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The Use of STEM (Science, Technology, Engineering, and Mathematics) Models to Improve Elementary School Science Concept Understanding

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Abstract

Science learning in elementary schools aims to help students understand scientific concepts through observation and real experiences. This study aims to describe the improvement of fifth-grade elementary school students' conceptual understanding related to the properties of light through the application of the STEM (Science, Technology, Engineering, and Mathematics) learning model. SDN 2 Cilumba conducted the study, employing the pre-experimental method of a one-group pretest-posttest design. The instruments used included a concept understanding test and interviews. The results of data analysis showed a significant increase in students' average scores, from 58.81 (pretest) to 78.53 (posttest). The paired t-test produced a significance value of 0.000 < 0.05, indicating that the STEM model was effective in improving students' conceptual understanding. The results of the interviews revealed that students were enthusiastic about participating in STEM-based learning, even though teachers faced time constraints and students had difficulty restating concepts. Overall, the majority of students were in the good understanding category (60.01%), excellent (26.66%), and sufficient (13.33%). These findings reinforce that the STEM approach can be an alternative to meaningful and intriguing science learning at the elementary school level.

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INTRODUCTION

Education is a process to improve understanding and self-potential, including a number of affective, cognitive, and psychomotor aspects of a person that will always develop optimally. The ability of students to understand the material can inspire them to produce original ideas or views on global issues, especially in the world of education (Susanti, Asrin, & Khair, 2021). Elementary school is a crucial initial stage in the introduction and development of understanding skills. At this stage, students begin to develop various aspects of their intelligence, including understanding skills. Improving understanding skills in elementary school students can strengthen students' basic thinking, which will help in further development. According to Perdiansyah (2021), conceptual understanding is obtained by someone as a process of thinking in re-exposing knowledge to process the learning materials they receive so that they become meaningful. Through this ability, students will be trained to choose various opinions, allowing them to distinguish between accurate and inaccurate opinions, as well as important and irrelevant opinions. Therefore, to improve the comprehension of conceptual understanding in elementary school students, it is important to apply what is supported by the use of a learning model that facilitates active student involvement during the learning process. To facilitate students getting good learning, science teaching in elementary schools is designed to be very interesting.

At the elementary school level, understanding science requires a strategy that goes beyond merely conveying knowledge; it must also encourage active participation from students in learning activities. Teachers are directed to be able to be a bridge to implement several strategies to ensure interesting and not boring learning, such as the use of teaching materials, media, and learning models (Soleman & Umanahu, 2023). However, the reality in the field is that the use of the lecture method is still the main option for some teachers when carrying out teaching and learning activities in the classroom, which does not show any innovation and actually causes students to quickly feel bored and passive and have difficulty understanding the concepts and intent of the learning given by the teacher.

Based on previous research findings from Jamia (2021) in its journal, the level of student understanding of science lessons with the project-based learning model showed that the proportion of students who completed was 52.20%, while the proportion of students who did not complete was 47.80%, according to the learning outcome data. This shows that, based on statistics on learning outcomes, learning implementation methods and student learning activities are not yet ideal compared to the expected goals. In another study conducted by Rahayu et al. in their journal (Rahayu, Salam, & Hamkah, 2021), they indicated that students in science subjects mostly scored below the KKM by 66.7%; these results indicate that limited understanding of students' concepts in science education correlates with low student learning outcomes.

Choosing the right and careful learning method to apply is one way to overcome these problems. Regarding this, the researcher provides ideas regarding learning methods that are considered appropriate to overcome each of the above problems, namely by implementing the STEM (Science, Technology, Engineering, and Mathematics) learning model. A meaningful learning process can be achieved with a STEM approach by integrating concepts, information, and abilities methodically (Setiawan, Sutrisno, Munzil, & Danar, 2020). The focus of the STEM approach is the early education level, which aims to stimulate and foster the interest of students by carrying out a number of activities that can arouse their curiosity and present the effectiveness of learning activities that are oriented towards problems systematically and are relevant to everyday life, where the four STEM elements are mutually associated.

The explanations are very much in line with each other, which makes the use of learning models very supportive of achieving the objectives of elementary school science learning. For this reason, it is critical for a teacher, especially an elementary school teacher, to be creative in applying learning methods in line with the provision and teaching of materials. The discussion of the learning model is raised as the title of this scientific paper entitled "Using the STEM (Science, Technology, Engineering, and Mathematics) Model to Improve Understanding of Elementary School Science Concepts." More specifically, the formulation of the problem to be raised is: Is there an increase in understanding of the science concept of light material for grade V elementary school to the application of the STEM model?. With this formulation, the aim is to provide additional references for teachers in delivering science material, especially to elementary school students. In addition, it is hoped that with this writing, science learning in elementary school, starting from teachers as transferors of knowledge and students as recipients of knowledge, becomes easy and the objectives of elementary school science learning are achieved.

METHOD

This study employed a pre-experimental method known as the One Group Pretest-Posttest Design. This design allows researchers to measure changes in student learning outcomes before and after the implementation of the STEM learning model without using a control group. Here is a description of this design:

$$0_1 \;\; X \;\; 0_2$$

Figure 1. One-Group Pretest-Posttest Design

description:
O_1 = Pretest (before treatment)
X = Treatment (implementation of the STEM learning model)
O_2 = Posttest (after treatment)

Through this design, researchers can determine the effectiveness of using the STEM model in improving students' understanding of science concepts. The subjects in this study were fifth-grade elementary school students with one class of participants. The selection of classes was carried out purposively, namely based on certain considerations that were relevant to the objectives of the study, such as class readiness and support from the school. This study used two types of instruments, namely the Concept Understanding Test (Pretest and Posttest) and the Interview Sheet.

The Data Collection Technique was carried out as follows: Firstly, we administered the pretest prior to instruction to gauge the students' initial comprehension of science concepts. Second, STEM-based learning was implemented using an integrated approach that combined science, technology, engineering, and mathematics in classroom activities. Third, the posttest was given after learning to determine changes in conceptual understanding. Fourth, interviews were conducted after the posttest to obtain qualitative data as support. The test result data was analyzed quantitatively using SPSS 25 software.

RESULT AND DISCUSSION

Result

This study uses the STEM (Science, Technology, Engineering, and Mathematics) paradigm to examine how students learn in class. The results of the pretest and posttest provide quantitative data used to answer the first research question, namely, "Is there an increase in the understanding of the science concept of light material for grade V SD towards the application of the STEM approach?" In addition, a hypothesis was proposed regarding the significance of increasing students' conceptual understanding of light material for grade V SDN 2 Cilumba.

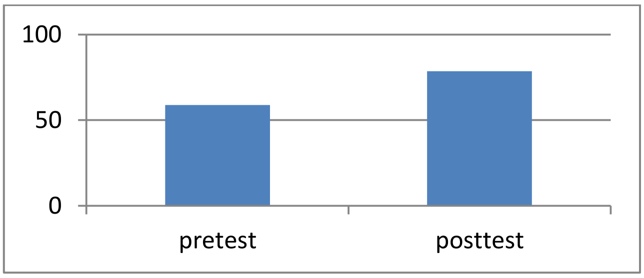

Figure 2. Pretest and Posttest Results

Table 1 reveals a significant difference in the results between the pre-test and post-test scores. Based on these statistical data, student achievement related to the average exam score after the implementation of the STEM method in learning activities has increased. In addition, research on the results of the pre-test and post-test will be entered into SPSS 25.0 to analyze the findings descriptively, which aims to find the lowest, maximum, and average scores. Consequently, the results are presented in the following table:

Table 2. Descriptive Test Results Table

	Mean	Std. Deviation	N
Pretest	58.8173	12.93647	23
Posttest	78.5304	9.60060	23

Based on table 2, it can be understood that there was an increase in the pre-test value to the post-test. The results of the data analysis above also show the significance of the average value of the two stages differing by a difference of 19.71. This gap does not allow us to conclude whether there is a difference in ability between the beginning and the end of learning because a normality test is still needed. In order to find information on whether the data from the pre-test and post-test results have a normal distribution, a normality test was carried out using SPSS 25.0. The analysis used the Lilliefors test (Kolmogorov-Smirnov) and the Shapiro-Wilk test with a significance level of 0.05 based on the P-value obtained. The hypotheses tested include: 1) H0 = If the Sig. (P-value) > 0.05 means that the data has a normal distribution, the hypothesis means that the data comes from a sample that is normally distributed. 2) H1 = If the Sig. (P-value) > 0.05 means that the data has a normal distribution, the hypothesis means that the data comes from a sample that is normally distributed. (P-value) < 0.05 if the data is not normally distributed, then the hypothesis states that the data comes from a sample that is not normally distributed. The results of the data normality test output conducted with SPSS 25.0 are as follows:

Table 2. Normality Test Results

	Shapiro-Wilk		
	Statistic	Df	Sig
Pretest	.969	23	.200*
Posttest	.855	23	.018

From the presentation of the data in table 3, the results of the normality test show that the results of the pretest and posttest score normality tests are greater than 0.05 in the Kolmogorov-Smirnov column. Thus, the distribution of both data is normal. Therefore, a homogeneity test is carried out to conclude the test because both data sets have a normal distribution. The purpose of this average difference test is to determine the initial ability (pretest) of the subject before receiving treatment and the final ability (posttest) after receiving treatment. The paired sample t-test, or average difference test, is used based on the assumption of homogeneity between the two variations (assuming the same variance).

Table 3. Paired Sample T-Test Result

Paired Samples Correlations				
		N	Correlation	Sig.
Pair 1	Sebelum diberikan perlakuan & Setelah diberikan perlakuan	23	,998	,000

The results of the Paired Simple T-Test as shown that there is a significant difference (two-tailed significance) in the learning outcomes of light science material in the pretest and posttest data, with a sig. value of 0.000 < 0.05.

Based on the results of teacher interview answers and the conclusion obtained, the difficulty of teachers in implementing the STEM model to improve students' conceptual understanding is the first: too few class hours make learning with discovery difficult to implement, especially to improve students' understanding abilities, which, in its implementation, this model requires a lot of free time to understand the material and experimental activities so that the student's understanding process can increase. Regarding the learning outcomes, almost all students responded positively, indicating their understanding of the material on the properties of light. Students' positive responses in understanding this material are supported by students' interest in discovery-based learning, as evidenced by the results of the questionnaire on the indicator to determine students' interest and response in discovery-based learning. it was concluded that almost all students were interested in this learning activity.

Discussion

This study intends to ascertain how the STEM learning model affects the comprehension of science ideas, particularly the content on the properties of light in primary school grade V. After implementing STEM-based learning, the data analysis results indicate a considerable rise in the difference between the pretest and posttest scores. Table 2 shows that the average pretest score of 58.81 rose to 78.53 in the posttest, representing a 19.71-point difference. This finding indicates that pupils' conceptual understanding significantly improved after being taught using the STEM approach. However, a normality test using Shapiro-Wilk was performed to make sure the data were suitable for parametric analysis. The results indicated that the posttest data (Sig. = 0.018) were not normally distributed, whereas the pretest data (Sig. = 0.200) were. However, given the small sample size (N = 23) and the t-test's strong resistance to modest deviations from normalcy, the Paired Sample T-Test technique was used even if the posttest data was not entirely normal (Ghozali, 2016). A Sig. (2-tailed) value of 0.000 < 0.05 was found in the t-test findings, indicating a significant difference between the pretest and posttest values.

The adoption of the STEM learning model can enhance fifth-grade elementary school students' comprehension of science ideas, according to the research hypothesis, which has been approved. These findings support the assertion made by Beers (2011) STEM education promotes the contextual and integrative application of knowledge, aiding in the development of students' conceptual understanding and critical thinking skills. Additionally, according to a study by Sanders (2009), the STEM method makes science topics more relatable to real-world situations, which raises student engagement. Students are recognized to be very enthusiastic about STEM-based learning, according to the findings of teacher and student interviews. Because learning involves exploration and experimentation, students feel more engaged. According to Bruner's hypothesis (1961), learning will have greater significance if students actively participate in the process of discovering concepts.

One of the challenges of implementation is the short duration of sessions, which makes it difficult for teachers to conduct experimental activities and classroom conditioning. Additionally, Roehrig et al. (2012) observed that the application of STEM is frequently restricted to the structural constraints of schools, such as limited time, resources, and teacher preparedness. Additionally, teachers reported that children struggled to restate the ideas they had learned. Such findings can be linked to the difficulties in the STEM method, which include kids' poor academic vocabulary and scientific literacy. Bybee (2013) asserts that promoting scientific literacy is one of STEM's primary objectives, and it takes time and habituation to achieve.

This research demonstrates that STEM education is a successful way to enhance learning science ideas in elementary school, particularly when it comes to the material on light's properties. This approach fosters positive attitudes and students' enthusiasm in science in addition to improving learning outcomes objectively. However, time, teacher preparation, and facility support must all be adjusted for STEM implementation to be successful. With effective management, we can reduce these challenges and transform the STEM approach into a sustainable innovation in primary school science instruction.

CONCLUSION

Research shows that the use of the STEM learning model has successfully improved the conceptual understanding of fifth-grade elementary school students. This is evidenced by the increase in the average student score from 58.81 (pretest) to 78.53 (posttest). The statistical test (t-test) also showed significant results (Sig. 0.000 < 0.005), meaning that this increase was not just a coincidence but a real result of learning with the STEM model. However, it is not without challenges. From the interview: Students have difficulty restating the concepts learned, especially during presentations or discussions. Teachers also face obstacles, especially in the limited class hours that make it difficult to carry out practices or experiments. Another obstacle is that students still have difficulty expressing ideas in their words. the use of language is still found to be "copy-pasted" from books. Although there are obstacles here and there, both students and teachers continue to show high enthusiasm. In fact, teachers are satisfied with the results achieved, because the STEM model has been proven to be able to significantly improve students' conceptual understanding.

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