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The Effect of Discovery Learning on Elementary School Students' Critical Thinking Skills and Learning Outcomes

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ABSTRACT

This study is motivated by the low level of critical thinking skills and learning outcomes among elementary school students, which is closely related to the continued dominance of teacher-centered instructional practices. Therefore, this study aims to examine the effect of the Discovery Learning model on elementary school students' critical thinking skills and learning outcomes. A quantitative method with a quasi-experimental design was employed, involving an experimental group and a control group. The participants consisted of 93 fifth-grade students at SD Negeri Beji, Pemalang Regency, in the 2025/2026 academic year. Data were collected using multiple-choice achievement tests to measure learning outcomes and questionnaires to assess students' critical thinking skills. Prior to hypothesis testing, the data were confirmed to meet classical assumption requirements. Data analysis was conducted using simple linear regression with the assistance of SPSS software. The results revealed that the Discovery Learning model had a significant positive effect on students' critical thinking skills and learning outcomes. These findings indicate that Discovery Learning is an effective instructional model for promoting active learning, strengthening higher-order thinking skills, and improving academic achievement in elementary education.

1. Introduction

Twenty-first century education emphasizes the development of higher-order thinking skills, particularly critical thinking, as an essential competence for students in responding to rapid developments in science, technology, and society. Critical thinking refers to the ability to analyze information, evaluate arguments, synthesize evidence, and make reasoned decisions based on valid considerations (Ennis, 2015; Facione, 2019). At the elementary school level, strengthening these skills is crucial because early cognitive development forms the foundation for students' long-term academic success, independence in learning, and adaptability to future learning

challenges. Students who are actively engaged in critical thinking activities tend to demonstrate deeper conceptual understanding and better learning outcomes across subject areas. Empirical evidence shows that learning environments which actively involve students in reasoning and problem-solving activities contribute significantly to the development of critical thinking and academic achievement (Rosiana et al., 2023; Wahyuni et al., 2021; Nuraini et al., 2025). Therefore, elementary education must prioritize instructional approaches that systematically cultivate students' higher-order thinking skills.

Instructional practices in elementary education play a decisive role in shaping students' critical thinking development. Learning environments that remain dominated by memorization-oriented and teacher-centered approaches tend to limit students' opportunities to question, analyze, interpret information, and construct knowledge independently. Consequently, students may demonstrate short-term academic performance without developing deep conceptual understanding or transferable cognitive skills. Gede et al. (2022) emphasized that the quality of learning processes and the design of assessment instruments significantly influence students' scientific literacy and higher-order thinking skills. Similarly, Hartati et al. (2025) reported that learning models designed to actively engage students in problem-solving processes have a positive impact on critical thinking skills. From a cognitive load perspective, learning environments that encourage interaction, collaboration, and guided exploration are more effective in facilitating meaningful knowledge construction than passive instruction (Kirschner et al., 2018). These findings indicate that instructional strategies should prioritize active student engagement, inquiry-based activities, and reflective reasoning processes.

In response to these challenges, a growing body of empirical evidence indicates that student-centered and problem-oriented learning models are more effective in improving critical thinking skills and learning outcomes than conventional approaches. Studies in the *Journal of Educational Sciences* report that problem-based learning, cooperative learning, and inquiry-based learning significantly improve students' cognitive learning outcomes (Ardiana et al., 2025; Khayyirah et al., 2024; Istiqori et al., 2025). Meta-analytic and experimental studies further confirm that constructivist-based learning models have a significant positive effect on students' reasoning abilities and conceptual understanding (Dewi et al., 2024; Mutmainnah et al., 2025; Rahayu et al., 2024). Among constructivist-oriented approaches, discovery learning is a model that strongly aligns with the principle of active knowledge construction.

Discovery learning engages students in systematic stages such as stimulation, problem identification, data collection, verification, and conclusion drawing, enabling them to explore concepts, formulate hypotheses, analyze data, and derive conclusions independently (Bruner, 1961; Alfieri et al., 2011). Empirical studies demonstrate that discovery learning has a significant positive effect on students' critical thinking skills and cognitive learning outcomes (Hasibuan et al., 2025; Qomariyah & Nurlim, 2025; Ora et al., 2025; Dewi et al., 2024; Mutmainnah et al., 2025).

In addition, recent studies highlight that innovative learning media and technology-enhanced instruction support active and meaningful learning. Research published in the *Journal of Educational Sciences* demonstrates that augmented reality-based learning media improve students' conceptual understanding, learning motivation, and learning outcomes across science and IPAS topics (Munawarah, 2025; Zahro et al., 2024; Syahrir et al., 2025; Febriyanti & Andriani, 2025). These findings suggest that discovery learning, when supported by appropriate learning resources and digital media, has strong potential to foster both critical thinking skills and academic achievement.

Despite extensive research on innovative learning models, empirical studies that simultaneously examine the effect of discovery learning on both critical thinking skills and learning outcomes in elementary IPAS contexts remain limited, especially those employing quantitative causal designs in public elementary schools within regional settings such as Pemalang Regency. Therefore, this study aims to investigate the effect of the discovery learning model on fifth-grade students' critical thinking skills and learning outcomes at SD Negeri Beji, Pemalang Regency. Specifically, this research addresses the following questions: (1) Does the discovery learning model significantly affect students' critical thinking skills? and (2) Does the discovery learning model significantly affect students' learning outcomes?

2. Methodology

This study employed a quantitative research approach using a quasi-experimental design to examine the effect of the Discovery Learning model on students' critical thinking skills and learning outcomes. This approach was selected because it allows researchers to investigate causal relationships between instructional treatments and learning outcomes within authentic classroom settings where random assignment of participants is often not feasible. Quasi-experimental research is widely used in educational studies to evaluate the effectiveness of instructional interventions while maintaining ecological validity (Creswell & Creswell, 2023; Sugiyono, 2021).

The research was conducted at SD Negeri Beji, Pemalang Regency, during the second semester of the 2025/2026 academic year. The participants consisted of all 93 fifth-grade students enrolled at the school. Due to the relatively small and manageable population size, a total sampling technique was applied, in which all members of the population were included as research participants. This sampling strategy ensured comprehensive representation and minimized sampling bias. The participants were assigned into two intact groups based on existing classroom arrangements, namely an experimental group and a control group.

The experimental group received instruction using the Discovery Learning model, whereas the control group was taught using conventional teacher-centered instructional methods. Discovery Learning emphasizes active knowledge construction through exploration, inquiry, and problem solving, which are essential for developing students' critical thinking skills and conceptual understanding

(Nurzaelani et al., 2025). The implementation of Discovery Learning followed systematic stages, including stimulation, problem identification, data collection, data analysis, verification, and conclusion drawing. These stages were designed to encourage students to actively engage in learning activities, explore learning materials, formulate hypotheses, analyze information, and draw conclusions independently. In contrast, the control group received instruction dominated by explanation, demonstration, and routine practice, with limited opportunities for student exploration.

Two research instruments were used to collect data in this study. Students' learning outcomes were measured using a multiple-choice achievement test in Ilmu Pengetahuan Alam dan Sosial (IPAS), which was designed to assess students' conceptual understanding and factual knowledge. Students' critical thinking skills were measured using a structured questionnaire developed based on critical thinking indicators, including analysis, evaluation, inference, and reasoning. Prior to data collection, both instruments were subjected to empirical validity testing and reliability analysis to ensure that they met acceptable standards of measurement accuracy and internal consistency. The instrument development and testing procedures followed established educational measurement guidelines (Widoyoko, 2023). Data collection was conducted after the instructional intervention had been completed. Both the experimental group and the control group were administered the same instruments under similar conditions to obtain post-test data. The use of identical instruments and standardized administration procedures ensured comparability between groups and reduced potential measurement errors.

Data analysis was carried out in two stages. First, descriptive statistical analysis was used to describe students' performance in terms of mean scores, standard deviations, and score distributions for both critical thinking skills and learning outcomes. Second, inferential statistical analysis using simple linear regression was performed to determine the magnitude and significance of the effect of the Discovery Learning model on the dependent variables. Prior to hypothesis testing, assumption tests included normality, linearity, heteroscedasticity, and multicollinearity tests to ensure that the data met regression analysis requirements. All statistical analyses were conducted using SPSS software. To facilitate clearer interpretation of students' learning outcomes, achievement scores were categorized into three levels, as presented in Table 1.

Table 1. Classification of Students' Learning Achievement

Score Range	Category
80–100	High
60–79	Moderate
0–59	Low

This classification enabled systematic interpretation of students' post-treatment achievement levels and supported meaningful comparison between the experimental and control groups.

3. Results and Discussion

The research was conducted in Grade V of SD Negeri Beji, Pemalang Regency, involving a total of 93 students. The experimental class consisted of 46 students (24 male and 22 female), while the control class consisted of 47 students (25 male and 22 female). Based on preliminary observations and discussions with classroom teachers, students demonstrated heterogeneous academic abilities, with most students categorized at a moderate level of achievement. Prior to the implementation of the discovery learning model, classroom instruction was predominantly teacher-centered and relied heavily on lecture-based explanations and textbook-oriented activities. Students were accustomed to receiving information directly from the teacher, completing structured exercises, and memorizing factual content, with limited opportunities for inquiry, exploration, and problem-solving.

The learning process before the intervention rarely involved group discussions, hands-on investigations, or contextual problem situations. As a result, students tended to be passive during lessons, asked few questions, and demonstrated limited engagement in higher-order thinking activities. Formative assessments indicated that many students experienced difficulties in explaining concepts using their own words, analyzing simple problems, and drawing conclusions based on evidence. These conditions suggest that existing instructional practices had not optimally supported the development of critical thinking skills and meaningful understanding. Therefore, the implementation of a student-centered learning model such as discovery learning was considered necessary to improve both critical thinking skills and learning outcomes.

Implementation of Discovery Learning during The Study

The discovery learning model was implemented over six instructional meetings. Each meeting followed systematic stages, namely stimulation, problem identification, data collection, data processing, verification, and generalization. At the stimulation stage, students were presented with contextual phenomena related to IPAS topics through pictures, short videos, and guiding questions to activate prior knowledge and stimulate curiosity. During the problem identification stage, students worked in small groups to formulate problem statements based on the presented phenomena. The teacher facilitated discussion by encouraging students to express ideas, ask questions, and exchange viewpoints within their groups. This stage aimed to foster students' sense of ownership of learning and promote initial analytical thinking.

At the data collection stage, students explored various learning resources such as student worksheets, textbooks, and digital learning media. Students conducted simple observations, read supporting materials, and recorded relevant information. The teacher acted as a facilitator by providing scaffolding and guiding questions when necessary. In the data processing stage, students organized the collected information, compared findings among group members, and discussed possible explanations. This stage emphasized reasoning, interpretation of evidence, and

identification of patterns. Students then proceeded to the verification stage, where they compared their conclusions with scientific concepts provided by the teacher to ensure conceptual accuracy.

Finally, at the generalization stage, each group presented their findings and conclusions. The teacher provided feedback, clarified misconceptions, and guided students to formulate general principles. This sequence allowed students to actively construct knowledge while developing critical thinking processes such as analyzing, evaluating, and concluding. Two main examples of discovery learning activities were implemented. First, students investigated the characteristics and functions of plant parts through direct observation of real plant specimens and digital visualizations. Second, students analyzed environmental change phenomena using case-based worksheets supported by images and guiding questions. These activities required students to identify problems, collect evidence, and draw conclusions collaboratively. Examples of learning media and student activities are shown in Figure 1, Figure 2, and Figure 3.



Figure 1. Augmented Reality-Based Learning Media Display

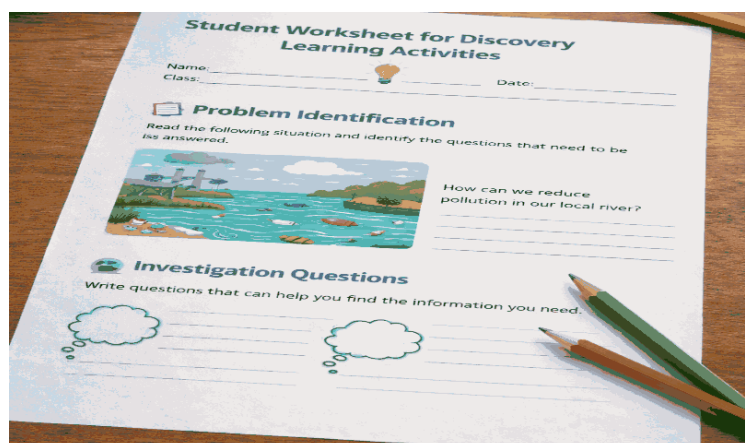


Figure 2. Student Worksheet for Discovery Learning Activities



Figure 3. Group Discussion and Investigation Process

Statistical Results

Before hypothesis testing, prerequisite analyses indicated that the data met regression assumptions, including normality, linearity, absence of heteroscedasticity, and absence of multicollinearity. Simple linear regression analysis was then conducted to examine the effect of discovery learning on learning outcomes and critical thinking skills. The descriptive statistics of students' learning outcomes and critical thinking skills are presented in Table 2.

Table 2. Mean Scores of Learning Outcomes and Critical Thinking Skills

Variable	Experimental Group	Control Group
Learning Outcomes	84.62	73.15
Critical Thinking Skills	82.47	70.38

Regression results for learning outcomes are shown in Table 3.

Table 3. Regression Results for Learning Outcomes

Predictor	B	t	p	R ²
Discovery Learning	0.68	7.21	0.000	0.36

The regression coefficient ($B = 0.68$) indicates that every one-unit increase in the implementation of discovery learning increases students' learning outcomes by 0.68 units. The coefficient of determination ($R^2 = 0.36$) indicates that discovery learning explains 36% of the variance in learning outcomes. Regression results for critical thinking skills are presented in Table 4.

Table 4. Regression Results for Critical Thinking Skills

Predictor	B	t	p	R ²
Discovery Learning	0.72	7.85	0.000	0.41

The regression coefficient ($B = 0.72$) indicates that every one-unit increase in the implementation of discovery learning increases students' critical thinking skills by

0.72 units. The R^2 value of 0.41 indicates that discovery learning accounts for 41% of the variance in students' critical thinking skills. These findings confirm that discovery learning has a significant positive effect on both dependent variables ($p < 0.05$).

Discussion

The findings demonstrate that discovery learning effectively improves students' critical thinking skills and learning outcomes. This improvement can be attributed to students' active involvement in constructing knowledge through exploration, discussion, and verification processes, which align with constructivist learning theory (Bruner, 1961; Alfieri et al., 2011). Through systematic stages of discovery learning, students are encouraged to engage in higher-order cognitive processes such as analyzing information, evaluating evidence, and drawing conclusions. The improvement in critical thinking skills contributes directly to better learning outcomes, as students who think critically are better able to understand concepts, apply knowledge, and solve problems (Ennis, 2015; Facione, 2019). The results of this study are consistent with previous research reporting positive effects of discovery learning on students' critical thinking skills and cognitive achievement (Kusumawati & Indarini, 2024; Eskris, 2021; Mutmainnah et al., 2025; Dewi et al., 2024).

In addition, the use of supportive learning media during discovery learning activities enhanced students' engagement and conceptual understanding. Technology-assisted and visual learning resources help make abstract concepts more concrete and meaningful, thereby supporting active learning (Munawarah, 2025; Zahro et al., 2024). Nevertheless, several limitations should be considered. The quasi-experimental design limits full control over extraneous variables, such as differences in teacher facilitation skills, classroom climate, and student motivation. The relatively short duration of the intervention may also have constrained the magnitude of observed effects. Furthermore, this study focused on a single school context, which may limit generalizability. Future studies are recommended to employ longer intervention periods, include multiple schools, and examine additional moderating variables to strengthen causal interpretation.

4. Conclusion

This study concludes that the discovery learning model is effective in enhancing elementary school students' critical thinking skills and learning outcomes. Students who participated in discovery-oriented instruction demonstrated greater involvement in exploring concepts, analyzing information, and formulating conclusions independently. Such learning experiences promote deeper conceptual understanding and encourage the development of higher-order thinking skills, which are essential for meaningful learning in elementary education. Furthermore, discovery learning was found to support improved academic achievement by creating learning environments that emphasize active inquiry, collaboration, and problem solving. Compared to traditional teacher-centered instruction, discovery

learning provides more opportunities for students to construct knowledge through direct experience, thereby strengthening their comprehension and retention of learning content. Overall, the findings indicate that discovery learning represents a practical and promising instructional model for elementary classrooms. The successful implementation of this model suggests that teachers are encouraged to integrate discovery-oriented activities into daily instruction to foster students' critical thinking and learning achievement. Future research may explore the application of discovery learning in different subjects, grade levels, and educational contexts, as well as its integration with various learning media and digital technologies.

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