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Implementation of STEM-oriented learning strategy toward science literacy skills in elementary school students

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Abstract: The study aims to examine the effect of STEM-oriented learning on science literacy skills in elementary school students. This study employed quasi-experimental research. The study population was all Sekolah Dasar Negeri Mungkid 2 students. The sample of this research was the entire students of Class IV SDN Mungkid 2 which totaled 16 students. The samples were obtained through a purposive sampling technique. The results of data on students' scientific literacy abilities were obtained through pretest and posttest activities. The data were then analyzed using SPSS Statistics 20. Data processing was started with a normality test, paired sample t test, hypothesis test, and N-gain test. The results of this study showed that implementation of STEM-oriented learning has proven to influence of elementary school students' science literacy skills.
Keywords: STEM; science literacy; learning

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Introduction

Science, Technology, Engineering, and Math (STEM), as defined by Kelly and Knowles (in Razi & Zhou, 2022), is a learning approach that combines two or more science, technology, engineering, and mathematics-related learning experiences tied to real-world problems to improve students' learning experiences. STEM-based learning is also known as integrated thematic learning (Sukmana, 2018). In STEM, each of the discipline of science, technology, engineering, and mathematics is interconnected. For example, in order to understand scientific notions, we require mathematics, and scientific thinking is necessary in math. In addition, we will require mathematical knowledge to utilize the technology (Arikan et al., 2022). According to Bybee, STEM learning must be structured to improve abilities in operating technology, engineering and design, and problem solving in real life (HiĞde, 2022). STEM learning is in keeping with the education required today, where learning must include not only science but also other components such as technology.

The twenty-first century also brings with it new problems in the sphere of life, one of which is the development of a high-quality human resources (Cahyaningsih & Roektiningroem, 2018). The ability to communicate, collaborate, think critically, and be creative are all important talents to cultivate in 21st century learning. Furthermore, 21st century education stresses student-centered learning and

the ability to think rationally. Human resources in the twenty-first century must be able to master some life skills as well as critical thinking skills, innovative, and technologically savvy (Sulistiyowati et al., 2018). Furthermore, 21st century learning promotes communication, collaboration, critical thinking, and creativity abilities through student-centered learning. Thus, teachers must not only enhance students' knowledge, but also educate them how to obtain those skills.

One way to support in the 21st century skills is through literacy activities. Literacy is an important skill for students to possess because it covers all facets of human life (Sanny & Hendawati, 2021). Furthermore, in the twenty-first century, technology can instantly transmit knowledge from numerous sectors of life to everyone in different parts of the world. Literacy skills are required to effectively filter and examine information, as well as to streamline good communication and public speaking. Science literacy is one factor that contributes to 21st-century skills (Sanny & Hendawati, 2021). Science literacy is a type of literacy that can assist students acquire scientific thinking skills. Science literacy leads to scientific attitudes (Fa'idah et al., 2019). Science literacy is defined as students' scientific competence to solve problems using science (Ichsan et al., 2022). Science literacy is critical for progressing from primary to advanced levels, particularly in developing nations including Indonesia. As a developing country, Indonesia must promote scientific literacy among its residence in order to increase scientific knowledge and problem-solving skills. However, the importance of establishing scientific literacy for students is not recognized and remains in the spotlight in Indonesian education. Due to the Indonesian population's lack of attention to the degree of scientific literacy, Indonesia has an average level of scientific literacy ability that is fairly poor. This is evident from PISA results showing that the scientific evaluation of Indonesian students in 2018 ranked 9 but from below, and that Indonesia is still below the average of scientific evaluation in various countries within the scope of the Organization for Economic Cooperation and Development (OECD). The OECD countries have an average of 489 in the scientific literacy category, but Indonesia is still far behind with a score of 396 (Highlights of the US PISA 2018 Results Web Report).

Science literacy is also linked to science education in schools or educational institutions. Science study can provide direct insight in order to improve students' competency in understanding the environment. Science is made up of three interconnected parts: attitudes, processes, and products. Science education in the school is expected to provide high science literacy skills for students, so that they are able to prepare themselves to be a responsive and sensitive society with problems in the surrounding environment as well as apply the science they have to solve any existing problems (Adiwiguna et al., 2019). Therefore, science literacy can be inferred as the scientific ability of a person to identify and solve problems in life.

One of the causes of the problem of the low level of science literacy in Indonesia is that the process of learning is still ongoing conventionally. The implementation of the IPA (Ilmu Pengetahuan Alam) or natural science learning process is still going in one direction, where the teacher becomes the center of control over the course of learning, which causes learning to become passive (Rohmah et al., 2019). However, according to data from P21 (Sulistiyowati et al., 2018) learning in the 21st century teaches 4C and is also characterized by a teacher center. In conventional learning, students play a role as learning objects who do not have many opportunities to develop their knowledge. They tend to accept the treatment given by teachers, so opportunities to expand literacy skills are also blocked. Unoriented learning of science literacy abilities leads to low scientific literacy skills among students (Almiasih et al., 2022).

There is more than one study outlining a variety of methods to improve student science literacy. STEM-based learning applications have a significant effect on science literacy by increasing student motivation, helping to understand topics, and enhancing STEM creativity (Afriana et al., 2016). STEM-oriented learning is also effectively used to improve science literacy skills (Ceylan & Ozdilek, 2015). STEM learning trains students to solve problems with logical thinking, critical thinking, technological literacy and can stimulate students to make decisions when solving everyday life problems.

The STEM-PBL approach carried out as one of the learning methods, shows that the STEM PBL approach has a more significant effect on the students' ability to think critically (Davidi et al., 2021). In addition, the results showed that through STEM-PjBL learning, some students have reached a

competent level, are able to make simple investigations, and are brave in presenting their opinions (Adriyawati et al., 2020; Sukardi et al., 2022; Sukardi et al., 2022). The results of the study also showed that STEM is able to make progress and have a positive impact on students.

Through the learning projects carried out, STEM PjBL is able to make students more active in learning and able to improve student literacy in conceptual thinking and critical thinking (Winarni et al., 2022). Based on previous research, it is clear that STEM-oriented learning has been shown to be effective in improving student literacy. However, there are still not many researchers who discuss the effectiveness of STEM-oriented learning that focuses on increasing science literacy. Therefore, in order to demonstrate the effectiveness of the application of STEM-oriented learning to the improvement of scientific literacy, this present study aims to examine the effect of STEM-oriented learning on science literacy skills.

Method

Research Design

The researchers used quantitative research to conduct this research. An experimental research design called "one group pre-post test design" was utilized. There are two variables in this study, namely the effect of using STEM (X) on science literacy (Y) of elementary school students. The data that would be generated by the researchers through this research was more accurate because this research was able to provide a comparison of a situation before and after given a treatment. The research design of this study is depicted in Table 1.

Table 1. Research Design

Subject	Pretest	Treatment	Posttest
The fourth-grade students	T_1	X	T_2

Information:

T_1 : Pretest before given a treatment

X : Treatment by implementing STEM-oriented learning strategy related to science literacy

T_2 : Posttest after given the treatment

Population and Sample

The population of this study was all students of SDN Mungkid 2. The research samples were taken using purposive sampling techniques. The sample consisted of 16 students of the 4th grade SDN Mungkid 2.

Research Instrument

The instrument used in this study is a test. The test consisted of two types: pretest and posttest. The pretest aims to investigate to what extent the students' science literacy skills is before being given treatment. Meanwhile, the posttest was conducted after the students received the treatment to find out the significance of the treatment that has been given to the improvement of student science literacy skills.

Data Collection Technique

The data was collected by the researchers through pre-test and posttest. Some steps that the researchers should consider as guidelines in data collection included performing a pretest to see the measurement of student's initial science literacy skills before implementing the STEM approach in learning, providing treatment by applying STEM approach in learning, and carrying a posttest to measure student science literacy skills after implementing the STEM approach in learning.

Data Analysis

The data was analyzed using a descriptive and an inferential statistics. From the collection of the data carried out, the researchers obtained data in the form of pre-test and posttest values that were then determined by the comparison. The aim of the comparison was to find the difference between the values obtained by students before and after receiving treatment. Data processing began with a normality test aimed at seeing whether or not the data was distributed normally, with the help of SPSS Statistics version 20. When the data tested has already had a normal distribution, the next step was to test a guided hypothesis on a paired sample t test. Then, the latter performed the N-gain analysis to see the criteria of the normalization gain obtained. The calculation of N-gain can be done based on the following formula (1):

$$< g > = \frac{< Sf > - < Si >}{100 - < Si >} \quad (1)$$

Results and Discussion

The study was conducted in the fourth grade of SDN Mungkid 2 with a sample comprising 16 students. The students performed a pretest to assess their first science literacy skills before being assigned the treatment. Following the pretest, students receive treatment in the form of STEM-focused project learning. After getting the treatment, all students took the posttest to find out the students' final science literacy skills. Figure 1 depicts the average student learning outcomes from the posttest. The posttest average is 83.125. The collected results show an improvement above the average pretest score of 42,500. In other words, the average value before and after treatment shows a significant increase of 40.625.

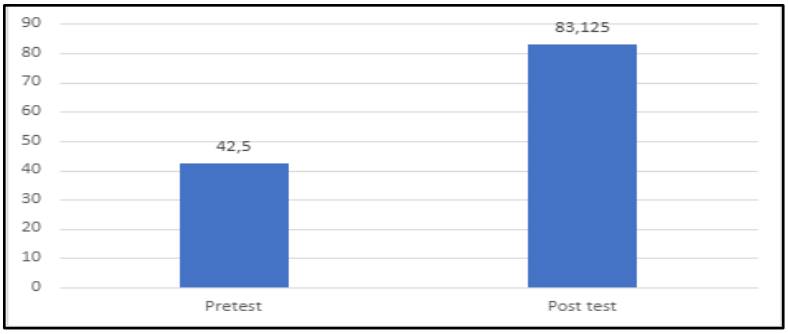

Figure 1. Average Pretest and Posttest Results

The normality test results of the pretest and posttest data were calculated using the Kolmogorov-Smirnov method using SPSS Statistics 20. In the data normality test using the Kolmogorov-Smirnov method in SPSS Statistics 20, a data set can be said to be normally distributed if it meets the Asymp criteria. Sig (2-tailed) > 0.05. Based on the pretest and posttest data normality tests using the Kolmogorov-Smirnov method, it can be concluded that the two data are normally distributed because of the Asymp value. Sig (2-tailed) for each data point shows results > 0.05.

A data that has been processed using a paired sample t-test can be said to be significant if the Sig. (2-tailed) < 0.05. The results of the paired sample t-test that has been carried out on the data from the pretest and posttest results, obtained a sig. (2-tailed) of 0.000. From this value, it is known that 0.000 <0.05, so based on the significant test conditions, it can be concluded that variables one and two of the data are significantly different. The results of the pretest and posttest variables are significantly different in determining or affecting students' science literacy skills.

Based on the results of the paired sample statistics test, it is known that the mean value of the pre-test outcome variable is 42.5000, while the mean of the post-test result variable is 83,1250. That is, the posttest result after the treatment has a higher mean value than the pre-test mean. From these results, it can be concluded that STEM-oriented learning has proven to be more effective in helping to increase student science literacy skills. Then, through the N-gain results, the N-gain category gives

meaning to the fact that the difference between the students' pre- and post-test results belongs to the high category. That is, the results showed an increase in student science literacy levels after assisted STEM-based learning.

Based on the research that has been carried out, the researchers obtained data in the form of student pretest and posttest scores. A total of 16 students who were selected from their population, namely the fourth class, had done the pretest and posttest. The average value of the results obtained by students in the pretest is 42.500 and the average posttest score is 83.125. The average value of students in the posttest increased by 40.625. The resulting data gives the meaning that the average value of student learning outcomes shows a significant increase after being given treatment in the form of STEM-oriented learning. The STEM method is used to assist and facilitate learning activities so that student learning outcomes increase (Ilmi et al., 2021; Yuniarti et al., 2021).

All pre-test and post-test data were analyzed using SPSS Statistics 20. Data analysis began with the normality test of the data, namely the Kolmogorov-Smirnov method. The results of pre-test and post-test values are in the normal category because of Asymp. Sig (2-tailed) pre-test and post-test results > 0.05, which is 0.580 for the pretest and 0.281 for the posttest. After the data showed normal results, the researchers continued the analysis using a parametric test, the paired sample t-test. The result obtained on Sig (2-tailed) is 0,000, which means that both variables, pretest and posttest, show significant differences because >0,05. The significance value indicates the result of 0,000 where the value is less than 0,05, so Ho is not accepted and Ha is accepted. The t-count value obtained is 8,341. Then, the calculation of the price dk based on the value of significance (α = 0,05), k = n – 2 = 16 - 2 = 14, obtains the price table result at figure 2,145. From the data obtained, if the result |t-count| > t-table is 8,341 > 2,145, then Ho is rejected and Ha is accepted. Thus, based on the calculations obtained, it can be concluded that STEM-based learning has an impact on student science literacy skills.

In order to determine the level of influence, the researchers conducted a gain normalization analysis. Based on the N-gain analysis performed, a value of 0.706 was obtained. According to Hake (Syuhendri, 2021), this value shows the result of a high level of influence. Therefore, research conducted at SD Negeri Mungkid 2 shows the results that the implementation of STEM-oriented learning can provide a high-intensity influence on the level of scientific literacy skills possessed by students.

Conclusion

Based on the significance values obtained from the paired sample t-test results, it is known that Ho is not accepted and Ha is accepted. With these results, the implementation of STEM-oriented learning strategies has a significant effect on elementary school students to acquire science literacy skills. The level of influence given can be seen from the value of the N-gain test result, which is at a value of 0,706. This shows that the influence of the implementation of STEM-oriented learning strategies on the presence of science literacy capabilities among SD students is high category.

Since the implementation of STEM-oriented learning has proven to be influential, this research has implications for the accuracy of the application of the STEM oriented learning among elementary school students. Teachers can implement STEM-oriented learning as one of their primary learning strategies for natural science in order to enhance student science literacy skills. The implementation of STEM-oriented learning can be applied not only in natural science subject but also in other subject areas. Due to the focus of this present study solely on enhancing science literacy skill, further researchers are suggested to investigate the effect of STEM-oriented learning on enhancing other literacy skills.

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