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# The Effect of Experimental Learning Methods on Students' Cognitive Abilities in Science Learning

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**Abstract:** Learning is a process of teaching and learning activities created by teachers to grow and develop cognitive, affective and psychomotor abilities. At present, there are still teachers who use rote learning methods so that students rarely get the opportunity to voice their opinions, find solutions to problems and participate actively in learning. This study aims to find out and show how experimental learning methods affect students' cognitive abilities in science learning in class IV SDN Ciracas 15 Pagi, East Jakarta. This research is a quantitative descriptive study using a quasy experimental design. A total of 53 students from one of Ciracas Elementary Schools in East Jakarta, both from class IV-A and IV-C were selected as samples using purposive sampling technique. To measure students' cognitive abilities, in this study data collection was carried out using the test method with cognitive ability test instruments in the form of multiple choice questions. Data analysis was performed using the t test. Based on the results of the data analysis, the results of the study show that the experimental class in science learning has significantly higher cognitive abilities, namely $\bar{x}$ = 81.718 compared to students in the control class, namely $\bar{x}$ = 73,857.

**Keywords:** Experimental learning methods; Students' cognitive abilities; Science learning

## Introduction

Learning is a process of teaching and learning activities in which there is interaction between teachers and students, students and students in educational situations to achieve the goals that have been set. The learning process requires teachers, students and learning resources (Novitasari & Meilana, 2022). A good learning process can help students develop their interest in learning, so that there are changes in behavior such as changes in cognitive, affective and psychomotor aspects (Ramdani et al., 2023).

In learning activities students are guided to be able to improve their cognitive abilities (Rahman, 2020). Natural Sciences (IPA) subjects are the only scientific disciplines that are able to develop cognitive abilities (Khalida & Astawan, 2021). Science subjects are subjects that study natural phenomena around us. At the elementary school level, science or science is one of the subjects that plays an important role in the world of education, this is because science can be a provision for students in facing difficulties in this era of globalization (Fauziah et al., 2022). Therefore, science can be said to be a subject that elementary school students find quite challenging (Yolanda & Meilana, 2021). In learning science, students must get used to it to carry out experiments, observations, collect data, test concepts and draw a conclusion (Rismawati et al., 2020). In practice in elementary schools, the field of Natural Science positions students as scientists in solving environmental facts, so that the learning process becomes easier and more satisfying (Nasution, 2022). Natural science learning objectives will be achieved if the teacher can create appropriate learning conditions and situations allows students to be active in forming, discovering and develop his knowledge (Oktavia, 2019). This is reinforced in the science curriculum which recommends that science learning in schools involves students in an investigation that will be completed together, which of course will

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make interactions between teachers and students more active (Nurjannah et al., 2023).

In fact, during field observations, there are still teachers who use rote learning methods so they do not provide direct experience to students, this will make it more difficult for students to understand a concept if they do not get enough practice. Students only remember what the teacher said by listening, writing, or both. Learning activities seem to make students look bored while studying.

Teachers are required by the Education Unit Level Curriculum (KTSP) to design and implement learning methods that make students happy and not bored during lessons so that they are motivated to learn at school, thus students' cognitive, affective and psychomotor abilities will increase. Therefore, teachers who have a very important role in the learning process must be able to choose and use appropriate learning methods in order to create an effective learning atmosphere (Triwardhani et al., 2020). Students become passive learners when they are taught by teachers using conventional methods that prioritize teacher activity (teacher centered). In fact, the activeness of students is very necessary during learning so that students are able to know and understand what they are learning.

Currently, education in Indonesia is still dominated by teachers as the main center of internal knowledge class (Savitri & Meilana, 2022). Most elementary school teachers still use a variety of learning models conventional or lectures, this results in students not being interested to learn and there are still some teachers who often provides material notes in quantities a lot. Some students just daydream or fall asleep in class when the teacher explains the material, while others are busy playing or chatting with friends to relieve boredom. During the learning process, there is no attitude of cooperation or discussion. Rarely do students get the opportunity to voice their opinions, find solutions to problems, and participate actively in group discussions.

Therefore, in elementary school teachers must develop and create innovative or interesting learning designs for science learning by adapting learning methods to student characteristics, especially the material to be taught. The experimental method is a method that is often used to train students' cognitive abilities during the learning process.

When observing in the field as a PLP student, conducting an experiment in class regarding material changes in the shape of objects. This experiment or experiment was carried out by all students together. The experiment that was carried out was the practice of making ice cream. This experimental activity can stimulate students' curiosity about the material to be studied. Students are very enthusiastic and spirit in learning. Students can observe, see and experience the process directly regarding changes in the shape of objects from liquid milk that changes to thicken to freeze. With this practicum, students better understand the material and hone student creativity and give students a deep impression of the material they are studying.

Cognitive abilities in students largely depend on the extent to which these students are active in socializing with the surrounding environment. The more active students socialize, the more cognitive abilities they have and vice versa (Rahman, 2020; Wulandari & Ambara, 2021). Therefore, the experimental method is very suitable to be applied to increase student activity in learning activities. Through the experimental method, students are invited to carry out direct experiments with proper instructions, so that it is easier for students to understand and practice the material they have learned.

The experimental method is a teaching method in which students directly test a theory against the knowledge they gain from the learning they receive. The experimental method in learning is a method that is carried out by inviting students to carry out experiments to prove themselves a question or hypothesis being studied (Azizah et al., 2021). This experimental method aims to teach students how to conduct their own experiments, follow a process, observe an object, state or process of something, solve problems, and find solutions (Haerani et al., 2023). Students learn to think scientifically through experimentation. The experimental learning method gives students the opportunity to find concrete evidence of the theory they are learning. Thus, students required to experience for yourself, search the truth, or trying to find something laws or propositions, and draw conclusions from the process he experienced.

Namiyanto (2023), Indicators of success in applying this experimental method consist of process indicators and result indicators. The experimental method indicators are as follows as follows: assessment of teacher and student activities in learning methods experiments are made in the form of teacher observation sheets and student; assessment of students' cognitive abilities is made in the form of a multiple choice written test.

Sourced from the problems above, the purpose of this study is to find out as well shows how the experimental learning method affects the cognitive abilities of students at SDN Ciracas 15 Pagi East Jakarta in learning science in class IV.

## Method

This type of research is a quantitative descriptive research and uses a quasy experimental design method.

The form of quasi-experimental design used by researchers is the nonquivalent control group design. The independent variable of this research is the experimental learning method, while the dependent variable is the students' cognitive ability.

This research was conducted in high school, in June even semester 2022/2023 at SDN Ciracas 15 Pagi, East Jakarta. This study involved fourth grade students at SDN Ciracas 15 Pagi as the study population. Classes IV-A and IV-C were selected as the research sample which totaled 53 students. In this study, the sampling technique used was purposive sampling technique. Data collection techniques in the form of observation, tests and documentation.

This study involved two classes, namely class IV-A and IV-C. Class IV-A is positioned as the treatment class, while class IV-C is positioned as the control class. Class IV-C received science learning through conventional methods because this method is a form of learning that is usually carried out at the school where the research was conducted. On the other hand, class IV-A gets learning by using experimental learning methods. The two classes received different forms of learning, but this research was conducted with the same number of meetings, namely two meetings and the same learning materials, namely energy sources, changes in energy forms and alternative energy sources.

The test technique used to measure students' cognitive abilities consisted of 15 items in the form of multiple choice questions, given twice, once as a pretest and once as a posttest. In this lesson plan, cognitive ability tests have previously been tried out by calculating and determining validity and reliability tests. The data were analyzed using prerequisite tests and hypothesis testing. To carry out the prerequisite test, the normality test and homogeneity test are used. Hypothesis testing is done by using the t test to determine whether there is a difference between the estimated value and the results of statistical analysis.

## Results and Discussion

This research was conducted at SDN Ciracas 15 Pagi, East Jakarta from 12-16 June 2023. This research This use two class that is class IV-A consists of 32 student as group experiment which use method learning experiment and class IV-C consists of 21 students as group control withuse method learning conventional like method lecture. All research subjects were given pretest and posttest questions by the researchers to assess students' cognitive abilities, the questions were in the form of multiple choices.

Before the test questions were used, they were first validated with 34 students in class IV-A at SDN Jatimulya 04 Bekasi. Then it was tested on students in grades IV-A and IV-C at SDN Ciracas 15 Pagi, East Jakarta. The purpose of this is to determine the validation and reliability of these items.

Before being given treatment, both classes were given a pre-test to find out students' initial abilities regarding the material to be studied. Students work on pre-test questions according to the makeshift abilities possessed by each student. After knowing the initial abilities of students in both classes, students are then given learning with different methods on energy sources, changes in energy forms and alternative energy sources. After being given different treatment in the experimental class and the control class, at the end of the meeting after the material had been taught, students were given a final test (post-test) to determine students' cognitive abilities. The results of the pretest and posttest of the experimental group and the control group are presented in Table 1.

**Table 1**. Results of Pretest and Posttest Experiment Group and Control Group

| Measurement | Average Score (Mean) | | Difference |
|---|---|---|---|
| | Experiment Class | Control Class | |
| Pretest | 60.53 | 60.48 | 0.05 |
| Posttest | 81.72 | 73.86 | 7.86 |
| Difference | 21.19 | 13.38 | |

The conclusion that can be drawn from the statistical calculations above is that the experimental group's pretest results were higher, namely 60.53 compared to the control group's pretest results, namely 60.48. In addition, the experimental group's posttest results were 81.72 higher than the control group's 73.86. Figure 1 describes the histogram used to present the previous table.

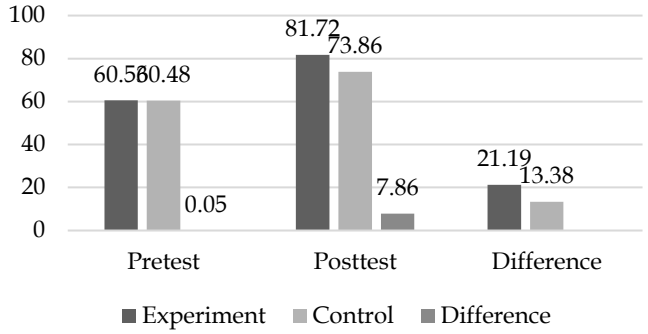


**Figure 1**. Histogram of Pretest and Posttest Results of the Experiment Group and the Control Group

The collected data is tested to answer the hypothesis by conducting a prerequisite test. In this study, the prerequisite test used consisted of the

normality test and homogeneity test. **Table 2** presents the results of the normality test in the experimental class.

**Table 2**. Experimental Class Normality Test Results

| Class | Data | N | $L_{count}$ | $L_{table}$ | Decision |
|---|---|---|---|---|---|
| Experi-ment | Pretest | 32 | 0.109 | 0.156 | $H_o$ accepted |
| | Posttest | | 0.140 | 0.156 | $H_o$ accepted |

Table 2 shows the normality test for the experimental class using the experimental learning method, which was carried out using the Liliefors test to measure 32 students in their cognitive abilities in science learning. Good value pretest $L_{count} < L_{table}$ (0.109 <0.156) and posttest $L_{count} < L_{table}$ (0.140 <0.156) indicates that the hypothesis $H_o$ accepted. In this case, it can be concluded that the data is normally distributed.

**Table 3**. Control Class Normality Test Results

| Class | Data | N | Lcount | Ltable | Decision |
|---|---|---|---|---|---|
| Control | Pretest | 21 | 0.169 | 0.188 | Ho accepted |
| | Posttest | | 0.186 | 0.188 | Ho accepted |

Table 3 shows the normality test for the control class using conventional learning methods, which was carried out using the Liliefors test to measure 21 students in their cognitive abilities in science learning. It is known that the pretest value of $L_{count} < L_{table}$ (0,169 < 0,188) and the posttest value $L_{count} < L_{table}$ (0.1860 <0.1881) indicates that the hypothesis Ho is accepted. In this case, it can be concluded that the data is normally distributed.

**Table 4**. Pretest Data Homogeneity Test Results

| Class | $\bar{x}$ | Variance | $F_{count}$ | $F_{table}$ | Decision |
|---|---|---|---|---|---|
| Experiment | 60.531 | 187.418 | 1.044 | 2.033 | Homogen |
| Control | 60.476 | 179.361 | | | |

Based on Table 4, the total variance (S) of the experimental class is 187.418 and the total variance (S) of the control class is 179.361. Known $F_{count}$ = 1,044 < $F_{table}$ = 2.033, then the calculation results indicate that the pretest data is homogeneous.

**Table 5**. Posttest Data Homogeneity Test Results

| Class | $\bar{x}$ | Variance | $F_{count}$ | $F_{table}$ | Decision |
|---|---|---|---|---|---|
| Experiment | 81.718 | 85.047 | 0.487 | 0.520 | Homogen |
| Control | 73.857 | 174.428 | | | |

Based on Table 5, the total variance (S) of the experimental class is 85.047 and the total variance (S) of the control class is 174.428. Because $F_{count}$ smaller than $F_{table}$ or 0.487 <0.520, then the calculation results show that the pretest data is homogeneous. Table 6 below shows the results of the class IV science learning test which measures students' cognitive abilities using the experimental learning method.

**Table 6**. Hypothesis Test Results

| Statistic Value | Class | | $t_{count}$ | $t_{table}$ | Conclusion |
|---|---|---|---|---|---|
| | Experi-ment | Control | | | |
| Mean | 81.718 | 73.857 | 2.554 | 1.675 | Ha accepted |
| Variance | 85.047 | 174.428 | | | |
| Number of samples | 32 | 21 | | | |

Table 6 is the data after treatment, obtained $t_{count} > t_{table}$ namely 2.554 > 1.675, so that it can be stated that Ha is accepted and Ho is rejected.

After conducting the research, it was found that there were differences in the cognitive abilities of the experimental group students who studied using the experimental learning method and the control group who studied with conventional methods, such as the lecture method. This shows that there are significant differences in cognitive abilities between the experimental group and the control group. The findings of this study are one goal with the research of Rora et al. (2022), which states that the cognitive abilities of students regarding the material properties and forms of objects are significantly influenced by the use of experimental methods. This was evident when the researcher used his analytical skills to complete the experiment. Furthermore, the research results of Astuti & Airlanda (2022), suggests that in learning, the use of experimental methods can develop students' cognitive abilities in learning science in class IV. This is reinforced by the statement made by Sasmita and Harjono (2021), who said that the use of this experimental method aims to equip students with the ability to conduct their own experiments and investigate the various problems they face.

In a study by Sarawati et al. (2020), regarding the effect of teaching the PBL method on students' cognitive abilities, it was found that the use of the PBL method had a significant effect on students' cognitive abilities in learning mathematics. Another fact was also found that the use of the PBL method did not only affect mathematics subjects. This causes a gap between the research that has been done and the facts in the field. This gap can be used by subsequent researchers to answer the question whether students' cognitive abilities are caused by the learning method used (PBL) or there are factors of learning methods and other materials that must be examined.

Aufa et al. (2023) suggests the steps needed to apply the experimental method in science learning activities are as follows:

**Before the learning begins, it is necessary to plan what experiments will be practiced**: the teacher determines in advance what experiments will be carried out in order to prepare the necessary tools and materials, master the theory of the experiment and know the purpose of the experiment to be carried out.

**Ask students to provide the equipment needed in the experiment:** experiments or trials on energy source materials, changes in energy forms and alternative energy sources are carried out using simple tools and materials but their function remains the same and can achieve learning objectives.

**Figure 2.** Students provide tools and experimental materials

**Forming students into various/heterogeneous study groups: t**his is done to train students to accept differences and be able to work together with friends from different backgrounds.

**Figure 3.** Students form study groups

**Communicating the learning objectives to be achieved during learning activities:** teachers need to communicate the purpose of teaching and learning activities to students, so that students can carry out their learning actions more independently. Express something that students must carry out during learning and provide an explanation of what skills or abilities they must master.

**Guiding students, supervising students and providing directions regarding the steps in conducting experiments:** even though students are the main actors in learning, teachers still supervise each student regarding what they do from the beginning to the end of learning. Supervise students by going around or being on each side of the class so that science learning using this experiment runs smoothly.

**Figure 4.** Direction and guidance when conducting experiments

**Ask students to make conclusions and report the results of the experiment:** students briefly explain the results of the experiment that was successfully carried out and become the final result of the experiment as a whole.

**Figure 5.** Students discuss the results of the experimental conclusions

**The results of the experiment are presented or communicated by each group: t**he results of each group's experiments are communicated to the other groups in turn. Students provide various interpretations of experimental results and express them with many ideas fluently.

**Figure 6.** Students present the results of experiments

**Responses from other groups are needed to the presentations that have been delivered by their friends; s**tudents develop creative thinking skills in the elaboration aspect, that is, students are trained to be able to carry out investigations according to objectives with detailed steps.

**Provide an evaluation to students regarding the experiments that have been carried out:** the teacher follows up on the experiments that have been carried out. This means that teachers and students both provide conclusions or evaluations of the results of experiments that have been carried out. There are two forms of evaluation, namely evaluation of the implementation of the experimental method and student evaluation. Evaluation of this experimental method consists of showing the results of the experiments that have been carried out, as well as looking at their implementation starting from the completeness and practicality of the props or experimental equipment. Apart from that, it also comes from student activities. Then the form of evaluation for students is in the form of tests, both written tests and oral tests.

**Next, the teacher presents some clear and detailed information on the results of experiments that the students have done:** the teacher provides conclusions at the end of the lesson or provides reinforcement so that there are no misunderstandings related to the material or experiments carried out.

According to Ismawati (2022), applying the experimental method can make the class and students active rather than just using the lecture method. Making students active in class can be interspersed with questions and answers or by appointing one of the students to practice or try in front of friends, as well as explaining the practice or experiment that is being carried out. The teacher can use the method of creating several groups of all the students in the class, then from each group the teacher works around this by selecting one or two students who are deemed capable of explaining the material or responsive so that the other students are also able to understand what the teacher is saying.

This can be seen by researchers that the application or implementation of experimental methods in science learning is appropriate and appropriate. The experimental method used is an experiment carried out by teachers on students using appropriate tools and materials that can be applied in everyday life so that they can develop students' thinking abilities.

The explanation above is in line with Ery Khaeriyah's journal, namely that the experimental method is a suitable method for learning science, this is because the experimental method is able to provide learning conditions that can develop thinking abilities and can also develop creativity optimally. Students are given the opportunity to develop their own concepts in their thinking, which can then be applied in their lives.

Wilujeng (2022), the application of experimental methods in natural science subjects prevents students from getting bored and fed up, on the contrary, students feel happy so that their learning activities increase. This is reinforced by Juista's statement (2021), through the application of experimental methods in learning, science students do not just receive information from teachers, but students can also gain knowledge through experience learn directly while being able to develop process skills.

From the explanation above, it can be seen that the application of the experimental method in science learning is the right thing for students to apply by looking at the environmental conditions of the students, class and also the school. Apart from that, it can also develop students' creativity so that they become more enthusiastic about learning.

## Conclusion

Based on the research findings and discussion, there is a significant difference between experimental learning methods and conventional methods in science learning on the cognitive abilities of fourth grade students at SDN Ciracas 15 Pagi. Based on data analysis, it can be concluded that the cognitive ability of students during science learning in the experimental group is x = 81.72 which is significantly higher than students in the control group who have cognitive abilities x = 73.86. The results showed that the experimental class scores were superior to the control class scores, because Ho was rejected and Ha was accepted. This success was influenced by the application of the experimental learning method in the experimental class. Based on data analysis, the hypothesis test (t test) resulted in $t_{count} > t_{table}$, namely 2.554> 1.675, so Ha is accepted, thus it can

be concluded that the experimental learning method used in class IV SDN Ciracas 15 Pagi East Jakarta has an effective effect in developing students' cognitive abilities in learning science material on energy sources, changes in energy forms, and alternative energy sources.

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