively when facing real-world problems. Therefore, STEM-based learning serves as a strategic alternative that can be adopted to enhance the quality of science education in elementary schools.

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