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The Influence of E-Module Teaching Materials Based on Science Technology Engineering Mathematics (STEM) on Global Warming Material on Students' Science Literacy Skills

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Abstract

This research aims to analyze the influence of STEM- based e-module teaching materials on students' scientific literacy skills. This research is experimental research with the concept of pretest-posttest non- equivalent control group design. The data collection method used in this research is the test and questionnaire method. The research was carried out in the odd semester of the 2023/2024 academic year. The population in this study were class VII students at Al-Islam Gunungpati Middle School, with research samples VII E for the experimental class and VII F for the control class. The technique used in sampling is purposive sampling technique. The research instrument is a pretest-posttest question sheet to measure scientific literacy skills and a questionnaire to measure scientific attitudes. The sampling technique used was a reated t-test, questionnaire data analysis, and N-gain. The research results showed that there was an effect of learning using e-module teaching materials during 3 meetings, namely 72.52% (good), 75.71% (good), 79.08% (good), and the results of the student questionnaire responses were 85.83 % (very good) so it can be concluded that STEM-based e-module teaching materials on global warming have an effect on students' scientific literacy skills..

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INTRODUCTION

Education is said to be a life process that aims to develop all individual potential so that they are able to live life well and become well-educated humans cognitively, affectively and psychomotorically. The aim of this educational process is so that each individual can become useful and have competitiveness according to his interests and talents. Although education is a long-term investment that takes time to see results. The success of this educational process can be measured by the ability of each educated individual to apply the knowledge and skills they have in various life contexts. Therefore, the education process requires serious attention from various parties, be it the government, educational institutions, or society as a whole (Miladiah et al., 2023). To improve the quality of education in Indonesia, the curriculum implemented must continue to develop according to the potential of the educational unit and it is necessary to evaluate the effectiveness of the implementation of the existing curriculum (Kamiludin et al., 2017). In 2019, Nadiem Makarim has changed and established the Merdeka Curriculum as a refinement of the previous curriculum, namely the 2013 Curriculum. The Merdeka Curriculum is the concept of "Freedom to Learn" which is different from the 2013 curriculum, according to Sherly et al, (2020) which means giving freedom to schools. , teachers and students who aim to be free to innovate, learn independently and be creative, and where this freedom starts with the teacher as the driving force.

Based on the results of observations and interviews with science teachers conducted at Al- Islam Gunungpati Middle School, information was obtained that the learning sources for students in studying Natural Sciences (IPA) were student books which were available on the market. However, there are no teaching materials specifically created by teachers to increase students' knowledge and understanding, especially regarding science applications in the field of technology. Teachers usually do more learning only using the available student books so that students tend not to explore and maximize their abilities. So learning requires a lot of innovation to be able to improve these various abilities accompanied by skills in using digital and technology-based media. Students' scientific literacy is low due to, among other things, the use of inappropriate learning methods and textbooks. Hasasiyah et al. (2020) also stated that several factors cause the low scientific literacy of students who have never worked on scientific literacy questions before that are related to the subjects they are taking.

Apart from that, Jamaluddin (2018) stated that students should have high scientific literacy skills and critical thinking skills. This is very important so that they develop students' scientific literacy skills. Mesa & Ricardo (2024) also stated that the role of teachers in motivating is very important in student learning so that they can achieve the best scientific literacy for all students. This scientific literacy also supports students to create their own procedures based on the investigations they carry out. In its development, the application of scientific literacy consists of four major dimensions (aspects) that are interconnected, namely the competency aspect (science process0, science content, science context, and science attitude (Liu, 2009). Each of these aspects has a different definition. The right solution to increase scientific literacy requires innovation to improve students' scientific literacy skills, one of which is using learning media in the form of e- modules.

Learning using e-modules can increase students' literacy because students become more independent and more active in participating in learning. Students' activeness in learning can also improve thinking skills, including scientific literacy. According to Solikin (2018), the use of e-modules has several advantages, including: 1) it is easier for teachers to deliver material or assignments when the teacher is unable to attend, 2) it is easier for students to obtain learning materials, 3) easy to carry anywhere and anytime, 4) students find it easier to get

teaching materials from teachers, and 5) students do not miss out on learning.

Apart from teaching materials in the form of e-modules, according to Banawi (2019), students' activeness in the process of teaching and learning activities is also influenced by the learning model used. One of the learning models applied by the independent curriculum is the discovery model (Discovery Learning). According to Panlennari et al. (2018) discovery learning model is a learning model that is based on independent discovery by students. This learning model is very appropriate to use in natural science (science) learning, because it can convey the standard content of science learning. Apart from that, Fitrianingtyas (2017) stated that science learning is not only related to students' understanding of the material, but also by making direct discoveries, making them stronger in understanding the material. One of the teaching tools that supports the implementation of the independent curriculum in helping students understand the material during the learning process is teaching materials (Magdalena et al., 2020).

Learning resources in the form of teaching materials are an important element in the formation of learning. The existence of teaching materials will help teachers design learning, while for the students themselves the teaching materials will help them master learning. According to Tristiantari & Sumantri (2016) learning materials or teaching materials are something that students want to learn and master, whether in the form of knowledge, skills, or attitudes through learning activities. This teaching material in the form of an e-module is a learning medium that can be innovated on the basis of learning models and other things, one of which uses a STEM approach. Learning in the Science, technology, engineering, and mathematics (STEM) approach is known as a multi-disciplinary method where concepts from STEM are combined and applied in real-life contexts. According to Burrows & Slater in (Shernoff et al., 2017), this approach allows students to understand the relationships between various scientific disciplines and apply them practically in real world situations. Additionally, Jackson et al. (2021) stated that STEM learning provides a good experience where students can have the opportunity to apply the critical thinking skills that students have to solve complex problems.

STEM education provides opportunities for teachers to teach students about concepts, principles and techniques from science, technology, engineering and mathematics in an integrated manner, both in the learning environment and in everyday life. Zamista (2018) stated that STEM education is the most appropriate form of approach to prepare a generation that is literate in STEM sciences, so that they are able to respond to the demands of the times and technological advances that continue to develop. Natural science or often called science is a type of material that has many formulas which make it difficult for students to understand the material, so that students are less interested in understanding the material. This assumption has a big influence on student learning outcomes, only students who are truly interested in studying science show satisfactory learning achievements. For this reason, to increase students' conceptual understanding of the material, practical activities are carried out. However, in the science learning process, not all learning material can be put into practice because there is no equipment in the laboratory, especially for Global Warming material.

Global Warming material is very important so alternative media are needed that can attract students' interest in studying Global Warming material. Ecological damage caused by carbon emissions from industrialization activities has caused an increase in the earth's temperature, which has a serious impact on climate change. According to Subiyanto et al. (2018), climate change has become the most pressing global issue today. To overcome the impact of global warming, involvement from the entire community, including future generations such as students, is very important. In the learning process there are global issues through reading texts regarding phenomena, causes, impacts on ecosystems, and efforts to overcome global warming in order to build

students' interest in reading in learning. Apart from that, the use of teaching materials is always updated according to the readiness of the school and students, the use of teaching materials can have an influence on student learning outcomes (Pranaja & Astuti, 2019).

Based on these problems, it is hoped that
STEM-based e-module teaching materials can become one of the innovative teaching materials used to support students' scientific literacy skills. Therefore, research was conducted with the title "The Effect of E-module Teaching Materials Based on Science Technology Engineering Mathematics (STEM) on Global Warming Material on Students' Science Literacy Skills".

METHOD

This research was carried out at Al-Islam Gunungpati Middle School which is located at Jl. Morokono, Gunungpati, Semarang City, Central Java in the odd semester of 2023/2024. The type of research used is Quasi Experimental Design with the form of pretest-posttest Nonequivalent Control Group Design.

Table 1. Nonequivalent Control Group Design
Research Design

Group	Pretest	Treatment	Posttes
Experiment (VII E)	O1	X1	O2
Control (VII F)	O3	X2	O4

(Sugiyono, 2015)

Information:
Group : Group/class used
O1 : Pretest results experimental group/class
O3 : Pretest results of the control group/class
O2 : Posttest results of the experimental group/class
O4 : Posttest results of the control group/class
X1 : Learning using teaching materials STEM-based e-module
X2 : Learning using student books

Homogeneity test

The homogeneity test was carried out to determine that the experimental class and control class had the same initial abilities because the samples were taken from the same population. The data used to analyze this initial data is the results of the Odd Semester Midterm Test Assessment for the 2023/2024 academic year in classes VII E and VII F. This analysis includes population homogeneity. The formula used to analyze population homogeneity data is as follows:

$$F = \frac{biggest\ Varians}{Smallest\ varians}$$

(Sugiyono, 2015)

Normality test

The data normality test is used to determine whether the pretest-posttest data on students' literacy abilities obtained in the research is normal or not before being analyzed. The formula used to test the normality of data is Chi-Square, which is as follows:

$$X^2 = \sum_{t-1}^{k} \frac{(0i-Ei)^2}{Ei}$$

Information:
X2 = Chi squared
0i = Frequency of observation results
Ei = Frequency of expectations
k = number of interval classes
(Sudjana, 2005)

Hypothesis test

The data analysis technique used for hypothesis testing is the paired sample t-test. The paired sample t-test was carried out because the type of data in this study was in interval form. This test functions to determine whether there is a significant influence on the use of STEM-based e-module learning media on students' scientific literacy skills. The formula used in the paired sample t-test is:

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}}$$

with

$$s^2 = \frac{(n_1-1)s_1^2 + (n_2-1)s_2^2}{n_1+n_2-2}$$

Information:
t = paired sample t-test

$\bar{x}_1$ = average value of the experimental class
$\bar{x}_2$ = average value of the control class
s^1 = variant data is a difference between the pretest and posttest experimental class
s^2 = variant data on the difference between pretest and posttest control class
n_1 = number of samples from the experimental class
n_2 = number of samples from the control class

N-gain test

This N-gain test was carried out on pretest posttest data to find out more clearly the magnitude of the difference in scientific literacy skills of experimental class and control class students. The N gain test formula used is as follows:

$$N - gain = \frac{Score\ Posttest - Score\ Pretest}{Score\ ideal - Score\ Pretest}$$

Information:
N-gain = The size of the gain factor
Ideal Score = Maximum total score
Pretest Score = Sum of pretest score
Posttest Score = Sum of posttest score

RESULT AND DISCUSSION

The instrument used to measure students' scientific literacy skills is using 20 multiple choice questions and a student response questionnaire. The results of pretest data analysis in the experimental class were 63.8 while the control class was 62.4. Based on these results, treatment was carried out in the form of learning using the Discovery Learning model assisted by STEM-based e-modules in the experimental class and Discovery Learning model learning assisted by student handbooks in the control class. After learning, the average score for the experimental class was 81, while for the control class the average score was 76.6. The average graph of the two classes can be seen in Figure 1.

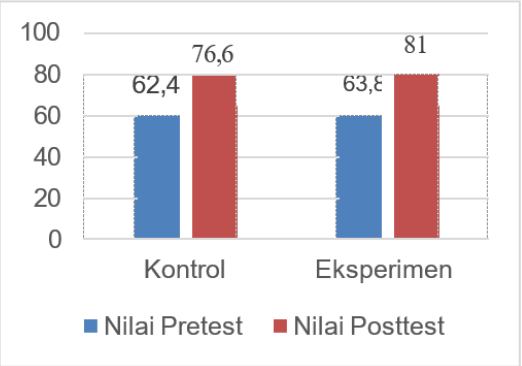

Figure 1. Average graph of the two classes

Data normality test to find out whether the data is normally distributed or not and determine the type of further analysis.

Table 2. Pretest-Posttest Data Normality Test Results

Data	Class	X^2_{count}	X^2 table	Criteria
Pretest	Experiment	5.30	9.48	Normal
	Control	6.30		Normal
Posttest	Experiment	3.09	9.48	Normal
	Control	7.09		Normal

Based on Table 2. because the second value of X2count < 9.48 = X2table then the posttest data values for the experimental class and control class are declared to be normally distributed. The normality test data obtained was then tested using the t-test and N-gain test.

Table 3. Paired Sample T-Test Results

Data	Class	$\bar{x}$	df	tcount	ttable	
Pretest	Experiment	63.8	48	0.55	2.01	
	Control	62.4				
Posttest	Experiment	81.0	48	2.60	2.01	There is influence
	Control	76.6				

The N-gain test aims to determine the increase in students' scientific literacy skills.

Table 4. N-gain of Science Literacy Skills

Data	Experiment		N-gain	Control		N-gain
	Pre-	Post-		Pre-	Post-	
$\bar{x}$	63.8	81	0.48	62.4	76.6	0.36
Category			Medium			Medium

The N-gain test is also analyzed according to each indicator, namely there are 8 scientific

literacy indicators which can be seen in the table below. The results of the scientific literacy skills data observed based on the global warming test scores on each scientific literacy indicator can be seen in Table 5.

Table 5. Results of analysis of each indicator of scientific literacy skills

Indicator	ain			
		Infor-	Experiment	Infor-
1	0.50	Mediun	0.62	Medium
2	0.48	Medium	0.53	Medium
3	0.41	Medium	0.46	Medium
4	0.40	Medium	0.42	Medium
5	0.22	Low	0.24	Low
6	0.42	Medium	0.43	Medium
7	0.32	Medium	0.35	Medium
8	0.32	Medium	0.42	Mediu
Avg	0.38	Medium	0.43	Mediu

Information:
1. Explain scientific phenomena
2. Use scientific evidence
3. Identify scientific questions
4. Understand the phenomenon
5. Solve problems
6. Interest in science and technology
7. Assess the scientific approach to inquiry
8. Awareness regarding environmental issues

The research carried out was to analyze the influence of STEM-based e-module teaching materials on students' scientific literacy skills on global warming material. The differences in the learning process carried out in the experimental class and the control class are the basis for differences in increasing students' scientific literacy skills. The results of the initial test of students' scientific literacy skills were classified as low. This is in accordance with research by Ahmad et al. (2018) which states that students' scientific literacy skills are still at the stage of just knowing basic facts. The results of the pretest data normality test in the experimental class produced an X2count of 5.30, while for the control class an X2count of 6.30 was produced. Because both X2count < 9.48 = X2table, the pretest data values for the experimental class and control class are declared to be normally distributed. Furthermore, the results of the posttest data normality test, in the experimental class produced an X2count of 3.09, while for the control class the resulting X2count was 7.09. Because the second value of X2count < 9.48 = X2 table, the posttest data values for the experimental class and control class are declared to be normally distributed.

The results of the t-test related to pretest data did not have a significant effect on the scientific literacy skills of students in the experimental class and control class because tcount = 0.55 < 2.01 = ttable and H0 was accepted. Furthermore, the results of the posttest scores in the experimental class and control class showed a significant influence on scientific literacy skills after providing discovery learning models assisted by STEM-based e-modules for the experimental class and student handbooks for the control class because the results of tcount = 2.60 > 2, 01 = ttable and H0 is rejected, then H1 is accepted.

The N-gain score results show that the experimental class score is higher than the control class. The experimental class got an N-gain value of 0.48, while the control class got an N-gain value of 0.36 so that both classes were included in the medium category with the difference in the number of N-gain values not being too much. This difference in increasing scientific literacy skills occurs because learning in the experimental class is given different treatment and places more emphasis on investigation, experimentation and problem solving skills. This statement is in accordance with the research results of Adi et al. (2017) who explained that learning that places more emphasis on skills, investigations, experiments and problem solving can increase students' scientific literacy.

The average pretest score obtained by the experimental class was 63.8 and 62.4 for the control class. The average score obtained is still low, this is due to the condition of students' readiness to face the pretest which is not yet considered ready so that students are not used to being trained on questions about scientific literacy. The results of the final test on the literacy skills of students in the experimental class and control class have increased. The average posttest score

obtained by the experimental class was 81 and for the control class the average score was 76.6. This increase was caused by being given different treatment using e-module teaching materials, which resulted in different final results. This is in line with research by Hutomo et al. (2016) stated that media and learning resources in learning used as support in delivering material to students can influence students' scientific literacy skills.

Learning media plays an important role in influencing student learning outcomes. This can be proven from the difference in pretest and posttest results between the experimental class and the control class. The experimental class got an average pretest score of 63.8 and a posttest of 81.0, while the control class got an average pretest score of 62.4 and an average posttest score of 76.6. This is in accordance with Amalia and Bintari (2016) who stated that the use of interesting learning media makes students remember the material in it better and it is easier to express it quickly and accurately. Apart from that, according to Nugrahaeni & Suyanto (2017), there is a relationship between student learning outcomes and scientific literacy, namely that the higher the student's learning outcomes, the higher the scientific literacy skills of the student.

The use of teaching materials in the form of STEM-based e-modules in the form of PDF files has several advantages. This is in accordance with research by Ratnawati (2021) which states that the e- module developed has the advantage that it can be accessed anywhere and at any time, which makes it easier for students to learn it. These advantages support the improvement of students' literacy skills.

The results of the student response questionnaire regarding learning assisted by STEM- based e-module teaching materials received very good responses. This can be seen from the students' learning response questionnaire which received a percentage of 85.83% in the very good category. This indicates that experimental class students are more enthusiastic and interested in using e-modules based on science technology engineering mathematics (STEM) because they present pictures, practice questions and simple practical experiment steps that can improve students' literacy skills in the material. global warming.

This research can influence students' scientific literacy skills because learning using e-module teaching materials helps students understand the learning material more easily. Through e-modules, examples of facts or phenomena that are appropriate to the surrounding environment can be presented to students. E-modules are also effective and efficient teaching materials so that students can use e-modules anywhere and anytime. This explanation is also supported by Yaumi (2017) research entitled application of discovery learning model tools to global warming material to train the scientific literacy skills of class VII middle school students. In the learning process there are global issues through reading texts regarding phenomena, causes, impacts on ecosystems, and efforts to overcome global warming in order to build students' interest in reading in learning. Apart from that, with the discovery learning model combined with reading texts about global science issues, students' scientific literacy can be trained.

CONCLUSION

Based on the results of the research that has been carried out, the results obtained are:

1. Learning using STEM-based e-module teaching materials which are applied to global warming material has an effect on improving students' scientific literacy skills as evidenced by the results of the average score on students' scientific literacy skills questionnaires at each meeting, namely 72.52% in the good category , 75.71% in the good category, and at the third meeting 79.08% in the good category.
2. Learning using STEM-based e-module teaching materials applied to global warming material has a significant effect on students' literacy skills. This is proven by the results of the t-test related to the posttest value, namely obtaining a tcount value of 2.60 > 2.01 ttable.

3. Students give positive responses to learning assisted by STEM-based e-module teaching materials. This is proven by the results of the student response questionnaire which obtained a percentage of 85.83% in the very good category.

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