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The Effect of Science, Technology, Engineering, and Mathematics (STEM) Approach on Science Literacy Skills of Grade IV Elementary School Students

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ABSTRACT

Science literacy skills have a very important role in science learning because students are required to be able to solve problems by utilizing technology. The low level of science literacy in Indonesia is the basis for this research. The objectives of this study were: 1) Knowing the effect of the STEM approach on improving the science literacy of elementary school students; 2) Knowing and analyzing the improvement of science literacy skills of students who get learning with the STEM approach better than students who get learning with conventional approaches. The research method used in this research is Quasi Experimental Design with the form of Non-equivalent Control Group Design which involves two classes in its implementation and is given different treatments in learning science with the subject matter of Changes in the Form of Objects with a subject of 43 students. The instrument used to obtain data before and after learning is a science literacy test instrument. Based on the research conducted, the conclusions were obtained; 1) There is an effect of STEM approach on science literacy skills of fourth grade students. 2) There is an increase in science literacy skills of students who get learning with the STEM approach better than students who get learning with conventional approaches.

INTRODUCTION

Entering the 21st century, many changes in life demand quality in all aspects, one of which is in the field of education. In this century, literacy is needed in facing educational challenges (Adrianti et al., 2018). Where human resources are required to have superior quality. One way to realize an increasingly advanced education in the field of science is to improve science literacy skills (Adrianti et al., 2018). Organization for Economic Co-operation and Development (OECD, 2023), states that science literacy is the ability to engage with science issues science ideas, as a reflective citizen because someone who is scientifically literate will be willing to engage in discourse about science and technology that requires competence to explain scientifically, evaluate and design research, and interpret data and evidence scientifically.

Science literacy has a very important role in science learning because students are required to be able to solve problems by utilizing technology. This is supported by the opinion of Irsan, (2021) which states that in science learning, science literacy has a very important role because it can prepare students who are qualified, reliable, and able to compete with the international world. However, this scientific literacy ability is inversely proportional to the facts that occur in the field. This is supported by the results of the Programne for International Student Assessment Study in 2022 (OECD, 2023) that Indonesia is ranked 68 with an average score of 383, where students can creatively and independently apply knowledge about science to various situations, including situations they are not familiar with. However, the score is still far from the international standard set by the OECD institution, where students should be able to recognize

correct explanations for familiar scientific phenomena and be able to use this knowledge to identify in simple cases whether a conclusion is valid based on the data provided (OECD, 2023). Based on the survey results, it shows that students' science literacy skills are still far from the international standard value set by the OECD institution, and shows that students' science literacy skills are still low compared to other countries.

In line with research conducted by Suparya et al., (2022) that the science literacy skills of elementary school students are still low with several contributing factors, namely: a) teaching materials used are not appropriate, b) student misconceptions, c) learning is not contextualized, d) low student reading skills, e) learning environment and climate, f) school infrastructure, g) human resources, h) school management. Based on the results of this study, the low science literacy skills of elementary school students are influenced by several causal factors. Science literacy skills in elementary school students need to be improved. One of the efforts that can be made to stimulate learning to improve science literacy skills in elementary school students is by applying learning approaches that can motivate students in the learning process and create science learning that supports the creation of science literate human resources. The right approach is applied to improve the science literacy skills of elementary school students by applying the STEM (Science, Technology, Engineering and Mathematics) approach.

The STEM approach is an effort made to integrate the fields of science, technology, engineering, and mathematics, and serves to educate students in solving problems faced in everyday life (Kong Suik Fern and Mohd Effendi, 2020). The integration of the four STEM components is used to solve problems faced by producing tested solutions. The STEM approach has also been recognized as having a great impact on learning in primary schools (Chiu et al., 2015) in (Ilmi & Subhan, 2023). With the STEM approach, learning can encourage students to hone cognitive, affective, psychomotor, design, develop, utilize technology and apply it in solving a problem that occurs in real life (Rohmah et al., 2019).

In addition to helping students obtain better science and math learning outcomes, STEM learning is able to train 21st century skills, namely communication, collaboration, creative, and problem-solving skills (Nuraeni, 2020). This is in accordance with the philosophy of the independent curriculum taught in elementary schools which emphasizes that learning skills is important in relation to everyday life and can develop character in students (Ilmi & Subhan, 2023). In addition, through the integration of 4 disciplines, students can conduct experiments and complete projects so as to improve memory and better understanding of STEM topics. Thus, there is a need for a STEM approach in science learning to gain a deeper understanding of the relationship between personalized learning and its application at the primary education level.

Several studies have been conducted in order to improve students' science literacy skills. The results of research conducted by Zahra (2022), showed that classes that applied the STEM approach obtained an increase and achievement of science literacy skills higher than classes that did not apply the STEM approach. Meanwhile, according to (Rohmah et al., 2019) also concluded in his research that to improve science literacy skills can use the STEM approach because it will shape student character by demanding student mindsets so that students have the knowledge and skills simultaneously to solve problems related to the environment by utilizing technology.

In addition, research conducted by Yuki (2022) which obtained conclusions from the results of the research conducted that the STEM approach was successful in improving the science literacy skills of elementary school students on the theme of our best friend's environment. It was found that the study still used the 2013 curriculum, while the school had begun to implement the independent curriculum. In addition, it was also found that there are other factors that influence the improvement of science literacy of elementary school students. This can be utilized by researchers to use the independent curriculum when given treatment. In addition,

researchers will look for other factors by applying the STEM approach to teaching materials, research locations and research methods that are different from previous studies.

Based on previous studies, it can be said that applying the STEM approach in learning can improve students' science literacy skills. This is because the STEM approach can train students' ability to apply their knowledge as a form of problem solving related to the environment by utilizing technology and designing a product that can be a solution to the problem, so that students are able to compete in the increasingly rapid development of science and technology. Thus, the STEM learning approach is expected to be a solution to improve students' science literacy skills. Of course, the learning must be active and fun, so that it can increase students' learning motivation in learning science. Thus, students do not only learn to memorize the material provided by the teacher, but students are able to understand learning by using concrete learning such as STEM learning. Therefore, the author is interested in taking research with the title "The Effect of Science, Technology, Engineering, and Mathematics (STEM) Approach on Science Literacy Ability of Grade IV Elementary School Students".

LITERATURE REVIEW

STEM stands for Science, Technology, Engineering and Mathematics. The STEM approach is an effort made to integrate the fields of science, technology, engineering and mathematics, and serves to educate students in solving problems faced in everyday life (Kong Suik Fern and Mohd Effendi, 2020). Furthermore, Nuraeni (2020) explained that STEM education is an educational approach that integrates science, technology, mathematics and engineering practices, where the learning process is related to the process of solving relevant problems that occur in children's lives and in the context of work in the STEM field. The integration of the four STEM components is used to solve problems faced by producing tested solutions.

The STEM approach has characteristics that can make students explore knowledge and train students to develop their skills. According to Nuraeni (2020) the characteristics of STEM learning include: a) student-centered; b) problem solving; c) encouraging knowledge transfer; d) physical product construction; e) interdisciplinary; f) collaboration. The STEM approach is supported by the theory of learning constructivism. According to Yakaman (2010) in (Nuragnia et al., 2021) states that one of the theories used in STEM learning is the theory of constructivism, which emphasizes learner-centered learning, and this theory also contains several activities, practices, problem or project-based, inquiry, authentic, and contextual learning. In addition, Henriksen et al., (2019) in (Nuragnia et al., 2021) stated that STEM learning can reflect a more creative education that is authentic to the real-world, and based on projects or problems.

In education, the STEM approach aims to prepare students to be ready to compete and work in accordance with their fields. STEM approach education also aims for students to have science and technology literacy skills in reading, writing, observing, and students are able to do science (Muharomah, 2017). When students go directly to the field, students will be able to face and solve problems in the surrounding environment with their abilities. The purpose of STEM education is to produce students who later when they will enter the community, they are able to develop the competencies they have to apply them to various situations and problems they face in everyday life (Mayasari et al, 2014).

According to Nuraeni (2020), the STEM approach has five stages in its implementation, namely ask, imagine, plan, create, improve. By using the STEM approach, the learning process will be more varied and innovative and can help students gain knowledge in dealing with real-world problems and can improve their abilities. That way, the STEM approach has advantages in its application. The STEM approach has advantages over other environmentally integrated approaches because the STEM approach is a lesson for teaching and learning that is integrated with science, technology, engineering, and mathematics (Muharomah, 2017). Sumaya et al,

(2021) also argue that the STEM approach has advantages, namely (1) fostering understanding to students regarding the interrelationship of principles, concepts, and expertise in certain disciplines; (2) arousing students' curiosity and creating students' creative imagination and critical thinking in order to solve a problem; (3) assisting students in understanding knowledge and experimenting with scientific processes; (4) encouraging cooperation between students in solving problems and needing each other in group cooperation, building students' active knowledge and memory through independent learning; (6) developing the relationship between learning, students' critical thinking, and taking action; (7) developing students' ability to apply the knowledge they have learned in everyday life.

Based on the four disciplines and stages of STEM learning, the STEM approach can be used as one of the strategies to improve the science literacy skills of elementary school students. Applying the STEM approach can train students in implementing their knowledge to get ideas to solve problems. In addition, using the STEM approach can increase knowledge and develop students' creativity.

Science literacy can be interpreted literally consisting of the word literatus which means literacy and scientia can be interpreted as having knowledge. Science literacy can be interpreted as a person's ability to understand science, communicate science, and apply scientific knowledge to solve problems so as to improve attitudes and sensitivity to the surrounding environment (Irsan, 2021).

Based on the PISA 2022 framework (OECD, 2023) science literacy consists of four aspects that will be obtained, namely: 1) Context aspect; 2) Aspect of Knowledge (Competence); 3) Aspect of Competence (Knowledge). According to the PISA 2022 framework (OECD, 2023) science literacy indicators, namely:

Table 1. PISA Framework 2022 Science Literacy Indicators

No.	Aspects of Science Literacy	Indikator
1.	Context	Understand personal, local/national, and global issues that are happening or have happened that require an understanding of science and technology in everyday life.
2.	Knowledge	Knowledge of the nature and artifacts of the world and technology (Content Knowledge), knowledge of how these ideas is generated (Procedural Knowledge). And an understanding of the reasons underlying these procedures and the justification for their use (Epistemic Knowledge).
3.	Competencies	a) the ability to explain phenomena scientifically, b) evaluate and design scientific research to be conducted c) interpreting data and evidence that has been produced scientifically

The table shows that there are several indicators of science literacy according to the PISA 2022 framework (OECD, 2023). In this study, researchers chose several science literacy indicators because they were adjusted to the learning outcomes of the subject matter that would be given during the learning process.

This study took teaching materials with the subject matter of the IPAS Class IV Book, namely "Forms of Substances and Their Changes". The implementation of teaching materials towards the STEM approach, namely:

Table 2. Implementation of Teaching Materials for the STEM Approach

Science	Technology	Engineering	Mathematics
Forms of Matter and Their Changes	Use of tools and materials to make a simple thermos	Designing, making, and testing a simple thermos	Comparing the melting time of ice in a glass and a thermos.

METHOD

The research method that will be used in this research is experimental quantitative research. This research uses Quasi Experimental Design with the form of Non-equivalent Control Group Design which involves two classes in its implementation and given different treatments. One group called the experimental group will be given treatment using the STEM approach and one group called the control group is given treatment using a conventional approach. The test was given for two meetings, namely before being given treatment (pretest) and after being given treatment (posttest). The description of the Non-equivalent Control Group Design according to Sugiyono (2015) is as follows:

Table 3. Research Design

O_1	X_1	O_2
O_3		O_4

Description:
O1: Pretest of experimental group
O2: Posttest of experimental group
O3: Pretest of control group
O4: Posttest of control group
X1: Treatment of Science, Technology, Engineering, and

Mathematics (STEM) approachThe sample of this research is high grade students totaling 47 students from 2 classes, namely 24 students from class IVA and 23 students from class IVB. The students came from State Elementary School 2 Anjun which is located in Plered District, Purwakarta Regency, West Java Province. With participants consisting of boys and girls. The class sampled in this study will be given a pretest and posttest as a data collection process. The technique in determining the sample used in this study is Purposive Sampling technique, meaning that the sample in the data collection process will be considered several things so that it is suitable to be used as a research sample (Sugiyono, 2015). The research data collected in this study used research instruments to collect data. The instruments used are test and non-test techniques.

RESULT AND DISCUSSION

Before calculating the increase in science literacy skills of grade IV students, calculations were carried out first to determine that the experimental class and control class came from the same level through the average pretest and posttest scores in the experimental class and control class.

Table 4. N-Gain Score Calculation Result Table

Class	Test Type	Score		Mean	*sd*	*N-Gain Score*	Desciption
		Min	Max				
Experimental	*Pre-Test*	30	70	54,35	10,369	61,50	Medium
	Post-Test	60	100	82,17	10,853		
Control	*Pre-Test*	30	70	47,50	12,085	21,65	Low
	Post-Test	40	80	58,550	11,367		

(Source, Research, 2024)

The average pretest results of the experimental class were 54.35 and the control class was 47.50 which showed that these two groups were in the same category, namely the sufficient category with a value range of 4 - 5. So, it can be interpreted that the two groups have the same science literacy skills. As for the posttest results, the experimental class amounted to 82.17 and the control class amounted to 58.550. This shows that there is a difference in the science literacy skills of students who get STEM learning better than students who get conventional learning.

In addition, the N-Gain results showed that the experimental class with the STEM approach was greater and had a high increase compared to the control class using the conventional approach. The results of the acquisition of the average value of N-Gain Score for learning using the STEM approach amounted to 61.50 where in the interpretation of the effectiveness of N-Gain is included in the medium category. While the acquisition of the average value of N-Gain Score for conventional learning amounted to 21.65 where in the category of N-Gain effectiveness interpretation division is included in the moderate category. Thus, it can be concluded that the increase in science literacy skills of students using the STEM approach is higher than the class using the conventional approach.

Learning activities using the STEM approach were carried out for three meetings. The six meetings discussed the subject matter of changes in the form of objects with the same learning topic, namely "How the Form of Objects Changes", but each meeting carried out different STEM learning stages. Furthermore, there are exercises on LKPD as a medium for evaluating the process of improving students' science literacy skills in accordance with the STEM learning stages. During the learning process, students look enthusiastic in doing STEM learning. There are some students who are not too active at the beginning of learning so they need more attention than other students.

Based on the explanation above, in general, the implementation of learning using the STEM approach can provide better results in improving the science literacy skills of grade IV students compared to students who do learning using conventional approaches. The following is an explanation of the stages of the factors that cause the improvement of science literacy skills of students who get STEM learning better than students who get conventional learning.

In this study, linear regression results were also obtained by showing the test results. coefficient of determination which can be seen in the figure below.

Table 5. Coefficient of Determination Test Results

R	R Square	Std. Error of the Estimate
0,220	0,048	0,037

D = 0,048 x 100%

D = 48%

Based on the results of the above calculations, the coefficient of determination (D) of 48% is obtained, which means that the application of the Science, Technology, Engineering, and Mathematics (STEM) approach influences the science literacy skills of grade IV students by 48%.

Thus, the influence of other factors on improving students' science literacy skills is 100% - 48% = 52%.

In this study, researchers provided learning using the STEM approach on the material of changes in the form of objects. Learning by using the STEM approach consists of 5 stages, namely: Ask, Imagine, Plan, Create, improve which is divided into 3 learning meetings. The five stages of STEM approach learning can have an influence on students' science literacy skills which can be seen from the results of simple linear regression in inferential analysis. Simple regression results from simple linear regression of the final score on the student science literacy test showed an effect of 48% from the application of the STEM approach compared to the class that received the conventional approach.

This can prove that the application of the STEM approach can provide students in understanding the material of changes in the form of objects for three meetings. In addition, there is also 52% influence of other factors that influence the application of the STEM approach to students' science literacy skills. the importance of integrated collaboration between subjects and technology to increase students' insight and in the process of solving problems that can train students' independence.

Based on the discussion presented above, it can be concluded that as an effort to develop and improve students' science literacy skills, teachers can apply the STEM approach with sufficient learning time duration so as to support the implementation of each learning stage to completion. In addition, students are enthusiastic because in the STEM learning stages students make products and conduct experiments which are new to students.

CONCLUSION

Based on the results of data processing and discussion that have been presented in chapter IV in full regarding the findings and discussion, it can be concluded that:

1. There is an effect of the STEM approach on the science literacy skills of fourth grade elementary school students.
2. The improvement of science literacy skills of students who learn with the STEM approach is better than students who learn with the conventional approach.

Based on the research that has been carried out, recommendations regarding the application of the STEM approach include:

1. Based on the results of the study, the improvement of science literacy skills of students who received learning with the STEM approach is better than students who received learning with conventional approaches. Thus, the STEM approach can be used as an alternative solution to develop and improve students' science literacy skills.
2. This study used the development of science literacy instruments in all aspects, namely competency aspects, knowledge aspects, and scientific aspects. However, the knowledge aspect only uses one learning indicator so it is recommended to develop science literacy instruments on other indicators such as indicators in other aspects of knowledge.
3. The application of the STEM approach is able to influence the science literacy skills of fourth grade students by 48%. Which means further research needs to be done to find out 52% which is influenced by other factors.

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