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The Effect of Experimental Methods on Science Learning Outcomes in Students

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Abstract

Natural Sciences is not only a collection of objects or living things, but also about how things work, how to think, and how to solve problems. This study aims to determine the effect of the experimental method on the learning outcomes of Natural Sciences material on the relationship between natural resources and the environment, technology, and society in elementary school students. This study employs an experimental research design. The research design used in this study is the "One Group Pretest Posttest Design." The population in this study consists of all students. This sampling technique is referred to as saturated sampling. The analysis results show that the percentage of learning achievement in Natural Sciences is above average. It is also evident that the pretest has a lower percentage of achievement than the posttest, with the respective percentages of achievement for each test (pretest-posttest) being 6.25% and 75%. The results of this study indicate that there is a significant effect of applying the experimental method on the learning outcomes of Sciences material on the relationship between natural resources, the environment, technology, and society among students.

INTRODUCTION

The subject of Natural Sciences is related to systematically finding out about nature, so that Natural Sciences is not only the mastery of a collection of knowledge in the form of facts, concepts, or principles, but also a process of discovery (Iskandar & Kusmayanti, 2018; Lubis et al., 2023; RI, 2006). Natural Sciences is a body of knowledge that involves systematically organized facts and demonstrates the application of general laws obtained through study and practice (Ginting et al., 2025).

Natural science obtains truth about natural facts and phenomena through inquiry (discovery), because natural science is related to facts, concepts, principles, and also the process of discovery itself (Hidayat, 2021; Kusmiati et al., 2020; Utami, 2013). Discoveries are obtained through experiments that can be conducted in laboratories or in the natural environment (Handayani, 2018).

Based on this statement, not all Natural Science subject matter, especially material on the relationship between natural resources and the environment, technology, and society, can be viewed alone, but needs to be practiced and tested.

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Students need to observe directly in the learning process because the focus of the Natural Sciences subject is on various events or occurrences found in the students' environment (Lestari et al., 2021; Sabrina et al., 2024; Septiani & Fatonah, 2024; Syafril et al., 2021). The Natural Sciences subject requires a real understanding of various events in the surrounding environment or society. This means that educators must be able to help students understand a subject matter or the elements within the subject matter in accordance with the environmental conditions of the students' lives.

Educators have tried to get students to focus on learning again by using warnings or threats, known as punishment. This can make students quiet for a moment, but after that they become noisy again. This situation continues, causing learning objectives to not be maximized and the learning outcomes achieved by students to remain unsatisfactory, as shown in the following table:

Table 1. Percentage of Daily Test Completion in Science Learning Participants

No	Student Code	Minimum Passing Criteria	Score	Completion	
				Completed	Not completed
1.	A	75	78	√	
2.	DR	75	44		√
3.	GK	75	85	√	
4.	LF	75	76	√	
5.	MAA	75	82	√	
6.	NA	75	78	√	
7.	NO	75	65		√
8.	PE	75	54		√
9.	R	75	80	√	
10.	RR	75	54		√
11.	SAP	75	65		√
12.	SA	75	78	√	
13.	SH	75	82	√	
14.	SR	75	70		√
15.	VM	75	72		√
16.	WPA	75	65		√
Total			1274	-	-
Average			70,77		

The data in the table above shows that out of 16 students, only 8 obtained science scores above the minimum passing grade. Therefore, it is necessary to develop a learning method that is not boring and makes students more interested, by creating a learning environment that is close to the real world.

METHODS

This study is a quantitative research using an experimental design. Experimental research is a research method used to investigate the effect of a specific treatment on another variable under controlled conditions (Katimo et al., 2016; Khalida & Astawan, 2021; Nurqomariah et al., 2017; Rahayu et al., 2020; Rukin, 2019; Rukin & Karinda Tifani, 2023; Sugiyono, 2018; Wahyuni et al., 2017; Engkizar et al., 2025; Oktavia et al., 2025). Research design is the plan for how the research will be conducted. The research design used in this study is the "One Group Pretest Posttest Design." Suryabrata

explains that in this design, a single group of subjects is used. First, measurements are taken, then the treatment is applied for a specific period, followed by a second round of measurements. Simply put, Suryasubrata describes the research design used as follows:

Table 2. Research Design Pattern: One Group Pretest-Posttest Design

Pretest	Treatment	Posttest
T1	X	T2

Explanation:
T1 = pretest before treatment is given
T2 = posttest after treatment is given
X = treatment

The instruments used in this study were learning outcome tests, which were used to measure the abilities, understanding, and skills of the students. There were two types of tests in this study: pre-tests and post-tests. The pre-tests were conducted before the lessons without using experimental methods, while the post-tests were conducted after the lessons using experimental methods.

RESULT AND DISCUSSION

Based on research conducted in grade IV of Elementary School 16 Simpang Haru, Padang Timur, Padang City, data was obtained on the learning outcomes of students in natural sciences. Students were given a pretest on the subject of the relationship between natural resources and the environment, technology, and society. Before teaching students using the experimental method, they were first informed about the subject matter to be studied.

The aspect measured in this study was learning outcomes in the cognitive domain, which was conducted by administering pretest and posttest questions to 16 students. The data obtained from the pretest and posttest questions were presented in the form of student scores ranging from 1 to 100. The final test data obtained and the initial test data (pretest) were analyzed to determine the percentage of students who passed and failed, the average score, the highest score (X_{max}), and the lowest score (X_{min}). The results obtained from the pretest and posttest are shown in table 3 below:

Table 3. Pre-test and Post-test Data in Science Learning

Statistical data interval	Pretest (person)	Posttest (person)
16-21	-	-
22-27	-	-
28-33	1	-
34-39	2	-
40-45	3	-
46-51	4	-
52-57	-	-
58-63	3	-
64-69	-	1
70-75	2	2
76-81	1	3
82-87	-	4
88-93	-	5
94-100	-	1

Completion and percentage	Completed 1 person (6,25%)	Completed 12 person (75%)
	Not Completed 15 person (93,75%)	Not Completed 4 person (25%)
x ¯	50,93	83,68
xmaks	80	97
xmin	28	64

Based on the table above, it can be seen that in the pretest, the average score of the students was 50.93, with the highest score obtained by a student being 80 and the lowest score being 28. Of the 16 students who took the pretest, only one passed with a percentage of 6.25%, while 15 students failed, representing 93.75%.

Meanwhile, in the final test (posttest), the average score of the students was 83.68, with the highest score being 97 and the lowest score being 64. Of the 16 students who took the final test, 12 passed with a percentage of 75%, and 4 students failed, which is 25%. From the completion rate of Natural Sciences learning above, it can also be seen that the pretest had a lower completion rate than the posttest, so the completion rates for each test (pretest-posttest) were 6.25% and 75%, respectively.

Data analysis was conducted to determine student learning outcomes by calculating the average score, which was useful for describing the learning outcomes of students in Natural Sciences after using the experimental method in teaching Natural Sciences to fourth-grade students at State Elementary School 16 Simpang Haru, Padang Timur District, Padang City. Analysis of student learning outcomes in Natural Sciences was conducted by determining the average pretest and posttest scores.

Determining the average pretest and posttest scores

To determine the average pretest and posttest scores, the formula proposed by Sudijono is used as follows:

$$\bar{x} = \frac{\sum X}{N} \quad \text{..... (4.1)}$$

Description:

$\bar{x}$ = Average score
$\sum X$ = Total score
N = Number of students

Average pretest score:

$$\bar{x} = \frac{\sum X}{N} = \frac{815}{16} = 50{,}93$$

Average posttest score :

$$\bar{x} = \frac{\sum X}{N} = \frac{1339}{16} = 83{,}68$$

From the results of the average pretest and posttest calculations above, we can see a significant difference in learning outcomes. To find out the difference between the average pretest and posttest scores, see the following table.

Table 4. Difference in Pretest and Posttest Average Scores

	$\bar{x}$	Difference	Highest Value	Lowest Value
Pretest	50,93	32,73	80	28

Posttest	83,68	97	64

From the table above, it can be seen that there is an increase in the average score between the pretest and posttest. Thus, it can be concluded that there is a difference in the science learning outcomes of fourth-grade elementary school students after applying the experimental method.

1. Calculate the effectiveness of treatment from the study using the formula:

$t_0 = \frac{MD}{SE_{MD}}$ …….…….. (4.2)

Table 5. Student Learning Scores after Pretest and Posttest using the Experimental Method

Subject	Pre-test score	Post-test score	Gain/difference (d) (*posttest* dan *pretest*)	Gain/difference (d^2) (*posttest* dan *pretest*)
1	58	92	37	1369
2	48	90	42	1764
3	28	85	57	3249
4	58	97	39	1521
5	73	89	16	256
6	53	82	29	841
7	46	73	27	729
8	73	80	7	49
9	43	87	44	1936
10	35	80	45	2025
11	45	90	45	2025
12	48	80	32	1024
13	80	90	10	100
14	50	73	23	529
15	45	87	42	1764
16	35	64	29	841
N = 16	815 $\bar{x}$ = 50,93	1339 $\bar{x}$ = 83,86	$\sum d = 524$	$\sum d^2 = 20022$

$Md = \frac{\sum d}{N} = \frac{524}{16} = 32{,}75$

To analyze the results of the experiment, a pretest-posttest one-group design was used with the following formula:

$t0 = \frac{MD}{SE_{MD}}$

$SD_D = \sqrt{\frac{\sum D^2}{N} - \left(\frac{\sum D}{N}\right)^2}$

$SD_D = \sqrt{\frac{20022}{16} - \left(\frac{524}{2216}\right)^2}$

$SD_D = \sqrt{\frac{20022}{16} - \left(\frac{274576}{256}\right)}$

$SD_D = \sqrt{1251{,}37 - 1072{,}56}$

$SD_D = \sqrt{178,81}$

$SD_D = 13,37$

$SE_{MD} = \frac{SD_D}{\sqrt{N-1}}$

$SE_{MD} = \frac{13,37}{\sqrt{16-1}}$

$SE_{MD} = \frac{13,37}{\sqrt{15}}$

$SE_{MD} = \frac{13,37}{3,87}$

$SE_{MD} = 3,54$

$t = \frac{MD}{SE_{MD}}$

$t = \frac{32,75}{3,54}$

$t = 9,25$

t= 9,25 (consulted with the t-value table)

df or db = N-1 = 16-1 = 15. With a df of 15, we consult the "t" value table, both at a significance level of 5% (see Appendix 15).

By comparing the t-value obtained in the calculation (9.25) with the critical t-value at the 5% significance level, we find that the t-value is greater than the critical t-value, indicating a significant difference.

2. Hypothesis testing

After testing the hypothesis using a t-test with the following statistical formulation, the hypothesis tested was:

$H_{0=}$ accepted if $t_{calculate} < t_{table}$

H_1 = accepted if jika $t_{calculate} < t_{table}$

Explanation :

$H_{0=}$ HypothesisNihil

H_1 = Alternative Hypothesis

Df = N-1, 15 with Df equal to 15, the critical value of t in the table is as follows :

At a significance level **5 % :** t_{table} = 2,13

Thus, $t_{calculate}$ (which is 9.25) is much greater than at a significance level of 5%. Therefore, the null hypothesis is rejected. This means that there is a significant difference in the mean between Variable 1 (variable X) and Variable II (variable Y). Their science scores have significantly improved or are better than before participating in the test program.

Students are given the opportunity to experience or do things themselves, follow a process, observe, analyze, prove, and draw their own conclusions about an object, so that the learning process does not seem monotonous and dominated by the role of the educator alone. meaning that in this learning process, students are required to engage in more learning activities and directly apply the concepts learned in Science education. Learning through the experimental method is a presentation of lessons where students conduct experiments by experiencing and proving for themselves what they have learned (Fauziah, 2022; Hamdani M et al., 2019; Hendawati & Kurniati, 2017; Pinasthika & Kaltsum, 2022; Ramayulis, 2016).

This can be seen in the steps of the experimental method according to

Ramayulis. First, explain the purpose of the experiment. The purpose of the experiment must be known in advance so that they know what problems are being solved in carrying out the experiment. Second, discuss in advance which problems are important to prioritize and which should be postponed. Third, before the experiment is conducted, the educator must first determine the necessary tools, the steps to be taken, the things to be recorded, and the variables that must be controlled. After the experiment is completed, the educator must: collect reports on the experiment, conduct a question-and-answer session about the process, and administer tests to assess the students' understanding (Ramayulis, 2016; Ath-Thukhi et al., 2025; Sari et al., 2025).

Based on the steps above, learning using the experimental method will make it easier for students to remember the concepts they have learned, and an active and joyful atmosphere will develop during the learning process. Cooperation among students will be dynamic, and a spirit of mutual assistance will emerge among all students. As a result, the knowledge they acquire will remain in their memory for a long time, have a better transfer effect, and enhance their critical thinking skills, thereby improving their learning outcomes.

Based on the researcher's observations during the study, it appears that in the teaching and learning process carried out in grade IV of Elementary School 16 Simpang Haru, Padang City, in accordance with the steps of the experimental learning method, students are more enthusiastic and interested in learning than before. This is because the teaching technique used was different from the usual approach. In this learning process, students worked in small groups, collaborating and sharing knowledge, while the teacher acted as a facilitator and motivator to empower the students' group work.

Based on the post-test data analysis, it was found that the classical learning completeness of the students had been achieved. The classical completeness percentage is defined as a completion rate of 75% or higher, which is the standard set by the school. The completion rate achieved in the post-test was 75%. This proves that classical learning completeness had been achieved at the school. When looking at the percentage of mastery, the students' results have improved from the pretest results. In the pretest, the mastery rate was 6.25% or 1 out of 16 students who took the pretest.

So, it can be concluded that applying this experimental method can improve students' thinking skills, creativity, and courage, which ultimately can improve their learning outcomes. This is evident from the 75% completion rate achieved in the post-test.

CONCLUSION

Based on the research results, data analysis, and discussion, it can be concluded that the implementation of the experimental method in the fourth grade of Elementary School 16 Simpang Haru, Padang Timur District, Padang City, has been carried out in accordance with the established plan, namely six sessions. Before starting the material, a pretest was conducted with an average score of 50.93. Out of the 16 students who took the test, one student achieved mastery, representing 6.25%. Meanwhile, in the posttest, the average score of the students was 83.68, and 12 students achieved mastery, representing 75%. Data analysis was conducted using a t-test. The calculated t-value was 9.25 and the critical t-value was 2.13. Since the calculated t-value was greater than the critical t-value ($9.25 > 2.13$) at a significance level of 0.05, the null hypothesis (H_0) was rejected, and the alternative hypothesis (Ha) was accepted. This indicates that the change in students' learning outcomes between the pretest and posttest was significant. Based on the research results, data analysis, and discussion, it can be concluded that there is a significant effect of applying the experimental method on the learning outcomes of science material on the relationship between natural resources, the

environment, technology, and society among fourth-grade students at Elementary School 16 Simpang Haru, Padang Timur District, Padang City.

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