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The Application of the Experimental Method on Science Learning Outcomes of Grade 4 Students at SDN Inpres Nebura, Sikka

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ABSTRACT

This study investigates the effectiveness of the experimental method in enhancing science learning outcomes among grade 4 students at SDN Inpres Nebura, focusing on the topic of photosynthesis. Employing a descriptive quantitative design, the study involved all students at SDN Inpres Nebura, with a purposive sample of 14 grade 4 students. Data were gathered through questionnaires and documentation sheets. The findings reveal a notable improvement in learning achievement, as the mean score increased from 69.29 on the pre-test to 79.29 on the post-test. Additionally, the questionnaire results demonstrate that the majority of students expressed highly positive perceptions of the experimental method, with an average positive response rate of 99%. These results suggest that the experimental method is an effective pedagogical approach for improving student learning outcomes in elementary science education.

Keywords
Active Learning
Elementary Education
Experimental Method
Photosynthesis Learning
Science Learning
Student Achievement

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Introduction

An ideal learning process provides students with opportunities to learn independently, collaborate with peers, and engage in reflection or self-assessment [1]. In this way, it supports

the optimal development of their potential, intelligence, and interests. One effective approach that promotes independent learning while nurturing students' cognitive abilities is the experimental method [2]-[4].

The experimental method enables students, either individually or in groups, to conduct experiments, observe processes, analyze results, and draw conclusions independently [5]. This method not only supports deeper conceptual understanding but also enhances students' critical thinking and problem-solving skills. In addition, the use of experimentation encourages active engagement and creates a more enjoyable learning environment. Such conditions positively influence learning outcomes when instruction is conducted in an engaging, varied, and student-centered manner [6].

At SDN Inpres Nebura (a public elementary school in Nusa Tenggara Timur, Indonesia), all classes have implemented the *Kurikulum Merdeka*. However, based on interviews with one of the teachers, classroom practices remain relatively limited in variation. Although several instructional models have been employed, more active and contextual approaches such as the experimental method have not yet been widely applied to strengthen students' direct understanding of scientific concepts. Teacher-centered strategies still dominate classroom practice. As a result, learning resources are restricted and students have limited experiences in exploring science meaningfully.

Interviews with science subject teachers also revealed that students' achievement in several topics has not yet reached the expected level. One of the most challenging topics is photosynthesis. Many students struggle to grasp the process, particularly with regard to factors influencing photosynthesis such as light, carbon dioxide (CO_2), and temperature. This difficulty largely stems from instruction that relies heavily on theoretical explanations from textbooks. The absence of practical activities or experiments has limited students' opportunities to reinforce their understanding.

Classroom observations further confirmed that science lessons are still dominated by lectures focusing on content delivery and rote memorization. Students were observed to be less motivated, rarely encouraged to ask questions or express opinions, and seldom exposed to concrete teaching aids. Consequently, they often face difficulties in comprehending and retaining material. They also lack confidence when responding to questions.

Given these challenges, there is a clear need for innovation in instructional strategies at school. Implementing the experimental method offers a potential solution to improving the quality of science instruction, particularly for grade 4 students. By providing opportunities to directly engage with scientific processes, students are expected to become more active, creative, and motivated. Ultimately, this approach is expected to support improved learning

outcomes. The objective of this study is to examine the effectiveness of the experimental method in enhancing science learning outcomes for grade 4 students.

Materials and Methods

A. Research Design and Context

This study employed a descriptive quantitative design [7]. A descriptive approach emphasizes the analysis of thought processes related to the dynamics of observed phenomena while consistently applying scientific reasoning. This method was chosen because it aligns with the research objectives, which focus on examining the implementation of the experimental method in relation to science learning outcomes among grade 4 students at SDN Inpres Nebura. The study was conducted at SDN Inpres Nebura, located in Koja Kojagete Village, Alok Timur District, Sikka Regency. The research took place during the even semester, from February 17 to February 22, 2025.

B. Population, Sample, and Data Collection

The population of this study consisted of all students in grades I through VI at SDN Inpres Nebura. A purposive sampling technique was employed to select participants who were considered most relevant to the research objectives. Based on this sampling strategy, the study focused on 14 students.

Data were collected using questionnaires, tests (pre-test and post-test), and documentation. The student response questionnaire was designed to obtain data regarding students' opinions, feelings, and perceptions after engaging in experimental activities. The instrument was adapted and modified from existing validated instruments that questionnaires are effective for gathering data on variables that cannot be directly observed, such as attitudes, perceptions, or motivation. The pre-test and post-test were administered to measure students' knowledge before and after the intervention. Documentation, including photographs and instructional materials, was also used to capture learning activities and provide supporting evidence for analysis. The questionnaire responses were measured using a Likert scale, which ranged from "Strongly Agree" (score 4) to "Strongly Disagree" (score 1).

C. Data Analysis

After data collection, the results were analyzed using quantitative descriptive statistics. The analysis involved presenting the findings in the form of tables and graphs to illustrate patterns and trends. Questionnaire data were further analyzed using percentage calculations. The interpretation of percentage results was based on predetermined score ranges. The classification of student scores is divided into three categories. Scores equal to or greater than 70 are classified as High, indicating strong mastery of the material. Scores ranging between 30 and 70 fall into the Medium category, reflecting a moderate level of understanding that still

requires improvement. Meanwhile, scores equal to or below 30 are categorized as Low, suggesting limited comprehension and the need for substantial reinforcement in learning.

Results

A. Learning Process Skills

1. Lesson Planning

In the planning stage, the researcher, who also acted as the classroom teacher for Grade IV, prepared a teaching module and established the learning objectives. The goal was for students to be able to describe the process of photosynthesis and explain its significance for living organisms. The main topic of instruction was "Photosynthesis: The Most Important Process on Earth." To support this objective, the researcher designed instructional materials aligned with the experimental method, prepared relevant teaching resources and media, and developed student worksheets (*Lembar Kerja Peserta Didik* or LKPD) to guide students through the learning process.

2. Implementation

The learning process was carried out by applying the experimental method based on the module prepared and approved by the principal of SDN Inpres Nebura. The implementation was divided into three stages: opening activities, core activities, and closing activities.

In the opening activities, the researcher began by greeting the students, creating a conducive classroom atmosphere, and conducting an apperception exercise. Students were asked to check under their desks and collect any trash, after which one student was invited to lead a prayer. The teacher then explained the basic competencies and learning objectives, emphasizing the importance of understanding photosynthesis and its results. The relevance of this topic to daily life was highlighted, and students were asked to recheck the tools and materials required for the experiment.

The core activities involved literacy and experimentation. Students first read a text titled *The Importance of Photosynthesis* and examined related illustrations. They were asked to recall the function of leaves, with the teacher explaining their role as the "kitchen" of plants. Students were divided into groups of four to five and guided to conduct an experiment known as the "Leaf Bubble Method" following the instructions in the student worksheet. Before the experiment, students reviewed basic concepts of oxygen and carbon dioxide, followed by an overview of the photosynthesis process.

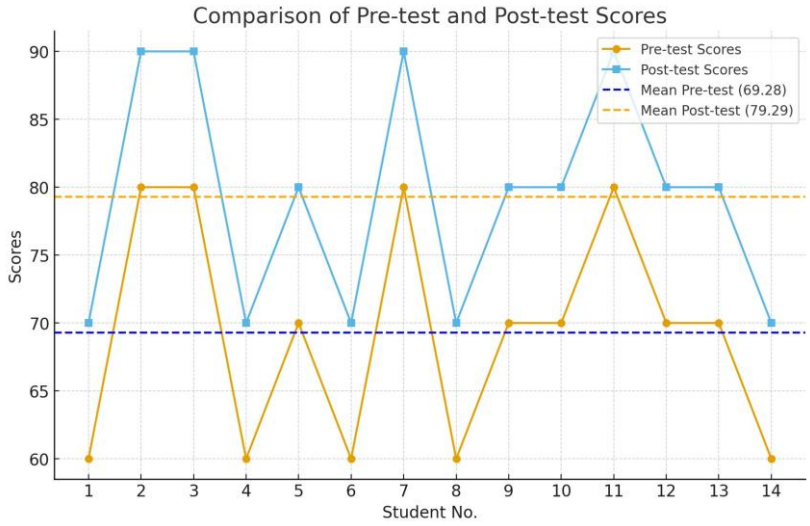
The experimental procedure consisted of several steps. Students prepared the necessary materials, including a transparent glass, fresh leaves, clean water, and direct sunlight. The glass was filled with water, and a fresh leaf, including its petiole, was

submerged. The glass was placed under direct sunlight for 15–30 minutes. During this time, students observed the appearance of air bubbles on the leaf surface or petiole, identifying these bubbles as oxygen produced during photosynthesis. Students recorded the time of bubble emergence, their frequency, and other relevant observations on the worksheet. Afterward, groups discussed their findings, related them to the concept of photosynthesis, and concluded that the bubbles were evidence of photosynthesis. Together with the teacher, the class summarized that photosynthesis occurs when plants absorb carbon dioxide and water and use sunlight to produce oxygen and glucose.

In the closing activities, the teacher reinforced key concepts and guided students to reflect on the importance of photosynthesis for living organisms. Students then completed essay questions in the worksheet, which were collected for assessment. Finally, the lesson concluded with a closing greeting.

B. Student Learning Outcomes

This study was conducted to evaluate the effectiveness of the instructional approach applied to grade 4 students. The primary focus was to compare student learning outcomes between the pre-test and post-test in order to measure the extent of improvement after participating in the learning process. The results of students' learning outcomes using the experimental method are presented in Fig. 1.



Based on Fig. 1, it can be observed that the pre-test scores of the 14 students ranged from 60 to 80, with an average score of 69.28. Meanwhile, the post-test scores ranged from 70 to 90, with an average score of 79.29. These results indicate a clear improvement in student learning outcomes after the implementation of the experimental method.

C. Student Questionnaire Results

To further examine students' responses to the use of the experimental method in science learning, a questionnaire was distributed. The indicators covered several aspects, including

conceptual understanding, learning interest, activeness, motivation, and the application of scientific attitudes. The questionnaire data were analyzed using a Likert scale.

Table 1. Analysis of Student Questionnaire Responses

No	Indicator	Average Percentage	Category
1	Students' enjoyment of science learning using the experimental method	99%	High
2	Ease of understanding photosynthesis concepts through experiments	99%	High
3	Understanding the importance of photosynthesis for living beings	99%	High
4	Student motivation after learning through experiments	99%	High
5	Ability to apply scientific attitudes through experiments	99%	High
6	Students' ability to solve problems independently	99%	High
7	Student participation in discussions and group work during experiments	99%	High
8	Ease of Using Student Worksheets	99%	High
9	Clarity of instructions in Student Worksheets	99%	High
10	Understanding the effects of temperature and CO_2 in the photosynthesis process	99%	High

As presented in Table 1, all indicators demonstrate a consistently positive response from students, with an average positive response rate of 99%, which falls within the "Very High" category. This indicates that students strongly favor the use of the experimental method in science learning.

Discussion

The findings of this study demonstrate that the learning outcomes of students at SDN Inpres Nebura improved significantly, as indicated by the comparison between pre-test and post-test scores. Prior to the application of the experimental method, the average pre-test score was relatively low, with most students failing to meet the learning objectives set out in the *Merdeka Curriculum*. However, after the implementation of the experimental method, post-test results showed substantial improvement, with the majority of students achieving or even exceeding the expected learning outcomes. These results confirm that the experimental method is effective in enhancing student achievement.

The questionnaire results further support this conclusion, indicating that the use of the experimental method had a significant positive impact on student learning. The Likert-scale analysis placed students' responses in the "very high" category, meaning that most students strongly agreed that the experimental method contributed to improving their learning outcomes. Accordingly, the experimental method can be regarded as an effective pedagogical approach to foster student engagement and achievement.

These findings are consistent with existing theoretical perspectives. Previous studies have argued that the experimental method is highly suitable for elementary education [8][9], as it actively involves students in the learning process [10][11](Hanifah et al., 2025). The experimental method allows students to perform experiments, observe processes, and document results, thereby engaging in scientific inquiry and constructing their own knowledge. As emphasized by Souisa [12], experimentation provides students with opportunities to conduct investigations individually or in groups, encouraging them to think critically and rationally. From a cognitive perspective, the experimental method goes beyond rote memorization; it enhances students' comprehension, internalization, and application of knowledge, making learning more meaningful and long-lasting.

This argument aligns with Rizky et al. [13], who emphasized that teaching methods significantly affect student outcomes and therefore must be efficient and effective. Since not all students easily grasp teacher explanations, it is essential to involve students actively in the learning process so that they better understand the material and remain motivated. Similarly, Awansyah [14] stressed that teaching should be student-centered, positioning learners as active participants rather than passive recipients of knowledge. In line with this perspective, classroom observations during this study revealed that previously passive students became more active when engaged in experimental learning. The shift from teacher-centered to student-centered instruction fostered greater participation [15][16], which directly contributed to improved learning outcomes, as evidenced by the post-test scores.

Overall, the findings provide strong empirical evidence that the experimental method promotes active engagement, supports deeper conceptual understanding, and effectively enhances student learning outcomes in elementary science education.

Conclusion

This study concludes that the implementation of the experimental method in science learning significantly improved the learning outcomes of grade 4 students at SDN Inpres Nebura. The comparison between pre-test and post-test results demonstrated a clear increase in student achievement, with most students successfully meeting or exceeding the expected competencies outlined in the *Merdeka Curriculum*.

The findings also revealed that the experimental method fostered high levels of student engagement, motivation, and scientific attitudes, as confirmed by the questionnaire results, which consistently fell within the "very high" category. By providing students with hands-on opportunities to explore, observe, and analyze, the experimental method not only enhanced their conceptual understanding of photosynthesis but also encouraged critical and rational thinking.

In line with previous studies, this research reinforces the notion that experimental learning is an effective student-centered approach that promotes active participation, deeper comprehension, and sustainable knowledge construction. Therefore, it is recommended that teachers integrate experimental methods more consistently in elementary science instruction to create meaningful and engaging learning experiences that contribute to improved academic outcomes.

Conflict of Interest

The authors declare that there is no conflict of interest.

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