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Implementation of Project-Based Learning in Science Courses in Early Childhood Education

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ABSTRACT

This study aims to determine the effect of implementing project-based learning (PBL) on the science understanding of students majoring in Early Childhood Education Teacher Education (PG PAUD) in the Early Childhood Science course. This study used a quasi-experimental method with a nonequivalent control group design. The subjects were third-semester PG PAUD students divided into an experimental class and a control class. Data collection techniques used a science concept understanding test and student activity observation sheets. Data were analyzed using descriptive and inferential statistical tests. The results showed that there was a significant difference between the science understanding of students who participated in project-based learning and students who participated in conventional learning. Project-based learning was proven effective in improving the understanding of science concepts and critical thinking skills of PG PAUD students.

Keywords: *Project-Based Learning, Experiments, Early Childhood Science*.

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INTRODUCTION

Science learning in early childhood education plays a crucial role in developing children's logical thinking skills, curiosity, and scientific attitudes from an early age. Science is not understood as a collection of concepts to be memorized, but rather as an exploratory process involving observation, experimentation, and simple problem-solving relevant to children's lives (Ministry of Education and Culture, 2015). Therefore, early childhood educators are required to design science lessons that are contextual, meaningful, and developmentally appropriate.

The Project-Based Learning (PjBL) model positions students as active subjects in a learning process that involves exploration and problem-solving based on real-world contexts. This approach has been proven to improve student learning outcomes, academic achievement, affective attitudes, and advanced thinking skills. The implementation of PjBL in early childhood education (PAUD) engages children in exploratory activities that provide space for hands-on experience and active participation in learning. Project activities

encourage children to make direct observations, make predictions, and draw conclusions, thereby deepening their understanding of scientific concepts. Furthermore, PjBL also stimulates children to think creatively and independently in completing tasks. In other words, PjBL not only enriches the learning experience but also develops critical thinking skills and creativity in early childhood.

Several studies have highlighted the effectiveness of PjBL in improving scientific literacy and skills. (Winda, et al., 2014) concluded that early childhood science skills can be enhanced through a project approach. Similarly, (Sakina, et al., (2025) found that implementing PjBL based on loose parts significantly improved scientific literacy and practical skills in early childhood. Meanwhile, (Dhanil, 2025) demonstrated that PjBL has proven effective in developing scientific literacy at various levels of education, yet its application in early childhood education remains limited. Scientific literacy is a fundamental skill for early childhood, as it helps them understand their environment, living things, and natural phenomena scientifically. Therefore, integrating PjBL into early childhood science learning is crucial as an effort to instill a foundation of scientific literacy from an early age.

In the context of distance learning (DL) during the pandemic, the PjBL model also plays a crucial role. (Prima and Lestari, 2021) reported that teacher-parent collaboration through the PjBL model helps children think critically, solve problems, and understand cause-and-effect relationships in science concepts. Similarly, (Putri and Taqiudin, 2021) implemented STEAM-PjBL with 5–6-year-old children through stages of reflection and exploration; the results showed an increase in children's problem-solving abilities from "not yet developed" to "very good." These findings illustrate that PjBL, even in an online environment, can still foster cognitive development, creativity, and collaboration in early childhood.

As prospective educators, students majoring in Early Childhood Teacher Education (PG PAUD) need to be equipped with a deep understanding of science concepts and adequate pedagogical skills. However, science instruction at universities tends to be theoretical and lecturer-centered, resulting in students lacking direct experience in applying science concepts to early childhood learning. This situation results in students' poor ability to connect scientific theory with learning practices in the PAUD classroom (Hosnan, 2014).

One learning model believed to be able to address this problem is project-based learning. Project-based learning emphasizes active student engagement in completing projects relevant to real-life contexts, enabling students to construct understanding through hands-on experience and collaboration (Thomas, 2000). This model aligns with the constructivist approach, which views learning as an active process of constructing knowledge.

The implementation of project-based learning in Early Childhood Science courses in the Early Childhood Education (PAUD) study program is expected to improve students' understanding of science concepts and their readiness to design creative science lessons appropriate to the characteristics of early childhood. Therefore, this study aims to empirically test the effect of project-based learning on PAUD students' science understanding through experimental research.

METHOD

Research Type and Design

This study used a quasi-experimental method with a nonequivalent control group design. This design involved two groups: an experimental group given project-based learning and a control group given conventional learning.

Research Subjects

The subjects were third-semester students majoring in Early Childhood Education (PG PAUD) at a university. The research sample consisted of two classes: one class as the experimental group and one class as the control group, selected using a purposive sampling technique.

Research Variables

- Independent variable: project-based learning
- Dependent variable: students' understanding of science

Data Collection Techniques

Data collection was conducted using:

1. A science concept understanding test, administered before (pretest) and after (posttest) treatment.
2. An observation sheet, to observe student activity and engagement during the learning process.

Data Analysis Techniques

Data were analyzed using descriptive statistics to determine the average and improvement in student learning outcomes, and inferential statistics to test differences in learning outcomes between the experimental and control groups.

FINDING AND DISCUSSION

Research result

Description of Pretest and Posttest Data

The results of the students' science understanding test were obtained through pretests and posttests in the experimental and control groups. Descriptive data analysis is presented in Table 1.

Table 1. Average Pretest and Posttest Scores for Science Understanding

Group	N	Pretest (Mean)	Posttest (Mean)	Gain
Experiment (PjBL)	30	62.40	85.30	22.90
Control (Conventional)	30	63.10	74.20	11.10

Table 1 shows that the average pretest scores for both groups were relatively similar. However, the average posttest score for the experimental group was higher than the control group, with a greater increase (gain).

Normality and Homogeneity Test

Before conducting the hypothesis test, the data was first tested for normality and homogeneity.

Table 2. Results of Data Normality Test (Kolmogorov–Smirnov)

Group	Sig. Pretest	Sig. Posttest	Information
Experiment	0.200	0.178	Normal
Control	0.192	0.165	Normal

The data is stated to be normally distributed because the significance value is > 0.05.

Table 3. Results of the Homogeneity Test (Levene's Test)

Data	Sig.	Information
Posttest	0.284	Homogeneous

The results of the homogeneity test showed a significance value > 0.05, so that the data for both groups came from homogeneous variance.

Hypothesis Testing

Hypothesis testing was conducted using **an independent t-test (Independent Sample t-Test)** on the posttest scores.

Table 4. Results of the t-test of students' understanding of science

Group	Mean	t count	Sig. (2-tailed)
Experiment	85.30	4,276	0,000
Control	74.20		

Based on Table 4, a significance value of 0.000 < 0.05 was obtained. Thus, **H_o was rejected and H_1 was accepted** , which means there is a significant difference between the scientific understanding of students who participated in project-based learning and conventional learning.

Student Activity Observation Results

In addition to the understanding test, observations were made of student activities during learning.

Table 5. Average Student Activity Score

Activity Aspects	Experiment	Control
Active discussion	88.5	70.2
Group work	90.1	72.4
Ability to link science with PAUD	87.6	69.8
Overall average	88.7	70.8

The observation results showed that students in the experimental group had a higher level of activity and involvement than the control group.

DISCUSSION

The significant improvement in students' scientific understanding in the experimental group indicates that project-based learning is effective in improving the quality of science instruction in Early Childhood Education (PAUD) programs. Students not only understand scientific concepts theoretically but are also able to apply them in learning projects appropriate to the characteristics of young children.

Statistical test results confirm that project-based learning provides a more meaningful learning experience, as students are directly involved in the exploration, design, and reflection process of science learning.

The results of this study are consistent with previous literature demonstrating the effectiveness of Project-Based Learning (PjBL) in early childhood science learning. For example,(Hindun, et al., 2024) reported that the implementation of Project-Based Learning (PjBL) significantly improved the scientific literacy and collaboration skills of junior high school students, strengthening evidence that project activities can build students' scientific literacy. (Winda, et al., 2014) even concluded that early childhood students' scientific abilities can be improved through project-based learning. (Sakina, et al., 2025) also found an increase in children's understanding of scientific concepts and practical skills through loose parts-based project learning.

The findings of improved critical thinking and problem-solving skills align with the findings of (Putri and Taqiudin, 2021), who reported that the implementation of STEAM-PjBL improved children's problem-solving abilities to an excellent level. Furthermore, (Permatasari, et al., 2025) stated that PjBL encourages independence and creativity in early childhood, providing an important foundation for their readiness for further education. Based on these studies, it can be concluded that PjBL is an effective method for early childhood science learning; it not only strengthens children's cognitive and creative aspects but also aligns with the spirit of 21st-century learning, which emphasizes collaboration, critical thinking, and problem-solving.

Overall, various studies support that the implementation of PjBL in the early childhood context has a positive impact: improving students' scientific literacy, critical thinking skills, and collaborative abilities. This strengthens the relevance of PjBL in early childhood science curriculum development and provides a scientific basis for its implementation.

CONCLUSION

Based on the research results, it can be concluded that the implementation of project-based learning significantly influenced the science understanding of PG PAUD students in the Early Childhood Science course. Students who participated in project-based learning had a better understanding of science concepts compared to students who participated in conventional learning.

SUGGESTION

Science lecturers are advised to implement project-based learning on an ongoing basis to improve the quality of instruction. Future research could examine the impact of project-based learning on other aspects, such as the creativity or pedagogical skills of early childhood education (PG PAUD) students.

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