Pendas : Jurnal Ilmiah Pendidikan Dasar,
ISSN Cetak : 2477-2143 ISSN Online : 2548-6950
Volume 10 Nomor 03, September 2025

SCIENCE LEARNING TO DEVELOP CRITICAL THINKING IN ELEMENTARY SCHOOL STUDENTS

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ABSTRACT

This study aims to analyze the implementation of science learning in developing critical thinking skills of elementary school students. The problem addressed in this research is the low level of students' critical thinking skills caused by teacher-centered learning and lack of meaningful learning experiences. This study employed a qualitative descriptive approach with subjects consisting of fifth-grade students and teachers at an elementary school. Data were collected through observation, interviews, and documentation. The findings indicate that student-centered, contextual, and activity-based science learning significantly improves students' critical thinking skills. This improvement is reflected in the increase of pretest and posttest scores with a moderate N-Gain category, as well as enhanced student participation in questioning, analyzing, and concluding. The use of experiments, cooperative learning, and contextual approaches based on local potential contributes to meaningful learning experiences and strengthens students' understanding. Therefore, innovative and interactive science learning plays a crucial role in fostering critical thinking skills in elementary education.

Keywords: *science learning, critical thinking, elementary school*

A. Introduction

Science education in elementary schools plays a strategic role in developing students' critical thinking skills, which is one of the essential competencies for the 21st century. Critical thinking skills not only involve mastering concepts but also the ability to analyze, evaluate, and make decisions based on scientific information in a rational manner (Facione, 2015; Ennis, 2011). Critical thinking is not enough to be taught verbally, but needs to be practiced through learning activities that require students to answer open-ended questions, compare data, build arguments, and test reasons (Ennis, 2009).

In the context of science learning, critical thinking is particularly relevant because science operates through a process of inquiry. Students need opportunities to observe phenomena, formulate questions, make predictions, test information, and draw conclusions. Critical thinking needs to be integrated directly into science learning activities, not taught as a separate skill (Vieira & Tenreiro, 2016).

However, the current state of science education still shows a tendency to be teacher-centered and focused on memorization, which has not optimally encouraged the development of higher-order thinking skills in students (Arda et al., 2024). This results in students' limited ability to connect scientific concepts with real-world phenomena in their surroundings.

This phenomenon is further supported by various studies indicating that elementary school students' critical thinking skills are still relatively low and have not developed optimally. This low level of ability is influenced by the use of conventional teaching methods, which fail to engage students in analytical and reflective thinking processes (Suparya, 2025; Masithoh et al., 2025). Additionally, critical thinking skills are closely linked to science literacy, where students are expected to understand concepts, apply knowledge, and make evidence-based decisions (OECD, 2019; Apriliana, 2024). Therefore, science education that lacks context and meaning directly impacts the low development of students' critical thinking skills.

Science education that integrates local potential and students' real-life experiences can be a solution to improve the quality of learning. The use of the environment as a learning resource has been proven to enhance student engagement and deepen their understanding (Puspaningrum, 2025a). Moreover, an educational approach based on core educational values can strengthen science literacy through more reflective and meaningful learning (Puspaningrum & Wahyudi, 2025). In this context, science education serves not only as a transfer of knowledge but also as a means of developing students' critical thinking skills and character.

Furthermore, various studies have shown that the development of critical thinking skills can be achieved through the application of innovative teaching models such as inquiry, problem-based learning (PBL), project-based learning (PjBL), and STEM. These models have been proven effective in improving critical thinking skills by encouraging students to actively engage in problem-solving processes and scientific exploration (Fitriadi et al., 2025; García-Carmona, 2023). The inquiry-based approach, in particular, is identified as an effective strategy for developing higher-order thinking skills in science education (García-Carmona, 2023). In addition, project-based learning has a significant impact on enhancing students' critical thinking skills through active involvement in investigative activities (Fitriadi et al., 2025).

In line with this, other studies indicate that the development of interactive learning media based on technology, including multimedia and artificial intelligence, can improve students' critical thinking skills through more engaging and adaptive learning experiences (Sari, 2025). Besides the model and media factors, a learning environment that encourages questioning, discussion, and reflection also plays a key role in shaping students' critical thinking skills (Pramusinta & Saputri, 2025). This shows that the development of critical thinking skills requires a comprehensive approach, considering teaching strategies, media, and the learning environment.

Empirical evidence in the field shows that elementary school students still struggle to express opinions, analyze problems, and make data-based decisions. This indicates that science education has not fully succeeded in optimally developing students' critical thinking skills (Puspaningrum et al., 2025). Therefore, there is a need for an innovative, contextual, and student-centered science learning design to address these challenges.

Based on the above discussion, the focus of this research is how science education can be designed and implemented to develop critical thinking skills in elementary school students. The purpose of this research is to describe and analyze the application of effective science education to improve students' critical thinking skills. This research is expected to provide theoretical benefits in the development of science education studies and practical benefits as a reference for teachers in designing innovative, contextual, and critical thinking-oriented learning.

B. Research Methods

This study uses a qualitative approach with a descriptive research design aimed at providing an in-depth description of the implementation of science education in developing critical thinking skills among elementary school students. This approach is chosen because it can holistically and contextually depict phenomena in accordance with the real conditions in the field.

The subjects of this study are fifth-grade elementary school students and their teachers who implement science education. The selection of subjects was carried out through purposive sampling, considering the characteristics of the class that has applied activity-based science learning and student engagement. The research location was determined based on its relevance to the observed learning context, particularly schools that have integrated innovative approaches into science education.

Data collection techniques were conducted through observation, interviews, and documentation. Observation was used to directly observe the ongoing science learning process in the classroom, especially activities that demonstrate indicators of students' critical thinking, such as the ability to ask questions, analyze, and draw conclusions. Interviews were conducted with both teachers and students to gain more in-depth information related to their learning experiences, strategies used, and challenges faced. Meanwhile, documentation was used to complement the data in the form of learning materials, student work results, and notes on learning activities.

The research instruments used include observation sheets for students' critical thinking activities, interview guidelines, and documentation formats. The critical thinking indicators observed refer to the ability to identify problems, analyze information, evaluate arguments, and draw logical conclusions.

Data analysis techniques use an interactive analysis model consisting of three stages: data reduction, data presentation, and conclusion drawing. Data reduction is carried out by sorting and simplifying data relevant to the research focus. Data presentation is done in the form of narrative descriptions to facilitate understanding of the research findings. Subsequently, conclusion drawing is done gradually, paying attention to patterns, relationships, and meanings derived from the obtained data.

To ensure the validity of the data, this study uses triangulation techniques, both source triangulation and method triangulation. Source triangulation is carried out by comparing data obtained from teachers and students, while method triangulation is carried out by comparing the results of observation, interviews, and documentation. Therefore, the research findings are expected to have a high level of validity and reliability.

The methodology used in this study is expected to provide a comprehensive picture of the implementation of science education in developing critical thinking skills among elementary school students, thus serving as a foundation for the development of more effective and innovative learning strategies.

C. Research Result

The research results indicate that the implementation of science education, which is oriented towards scientific activities, contextual learning, and student-centered approaches, has a positive impact on the enhancement of critical thinking skills among elementary school students. This improvement is observed not only in the cognitive aspects through test results but also in the change in students' learning behaviors during the learning process. Students became more active in asking questions, expressing opinions, conducting simple analyses, and drawing conclusions based on the evidence they obtained.

Quantitatively, the research results show an improvement in students' critical thinking skills, measured through pretest and posttest scores. This data is further supported by the N-Gain calculation to assess the level of improvement in students' abilities after the learning intervention.

Table 1: Pretest, Posttest, and N-Gain of Critical Thinking Skills of Students

Component	Experiment	Control
N	25	25
Pretest ($\bar{x}$)	36	36
Pretest (S)	21,25	21,25
Posttest ($\bar{x}$)	61	61
Posttest (S)	27,47	27,47
N-Gain ($\bar{x}$)	0,425	0,425
N-Gain (S)	0,253	0,253

Based on Table 1, it can be observed that the average posttest score showed an improvement compared to the pretest in both classes. The N-Gain score of 0.425 indicates that the improvement in critical thinking skills falls within the moderate category. Although the numerical improvement appears relatively similar, the observation results indicate that the quality of the thinking process in the experimental class is more developed compared to the control class. This suggests that actively and contextually designed learning not only enhances learning outcomes but also deepens the students' thinking process.

The observation results during the learning process showed that students in the experimental class were more active in various indicators of critical thinking, such as identifying problems, asking questions, providing reasoning for answers, and evaluating the information obtained. Students also demonstrated improvement in their ability to cooperate and engage in group discussions. These activities were less frequently observed in the control class, where students tended to remain passive and wait for the teacher's explanations.

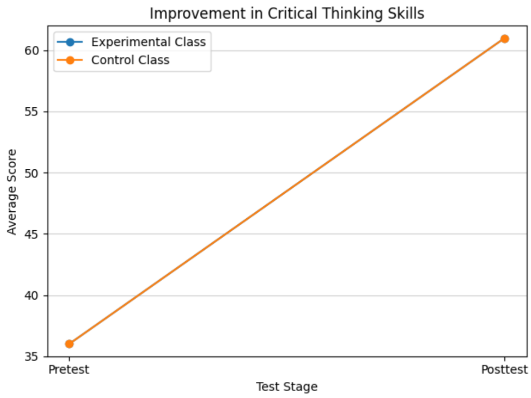

Figure 1: Improvement in Critical Thinking Skills

The graph shows a trend of improvement in the average scores from pretest to posttest, with a more stable and consistent increase in the experimental class compared to the control class.

The use of visual-based learning media also contributed to enhancing students' understanding of scientific concepts. One example used in this study is the material on the water cycle.

D. Discussion

The results of this study show that student-centered, activity-based science education has a significant impact on the development of students' critical thinking skills. This aligns with the theory that critical thinking develops through learning experiences that involve analysis, evaluation, and reflection (Facione, 2015; Ennis, 2011). Learning that solely focuses on content delivery is insufficient for developing these skills.

The improvement in critical thinking skills in this study is closely related to the application of experimental-based learning. Through experimental activities, students are directly involved in the scientific process, from observing, formulating hypotheses, conducting experiments, to drawing conclusions. This process provides meaningful learning experiences and encourages students to think systematically and logically (Puspaningrum, 2025b).

Additionally, the integration of local potential into the learning process plays an important role in increasing student engagement. Learning that is connected to the surrounding environment makes it easier for students to understand concepts because it is concrete and close to their everyday lives (Puspaningrum, 2025a). This strengthens the view that contextual learning can enhance the quality of students' understanding and critical thinking abilities.

Social interaction in cooperative learning is also a key factor in the development of critical thinking skills. Through group discussions, students learn to express ideas, defend arguments, and respect others' opinions. This activity strengthens the analytical and evaluative skills that are part of critical thinking (Puspaningrum et al., 2025). This is consistent with research stating that problem-based learning and inquiry-based learning models are effective in improving critical thinking skills because they actively involve students in the learning process (Fitriadi et al., 2025; García-Carmona, 2023).

The use of visual and interactive learning media has also been shown to help students understand concepts more deeply. Visualizations, such as diagrams of the water cycle, provide concrete representations that make it easier for students to connect abstract concepts with real-world phenomena (Sari, 2025). Moreover, a learning environment that supports questioning and reflection is also an important factor in developing students' critical thinking skills (Pramusinta & Saputri, 2025).

Therefore, the results of this study emphasize that innovative, contextual, and student-centered science education not only improves learning outcomes but also significantly develops critical thinking skills. The implications of this research highlight the importance of the teacher's role in designing learning that provides space for students to actively think, explore, and collaborate. Science education should no longer focus solely on memorization, but rather on deep and meaningful scientific thinking processes.

E. Conclusion

Based on the research findings and discussion, it can be concluded that science education designed to be active, contextual, and student-centered effectively enhances elementary students' critical thinking skills. This improvement is demonstrated through the pretest and posttest results, which show an increase in scores with a moderate category based on the N-Gain value, as well as supported by changes in students' learning activities, which became more analytical, reflective, and participatory during the learning process.

Science education that integrates scientific activities such as experiments, discussions, and problem-solving has proven effective in encouraging students to develop critical thinking skills. In addition, the utilization of local potential and the use of visual learning media also contribute to strengthening conceptual understanding and enhancing student engagement in learning. Social interaction through cooperative learning further enriches students' thinking processes through activities like exchanging ideas and evaluating opinions.

Thus, science education serves not only as a means of transferring knowledge but also as a platform for optimally developing students' critical thinking skills. Therefore, teachers are expected to be able to design innovative, contextual, and student-oriented learning that can create meaningful and sustainable learning processes.

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