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Analysis of The Effectiveness of Project-Based Learning Methods in Improving Elementary School Students' Science Learning Outcomes

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Abstract

This study aims to analyze the effectiveness of project-based learning methods in improving learning outcomes and student motivation in Natural Science (IPA) subjects in elementary schools. The background of this study is based on the problem of low student achievement in science learning outcomes and minimal active student involvement in conventional learning, which is still dominated by lecture methods. Students tend to be passive, less participatory, and unable to understand science concepts in depth due to this condition. Therefore, alternative learning strategies are needed that are more interactive and encourage direct student involvement. Project-based learning methods are considered one solution because they provide opportunities for students to learn through real-life experiences, group collaboration, and the application of concepts in everyday life contexts. This study used a quasi-experimental design with a pretest and posttest control group model, involving two classes as samples. The experimental class implemented the project-based method, while the control class continued to use conventional learning. The instruments used included a science test for learning outcomes and a learning motivation questionnaire. Data were analyzed using a t-test to compare the two groups. The results showed a significant increase in both learning outcomes and student motivation. These findings indicate that the project-based method is an effective science learning strategy in elementary schools.

Keywords: Project-Based_Learning; Learning_Outcomes; Learning_Motivation; Natural_Sciences (IPA); Elementary_School

1. Introduction

Education is a crucial aspect in shaping a quality generation, particularly at the elementary school level, which serves as the primary foundation for the development of students' knowledge, attitudes, and skills. Natural Sciences (IPA) plays a crucial role in equipping students with critical thinking skills, an understanding of scientific concepts, and the skills to solve problems related to everyday life. This learning achievement was also accompanied by an increase in the number of students who completed the course. Furthermore, the implementation of this model has been proven to increase student activity in learning, as demonstrated by the high level of student activity related to critical thinking, the courage to ask questions and argue, and the provision of solutions [1].

However, the reality is that the science learning process in elementary schools still often faces various obstacles, such as teachers' tendency to use lecture methods and written assignments, which make students passive recipients of information. As a result, students have less opportunity to explore, experiment, and discover concepts independently. This condition results in low student engagement in learning, poor conceptual understanding, and suboptimal learning outcomes. The use of this Wordwall application as a learning medium is effective in science lessons, particularly in elementary schools. Furthermore, this Wordwall

application encourages student interest in completing quizzes, which will help improve overall learning outcomes for those who use it [2].

The problem of low science learning outcomes for elementary school students has prompted various efforts to identify more effective learning strategies. Several previous studies have shown that implementing innovative learning models can improve student activity and learning outcomes. For example, research using problem-based learning (PBL) models has shown that it can improve critical thinking skills and conceptual understanding. Similarly, the inquiry approach, which provides students with opportunities to discover knowledge through experimentation, has been shown to foster motivation and curiosity. Furthermore, cooperative learning models are often implemented to train students to work together while improving learning outcomes. Although the results of these studies are quite positive, most still place students in learning situations that are limited to problem-solving or concept exploration, not to the stage of creating tangible products with contextual meaning.

One learning model that is believed to be able to provide meaningful learning experiences is project-based learning (PjBL). This model emphasizes the active involvement of students in working on projects that are relevant to everyday life. Through projects, students not only learn to understand concepts but also hone collaboration, communication, creativity, and problem-solving skills. Several studies have indicated that the application of PjBL can increase learning motivation and higher-order thinking skills. However, studies on the effectiveness of PjBL in directly improving science learning outcomes at the elementary school level are still relatively limited. (1) There is a positive influence on project-based learning model for the creativity of the student; (2) There is a positive influence on project-based learning model for learning outcomes Elementary Science Education students; and (3) There is a positive influence on project-based learning model for learning outcomes IPA Education Elementary students simultaneously [3].

This is an important research gap for further study. Therefore, based on the description of the background of the problem, this study is formulated in the following research questions:How is the application of project-based learning methods in science subjects in elementary schools? Are project-based learning methods effective in improving science learning outcomes among elementary school students? What factors support and hinder the application of project-based learning methods in elementary schools? To answer these questions, this study proposes a conceptual framework that the application of PjBL in science learning in elementary schools can provide a more authentic and contextual learning experience. The process of planning, implementing, and completing a project allows students to connect theory with practice, making science concepts easier to understand and remember. Furthermore, we believe that student involvement in group work, discussions, and project presentations enhances communication skills, collaboration, and a sense of responsibility. In other words, through PjBL, students are required to understand science material and develop 21st-century skills that are essential in real life. The activeness of students in the learning process also has an important role in learning outcomes. The project-based learning learning model is a scientific approach and consists of several stages, including observing, asking questions, gathering information, reasoning, and communicating. Through these various stages students can increase their role in the learning process [4].

This research is expected to provide a concrete picture of how project-based learning can be applied to science subjects in elementary schools, the extent to which this method influences student learning outcomes, and the factors that support and hinder its success. Therefore, the results of this study are expected to serve as a reference for teachers, schools, and other researchers in developing innovative and relevant learning strategies tailored to student needs.

2. Methodology

This study used a quantitative approach with a quasi-experimental design [5] We chose the quantitative approach because it measures numerical data and statistically analyzes it to identify differences in student learning outcomes. The experimental design used was a Nonequivalent Control Group Design, which involved two groups of research subjects, namely the experimental group and the control group. In this design, both groups were given an initial test (pretest) and a final test (posttest). However, only the experimental group received treatment in the form of the application of project-based learning methods (PBL), while the control group was given learning with conventional methods, namely lectures, discussions, and simple assignments.

Table 1. Experimental Treatment using PjBl and conventional study

Group	Pretest	Treatment	Posttest
Experiment	O1	X	O2
Control	O1	-	O2

Keterangan:

- O1 = Pretest
- O2 = Posttest
- X = The treatment using Project-Based Learning (PjBL)
- - = The treatment using conventional study

With this research design, researchers can compare students' science learning outcomes between the experimental and control groups to determine the effectiveness of implementing the project-based learning method. The population in this study was all sixth-grade students at Padang Alipan 45 Public Elementary School in the 2024/2025 academic year. Sixth-grade students were selected because at this level, students have more mature thinking skills than lower grades and are therefore considered more prepared to participate in project-based learning, which requires collaborative activities, problem-solving skills, and critical thinking skills. The research sample was determined using a purposive sampling technique, which selects samples based on certain considerations, such as a relatively equal number of students in each class, equitable student characteristics, and similar subject matter.

Based on these considerations, two classes were selected as samples: class VI A as the experimental group, which received learning using the Project-Based Learning (PjBL)

method, and class VI B as the control group, which received learning using the conventional method. The total sample size was 40 students, consisting of 20 students in the experimental group and 20 students in the control group. This study has several variables: the independent variable, the project-based learning method; the dependent variable, the science learning outcomes of elementary school students; and control variables, including subject matter, teacher, learning time, and learning resources. The presence of control variables is expected to ensure that learning outcomes are truly caused by differences in learning methods and not by other factors. The research instrument used was a test for science learning outcomes designed based on competency achievement indicators in the sixth-grade elementary school curriculum. The test consisted of 20 multiple-choice questions and 5 short essay questions. Before use, the test instrument was pre-tested to determine item validity using the product-moment correlation technique, reliability using the Kuder-Richardson (KR-20) formula, difficulty level to ensure that the questions were not too easy or too difficult, and discriminatory power to ensure the questions could differentiate between high-ability and low-ability students. In addition to the test, the researchers also used an observation sheet for learning implementation to ensure the implementation of PjBL was in accordance with the syntax, including determining fundamental questions, project planning, scheduling, project implementation, report and presentation preparation, and evaluation. The research procedure was carried out through three main stages, namely the preparation, implementation, and analysis stages.

The results of individual learning mastery are seen as indicators of success. In the first cycle, the first meeting obtained individual learning completeness of 32.5%, then the second meeting was 65%. In the second cycle, the third meeting was 75%, then the fourth meeting was 85% with a score of 75. The results of the research prove that student learning outcomes can be increased effectively by applying the Project Based Learning model [6].

The general conclusion of this research is to get an overview of project-based learning management in increasing students' creativity at SMAN 14 Bandung. Specific conclusions of this research: project-based learning planning at SMAN 14 Bandung in the form of teaching modules and collaboration project proposals for class X History and Indonesian language subjects, organizing project-based learning at SMAN 14 Bandung involves various elements consisting of the principal, curriculum, teachers, and students, the implementation of project-based learning at SMAN 14 Bandung is running by the project objectives, the results of students' ideas and creativity are in the form of cabaret performances, supervision of project-based learning at SMAN 14 Bandung is carried out by teachers as control of the implementation of project activities, teachers carry out the supervision process starting from preparation, implementation to evaluation of project activities [7].

In the preparation stage, the researcher determined the research subjects, divided students into experimental and control groups, developed project-based learning tools including lesson plans and student worksheets, created test instruments for assessing science learning outcomes, and conducted instrument trials to ensure their validity and reliability. The next stage was the implementation stage, which applied the project-based learning method to the experimental class and the conventional learning method to the control class, while still administering pretests and posttests to both groups. Next, the analysis stage was carried out by processing the pretest and posttest data using statistical analysis techniques to determine the

effectiveness of the PjBL method in improving elementary school students' science learning outcomes.

3. Result and Discussion

This study involved two groups: Class VI A as the experimental group (Project-Based Learning) and Class VI B as the control group (conventional learning). The data collected consisted of pretest and posttest scores of students' science learning outcomes.

Table 2. Average Pretest and Posttest Results

Group	N	Rata-rata Pretest	Rata-rata Posttest	Gain
Eksperimen	20	56,40	82,75	26,35
Control	20	55,85	72,10	16,25

The table shows that the average posttest score for students in the experimental group was higher than that of the control group. This indicates a greater improvement in learning outcomes in the experimental group after implementing project-based learning. Before testing the hypotheses, prerequisite analysis tests were conducted, including normality and homogeneity tests. The results of the normality test using the Kolmogorov-Smirnov test showed that all data, both pretest and posttest scores from the experimental and control groups, had a significance value greater than 0.05. This indicates that the data were normally distributed. Furthermore, a homogeneity test using the Levene's Test obtained a significance value of 0.296, which is greater than 0.05. Thus, the data for both groups had homogeneous variance, allowing for further analysis with an independent t-test. Hypothesis testing was conducted using an independent t-test to compare the posttest results between the experimental and control groups. The results of the independent t-test are presented in Table 3 below:

Table 3. Results of the independent T-test are presented

Group	N	Mean	t-hitung	Sig.(2-tailed)
Eksperimen	20	82,75		
Control	20	72,10	3,412	0,002

Interpretation: The significance value (Sig. 2-tailed) is 0.002 < 0.05. Thus, there is a significant difference between the learning outcomes of students in the experimental and control groups. N-Gain Analysis To determine the level of improvement in learning outcomes, the normalized gain (N-Gain) calculation was used.

Tabel 4. N-Gain Results for the Experimental and Control Groups

Group	Average N-Gain	Category
Eksperimen	0,62	Moderate
Control	0,37	Moderate

The findings of this study indicate that project-based learning (PjBL) is more effective in improving students' science learning outcomes compared to conventional methods. The significant difference in post-test results between the experimental and control groups, where

the experimental group's average score was higher, demonstrates this effectiveness. Furthermore, the experimental group's learning outcome (N-Gain) was also significantly greater, at 0.62, compared to the control group's 0.37. These findings align with constructivism theory, which emphasizes the importance of active student involvement in the process of constructing knowledge through direct experience, discussion, and problem-solving. The implementation of PjBL provides students with opportunities for collaboration, critical thinking skills, and connections between learning and real-life situations. Therefore, PjBL not only improves cognitive learning outcomes but also creates a more meaningful and interactive learning process that supports the development of 21st-century skills.

4. Conclusion

Based on the research results and discussions conducted, it can be concluded that there is a significant difference between the science learning outcomes of students taught using project-based learning (PjBL) and those taught using conventional methods. The implementation of PjBL has been proven to improve students' science learning outcomes more effectively, as demonstrated by higher average posttest scores and greater N-Gain values in the experimental group compared to the control group. Furthermore, PjBL provides meaningful learning experiences, encouraging the development of critical thinking skills, collaboration, and student responsibility in the learning process. Therefore, the PjBL method is worthy of being considered as an alternative science learning strategy in elementary schools because it has been proven to significantly improve student learning outcomes. Therefore, schools are expected to provide facilities, learning resources, and a conducive environment to encourage students to be more active in exploring, collaborating, and applying learned concepts in real-life situations.

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