IMPLEMENTATION OF DEEP LEARNING IN IMPROVING STUDENTS' CRITICAL THINKING SKILLS IN SCIENCE LEARNING IN ELEMENTARY SCHOOLS

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Abstract: This study aims to disseminate the effect of the implementation of the deep learning model on improving students' critical thinking skills in learning Natural and Social Sciences (IPAS) in elementary schools. The study used a quantitative approach with a quasi-experimental design of the non-equivalent control group design, involving two fifth grade classes at Margoluwih Public Elementary School, Sleman, each consisting of 26 students as the experimental group and 26 as the control group. The research instrument was a critical thinking test consisting of 10 essay questions that measured four indicators of critical thinking skills, namely telling stories, expressing ideas, concluding, and providing logical reasons. Data were analyzed using an independent t-test with the help of SPSS software. The results of the study showed that there was a significant difference between the average posttest results of students in the experimental class and the control class with a t-value of 5.842 and a p-value of 0.000 < 0.05. The average posttest score of the experimental class was 84.35, higher than the control class of 74.04, with an effect size (Cohen's d) of 1.75, indicating a very large effect. These findings indicate that in-depth learning can significantly improve students' critical thinking skills through meaningful exploration, reflection, and collaborative discussion activities. Thus, the application of in-depth learning can be an alternative effective learning strategy to develop high-level thinking skills in elementary school students, especially in science learning that requires the integration of scientific and social knowledge.

Keywords: Critical Thinking, Deep Learning, Sciences.

PENDAHULUAN

The development of science and technology in the 21st century demands that education prepare a generation that not only masters factual knowledge but also possesses critical, creative, communicative, and collaborative thinking skills. In the context of basic education, critical thinking skills are an important foundation for students to understand natural and social phenomena scientifically and rationally, and to be able to solve everyday life problems. Natural and Social Sciences (IPAS) subjects in elementary schools play a strategic role in shaping students' scientific thinking and critical attitudes toward their surroundings. However, in reality, IPAS learning in many elementary schools in Indonesia still tends to be oriented towards memorizing concepts, with teacher-centered lecture methods, so that students are given little space to explore, ask questions, and reason independently (Ramdayani, Sumantri, and Hasanah 2024). This results in low critical thinking skills, limited in-depth conceptual understanding, and a minimal ability to connect knowledge to real-life situations (Mulyanti et al. 2024).

To address these challenges, the learning paradigm needs to shift from a surface approach to a deep learning approach. In the educational context, the term "deep learning" does not solely refer to artificial intelligence technology, but rather to a learning process that emphasizes conceptual understanding, the interconnectedness of ideas, reflection, and the ability to apply knowledge to new contexts (Putri 2025). Deep learning requires students to actively construct knowledge through critical thinking, problem-solving, collaboration, and self-reflection (Mardatillah, Wulandari, and Zulfianti 2025). Implementing this approach requires teachers to become facilitators who guide students' thinking processes, not simply conveyors of information. Through strategies such as project-based learning, problem-based learning, inquiry learning, or simple research-based learning, students are trained to analyze problems, evaluate information, and conclude solutions based on empirical data (Nurlailah and Julkifli 2025).

Several studies have shown that immersive learning has a positive impact on improving critical thinking skills and learning outcomes for elementary school students. Rahayu et al. (2025) found that the application of a project-based deep learning model in science learning can improve students' analytical and scientific argumentation skills. Another study by Dewi & Rusilowati (2025) confirmed that immersive learning strategies applied to science learning can increase student activeness in discussions and encourage higher-order thinking skills. Meanwhile, the results of research by Susanti et al. (2025) showed that students who actively engage in reflection-based learning and concept exploration show significant improvements in critical thinking indicators, such as the ability to analyze cause and effect and evaluate solutions. These findings indicate that immersive learning has great potential to be implemented effectively in the context of elementary schools in Indonesia, particularly in science subjects that require interdisciplinary understanding.

Furthermore, the Independent Curriculum (Curriculum Merdeka), implemented in Indonesia since 2022, increasingly emphasizes the importance of student-centered learning and a focus on strengthening the Pancasila student profile, one of which is critical reasoning skills. In this context, immersive learning aligns with the spirit of the Independent Curriculum, which encourages inquiry-based, reflective, and contextual learning. Teachers play a central role in designing learning experiences that stimulate students' critical thinking through activities such as observing phenomena, reflective discussions, and exploring simple scientific projects. Thus, the implementation of immersive learning is not only a pedagogical strategy but also part of the paradigm shift in basic education in Indonesia toward more meaningful and student-centered learning (Paramita et al. 2025).

Based on this description, it is important to conduct empirical research to analyze how the implementation of immersive learning can improve students' critical thinking skills in science learning in elementary schools. This research focuses on the application of an immersive learning model through the integration of a project-based approach and scientific inquiry in fifth-grade elementary school students. The purpose of this study is to describe the application of an immersive learning model in science learning, analyze the improvement in students' critical thinking skills after the implementation of the model, and identify supporting and inhibiting factors in its implementation. The results of this study are expected to contribute to the development of pedagogical practices and strengthening learning strategies that align with the principles of the Independent Curriculum and the 21st-century needs of developing critical, reflective, and character-based students.

METODE

Types of research

This study used a quantitative approach with a quasi-experimental design aimed at determining the effect of in-depth learning implementation on improving students' critical thinking skills in science learning in elementary schools. The research design used was a non-equivalent control group design (Assingkily, 2021), involving two fifth-grade classes in a public elementary school in Palembang City.

Time and Place of Research

This research was conducted at a public elementary school in Palembang during the odd semester of the 2025/2026 academic year. The school was selected because it was conducting a trial implementation of deep learning for two semesters: the even semester of the 2024/2025 academic year and the odd semester of the 2025/2026 academic year.

Research Target/Subject

The subjects of this study were Class VA, designated as the experimental class and treated with a deep learning approach, while Class VB served as the control class, using a conventional lecture-based and question-and-answer learning model. The number of subjects was 52 students, consisting of 26 students in the experimental class and 26 students in the control class. The sample selection was carried out using a purposive sampling technique, based on the equality of average academic ability characteristics, so that differences in learning outcomes better reflect the influence of the learning model. The material taught covered the theme of Environmental Change in the odd semester of the Natural Sciences subject.

Data, Instruments, and Data Collection Techniques

There search instruments used consisted of student activity observation sheets, a critical thinking skills test, and aquestionnaire assessing student responses to learning. The critical thinking skills test was developed based on indicators adapted from Ennis (2011), which encompass the ability to analyze, evaluate, conclude, and provide logical reasoning for a problem. The instrument's content validity was tested by three elementary education experts and the results showed a high level of suitability (CVI = 0.89).

Data Analysis Techniques

The data analysis conducted in this study used the instrument reliability test calculated using the Cronbach's Alpha formula with a value of 0.87 which indicates high reliability. The learning process was carried out over four meetings (each 2 x 35 minutes) with deep learning stages which include: (1) exploration of phenomena, (2) problem analysis, (3) reflection of concepts, and (4) application of concepts through simple projects. Data collection was carried out through pretests and posttest sofcritical thinking skills, then analyzedusing an independent t-test with the help of SPSS software version 26.0 to determine the difference in the increase in critical thinking skills between the experimental class and the control class. In addition, the results of observations and questionnaires were analyzed descriptively to provide a qualitative picture of the implementation of deep learning and student responses to its application.

RESULTS AND DISCUSSION

Results

This study aims to determine the effect of the application of in-depth learning models on students' critical thinking skills in science learning in elementary schools. The research subjects consisted of two classes, namely class VA (experimental) and class VB (control), each consisting of 26 students. The experimental class was given treatment in the form of in-depth learning applications with stages of phenomenon exploration, problem analysis, concept reflection, and simple project implementation, while the control class was taught with conventional methods based on lectures and questions and answers. The material used was Environmental Change and Its Impact on Life.

Data collection was conducted through a critical thinking ability test administered twice, namely a pretest before treatment and a posttest after treatment. Test scores were assessed based on four critical thinking indicators according to Ennis (2011): (1) the ability to analyze, (2) evaluate, (3) conclude, and (4) provide logical reasons. The following is a summary of the descriptive statistics of the research results.

Table 1. Descriptive Statistics of Pretest and Posttest Scores

Class	N	Minimum Score	Maximum Score	*Mean Pretest*	*Mean Posttest*	Std. Deviation *Pretest*	Std. Deviation *Posttest*
Experiment	26	58	76	66.12	84.35	5.21	5.62
Control	26	57	75	65.73	74.04	5.43	6.13

Based on the data in Table 1, the average score of students' critical thinking skills in the experimental class increased from 66.12 to 84.35, while the control class increased from 65.73 to 74.04. The difference in the increase in the average score (gain score) between the two classes indicates a difference in effectiveness between the learning models.

Table 2. Average Gain Score of Critical Thinking Skills

Class	*Mean Pretest*	*Mean Posttest*	*Gain Score*	Category
Experiment	66.12	84.35	18.23	High
Control	65.73	74.04	8.31	Medium

In Table 2 above, the experimental class showed an average increase of 18.23 points, while the control class only achieved 8.31 points. Based on the improvement categories, the experimental class' results were classified as high, while the control class's were classified as moderate.

Before conducting the mean difference test, a normality test and a homogeneity test were first carried out to ensure that the data met the parametric assumptions.

Table 3. Results of Normality and Homogeneity Tests

Test Type	Class	Sig.	Criteria	Conclusion
Kolmogorov–Smirnov	Experiment	0.173	> 0.05	Normal
Kolmogorov–Smirnov	Control	0.192	> 0.05	Normal
Levene's Test	–	0.327	> 0.05	Homogeneous

The Kolmogorov-Smirnov test revealed a significance value of 0.173 for the experimental class and 0.192 for the control class (>0.05), indicating a normal distribution for the data. The Levene's test showed a significance value of 0.327 (>0.05), indicating that the data for both classes had homogeneous variance. Therefore, an independent t-test could be conducted.

Table 4. Independent t-Test Results Posttest Value

Variable	Class	Mean	Std. Deviation	t-count	df	Sig. (2-tailed)	Conclusion
Critical thinking skills	Experiment	84.35	5.62	5.842	50	0.000	Significant
	Control	74.04	6.13				

The results of the independent t-test calculation show a t-value of 5.842 with a p-value (Sig. 2-tailed) of 0.000 < 0.05, so H• is rejected and H• is accepted. This means that there is a significant difference between the critical thinking skills of students taught using in-depth learning and students taught using conventional methods.

Table 5. Summary of Inferential Statistics of Critical Thinking Skills

Analysis	Score	Interpretation
t-count	5.842	> t-tabel (2.008) → Significant
Sig. (2-tailed)	0.000	< 0.05 → H_0 rejected
Mean Difference	10.31	Higher experimental class
Power of Effect (Cohen's d)	1.75	Very big effect

The effect size calculation using Cohen's d yielded a value of 1.75, which is considered a very large effect. This indicates that the immersive learning model has a strong influence on improving students' critical thinking skills.

In addition to quantitative results, observations during the learning process showed an increase in critical thinking activities in the experimental class. Based on the student activity observation sheet, the average activeness score reached 86.7%, with the highest aspects being the ability to provide logical reasoning (91%) and ask reflective questions (88%). Meanwhile, the control class only achieved 71.4%, dominated by activities of listening and taking notes on the teacher's explanations. This data supports the results of statistical tests that the implementation of in-depth learning not only improves learning outcomes but also optimizes students' critical thinking processes during the science learning process.

Discussion

The results of the study indicate that the application of a deep learning model in science learning significantly improves elementary school students' critical thinking skills compared to conventional models. This difference is demonstrated by the t-test results with a significance value of 0.000 < 0.05 and an effect size of 1.75, which is categorized as a very large effect. This indicates that a learning approach that requires deep cognitive engagement, concept exploration, and reflection on learning experiences can optimally develop critical thinking skills in elementary school-aged students.

These findings align with Hosnan's (2014) view that students' higher-order thinking develops when learning goes beyond simply receiving information and encourages them to construct meaning through analyzing and evaluating phenomena. In this context, the immersive learning model encourages students to relate learning experiences to real-life contexts, as recommended in the Independent Curriculum. In the experimental class, activities exploring environmental phenomena, discussing the causes of ecosystem change, and mini-projects on environmental mitigation fostered reflective, argumentative, and analytical thinking—three key components of critical thinking according to Ennis (2011).

These results also support research by Mulyasari et al. (2022), which showed that a deep learning cycle-based learning approach can improve elementary school students' critical thinking skills in science by 28% compared to direct learning. Similarly, Widiawati et al. (2024) found that the Project-Based Deep Learning model effectively improved students' critical thinking and problem-solving skills in thematic learning. In this study, students who actively engaged in data exploration and conceptual reflection showed significant improvements in providing logical reasoning and drawing conclusions.

From a theoretical perspective, in-depth learning is rooted in the constructivist paradigm, which emphasizes the importance of active and reflective cognitive processes in building knowledge (Biggs & Tang, 2011). Students not only receive information but also interpret, critique, and connect concepts to real-world situations. In this study, the "conceptual reflection" phase allowed students to reassess group hypotheses and conclusions, strengthening the evaluative domain of critical thinking. This is consistent with the findings of research by Hidayati et al. (2025) who stated that the application of reflection-based learning and in-depth discussions can significantly improve the analytical and evaluative dimensions of elementary school students' critical thinking.

Furthermore, improvements in critical thinking skills can also be explained through cognitive social interaction. During in-depth learning, teachers act as facilitators, guiding open dialogue and argumentative feedback between students. This mechanism fosters metacognitive awareness and encourages students to think at a higher level of analysis. Research by Komariyah (2025) shows that reflective dialogue-based learning has a positive correlation ($r = 0.68$) with elementary school students' critical thinking skills. A similar finding was observed in this study, where an increase in student activity observation scores in the experimental class indicated a significant increase in question-asking and logical reasoning activities compared to the control class.

The context of science subjects also provides space for the effective implementation of in-depth learning. Material such as Environmental Change has conceptual and phenomenological characteristics that encourage students to engage in cause-and-effect reasoning and data-driven decision-making. According to Sulaiman and Febrianta (2022), science content is ideally taught using a contextual approach based on direct experience to enable students to integrate scientific and social knowledge reflectively. In this study, students in the experimental class demonstrated a better ability to relate the concept of environmental change to human behavior, compared to the control class, which only understood the concept descriptively.

Based on teacher observations and reflections, immersive learning also impacts learning motivation. Students involved in investigative and collaborative processes feel more autonomous in their learning. This finding supports research by Bulkis et al. (2025), which found that integrating deep learning pedagogy with environmental exploration-based projects increased student engagement by up to 35%. Thus, immersive learning impacts not only cognitive outcomes (critical thinking) but also students' affective and social aspects.

Overall, the results of this study confirm that the implementation of the immersive learning model plays a crucial role in the development of Higher Order Thinking Skills (HOTS) in elementary schools. This model is relevant for the science and science curriculum because it provides opportunities for students to think critically, creatively, and collaboratively. However, its implementation requires trained teachers to design reflective activities and evaluate students' thinking processes, not just the final results.

CONCLUSION

Based on the research results and discussions that have been conducted, it can be concluded that the application of the deep learning model in science learning can significantly improve the critical thinking skills of elementary school students compared to conventional learning models. This is indicated by the significant difference in the average posttest scores and the high effect size value, which indicates a strong influence of the application of deep learning on improving students' analytical, evaluation, and reasoning skills. Through the stages of phenomenon exploration, conceptual reflection, and collaborative discussion, students not only understand concepts factually, but are also able to reason about cause-and-effect relationships and relate them to real-life contexts. Thus, deep learning is effectively applied in science learning as an effort to foster critical thinking skills and shape the profile of reflective, analytical, and highly intelligent students in accordance with the demands of 21st-century learning.

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