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The Influence of Experimental Methods on Understanding Concepts, Materials, Properties and Changes in the Form of Objects

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Abstract: Students' conceptual understanding of science learning is relatively low. Another factor that causes low understanding of students' concepts is because students have not been invited to directly experiment or conduct direct experiments in science learning, especially the material on the properties of objects and various changes in the state of objects. This study aims to see the effect of the experimental method on the conceptual understanding of fourth grade elementary school students. This study is a quantitative study with a pre-experimental method. The design of this study uses The One-Group Pretest-Posttest Design. The population in this study were all fourth grades elementary school students. The sample selection used the Purposive Sampling technique. The sample used in this study was 30 fourth grade students of SDN 3 Muara Enim. The research instrument used to measure students' conceptual understanding used pretest and posttest questions. The data obtained were then analyzed using SPSS 25.0 to test normality, homogeneity, and the One Sample T-Test hypothesis test. The results of the data analysis showed that the experimental method had an effect on the understanding of fourth grade elementary school students on the material on the properties and changes in the state of objects as evidenced by the results of the hypothesis test of 0.000.

Keywords: Elementary school; Experimental method; Form of objects

Introduction

Education is one of the main keys for a student in his efforts to increase knowledge and deepen understanding. The process of gaining knowledge and understanding is in line with the goal of education to produce competent students (Fadwa et al., 2023). Through the teaching and learning process of various disciplines in the classroom, knowledge and understanding can be obtained (Harsono et al., 2023; Yusmar & Fadilah, 2023). In learning activities, understanding is one of the most important needs of students, especially understanding concepts. This statement is reinforced by Riad et al. (2023) who said that one of the skills that children need to acquire to write in their own language and explain, describe, give examples, and make conclusions is conceptual understanding. Because conceptual understanding is a prerequisite for other thinking skills that students must acquire, conceptual understanding plays an important role in the application of learning (Budianti & Fauzanah, 2022). One of the disciplines that plays an important role in developing students' conceptual understanding is science. Science is a science that studies naturally occurring phenomena that are arranged methodically based on human observations and experimental results (Savitri & Meilana, 2022).

Understanding concepts in science includes learning how to group objects based on their characteristics and parts, such as how to apply, utilize, and choose a process that has been explained from a

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concept (Cahya et al., 2023a; Fahraz & Setiyawati, 2023). In the science learning process, the emphasis is on developing the ability to understand scientific concepts through direct experience (Sari & Hanum, 2023; Prastika et al., 2023). Science teaching has different teaching from other subjects, such as involving students in experiments, observing, collecting data, validating theories, and drawing conclusions. Given the importance of science education, the content of science subjects must be applicable in students' daily lives so that it can be used to improve science learning (Sondang, 2023; Zulyusri et al., 2023). The results of Indonesia's 2018 PISA scores have been published by the OECD. Compared to the 2015 PISA results, Indonesia's ranking has decreased due to these findings. Based on the results of the PISA tests of Indonesian students conducted in 2006, 2009, 2012, and 2015, the average scientific literacy score was classified as poor, ranging from 382 to 403 points. Then in 2018 it decreased further until the scientific literacy score became 396. PISA research data shows that students have difficulty understanding the concepts or meaning of learning content because they are unable to grasp and understand the material (Cahya et al., 2023b).

Facts in the field also show that students' conceptual understanding in science learning is relatively low. Based on initial observations conducted in class, information was obtained that students still have difficulty in understanding the concept of science, namely the properties of objects and various changes in the state of objects. Classroom learning has not used concrete examples in explaining the material. In addition, the results of interviews with class teachers also strengthen the facts in the field that students' ability to understand science concepts is still low. Another factor that causes low student conceptual understanding is because students have not been invited to directly experiment or conduct direct experiments in science learning, especially the material on the properties of objects and various changes in the state of objects. The material on the properties of objects and changes in the state of objects is not just memorizing but also having to do experiments or trials.

The assessment of the high and low level of students' conceptual understanding can be seen from the indicators of conceptual understanding. Indicators of conceptual understanding in this study include, students are able to interpret, give examples, group, draw inferences, explain, and compare (Ayub et al., 2020; Gunada et al., 2020). In addition, the revised results of Bloom's taxonomy were revealed by Hassija et al. (2024) mentions seven stages of the understanding process, including interpreting, giving examples, classifying, summarizing, comparing, and explaining. Overcoming problems that occur in the field, an appropriate solution is needed, one of which is by choosing the right learning method. Several previous studies have shown different findings. The results of research conducted by Ute et al. (2021) shows that the learning method with a guided inquiry approach has an effect on students' understanding of concepts in science learning. In addition, research conducted by Armadi & Nazlimar (2023) shows that the method that can improve students' conceptual understanding in science learning is the Explicit Instruction method. Based on previous studies, it is known that there are several researchers who have tried to see students' conceptual understanding through different methods.

The method used in this study uses the experimental method. The experimental method is a teaching method in which students can conduct experiments, observe experimental procedures, and record their findings, then present them in front of the class and be evaluated by the teacher. The advantages of the experimental method include that students are trained to use scientific methods to prove the truth, are more active in thinking and learning independently with teacher guidance, and gain knowledge based on direct experience (Susilowati, 2023). Based on the explanation of the importance of handling the problem of students' lack of conceptual understanding above, there is an urgency regarding the need for research that can answer whether the experimental method has an effect on students' understanding in science learning.

Method

This study uses a quantitative approach with a pre-experimental research type with the One-Group Pretest-Posttest Design research design (Indrasari & Wulandari, 2024). This type of research is used to determine the effect of a treatment on the dependent variable without using a control group. The independent variable in this study is the experimental method with the dependent variable being students' conceptual understanding in science lessons. The research flow can be described as follows.

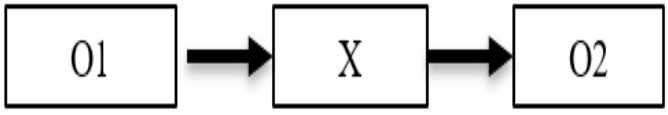

Figure 1. Research Design

Description:
O1: Data from the learning test results on understanding the concept of the properties of objects and changes in

the state of objects conducted before being given treatment
O2: Data from the learning test results on understanding the concept of the properties of objects and changes in the state of objects conducted after being given treatment
X: Treatment of fourth grade students using the experimental method in learning the properties of objects and changes in the state of objects in science subjects.

This research was conducted at SDN 3 Muara Enim. The sampling technique in this study used purposive sampling. After sampling, this study focused its research subjects on class IV of SDN 3 Muara Enim totaling 30 students. This study used observation and learning outcome tests as data collection techniques. The instruments in this study used pretest and posttest questions in the form of 10 multiple choices and 5 essay questions on the material on the properties of objects and changes in the state of objects in science subjects. The learning outcome instrument was used to determine the level of students' conceptual understanding of the material on the properties of objects and changes in the state of objects. The data analysis technique in this study used parametric statistical tests with prerequisite tests, namely, normality tests and homogeneity tests using SPSS 25.0 software. After that, a hypothesis test was conducted using the One Sample T-Test to see if there was a difference in students' conceptual understanding before and after being given treatment. The research hypothesis can be formulated as follows:
H0 = the experimental method has no effect on students' conceptual understanding
Ha = the experimental method has an effect on students' conceptual understanding

Result and Discussion

Table 1. Pretest and posttest data

Statistics	Pretest	Posttest
N	30	30
Mean	54.13	85.03
Std. Deviation	3.84	3.26
Minimum	48	80
Maximum	62	93

The test results were obtained during the research in class IV of SDN Muara Enim in the subject of science on the material of the properties of objects and changes in the state of objects. Data were obtained through tests before and after being given treatment during the learning process. The KKTP for science subjects that has been determined by the school is 70. The data on students' pretest scores can be seen in Table 1.

Based on the statistical data above, the results of the students' pretest and posttest showed a difference in the students' conceptual understanding scores. The test conducted before the treatment (pretest) got a minimum score of 48 and a maximum score of 62, while the test conducted after the experimental method treatment showed a minimum score of 80 and a maximum score of 93. From these data, it is known that the students' pretest score on the conceptual understanding test got an average score of 54.13 while the students' posttest got an average score of 85.03. This shows that there is a significant difference in students' conceptual understanding of the material on the properties of objects and changes in the state of objects before the experimental method treatment was given and after the experimental method treatment was given from the posttest results which were far superior to the pretest results. An illustration of the pretest and posttest scores of students' conceptual understanding can be seen in the following diagram.

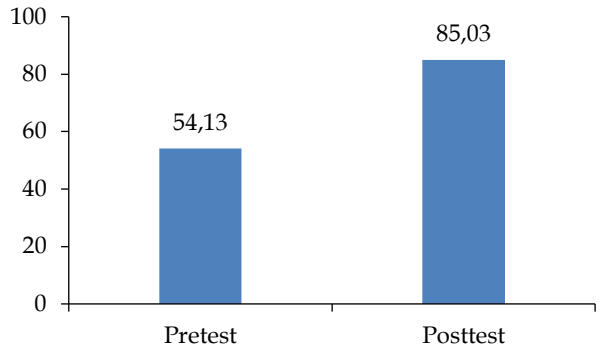

Figure 2. Pretest-posttest diagram of students' concept understanding

After statistical analysis of the pretest and posttest data, the next step was to test the prerequisite analysis, namely the normality and homogeneity tests. The normality test in this study was to see whether the distribution of the research data was normally distributed or not. The results of the normality test can be seen in Table 2.

Table 2. Pretest-posttest normality test

Test	Shapiro Wilk		
	Statistic	df	Sig.
Pretest	0.95	30	0.20
Posttest	0.96	30	0.30

Based on the results of the normality test above, it is known that the results of the student's pretest have a

sig. value of 0.203 and the results of the student's posttest have a sig. value of 0.303. From these results, it shows that both sig. values of the pretest and posttest are greater than 0.05 and it can be concluded that the data in this study are normally distributed. After conducting the normality test, the next step is to conduct a research homogeneity test which aims to see whether the data in this study have the same variance or not. The results of the homogeneity test are presented in Table 3.

Table 3. Homogeneity test

	Statistic		
Data	df1	df2	Sig.
Concept Understanding	1	58	0.08

Based on the homogeneity test table, it is known that the significance value of the students' conceptual understanding data is 0.082. The sig. value of the conceptual understanding obtained by students shows that the Sig. score of the data is more than 0.05. So, it can be said that the data on students' conceptual understanding of the material on the properties of objects and changes in the state of objects is homogeneous. Next, conduct a One Sample T-Test which functions to determine the hypothesis of the average comparison in the sample. The results of the One Sample T-Test can be seen in Table 4.

Table 4. One Sample T-Test

	Statistics			
Result	t	df	Mean Difference	Sig. (2-tailed)
Concept Understanding	33.73	59	69.58	0.000

Based on the results of the One Sample T-Test hypothesis test, the Sig. value is 0.000 < 0.05. So, it can be concluded that H0 is rejected and Ha is accepted. This means that there is an influence of the use of experimental methods on students' conceptual understanding of the material on the properties of objects and changes in the state of objects. The findings of this study indicate that teaching elementary school students using experimental methods can be applied, because it has a significant effect on conceptual understanding and teaches students how to reconstruct their knowledge independently. Science learning in elementary schools consists of conceptual learning elements that make it difficult for students to understand the concept (Rahmawati, 2021; Nur'ariyani et al., 2023; Fiteriani et al., 2023). Because science learning involves students in understanding the surrounding environment and themselves through experiments and direct observation, the experimental model learning process is very appropriate to be applied in science education (Andriani & Supiah, 2021; Shao et al., 2024; Darling-Hammond et al., 2020; Alfiyandri et al., 2023).

The experimental method used in this study invites students to conduct experiments directly, independently or in groups, and draw conclusions based on their respective experiences after conducting the experiment (Beiderbeck et al., 2021; Tasquier et al., 2022). There are three stages in implementing the experimental method in the learning process, namely exposition, exploration, and evaluation (Marfuatun & Riandi, 2022; Sari et al., 2023; Pedaste et al., 2015). The implementation of the research began with the provision of a test before being given treatment. After students worked on the pretest questions, the next step was the application of the experimental method in the learning process. The experimental method applied was in accordance with the steps that had been prepared. The first stage is exposition (Aswanti & Isnaeni, 2023). In this initial stage, before starting the experiment, the teacher discussed the basic guidelines. The teacher also discussed the objectives, challenges, and instruments and equipment that would be used. The teacher invited students to experiment directly on the material on the properties and changes in the state of objects. At this stage, the aim is for students to develop a mindset and understand the experimental procedure. The exposition stage activities can be seen in Figure 3.

Figure 3. Exposition stage

The second stage is exploration. By dividing students into several parts, the teacher exemplifies to students the work steps in the experimental practice. Through group experiments, students can help each other, communicate, and exchange ideas by conducting group experiments and finding answers to experimental questions. This is in line with Sappaile et al. (2023), Zhu et al. (2016), and Gustiawan et al. (2023), that to expand their knowledge and understanding, students in a

cooperative learning environment are required to encourage, debate, and support each other. In the experimental process, students appear enthusiastic in observing because students can directly see the properties and changes in the form of objects, for example the change of solid objects into liquids, namely melting ice cubes. The implementation of the exploration stage can be seen in Figure 4.

Figure 4. Exploration stage

The third stage is evaluation. At the stage after conducting the experiment, students are asked to discuss with their group members then write down the conclusions obtained and present them in front of the class. After presenting the results of the experiment, students are able to answer questions from the teacher when asked to mention examples of changes in the state of objects and their properties. Students are also able to group objects that are liquid and solid (Warfa et al., 2018). After the learning ends, students are given post-test questions to measure the level of understanding of students' concepts after being given treatment in the form of an experimental method. The implementation of the evaluation can be seen in Figure 5

Figure 5. Evaluation stage

Based on the explanation of the activities above, the researcher concluded that learning by applying the experimental method to students' conceptual understanding of the material on the properties and changes in the state of objects. The results of research conducted by Nurhidayat et al. (2023) and Putri & Meilana (2023) strengthen this research that using the experimental method in learning has an effect on students' conceptual understanding. In addition, research conducted by Novita & Jumadi (2022) shows that students' conceptual understanding in science learning can be developed using the experimental method, because the experimental method accustoms students to conducting an experiment and explaining the results of the experiment based on personal experience.

Conclusion

Based on the data that has been analyzed and the discussion that has been presented in this study, it can be concluded that there is a very significant difference in students' conceptual understanding after the application of the experimental method in science learning on the material of the properties of objects and changes in the state of objects. The test results show that the experimental method has a significant influence on the conceptual understanding of fourth grade elementary school students. Through the experimental method, students carry out three stages, namely the exposition stage, a stage that provides students with initial knowledge, provides instructions and explains the procedures before carrying out experimental activities on changes in the state of objects. After that, the second stage, namely exploration, students already understand the procedural implementation of the experiment based on the teacher's explanation so that at this stage students carry out trial activities on changes in the state and properties of objects. The third stage is evaluation, the evaluation is carried out by giving students questions to measure students' understanding of changes in the state and properties of objects. Some suggestions given that overlap with this study are for teachers in elementary schools to prioritize the safety and security of students in carrying out experiments. Furthermore, for future research, it is recommended to test other methods with the material on changes in the state and properties of objects so as to obtain varied results.

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Conflicts of Interest
The authors declare no conflict of interest.

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