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The Impact of experimental methods on Science learning outcomes at SDIP YLPI Pekanbaru

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ABSTRACT

This study aims to examine the effect of experimental methods on the learning outcomes of fourth-grade students at SDIP YLPI Pekanbaru regarding the topic of "Perubahan Wujud Benda". The research employed a quantitative, nonequivalent control group design, involving two non-randomly selected groups: an experimental group and a control group. The experimental group was taught using hands-on experiments, while the control group received traditional instruction. A multiple-choice test was used to assess students' learning outcomes before and after instruction. The data analysis revealed a significant difference in the posttest scores between the two groups. Students who experienced the experimental method showed higher learning gains compared to those taught conventionally. This finding suggests that experimental methods can be more effective in enhancing students' understanding of material changes. The study highlights the importance of active learning strategies in science education and recommends the broader implementation of experimental approaches in elementary classrooms to promote student engagement and conceptual mastery.

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ABSTRAK

Penelitian ini bertujuan untuk mengetahui pengaruh metode eksperimen terhadap hasil belajar murid kelas IV SDIP YLPI Pekanbaru pada materi "Perubahan Wujud Benda". Metode yang digunakan adalah pendekatan kuantitatif dengan desain Nonequivalent Control Group Design, di mana dua kelompok murid, yaitu kelompok eksperimen dan kelompok kontrol, dipilih tanpa pengacakan. Kelompok eksperimen menggunakan metode pembelajaran eksperimen, sedangkan kelompok kontrol menggunakan metode konvensional. Instrumen yang digunakan berupa tes pilihan ganda untuk mengukur hasil belajar, yang diberikan sebelum dan sesudah pembelajaran. Hasil analisis data menunjukkan bahwa terdapat perbedaan signifikan antara nilai rata-rata posttest kelompok eksperimen dan kelompok kontrol. Murid yang mengikuti pembelajaran dengan metode eksperimen menunjukkan peningkatan hasil belajar yang lebih tinggi dibandingkan dengan kelompok kontrol. Hal ini menunjukkan bahwa metode eksperimen lebih efektif dalam meningkatkan pemahaman murid terhadap konsep perubahan wujud benda. Temuan ini merekomendasikan penerapan metode eksperimen sebagai strategi pembelajaran aktif yang dapat mendorong keterlibatan murid dan memperkuat konsep dalam pelajaran IPA di sekolah dasar.

Kata kunci: *capaian belajar murid; metode experimental; pembelajaran IPAS*

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INTRODUCTION

One of the important factors in a country's development is its level of education. The fighters and pioneers of this nation, since the time of the independence movement, have realized that education is essential to cultivate collective intelligence and free the country from the shackles of colonialism (Anisa, 2023). Thus, learners can develop moral principles and abilities that benefit society, groups, nations, and individuals as well as foster spiritual resilience, self-control, mature character development, and intellectual capacity (Judrah et al., 2024). In the broadest sense, education is a dynamic learning process, not limited by a particular time, place, or teaching strategy. As part of human social responsibility, education takes place throughout life in a variety of contexts and can be facilitated by anyone (Syaharani et al., 2024). The primary function of education is to transmit knowledge, preserving cultural heritage, and passing it down from generation to generation.

From elementary school to college, many disciplines are taught in formal education. Natural Sciences and Social Sciences (IPAS) are important courses that cover scientific and social issues (Arief, 2021). The two disciplines, the natural sciences and the social sciences, are combined into a single curriculum unit, or IPAS. As a science that investigates various cosmic events, the core content of science in the IPAS structure remains faithful to its fundamental nature. In essence, the goal of science education is to equip students with the knowledge and analytical skills to understand natural processes more deeply. Therefore, the learning process is optimally structured to allow students to actively explore scientific topics through meaningful interactions and hands-on experience, earning achievement, which is usually displayed as a grade, can be used to measure the level of scientific learning competence (Asmaarobiyah et al., 2025; Wahyudi et al., 2023).

Less engaging and repetitive instruction can cause students to become disinterested in the subject matter. The understanding that lecture-based learning strategies are too dominant risks reducing student engagement in the learning process, leading them to absorb only passive information. Simply put, students' enthusiasm for science decreases, and their interest in scientific ideas fades, ultimately preventing the development of critical inquiry in science education. Children often have difficulty solving problems if they do not try to apply the activity directly (Fauziah et al., 2022).

Based on the results of the researcher's interview with the homeroom teacher of class IV of SDIP YLPI Pekanbaru on January 29, 2025. The instructor explained that they have implemented several learning strategies in science classes, including live lectures, question-and-answer sessions, group discussions, and the use of traditional learning resources such as textbooks. However, the problem is that the learning models and techniques used are repetitive and less varied. Students quickly become disinterested and struggle to understand the material, making science education less effective. Furthermore, many students still struggle to understand the subject matter. Poor children's learning outcomes are proof of this. Among 22 students, only 10 (45.45%) met the KKM criteria, with a score of 70. The remaining 12 (54.55%) students are still below the KKM threshold.

As explained above, elementary school science education focuses on process and concept skills. To achieve this, participants are trained to receive hands-on learning experiences. Students are allowed to observe, conduct research, identify problems, and discuss possible solutions. The concepts and experiences students gain will be more valuable and difficult to forget because they will discover them on their own. Therefore, educators must innovate to build a learning environment that children like. Using diverse learning to capture students' attention and improve their learning outcomes is one of them.

The learning process can use methods. Method is the process or approach that facilitators use to guide learning exchanges while supervising the overall system to achieve goals (Azumah et al., 2025). The experimental method is a teaching technique in which students test theories by experiencing and

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demonstrating what they have learned. Students will achieve the best learning outcomes by using experimental methods, which train them to think critically and demonstrate the practical validity of the topics they are learning (Nurlaela, 2023). This method is worth trying because science learning allows students to be directly involved in experiments and observe changes in the form of objects, so students are expected to remember the learning process better than with conventional methods.

With this background, the researcher intends to conduct this research to determine the extent to which the experimental learning method influences the learning achievements of grade 4 students at SDIP YLPI Pekanbaru, especially on the material "Perubahan Wujud Benda".

LITERATURE REVIEW

Experimental Methods

This experimental approach is intended to enable students to play an active role in designing and carrying out experiments, determining facts, collecting and evaluating data, controlling variables, and solving problems independently (Laila, 2021). Therefore, learners must conduct experiments directly, investigate the truth, find patterns or principles, and draw conclusions from the procedures they perform.

The experimental method is a teaching approach in which students test a concept, observe the procedure, record the results, present the results to the class, and then ask the teacher to make corrections (Ulya et al., 2025). Students can use this experimental approach to gain a deeper understanding of the world, apply direct observation to specific items or events, and foster an experiential understanding. In reality, experiments use the principles of the scientific method in their implementation (Nafiqoh & Wulansuci, 2020). According to the definition above, the experimental method is a teaching strategy that uses experiments and environmental exploration activities to allow students to examine a phenomenon or an object.

Learning Outcomes

Understanding, mastery, and learning outcomes are some of the measures of student achievement in school. The more deeply students understand the teacher's explanation, the better their learning results will be. These factors exacerbate and interact with one another. Because learning outcomes serve as a benchmark for evaluating learning, they significantly impact the strategies and resources used in the classroom. Therefore, students must meet all learning objectives. The outcomes of students' learning process are known as learning outcomes (Ichiana et al., 2023).

A wealth of knowledge about best practices for achieving learning effectiveness has existed since the beginning of human behavior research. Psychologists and educators are still investigating the various factors that affect learning success. By understanding the factors that affect learning outcomes, educators and learners can jointly implement interventions aimed more at optimizing academic performance (Oktaviana et al., 2025).

There are two main categories of elements that affect the learning process, namely internal and external influences (Segara et al., 2025). Biology (physical condition) and psychology (mental condition) are examples of internal factors inherent in students. Meanwhile, external influences are those that come from the environment around students, especially the educational environment, including schools.

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Natural and Social Science (IPAS) Learning

The Independent Curriculum lists IPAS as one of the courses. Natural sciences and social sciences are integrated in IPAS. Here, the scientific community discusses the interaction between organisms and inanimate objects in ecosystems. IPAS also examines how humans live their lives, both as social creatures who adapt to their environment and as individuals (Mayangsari et al., 2024). Scientific activities in both basic and integrated science process skills can develop students' critical thinking skills. This is because each activity in science learning is interconnected, fostering concrete, focused understanding and thinking among students. For example, the observation stage is followed by a comparison of findings, which can prompt students to take the initiative to learn more about what they observed (Fauziah, 2022).

Based on the definition of science education, educators must create teaching materials that arouse students to be enthusiastic about the learning process. Learning exercises should be stimulating and fun, encourage experimentation, provide positive experiences, and help students develop their critical thinking skills. Science education is essential for human progress, both in the field of technology development that supports daily life and in the field of application of concepts (Utami et al., 2025).

METHODS

This study uses a quantitative, nonequivalent control-group design. Participants in the experimental and control groups were not randomly selected in this study. This research was conducted at SDIP YLPI Pekanbaru in April 2025, during the second semester of the 2024-2025 school year. The research population consists of all grade IV students at SDIP YLPI Pekanbaru, totaling 47 people, of whom 19 are female and 28 are male. After an initial homogeneity test, the study was conducted with 22 grade IV B students at SDIP YLPI Pekanbaru, comprising 13 males and nine females. The data collection methods used by the researcher are tests, documentation, and observation. The research instruments used were paper-based, notes, and observations. The data analysis method uses nonparametric tests, namely the Mann-Whitney and Wilcoxon Signed Rank tests.

RESULTS AND DISCUSSION

Test Results

The pre-test is conducted before the research using an experimental method to assess the learning outcomes of science at SDIP YLPI Pekanbaru. This pretest is conducted to assess the students' initial ability and to serve as a benchmark for selecting the research sample. After the pretest, the researcher implements an experimental instructional method with the experimental class, while the control class receives a conventional teaching method, such as lecturing, for comparison. The posttest is administered after the treatment for both classes; the posttest results inform the formulation of the learning outcomes discussed in this study. The results of the pre-test and post-test for both the experimental and control classes are as follows.

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Table 1. Result of Pretest and Posttest for Experimental Class and Control Class

Student Code	Experimental Class		Student Code	Control Class	
	Pretest	Posttest		Pretest	Posttest
	Score Value	Score Value		Score Value	Score Value
E-1	70	80	K-1	80	90
E-2	40	100	K-2	30	30
E-3	50	100	K-3	50	60
E-4	60	70	K-4	60	80
E-5	80	90	K-5	70	70
E-6	50	90	K-6	60	60
E-7	70	100	K-7	70	90
E-8	80	100	K-8	70	80
E-9	30	90	K-9	30	30
E-10	30	80	K-10	30	70
E-11	70	80	K-11	80	70
E-12	70	90	K-12	80	80
E-13	50	70	K-13	50	60
E-14	70	100	K-14	80	70
E-15	80	90	K-15	80	60
E-16	50	100	K-16	40	60
E-17	70	100	K-17	80	60
E-18	80	80	K-18	70	70
E-19	30	100	K-19	40	40
E-20	30	80	K-20	30	40
E-21	70	80	K-21	60	60
E-22	70	90	K-22	60	80
-	-	-	K-23	60	70
-	-	-	K-24	70	80
-	-	-	K-25	50	50

Source: Research 2025

Based on the pre-test and post-test score calculations, the experimental class's average score is higher than the control class's, indicating that learning in the experimental class is better. In other words, using an experimental method can improve students' learning outcomes compared to a control class using the conventional method. Numerous recent studies also support this statement. For example, another study with a similar research design found that the application of experimental methods had a positive impact on students' science learning outcomes (Khalida et al., 2021). Similarly, other studies have shown that students involved in experimental learning activities achieve significantly higher levels than those taught using conventional methods (Hurit & Wati, 2020; Susilowati, 2023). Other studies have also emphasized that experimental learning encourages active student participation, thereby improving understanding and retention of scientific concepts (Utaminingsih & Nizaar, 2020).

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The experimental method enables students to be active participants in learning activities. This can be seen in the learning steps that start with initial experiments, formulating hypotheses, conducting experiments, drawing conclusions, and evaluating. Of all the steps, the experimental method always involves student participation, which can encourage students to be active during the learning process. Therefore, the experimental method is a learning method that aligns with the thinking characteristics of elementary school students, which are real, thereby fostering curiosity and scientific thinking.

Data Analysis

Data analysis for the hypothesis test will use non-parametric tests. In this study, researchers use the Mann-Whitney Test to determine students' ability and knowledge levels before and after treatment in both classes. This decision was taken after the data distribution failed to meet the requirements for parametric tests, such as the Normality and Homogeneity Tests. The results of the pre-test and post-test using the Mann-Whitney test are shown in **Table 2** below.

Table 2. Mann-Whitney Test for Pretest

Ranks	Treatment	N	Mean Rank	Sum of Ranks
Pretest	Experiment	22	23.98	527.50
	Control	25	24.02	600.50
	Total	47		

Test Statistics[a]	Pretest
Mann-Whitney U	274.500
Wilcoxon W	527.500
Z	-.011
Asymp. Sig. (2-tailed)	.991

a. Grouping Variable: Treatment

Source: Research 2025

In the pretest, the Mann-Whitney test results for the experiment and control classes are significant. 0.991 > 0.05. The data indicate no difference in average, indicating that both Experiment Classes and Control Classes have the same starting ability before treatment.

Table 3. Mann-Whitney Test for Posttest

Ranks	Treatment	N	Mean Rank	Sum of Ranks
Posttest	Experiment	22	34.09	750.00
	Control	25	15.12	378.00
	Total	47		

Test Statistics[a]	Posttest
Mann-Whitney U	53.000
Wilcoxon W	378.000
Z	-4.807
Asymp. Sig. (2-tailed)	.000

a. Grouping Variable: Treatment

Source: Research 2025

The posttest results in **Table 3** show that the data for the experiment and control classes are significant. 0.00 < 0.05. This data indicates a difference in the mean, suggesting that the two classes have different abilities after treatment. To determine whether there is an increase in learning outcomes across classes, the researcher will use the Wilcoxon Test, as shown in **Table 4**.

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Table 4. Wilcoxon Signed Ranks Test for Experiment Classes

Ranks				
		N	Mean Rank	Sum of Ranks
Posttest Experiment - Pretest Experiment	Negative Ranks	0a	.00	.00
	Positive Ranks	21b	11.00	231.00
	Ties	1c		
	Total	22		

a. Posttest Experiment < Pretest Experiment
b. Posttest Experiment > Pretest Experiment
c. Postest Experiment = Pretest Experiment

Test Statistics[a]	
Posttest Experiment - Pretest Experiment	
Z	-4.033b
Asymp. Sig. (2-tailed)	.000

a. Wilcoxon Signed Ranks Test
b. Based on negative ranks.

Source: Research 2025

In the experimental class, the result is significant. 000 < 0.05, indicating a difference in learning outcomes before and after the treatment in the experimental learning model. This result indicates that there is a difference in ability in the experiment class after the treatment. Looking back at the increased average score of the experiment class in **Table 1** above, the experimental method yielded a positive effect on student learning outcomes. Furthermore, the results of the Control Class are shown in **Table 5** below.

Table 5. Wilcoxon Signed Ranks Test for Control Classes

Ranks				
		N	Mean Rank	Sum of Ranks
Control Posttest - Control Pretest	Negative Ranks	4a	8.75	35.00
	Positive Ranks	12b	8.42	101.00
	Ties	9c		
	Total	25		

a. Control Posttest < Control Pretest
b. Control Posttest > Control Pretest
c. Control Posttest = Control Pretest

Test Statistics[a]	
Control Posttest - Control Pretest	
Z	-1.752b
Asymp. Sig. (2-tailed)	.080

a. Wilcoxon Signed Ranks Test
b. Based on negative ranks.

Source: Research 2025

Result in control class is sig. 0.080 > 0.05 indicates no difference in learning outcomes before and after learning. Even though **Table 1** shows that a few students in the control class have higher scores, the impact is not as significant as in the experimental class. The average scores on the pre-test and post-test in the control class do not increase significantly, and the level of knowledge remains the same after the Wilcoxon test.

Discussion

Based on the results in the five tables above, it can be concluded that the use of experimental methods in learning science material on “Perubahan Wujud Benda” has a positive influence on fourth-grade SDIP YLPI Pekanbaru. After collecting the base data from an interview with the homeroom teacher of class IV

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at SDIP YLPI Pekanbaru, the researcher listed several teaching methods used by the teacher, including live lectures, question-and-answer sessions, group discussions, and the use of traditional learning resources, such as textbooks. A pretest was held to assess the students' initial ability with the submitted material.

During the pre-test, students generally answer only questions within their modest abilities because the material tested has not been taught. The results, in the form of an average score, are: class IV A is 60, and class IV B is 57. From these scores, the upper, middle, and lower categories are then determined to determine the appropriate approach for the experimental method class and the control class using the lecture method. Pre-test results from the two classes (experimental and control) show no significant difference, indicating they are at the same level at the beginning.

Treatment was given to the experimental class, which used an experiential learning method in which students were involved in the learning process. Such as using simple experiments to observe changes in objects. For example, observing ice cubes melting as a material changing from a solid object to a liquid object, evaporation in boiling water (material liquid change to vapor), or an example of camphor sublimating and getting smaller when used for a long time (changing from a solid to a gas). These observations allow students to imagine changes in the form of objects, making them easier to understand because they have seen real-world examples. Students appear to be more enthusiastic when learning using the experimental method. They focus on the simple experiments the teacher conducts and ask questions when something catches their attention. In a control class, when a researcher uses only the conventional method, such as lecturing, students' focus is easily distracted because the teacher only explains what is in the textbook. Although the textbook includes illustrations, students' enthusiasm is not as high as in experimental classes that use hands-on experiments.

Post-test will be held after the treatment for both classes. Students were asked to complete multiple-choice questions on the topic of "Perubahan Wujud Benda" created by the researcher. The results obtained are shown in **Table 1**, where both classes have increased their scores. However, only the experimental class had a significant and influential increase in scores. In the control class, some students showed slight improvement, while the rest did not. Based on the Wilcoxon test, the pre-test and post-test results for the Experimental Class showed an increase in students' knowledge at SDIP YLPI Pekanbaru. Meanwhile, in the control class, the results were similar. This shows that the experimental method treatment influences the understanding of 4th-grade students at SDIP YLPI Pekanbaru, especially regarding the material "Perubahan Wujud Benda". This finding is also supported by research on the same topic, which states that, in terms of time efficiency when using experimental methods, researchers need to pay attention to the time allocated to presenting the material, ensuring students grasp it quickly and avoid becoming bored with prolonged learning (Sulastri, 2020). This time, efficiency can improve understanding of the concept of changes in the state of matter during each cycle.

Based on observations at SDIP YLPI Pekanbaru, it was found that teachers still tend to use monotonous lecture methods, namely those without variety, in grade IV science subjects. Thus, students get bored quickly, lack interest in listening to the teacher's explanation, and are less active in discussing during teaching and learning activities. This results in low student learning outcomes and unachieved learning objectives. Learning activities using the lecture method make it difficult for students to understand or remember the material (Jafar, 2021). This is likely because students sit and listen to the teacher's explanations, which often leads to missed material and makes it difficult to find interesting points. During the lecture-based learning process, students are only given simple material from the textbook they hold, and then several questions. When teachers give examples of real problems, students find it challenging to understand because learning is centered only on the teacher's side (Putra & Lutfiyah, 2020).

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Therefore, a variety of learning methods are needed to deliver this science material, including the experimental method. However, teachers can also use other engaging methods, such as interactive and effective learning models, media, games, or videos (Berutu & Tambunan, 2025). Learning through games tends to pique students' interest in direct involvement and winning by answering questions correctly. Meanwhile, learning through videos tends to stimulate students' audio-visual understanding of the material with moving animations and attractive colors (Pamungkas & Koeswanti, 2021; Pratiwi et al., 2021).

As already explained, experimental methods tend to excel at capturing students' attention because students are directly confronted with problems. They see and understand phenomena holistically. The teacher's job is to make experiments engaging at each meeting, especially for diverse materials. After all, one experiment on one topic cannot be compared to another; the experimental materials differ, and the phenomena presented to students differ as well. Challenges with this method include providing engaging practice for students while also supervising their practice. Furthermore, the tools and materials used can be expensive. Some experiments can also fail due to various factors, particularly those requiring complex chemical processes (especially for higher-level materials), human error, and inadequate equipment. Another challenge is that teachers need to encourage students to work cooperatively in classroom experimental practices, which, of course, do not always run smoothly (Fazriani et al, 2024; Pratiwi et al., 2020; Sondang, 2023; Sukma, 2024).

CONCLUSION

Based on the research results above, it can be concluded that the experimental learning method has a positive effect on 4th-grade students' SDIP YLPI Pekanbaru in understanding the topic "Perubahan Wujud Benda" and also increases students' learning outcomes. Another positive effect of this method is the students' enthusiasm when learning directly in class. Students tend to prefer varied learning processes that involve them directly. Furthermore, teachers actively provide guidance and instruction while also engaging with students in completing the experiments. This learning process allows students to retain the material comprehensively and effectively. It is further recommended to apply this experimental method as active learning to strengthen learning concepts in this subject. It is hoped that further research can examine the application of this method to other subjects by adapting it to the concepts of these subjects.

AUTHOR'S NOTE

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