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The Influence of Project Based Learning and Critical Thinking Learning Models on Science Learning Outcomes of Grade V Elementary School

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ABSTRACT
Background This study investigates the effect of the Project-Based Learning (PjBL) model and students' critical thinking skills on science learning outcomes of fifth-grade elementary school students. The research employed an experimental method with a 2×2 factorial design, involving two independent variable learning models (PjBL) and conventional learning) and critical thinking skills (high and low) and one dependent variable, namely science learning outcomes. The participants consisted of 67 fifth-grade students from SDN Pejaten Barat 06, South Jakarta, divided into an experimental group (34 students) and a control group (33 students). Data were collected using science learning outcome tests, critical thinking questionnaires, observation sheets, interviews, and documentation. Instrument validity and reliability were tested prior to data analysis. The data were analyzed using two-way ANOVA and t-tests with the assistance of SPSS. The results showed that the application of the Project-Based Learning model had a significant positive effect on students' science learning outcomes. The experimental group achieved a higher average posttest score (92.13) compared to the control group (77.39). Students' critical thinking skills also significantly influenced learning outcomes, with students who demonstrated high critical thinking skills achieving better results than those with lower levels. Furthermore, the analysis revealed a significant interaction between the PjBL model and critical thinking skills on science learning outcomes, indicating that PjBL is more effective when accompanied by the development of students' critical thinking abilities. In conclusion, the Project-Based Learning model integrated with critical thinking development is effective in improving science learning outcomes, promoting active participation, collaboration, and higher-order thinking skills. This learning model is recommended as an innovative instructional approach to enhance the quality of science learning in elementary schools in accordance with 21st-century educational demands.

Keywords: Project Based Learning Model, Science, Project Activities, Critical Thinking

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INTRODUCTION

Education plays a central role in improving the quality of human resources and shaping society's way of thinking. Law No. 20 of 2003 emphasizes that education aims to develop students' potential holistically—spiritually, intellectually, in attitude, and in skills. In elementary schools, particularly in science learning, students are expected to gain meaningful learning experiences through scientific activities, direct observation, exploration, and knowledge construction. However, observations show that science learning in elementary schools is still dominated by expository methods and one-way communication, causing students to become passive, less engaged, insufficiently stimulated to think critically, and resulting in learning outcomes that remain below the minimum mastery criteria, with an average score of 61.

Critical thinking ability is an essential component of higher order thinking skills that must be developed early. The low level of students' critical thinking skills is closely related to the lack of variation in instructional models used by teachers. Various studies indicate that the Project-Based Learning (PjBL) model is effective in improving critical thinking, creativity, and science learning outcomes because it provides real learning experiences and encourages students to actively solve problems. PjBL allows students to collect and analyze information, identify issues, draw conclusions, and produce projects that are relevant to daily life.

In the context of science learning for fifth graders at SDN Pejaten Barat 06, the implementation of PjBL is expected to address problems related to monotonous and less varied instructional practices. Based on these conditions, the problem statements in this study include how the Project-Based Learning model influences science learning outcomes; how students' critical thinking skills contribute to their academic

achievement; and how the interaction between PjBL and critical thinking skills affects overall science learning outcomes. These problem statements form the foundation for understanding the key factors that determine improvements in the quality of science instruction.

Aligned with these problem statements, this study aims to analyze the influence of the Project-Based Learning model on science learning outcomes, to identify the relationship between critical thinking skills and student achievement, and to examine the interaction between these two variables in enhancing students' understanding of scientific concepts. These objectives are expected to provide a comprehensive picture of the effectiveness of PjBL as an active, contextual, and engaging learning model for elementary school students.

The benefits of this study include both theoretical and practical contributions. Theoretically, the results can enrich scientific literature on the effectiveness of PjBL in science learning and its contribution to the development of critical thinking skills at the elementary level. Practically, this research will benefit teachers by offering insights into effective and innovative instructional models; schools by supporting improvements in teaching strategies; and students by fostering more meaningful learning experiences, increasing motivation, and generating positive impacts on learning outcomes and critical thinking abilities. Thus, the application of PjBL is expected to bring significant improvements to the quality of both the learning process and students' science achievement.

METHOD

The research method used in this study is the experimental method. An experimental method can be defined as a research method used to determine the effect of a particular treatment on other variables under controlled conditions. In experimental methods, there are two groups: the experimental group and the control group.

In this study, the design used is a 2×2 factorial design. According to Hasnan et al.(2020) , this design was chosen because it involves two independent variables and one dependent variable. Kristianawati et al. (2015) states that a research design can be interpreted as a structure in which two or more independent variables are compared to examine their independent and interactive effects on a dependent variable.

This study consists of three variables: two independent variables, namely the learning model and students' critical thinking skills, and one dependent variable, namely students' science learning outcomes. The structure of the design can be seen on the table below:

Table I. Data Collection Scenario Table

A (Learning Model)	B (Critical Thinking Skills)	A1	A2	∑ b
High (B1)	A1B1	A2B1	B_1	
Low (B2)	A1B2	A2B2	B_2	
∑ k	A_1	A_2	Total	

This study utilized data sources obtained from locations where data could be collected. Primary data was obtained directly from students through tests, questionnaires, and observations, while secondary data were collected from school documents and relevant records. The population of the study consisted of all Grade V students at SDN Pejaten Barat 06, Pasar Minggu District, South Jakarta Administrative City, during the 2023/2024 academic year. The sample included 67 students, who were divided into an experimental group (34 students) and a control group (33 students). The experimental intervention was conducted over six instructional meetings across three weeks, with a frequency of two meetings per week. Each meeting lasted approximately 2 × 35 minutes, following the school's standard instructional schedule.

In the experimental group, learning was implemented using the Project-Based Learning (PjBL) model. Students were engaged in structured science projects related to daily-life phenomena, such as energy transformation and environmental issues. The PjBL activities followed systematic stages: (1) problem identification, (2) project planning, (3) data collection through observation and simple experiments, (4) project development and product creation, (5) presentation of project results, and (6) reflection and evaluation. These activities were designed to encourage active learning, collaboration, problem-solving, and the development of critical thinking skills.

In contrast, the control group received conventional instruction, characterized by teacher-centered learning, including lectures, textbook-based explanations, question-and-answer sessions, and individual written exercises. No project-based or collaborative learning activities were implemented in the control group. This instructional approach reflects the commonly used teaching practices at the school and served as a basis for comparison with the PjBL intervention.

To minimize the influence of potential confounding variables, several control measures were applied. Both the experimental and control groups were taught by teachers with comparable teaching experience and academic qualifications. The learning objectives, instructional time allocation, curriculum content, and assessment instruments were kept consistent across groups. Students' initial abilities were measured using a pretest to ensure equivalence between groups prior to the intervention. In addition, the learning environment, classroom facilities, and external motivational factors were maintained as consistently as possible during the study period.

Data collection techniques included science learning outcome tests, critical thinking questionnaires using a Likert

scale, observation sheets, and documentation. Instrument validity was assessed through content validity (expert judgment) and empirical validity using product moment correlation with SPSS. Instrument reliability was analyzed using Cronbach's Alpha, indicating that the instruments were reliable and suitable for use. Data analysis was conducted using two-way ANOVA to examine the main effects and interaction effects of the learning model and critical thinking skills on science learning outcomes, supported by t-tests for group comparisons, with the assistance of SPSS software.

RESULTS AND DISCUSSION

Results

This study aims to analyze the influence of the Project Based Learning (PjBL) model and critical thinking skills on the science learning outcomes of grade V elementary school students. The study used an experimental design with two groups, namely the experimental class (34 students) who applied PjBL and the control class (33 students) who used conventional learning.

The results of the validation of the learning tools by material experts and learning experts showed an average score of 93% with the category of very feasible. Empirical validation through limited trials showed the implementation of PjBL by 92% and the positive response of students by 87%, which indicates that the learning tools are practical, effective, and support active and collaborative learning.

The critical thinking ability instrument consisting of six indicators was declared valid with an average value of ≥ 3.00. Reliability tests using Cronbach's Alpha yielded a value of 0.693, indicating that the instrument was in the category of reliability and suitable for use in the study.

Science Learning Outcomes

The results of the pretest showed that the initial ability of students in the experimental class (53.66) and the control class (55.74) was relatively balanced. After being given treatment, both classes experienced an increase in learning outcomes, but the improvement in the experimental class was more significant.

The average posttest score of the experimental class reached 92.13 with an increase of 38.47 points, while the control class reached 77.39 with an increase of 21.65 points. The results of the statistical test showed that the difference in learning outcomes between the two groups was statistically significant, so it can be concluded that the application of the PjBL model has a greater influence on science learning outcomes than conventional learning.

Critical Thinking Skills

The results of observations showed that the critical thinking skills of students in the experimental class were in the high category with an average score of 3.1–3.6. The highest indicator is found in the ability to answer questions and solve problems, while evaluation and assessment indicators still need strengthening. These findings show that PjBL is effective in developing critical thinking skills, particularly through discussion activities, problem analysis, and project-based problem-solving.

Observation Results of PjBL Implementation

The results of the observation of the implementation of PjBL showed an average score of 4.33 out of a scale of 5, with a relatively small standard deviation, which indicates high and equal student involvement. The highest indicator is found at the stage of preparing the project schedule, while the evaluation indicator gets the lowest score. This shows that the stage of reflection and evaluation of project results still needs to be improved so that learning is more optimal.

Prerequisite Test and Hypothesis Test

The results of the homogeneity test showed that the variance of data between groups was homogeneous (Sig. > 0.05). Furthermore, the results of the ANOVA test showed that the PjBL model had a significant effect on science learning outcomes (Sig. < 0.001), with a contribution of 67.2% to the variation in learning outcomes. The t-test also showed a significant difference between the experimental class and the control class, with the learning outcomes of the experimental class consistently higher.

Discussion

The results of this study show that the implementation of Project Based Learning (PjBL) which is integrated with the development of critical thinking skills has a positive influence on the science learning outcomes of elementary school students. This finding is in line with the results of Rahayu's research (2025) Anazifa (2017) which states that PjBL effectively improves conceptual understanding because students are directly involved in the process of investigation, planning, and completion of meaningful projects. Project-based learning allows students to build knowledge through real experiences, in accordance with constructivist theories that emphasize the active role of students in the learning process. Widiawati (2024) Puspitanignrum (2025)

The higher increase in learning outcomes in the experimental class compared to the control class also supports the findings of Munawaroh's research (2023) Manalu (2024) which states that PjBL is able to increase student involvement, motivation, and perseverance in learning science. Through group work and contextual problem-solving, students become more responsible for their learning process. This has an impact on increasing cognitive learning outcomes, especially in science subjects that require an understanding of concepts and applications in daily life.

In addition, the results of this study reinforce Zahara's research findings (2024) Munawwaroh (2023) which confirms that critical thinking skills are closely related to learning outcomes. Students who have good critical thinking skills tend to be able to analyze information, draw conclusions based on data, and solve problems logically. The integration of critical thinking in PjBL provides space for students to ask, argue, and evaluate solutions, so that learning is not only oriented to the result, but also to the thinking process.

In addition, students' critical thinking skills have a significant influence on science learning outcomes. Students with high levels of critical thinking demonstrate better learning

outcomes compared to those with lower critical thinking skills Ratna (2016) . The most developed indicators of critical thinking include the ability to answer questions, analyze problems, and solve problems logically.

The interaction analysis results indicate a significant interaction between the Project-Based Learning (PjBL) model and critical thinking skills on science learning outcomes. This finding suggests that the implementation of PjBL is more effective when supported by the development of students' critical thinking skills. Thus, PjBL not only improves cognitive learning outcomes but also fosters higher-order thinking skills that are relevant to the demands of 21st-century learning.

The findings of this study are also consistent with Pertiwi's research (2025) and Lidya (2023) which states that PjBL is effective in developing higher order thinking skills, such as analysis, synthesis, and evaluation. In PjBL, students not only produce products, but also present and reflect on their work processes. However, as stated in the study of Nyoman et al (2023), the reflection stage in PjBL needs to be systematically designed so that students' evaluation abilities develop optimally. This is in line with the results of this study which show that evaluation and assessment indicators still need strengthening.

Based on the results of the research and supported by various previous studies, it can be concluded that the Project Based Learning model combined with the development of critical thinking skills is an effective learning approach to improve the science learning outcomes of elementary school students. This model not only improves academic achievement, but also equips students with critical thinking, collaboration, and problem-solving skills relevant to the demands of 21st-century learning. Imarida (2024) Pantudai et al (2023).

One important finding of this study is that the evaluation and reflection stage of Project-Based Learning (PjBL) received the lowest observation score, indicating that this phase has not been optimally implemented. This condition can be explained by the fact that elementary school students generally have limited experience with reflective and metacognitive learning activities. According to Dewey (1933) reflection is a deliberate and active process that requires learners to examine their experiences critically, which does not develop automatically without continuous practice and guidance. Similarly, Schön (1983) emphasizes that reflective thinking must be explicitly facilitated to help learners evaluate their actions and learning outcomes. In the context of this study, students tended to focus more on completing project products rather than analyzing the learning process itself. In addition, limited instructional time often caused teachers to prioritize project completion over structured reflection activities, a challenge also reported in previous PjBL studies Kokosatki et al (2016).

CONCLUSION

Based on the results of the study and the discussion, it can be concluded that the implementation of the Project-Based Learning (PjBL) model has a positive and significant effect on the science learning outcomes of fifth-grade elementary school students. Students who learned through PjBL achieved higher posttest scores compared to those who experienced conventional instruction, indicating that PjBL is more effective in improving students' understanding of science concepts.

The findings also show that students' critical thinking skills contribute significantly to science learning outcomes. Students with higher levels of critical thinking demonstrated better abilities in analyzing information, solving problems, and drawing logical conclusions, which positively influenced their academic achievement. The integration of critical thinking activities within PjBL encouraged active participation, meaningful discussion, and problem-solving based on real-life contexts.

Furthermore, the interaction between the PjBL model and critical thinking skills was proven to enhance science learning outcomes more effectively. PjBL provided a learning environment that actively engaged students in planning, implementing, and evaluating projects, thereby fostering higher order thinking skills. Overall, the Project-Based Learning model integrated with critical thinking development is an effective approach to improving both the quality of the learning process and science learning outcomes of elementary school students, in line with the demands of 21st-century education.

In addition, the results of this study indicate that the successful implementation of Project-Based Learning requires careful attention to each stage of the learning process, particularly evaluation and reflection activities. Although PjBL has proven effective in improving science learning outcomes and critical thinking skills, optimal results are achieved when teachers consistently guide students to reflect on their learning experiences, assess project outcomes, and connect newly acquired knowledge with prior understanding. Strengthening these stages can help students develop metacognitive awareness, deepen conceptual understanding, and sustain long-term learning gains. Therefore, teachers are encouraged to design PjBL activities that not only focus on project completion but also emphasize structured reflection and evaluation to maximize the impact of PjBL on elementary school science education.

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