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The influence of using context-based optical instrument e-modules on the scientific literacy of class XI MIPA students at SMAN 12 Padang

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Abstract

Since scientific knowledge is the foundation of daily living in the twenty-first century, science literacy is a crucial ability for pupils. But the level of scientific literacy of some students in Indonesia is still low. The test results at SMAN 12 Padang showed that pupils' level of science literacy wa really low. The fact that instructors' instructional resources are still not geared toward improving students' science literacy is one of the reasons why science literacy remains low. One way to increase science literacy is to use context-based physics learning e-modules that are able to connect science concepts with real everyday topics or problems. This research seeks to determine the effects of utilizing optical instrument e-modules on the science literacy of class XI students of SMAN 12 Padang. This study used a control group in a quasi-experimental setup that is only tested after the test. The participants in this study were SMAN 12 Padang class XI Mipa students. The sampling process used the purposive sampling technique. The sample in this study was 35 students of class XI Mipa 3 and 36 students of class XI Mipa 4. The study's findings come from the science literacy abilities of the students. Aspects of students' science literacy skills include science competencies, knowledge, context, and attitudes. Data collection was carried out by descriptive tests of 11 questions and questionnaires. The instruments utilized in this investigation were written tests in the form of questionnaires and descriptive inquiries. The hypothesis test's findings yielded a computed t value = 4.007 and a t table value = 1.995 at a significance level of α = 0.05. Because the hypothesis is accepted at a significance level of 0.05. Considering the outcomes, it can be said thet using e-module optical instruments has a beneficial influence on the scientific knowledge of class XI Mipa students of SMAN 12 Padang.

Keywords: context; optical instrument e-module; physics; scientific literacy

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INTRODUCTION

The quick advancement of science, technology, and information in every aspect of life worldwide is a defining feature of the twenty-first century (Banjarnahor, 2022). This development is a challenge in the 21st century to form competitive and quality human resources (Mardhiyah et al., 2021). One effort to produce quality in the twenty-first century human resources is the development of human resources through special institutions such as educational institutions (Malikah & Wafroturrohmah, 2022). 21st century education intends to equip pupils to succeed and adapt in a changing society.

In the 21st century, In many nations, science and technology are advancing extremely quickly so that humans must be able to adapt to developments in various fields. One of them works in the educational sector, because success in The primary element influencing a nation's development in the midst of global flows (Murti & Sunarti, 2021). In the twenty-first century, education needs to be able to prepare and ensure that students possess the ability to study and innovate, use technology and information media effectively, and work and live by applying life skills. Based on the results of the World Economic Forum (WEF) review, there are 16 skills needed by students in the twenty-first century. One of the skills needed in the twenty-first century is scientific literacy. (Chusni et al., 2018). One of the subjects that has started to get a lot of attention in the academic community is scientific literacy. This is due to the fact that everyone needs to be proficient in scientific literacy in order to address problems. Living in the age of science and technology requires scientific literacy in physics. The purpose of The purpose of this study is to give a summary of scientific literacy research in physics learning in Indonesia (Nurhasanah et al., 2020).

Students that prossess scientific literacy are able to identify, comprehend, and apply the knowledge they have learned in the classroom. Students need to be scientifically literate in order to use science in their daily lives and comprehend science as a concept (Sutrisna, 2021). In order to improve education and make it competitive with other nations, measuring scientific literacy is essential to ascertain students' levels and help them reach high or good scientific literacy (Pratiwi et al., 2019).

Science literacy has a significant part in formal education, including in physics learning. The scientific field of physics is one that develops through the scientific process. Learning physics can be applied as a method, end result, mindset, or technology. Acquiring knowledge that aligns with the principles of physics education is that which can lead to science literacy. Science literacy plays an important role in physics learning because by mastering science literacy, students can understand the basic concepts of physics properly and correctly (Lestari et al., 2022). Scientific literacy is one of the important skills for students, so that students can apply science correctly. In order to solve difficulties in daily life and make judgments based on scientific knowledge, students who are scientifically literate must be highly sensitive to both themselves and their environment (Novitasari et al., 2022).

According to the PISA assesment's findings, between 2000 and 2018, Indonesian students' scientific literacy scores were below the PISA-established average. During the seven times of participation in the PISA assessment, Indonesia has consistently ranked last ten rankings of a number of other participating countries, even the scientific literacy ratings of Indonesian students in 2018 decreased compared to 2015. This shows that Indonesian pupils' scientific literacy is comparatively low (Yusmar & Fadilah, 2023).

This low additionally, scientific literacy aligns with the results of the scientific literacy test on the Fluid material given to class XI Mipa students of SMAN 12 Padang on October 18-20, 2023. The instrument used was made by Khairunisyaq which has been validated by experts. Students at XI Mipa have an average overall scientific literacy of 54.16, which falls into the very poor range. This demonstrates how low the scientific literacy of SMAN 12 Padang City's class XI Mipa kids is remains.

The poor level of scientific literacy among the students is typically the result of a learning process that has not been focused on improving students' scientific literacy. Students' low scientific literacy is caused by a number of reasons, including: 1) the use of improper instructional resources, 2) misunderstandings, 3) noncontextual instruction, 4) poor reading proficiency, and 5) an unfavorable learning atmosphere (Fuadi et al., 2020). The low level of scientific literacy in Indonesia is not only caused

by students being lazy to read, but also other factors such as the selection of textbooks and non-contextual learning.

Considering the findings of the interviews conducted alongside instructors of physics at SMAN 12 Padang City, it was obtained that the teaching materials most often used by teachers are instructional resources in the form of books. In addition, no e-modules or other educational resources have been used. at SMAN 12 Padang. This causes students' poor scientific literacy because they only rely on text and do not touch the souls of students. Lessons consequently grow dull, and pupils fail to comprehend the subject in light of real-world situations. With scientific literacy, students can discover, ask questions, and determine decisions that are developed from their curiosity related to their daily life experiences so that they can be interpreted (Doa et al., 2021).

One of the efforts that can be made to overcome the issues that have been conveyed enhancing pupils' scientific literacy abilities is to develop electronic teaching materials such as context-based e-modules (Muzijah et al., 2020). E-modules are a form of electronic-based teaching material presentation designed by teachers to be studied independently by students (Desnita et al., 2022). The purpose of being presented in electronic format is to be able to contain animation, audio visuals, sound, and others. By studying independently with e-modules, students can build more meaningful knowledge and develop their knowledge (Aydin & Aytekin, 2018). In addition, the use of E-modules can save paper usage so that it is more environmentally friendly and can be accessed very easily, only requiring a laptop or cellphone online (Hardinata & Putri, 2019).

Considering the advantages of the e-module, it is appropriate for use in the educational process. This is in accordance with the findings of studies carried out by Muzijah (2020) where the findings of her investigation revealed that e-modules using exe-learning can be used as teaching materials that can train students' scientific literacy. Nurhasnah & Sari (2020) also stated that e-modules are very reliable, useful, and efficient in raising pupils' scientific literacy levels while they study physics.

Contextual-based e-modules are chosen because ordinary phenomena and the concept of physics are tightly intertwined. One of the physics subject materials that requires e-modules and can train students' scientific literacy skills is the concept of optical instruments. The selection of the concept of optical instruments is founded on the idea that optical instruments being closely related to everyday life. This material is a physics subject for grade XI high school in the even semester contained in the 2013 curriculum. Physics material that utilizes the properties of light, reflection, and refraction of light to form shadows from an object. In context-based e-modules, the concept of optical instruments will be presented with animation, video, images, and sound. Studying optical instrument material requires good scientific literacy to create a more interesting learning process and build student knowledge in a structured manner.

Based on the background that has been presented, the author is eager to carry out a study entitled "The Effect of Using Optical Device E-modules on Science Literacy of Class XI Mipa Students of SMAN 12 Padang". With the hope that the application of optical device students will benefit from using e-modules. science literacy XI Mipa of SMAN 12 Padang City.

METHODS

Quasi-experimental research is the approach used in this investigation. The population used is class XI Mipa students at SMAN 12 Padang who are registered during the academic year 2023-2024's even semester. The sample class was determined using purposive sampling technique, so class XI Mipa 3 was chosen as the experimental class and class XI Mipa 4 as the control class. In this study, the

experimental group was given context-based e-modules for their learning, while the control group was given a textbook. After being given different lessons, a final test will be administered to both groups to see the impact that e-modules have on pupils scientific literacy. The tool that was utilized was a descriptive question made up of 15 questions and had been examined for discrimination, difficulty, validity, and reliability power of the questions. After being tested, 11 valid questions and 4 invalid questions were obtained, while the reliability obtained was 0.87 in the very high category. The data analysis used includes prerequisite tests which incorporate tests for homogeneity and normalcy, and hypothesis tests using t-tests. This study's design was a posttest-only control group design. This study's design can be viewed in Table 1.

Table 1. Reseacrh Design

Group	Treatment	Posttest
Experiment	X	O
Control	Y	O

Source: (Sugiyono, 2017)

where O is the experimental and control groups' final test, X is the experimental group's course of therapy was by using context-based physics learning e-modules, and Y is the treatment given to the control group was by using a textbook.

The variables used in this study consist of three types of variables: independent, dependent, and control. The study's independent variable is the optical instrument e-module, while the dependent variable in this study is scientific literacy, and the control variables in this study are the CTL model and textbooks.

RESULTS AND DISCUSSION

Research Result

During the even semester of the academic year 2023–2024, the study was conducted at SMAN 12 Padang a control class and an experimental class made up the research sample. Research data on students' scientific literacy abilities, which encompass features of science competence, aspects of science knowledge, and aspects of science context, was gathered based on the conducted studies, and aspects of science attitudes. Trough a written test, information on scientific literacy skills was gathered at the end of the research in the form of a posttest consisting of 11 questions that had been tested first. Science attitude data was obtained by filling out a scientific literacy attitude questionnaire at the end of the research. This research data can be seen as follows:

The effect of e-modules in scientific literacy ability

Assessment of students' scientific literacy skills was carried out using a written test. A set of eleven descriptive questions served as the instrument. Each question contains There are three ways to measure scientific literacy: scientific competence, scientific knowledge, and scientific context. For scientific competence, it includes using science to evaluate and conduct scientific research (K2), explain events scientifically (K2), and interpret facts and evidence scientifically (K3). The scientific knowledge indicator consists of: content (P1), procedures (P2), and epistemic (P3). Furthermore, the scientific context indicator consists of: personal (P), local (L), and global (G). The questions used for the test were taken from questions that had been previously tested at SMAN 8 Padang. The written test was conducted at

the conclusion of the research activity given to the experimental class and the control class. The mean value for each indicator is shown in Figure 1.

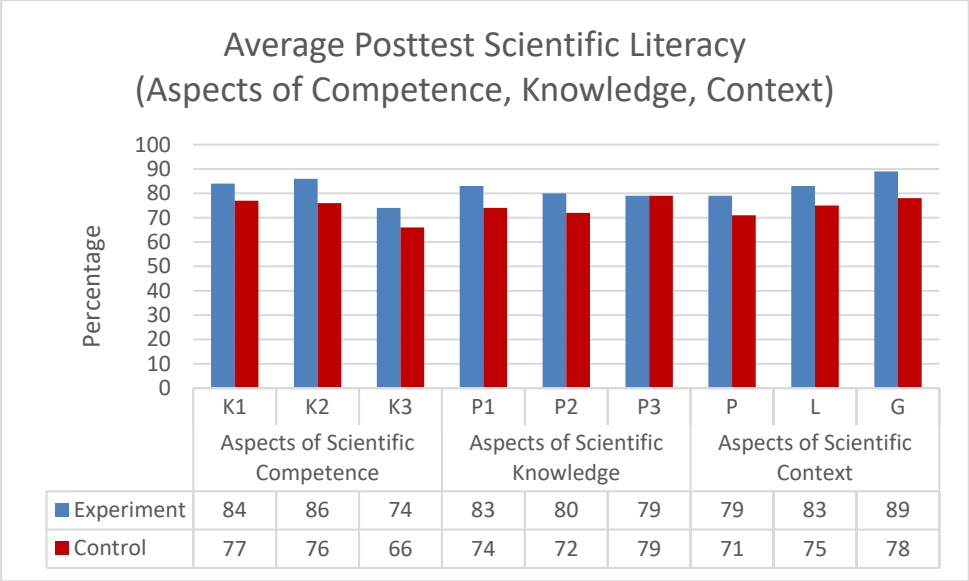

Figure 1. Average science literacy ability for each indicator

Based on Figure 1, the experimental class, pupils' proficiency in science literacy surpasses that of the control group. The highest percentage of students' science literacy in the experimental group is in the global indicator, which is 89% and the lowest percentage is in the sign of a scientific interpretation of data and evidence, which is 74%. While largest proportion of pupils science literacy in the control group is in the epistemic indication with the lowest proportion found in the personal indicator, which is 71%.

After the calculation, the statistical results of the two sample classes were obtained. Data on students' science reading skills can be observed in the outcomes of parameter statistics. Descriptive statistical analysis, the normalcy test, the homogeneity test, and the hypothesis test are the parameter statistics that are employed. The outcomes of the statistical computations can be observed in table 2.

Table 2. Findings from the Data Analysis of Students' Science Literacy Skills

No.	Types of Statistics	Statistical Parameters	Class	
			Experiment	Control
1	Descriptive statistics	Average	81,20	75,31
		Standard deviation	6,140	6,075
		Variance	37,70	36,90
		Maximum	93,00	89,00
		Minimum	68,00	66,00
2	Normality Test	N	35	36
		A	0,05	0,05
		L_0	0,124	0,120
		L_t	0,150	0,148
		Information	**Normal**	
3	Homogeneity Test	F_h	1,02	
		F_t	1,84	
		Information	**Homogeneous**	

No.	Types of Statistics	Statistical Parameters	Class	
			Experiment	Control
4	Hypothesis Testing	t_h	4,007	
		t_t	1,995	
		Information	**H_0 is rejected**	

Table 2 demonstrates that the control group's average was lower than that of the experimental class, with the experimental group's average scientific literacy skills score being 81.20 and the control groups's being 75.31. These results indicate that context-based e-modules impact pupils's proficiency in scientific literacy.

A comparison exam of two methods can be applied to assess difference in students' scientific literacy abilities. Following the normality and homogeneity tests, the comparison test of means is conducted in sample classes are met. To determine if The distribution of the two sample classes is regular, the normality test is utilized or not. The prices were derived from the normalcy test findings that were conducted of L_0 and L_t at a real level of 0.05 with the number of students in there are 35 individuals were in the control group and 36 were in the experimental group. The results of the normality test indicated that both sample classes were normally distributed.

Following the normality test, a homogeneity test is performed to determine whether or not the variance of the data from the two sample classes is homogeneous. The homogeneity test's findings that have been carried out obtained F_{count} = 1.02 and Ft = 1.84. The findings indicate that $F_{count} < F_{table}$, which means that both the variance is homogeneous across sample classes. The t test is utilized to ascertain the hypothesis outcomes because the collected data are normally distributed with homogeneous variance.

Table 2 provides an explanation of why the two sample classes' t_{count} value is 4.007, while the t_{table} value with dk = n1 + n2 - 2 is 1.995. The H_0 acceptance area, if the t_{count} value is between the t_{table} values. The H_0 rejection area, if the t_{count} value is outside the H_0 acceptance area. This demonstrates the disparity in kids' scientific literacy skills who use e-modules and those who do not. The working hypothesis acceptance curve can be seen in Figure 2.

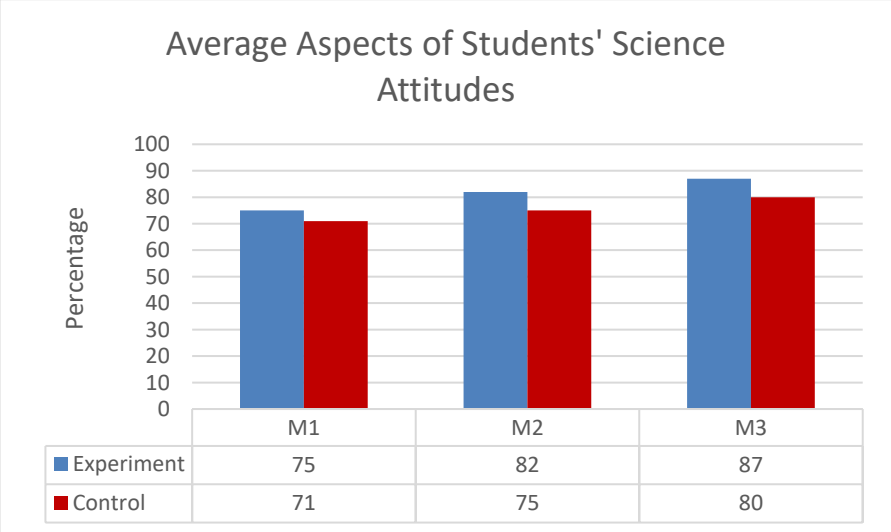

Figure 2. Hypothesis acceptance curve

As illustrated in Figure 2, t_{count} is outside the H_0 acceptance area. Since H1 is approved, there must be a difference the two sample classes' students' scientific literacy skills as a result of the intervention, which involved using context-based e-modules. The application of context-based e-modules in one of the sample classes has an effect on the scientific literacy abilities of students at SMAN 12 Padang.

The influence of e-modules on science attitudes

Assessment of scientific literacy skills on science attitude indicators is completed by completing a survey on students. The questionnaire consists of 18 statements containing 3 indicators of science attitudes, namely enthusiasm for technology and science (M1), evaluating the scientific method to investigation (M2), and perception and awareness of environmental problems (M3). The average each indicator's value is displayed in Figure 3.

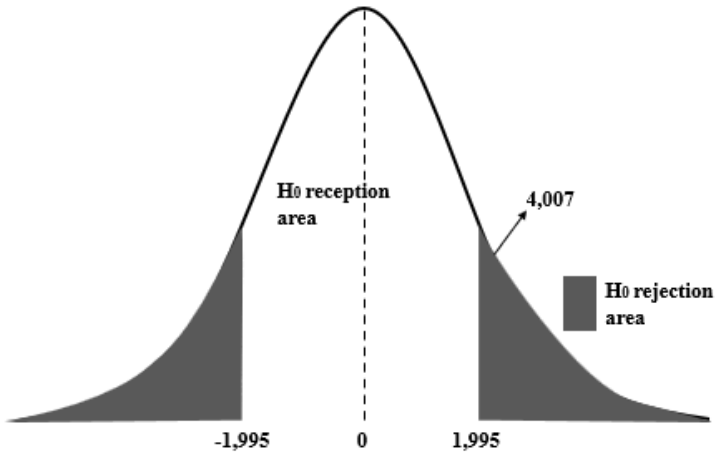

Figure 3. Average of students' science literacy attitude questionnaire

In Figure 3, the science literacy ability in the science attitude indicator of students in the experimental group outperform those in the control group. The data on science literacy ability in the science attitude indicator was obtained from the results of parameter statistics. The normalcy test, the homogeneity test, and descriptive analysis, and comparison tests were the parameter statistics that were employed. The results of the statistical calculations can be observed in Table 3.

Table 3. Results of Student Science Attitude Data Analysis

No.	Types of Statistics	Statistical Parameters	Class	
			Experiment	Control
1	Descriptive statistics	Average	70,51	65,61
		Standard deviation	6,02	4,48
		Variance	36,2	20,07
		Maximum	82,00	75,00
		Minimum	57,00	56,00
2	Normality Test	N	35	36
		A	0,05	0,05
		L_0	0,059	0,108
		L_t	0,150	0,148
		Information	**Normal**	

No.	Types of Statistics	Statistical Parameters	Class	
			Experiment	Control
3	Homogeneity Test	F_h	1,81	
		F_t	1,84	
		Information	**Homogeneous**	
4	Hypothesis Testing	t_h	3,86	
		t_t	1,995	
		Information	**H_0 is rejected**	

Table 3 makes it clear that the experimental group's mean scientific literacy ability score on the science attitude indicator is 70.51, whereas the control group's score is 65.61. This indicates that the average scientific literacy score of the experimental group is higher than the average science attitude score of the control group on the science attitude indicator.

The importance of scientific literacy ability on the science attitude indicator possessed by students can be tested by a comparison test of two means. The comparison test of means is carried out after thetests for homogeneity and normalcy are performed. The normality test is used to see whether the distribution of the two sample classes is normal or not. Both sample classes will be normally distributed if the $L_0 < L_t$ value is obtained at a level of 0.05. Based on the normalcy test findings, it was obtained that the distribution of both sample classes was normal.

To ascertain whether or not the variance of the data from the two sample classes is homogeneous, a homogeneity test is conducted after the normality test. The results obtained from the homogeneity test were Ft = 1.84 and Fh = 1.81. According to these findings, Fh < Ft, indicating homogenous variance in both sample groups. The t-test is utilized to ascertain the hypothesis outcomes because the acquired data are regularly distributed and have a homogeneous variance.

Table 3 shows that amongst the two sample classes, the high value of t_{count} is 3.86, while the t_{table} value with dk = n1 + n2 - 2 is 1.995. This shows that there is a difference in students' scientific literacy abilities in the science attitude indicator that uses e-modules and those that do not.

Results of analysis of surveys of students' opinions regarding the employment of context-based e-modules

Based on their indicators, the experimental group's student response questionnaire data about the use of context-based e-modules was processed. Students' interest in studying physics through context-based e-modules was interpreted based on the data, which was presented as a percentage. This is shown in Table 4.

Table 4. Student responses to the use of context-based e-modules

Questionnaire Indicator	Percentage	Category
Student responses to physics learning using context-based e-modules	83,14	Very well
Students' scientific literacy skills after learning using context-based e-modules	81,71	Very well
The advantages of learning with context-based e-modules compared to commonly used teaching materials	82	Very well
Average	**82,29**	**Very well**

Table 4 shows the average percentage of student responses to context-based e-modules have an

82% percentage, which puts them in the very good category. This shows that using context-based e-modules during learning can make students better understand the concept of optical instruments.

Discussion

This research on impact of utilizing e-module optical tools on the scientific literacy of class XI students of SMAN 12 Padang began with how students' scientific literacy is measured ability tests which were still very low. Furthermore, the findings of the interviews conducted with physics instructors of class XI MIPA SMAN 12 Padang showed that there had been no use of teaching materials in the form of e-modules at SMAN 12 Padang. Additionally, teachers' instructional resources have not been connected with students' daily lives and tend to be monotonous.

It may be concluded from the results of the data analysis and hypothesis testing that the use of e-modules affects the scientific literacy of SMAN 12 Padang class XI pupils. There were notable disparities between the two groups' final scores or results. In comparison to the control group, the experimental group received a better score. where the experimental group's average score was 81.20 and the control group's was 75.31. This is because in the experimental group, learning uses contextual-based e-modules, while in the control group, textbooks are used. Contextual-based e-modules are based on direct experience and the reality that exists in the environment around students. Students are invited to be fully involved and responsible for the formation of knowledge during learning. This is in accordance with what was stated by Wulandari et al., (2023) in their research, e-modules have an influence on students' scientific literacy. In addition, the contextual learning paradigm serves as a guide for the learning steps in the e-module, where the model contains steps that enable students to accommodate in training students' scientific literacy skills. This is also in line with the research of Saniah et al., (2022) that the Contextual Teaching and Learning (CTL) learning model has a significant effect on students' scientific literacy in high school.

The results of the control group students' scientific literacy skills were lower than those of the experimental group. This happened because the learning process in the control group used textbooks. Textbooks are usually dominated by long writings, making it challenging for pupils to comprehend the material and are lazy to read them. In addition, during the educational process, only a few students were active in learning, such as asking questions and expressing their opinions. This is consistent with the findings of Ngertini et al., (2014) which states that logical, critical, initiative and adaptive thinking skills towards change and development are skills that lead students to have scientific literacy skills.

The results of the experimental group students' scientific literacy attitude questionnaire scores were superior to those of the control group. This is because this attitude aspect cannot be separated from the use of contextual-based e-modules which encourage students to learn independently according to their skills and passions. Activities in this contextual-based e-module also facilitate students to increase their interest in science and technology in the process of environmental problems. So that students can build an attitude of awareness towards the environment.

The results of the experimental group student response questionnaire regarding the use of context-based e-modules were in the very good category with a percentage of 82%. This indicates that students in the experimental group were more enthusiastic and interested in using contextual-based e-modules because they presented videos, images, animations, and practice questions that could improve students' scientific literacy skills in optical instrument material. The use of contextual-based e-modules also made students understand the concept of optical instruments correctly. This is consistent with research by Puspitasari (2019), which found that e-modules are a highly effective way to boost students' motivation

for learning.

Based on the posttest statistical hypothesis test, H_0 was rejected and H_1 was accepted. The experimental group's mean value was superior to the control group. This is because when student learning in the experimental group used contextual-based e-modules, while the control group did not use them. The conclusion of the hypothesis states that there is an impact of e-module usage on The scientific literacy abilities of SMAN 12 Padang's class XI Mipa pupils. Nurhasnah & Sari's (2020) research, which claims that contextually oriented e-modules can enhance the scientific literacy skills of pupils, supports the findings of this study.

CONCLUSION

The employment of contex-based optical instrument e-modules has a positive impact on the scientific literacy of SMAN 12 Padang's class XI Mipa pupils, according to the research findings that have been acquired.

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