PILLAR OF PHYSICS EDUCATION
Vol. 16 (2), 2023, page.155-161
ISSN (Print) : 2337-9618
ISSN (Online) : 2684-8880

Effect Of Stem Integrated Physics E-Modules To Improve Creative Thinking Ability

Febbi Rahmadani [1], Festiyed [1], Desnita[1], Asrizal[1]

[1] *Department of Physics, Universitas Negeri Padang, Jl. Prof. Dr. Hamka Air Tawar Padang 25131, Indonesia*

Corresponding author. Email:festiyed@fmipa.unp.ac id

ABSTRACT

The Industrial Revolution 4.0 is an era of rapid development and technology. This era requires the ability to higher order thinking to prepare participants for development. Based on the demands of Time for national education issued an effort to increase the curriculum to the 2013 curriculum to stimulate participants to educate. The 2013 curriculum sets graduate competency standards based on student readiness, national education goals, and needs. Updating the learning process is urgently needed, one of which is by adjusting the teaching materials used for the material to be delivered. In the learning process, the main component is the availability of teaching materials that will be used by students. There are teaching materials in the form of print and non-print. The purpose of this study was to see the effect of the STEM Integrated Physics E-Module to improve the Creative Thinking Ability of Class XI Students of. This research method uses a quasi-experimental design using the posttest only design. After conducting the research it turned out that students' creative thinking abilities as seen from each student's answer from the two sample classes had different averages in common, namely the normality test, test homogeneity, two-mean similarity test From the analysis results obtained, namely the value of th is in the H0 resistance area so that it can be said that H1 is accepted at a significant level of 0.05. The results of the statistical analysis of the data show that th> tt is 2,764473449> 1,67528495042491, so it can be concluded that there are differences in students' creative thinking skills in the aspect of knowledge using e-modules and not using e-modules.

Keywords :E-Modules STEM Skills CreativeThinking, Sound and LightWaves

I. INTRODUCTION

The industrial revolution 4.0 requires students to have 21st century skills. The century where various information is available anywhere and anytime so that it is obtained by all people in all corners of the world without exception. The development of science and technology (IPTEK) is so fast, there is no more space for us to communicate with each other. The development of science and technology has an impact on the challenges and global competition faced by every country. In Indonesia, it is necessary to create quality human resources to be able to compete with the wider community. On this basis, 21st century education should be able to develop superior competence knowledge, skills, attitudes and values[1] 21st century graduates must have good competence[2] Science learning in the 21st century cannot be separated from the application of technology and information. Technological developments are marked by the emergence of various technology-based activities, such as ecommerce, e-government, e-medicine, elaboratory, and e-education, all of which are electronic based [3]

Education is a very important thing in life, be it family life, national life or state life. Education is a form of conscious effort to achieve better progress. In learning, education means efforts to create an active learning atmosphere and develop the potential that exists in students from those who do not know to know. Education according to Law no. 20 of 2003 namely educating the life of the nation and developing the Indonesian person as a whole, namely human beings who have faith and are devoted to God Almighty and have noble character, have knowledge and skills, physical and spiritual health, a solid and independent personality and a sense of social responsibility and nationality

The government always seeks to improve the quality of education through the procurement of textbooks and improving the curriculum[4]. The 2013 curriculum is the result of the embodiment of this law. The 2013 curriculum is a curriculum that adheres to the basic view that knowledge cannot simply be transferred from educators to students. Through the 2013 curriculum, it is hoped that students will be active, creative and independent. Learners are subjects who have the ability to actively seek, process, construct, and use knowledge. Learning that is applied to the 2013 curriculum is learning that can develop knowledge, skills, and attitudes [5]**.** Learning must be related to the opportunities given to students to construct knowledge in their cognitive processes so that they really understand and can apply knowledge, students need to be encouraged to work on solving problems, finding things for themselves, and trying hard to realize their ideas [6].

Based on learning physics according to the revised 2013 curriculum, students are required to have attitude, knowledge and skill competencies. To support the competence of students, we need a learning resource such as teaching materials, one of which is a book. Books are very important to use in the learning process for both teachers and students in order to achieve an effective and efficient learning process. Books have an important role in helping to improve students' academic achievement. Books as learning resources contain subject matter, methods and ways to evaluate lessons in a systematic and interesting way. Books are a source that helps students in independent learning, and also helps teachers in the learning process. In addition, the book is used as a guide in improving student achievement and competence[7]

The development of Science and Technology (IPTEK) in learning activities drives developments in learning resources and learning media. Recently, there have been the latest innovations regarding Information Technology-based teaching materials, so physics learning has also participated in making these developments. Updating the learning process is urgently needed, one of which is by adjusting the teaching materials used for the material to be delivered . Teaching materials that can be used according to the demands of the industrial revolution 4.0 are non-printed teaching materials. Non-printed teaching materials are all materials used to assist educators in carrying out learning activities as outlined in non-printed technology. One of the non-printed teaching materials in accordance with the development of industry 4.0 is an electronic module (e-module). The module is a tool or means of learning that contains materials, methods, and ways of evaluating that are designed systematically and attractively [8]**.** Teaching materials are designed as tools that can help educators and students in the learning process so that learning is more effective. The teaching materials used are usually printed or non-printed, one of which is a module/e-module.[9]

Student independence is prioritized in using the E-module. One of the subjects that require independence is productive subjects. So it can be concluded that the existence of an electronic module can add learning media that can help students explore knowledge and deepen practical knowledge.[10]. The electronic module is a non-printed output module. Modules are a set of planned learning and are used to help students learn independently, and can achieve the objectives of physical learning. [11] Modules are printed teaching materials that are able to help students understand lessons with educators in class or without an educator.The module is a book written with the aim that students can learn independently without or with the guidance of educators. Modules must be arranged systematically, meaning that modules must be in accordance with the learning objectives to be achieved, the characteristics and needs so that students can learn independently [12]**.** E-modules are non-printed teaching materials or modules in digital form for use using a computer device. So it can be interpreted that the e-module is a set of non-printed teaching materials that are used for independent study by students. Learning by using modules can make students measure their own level of mastery of the material discussed in each module unit, so that if they have mastered it, students can continue to the next level. Conversely, if students are unable, students will be asked to repeat and study it again [11] This is because the E-Module is designed with an attractive layout and diverse learning media so that the learning process is more meaningful if there is a change in student competence[13] Creative thinking and responsiveness in solving problems are important skills that must be mastered by students. This is based on the 2013 curriculum requirements, which define competency standards for Senior High School and Vocational School graduates. Students must have the ability to think creatively to solve productive, critical, independent, collaborative, and communicative problems[14]

The third real condition was obtained from the study of literature *journal research* on sound and light waves. Based on research conducted [15] teachers do not yet have access to references to STEM learning models accompanied by guidelines for use and the tools needed . Based on research conducted from the journal research on sound and light waves, it was stated that 46% of students were less interested in learning sound waves. The lack of interest in these students is caused by several reasons including: students still have difficulty working on sound problems, the teacher lacks motivation and the teacher does not use teaching aids in learning. Furthermore, based on the research of it was stated that with a percentage score of 16.7% students experienced difficulties in the material of sound and light waves. This is because the teacher-centered learning process makes students passive, lazy to learn and does not understand the concept of the material provided by the teacher in the learning process.

Teachers still have some difficulties in bringing out skills in students. Among them is the lack of precise learning approach used, so that the expected skills of students do not appear. Whereas critical thinking skills, creative, collaborative and problem solving skills are important skills that students must have. Moreover, along with the times, students must be able to adapt to increasingly sophisticated technology [16]. Researchers have conducted various studies, one of which is by applying STEM to improve 4C Skills in the 21st Century . This research uses e-modules that have been developed by with the title "Development of STEM Integrated E-Modules to Improve 21st Century 4C Skills". From this research the product produced is STEM integrated e-module on the material of sound and light waves as well as optical devices. From this research, *the final product was assisted by professional flipbook media* equipped with videos and STEM learning. The e-module has been validated by Physics lecturers. However, there are still a number of schools that have not implemented STEM. On the subject of sound and light waves as well as optical devices. From this research, the final product is supported by *professional flipbook* media equipped with videos and STEM learning. This research has not tested its effect in class, so researchers are interested in testing this product at Senior High School , in order to see the effect on students' creative thinking abilities[17].

Based on the results of the initial study in looking at the influence of students' creative thinking, it was obtained from the test scores of class XI students , totaling 7 classes. It is known that the value obtained students in class XI is still relatively low. This value is still far from the expected Minimum Completeness Criteria average. The implementation of learning has not used the STEM learning model and learning is still teacher-centered. Therefore a solution is needed to overcome this, one of which is by using the right learning resources. The title of this research is "The Influence of STEM Integrated Physics E-Module to Improve Creative Thinking Ability of Class XI Students "

II. METHOD

The type of research used is experimental or quantitative research. That this design has a control group, but it does not fully function to control external variables that affect the implementation of the experiment. This opinion is reinforced by that this design is also influenced by other variables and not solely by treatment. This study aims to directly test the effect of a variable on other variables and test the hypothesis of a causal relationship. A quasi-experiment is a type of research that is used to examine a group that cannot fully control external variables. The initial step in this study was to randomly select the experimental group and the control group.[18]

This study used a quasi experimental method (*quasi experimental design*) using the posttest only design . The two groups in this study, namely the control and experimental groups, were given different treatments. the group with the control variable is the group that uses teaching materials in the form of textbooks and learning is still conventional, while the experimental variable group, learning uses STEM-integrated e-modules. After being given different treatment to the two groups, both groups were given a final test (posttest) to determine the creative thinking ability of each group. This study aims to investigate the effect of STEM integrated e-module on the creative thinking skills of class XI students of Senior High School .

Test statistical analysis of final test questions, namely:

a. Validation

An item is said to be valid when it can be determined what exactly will be measured. The validity used is content validity as measured in terms of tests for measuring student learning outcomes. The content validity of the questions to be tested is validated by the supervisor.

b. Reliability

Reliability is the accuracy of a test when used on the same subject . reliability for objective questions can be calculated using the Kuder-Richardson

Table 1 Classification of Reliability Index Questions

No.	Indeks Reliabilitas	Klasifikasi
1	$0,00<r_{11}<0,20$	Very low
2	$0,20< r_{11}<0,40$	Low
3	$0,40< r_{11}<0,60$	Currently
4	$0,60< r_{11}<0,80$	Tall
5	$0,80< r_{11}<1,00$	Very high

(Source: Arikunto[19])

c. Problem Difficulty Level

Whether a test is good or bad can be determined by the level of difficulty of the questions. The difficulty level of a question can determine whether a question is good or not, so it needs to be revised. Questions that are too easy or too difficult are bad questions. To test the difficulty level of a question, there is a number that indicates how difficult or easy the question is called the Difficulty Index (p).

Table 2 Problem Difficulty Level

Value	Category
0,71-1,00	Easy
0,31-0,70	Currently
0,00-0,30	Hard

(Source: Arikunto, [19]

d. Problem Difference Power

Differential power is needed to distinguish students who have high abilities from students who have low abilities. If difficult questions can be answered correctly by low-ability students, then the question is said to be not good, because it cannot distinguish high-ability students from low-ability students .

Table 3 Classification of Difference Power Index

No	Power Difference Index	Classification
1.	0,71-1,00	Very good
2.	0,41-0,70	Good
3.	0,21-0,40	Enough
4	0,00-0,20	Bad

(Source: Arikunto, [19]

III. RESULTS AND DISCUSSION

1. The Effect of E-module on Students' Creative Thinking Knowledge

Data from knowledge research results are taken from learning outcomes or posttest at the end of the study. The test is in the form of a written test with 20 essay questions. Posttest questions are designed to refer to indicators of creative thinking questions. Posttest questions are designed to refer to indicators of creative thinking. Before being used the questions have been tested so that the questions are suitable for use for the posttest. The results of data analysis from the two sample classes for knowledge can be explained in Table 4.

Table 4 Average Value , Standard Deviation and Variance in the Knowledge of Students of the Two Sample Classes

Class	N	$\bar{x}$	S	S^2	Information
(Experiment)	25	0.05	14,80375	219,151041666667	Normal
(Control)	28	0.05	12,18214	148,404431216931	Normal

Based on Table 1 , it can be revealed that the average score of the experimental class students is 77.95 while the control class is 66.69643. Based on these data it is explained that the average value of the experimental class is higher than the control class. The standard deviation of the control class is greater than that of the experimental class. This shows that the knowledge of students in the control class varies more from the experimental class. Then to find out whether the difference in the values of the two sample classes is significant or not, statistical analysis is carried out in the form of a normality test, homogeneity test and two average similarity test.

a. Normality test

The normality test used in this research is the Liliefors test. The normality test is carried out on students' knowledge. The instrument used to measure students' knowledge uses a written test. The results of the normality test for the two sample classes on knowledge can be described in Table 5.

Table 5 Normality Test Results of the Two Sample Classes on Knowledge

Class	N	α	L_o	L_t	Information
Experiment	25	0.05	0,135	0,173	Normal
Control	28	0.05	0,147	0,161	Normal

Based on Table 2, it can be stated that the experimental class has a value L_0in the control class, namely 0,13507. Both sample classes are normally distributed if they have a value of $L_0 < L_t$. The value $L_t$at a significant level of

0.05 for n=25 was 0,13507, and for n=28 it was L_0 0,147352. The results of the normality test for the two sample classes obtained values of $L_0 < L_t$. Means from the learning outcomes data of the two sample classes from normally distributed populations.

b. Homogeneity Test

Homogeneity test was carried out to see whether the two sample classes have homogeneous variants or not. The homogeneity test carried out in this research is the F test. The results of the homogeneity test of the two sample classes on knowledge are described in Table 6.

Table 6 Homogeneity Test of the Two Sample Classes on Knowledge

Class	N	S^2	A	F_h	Ft_	Information
Experiment	25	219,15	0.05	1,47	1,92	Homogeneous
Control	28	148,40	0.05			

From the results of the homogeneity test analysis in Table 3, it can be explained that the two samples have a value of $F_h < F_t$. Where the value $F_h$is obtained 1,4767,while the value of $F_t$the two sample classes is this. 1,92994This shows that the learning outcomes of the two sample classes are homogeneous.

c. Hypothesis testing

Based on the results of the analysis of the normality test and homogeneity test at the end of the two sample classes, the data were normally distributed and had a homogeneous variant, so the two average similarity hypothesis tests were carried out. The test for the similarity of the two averages is done in the form of a t test. The results of the t-test analysis for the two sample classes are as described in Table 7.

Table 7 The results of the two similarity tests on the average of the two sample classes on knowledge

Class	N	A	$\bar{x}$	S^2	t_h	t_t
Experiment	25	0.05	76,95	0.05	2,7644	0,003957
Control	28	0.05	66,69642857	0.05		

Based on Table 4, it can be analyzed that the average value of the knowledge aspect of the experimental class is higher than the average value of the control class. The results of the t-test analysis of the two sample classes obtained values $t_{hitung} = 2{,}7644$ while the values t_{tabel} were $0{,}003957$. Recipient criteria H_0 If $-t_{(0,975)} < t_{hitung} < t_{(0,975)}$at a real level$0{,}05$ and $dk = 53$. Based on the results of data analysis, prices $t_{hitung}$are outside the acceptance area H_0, or are in the acceptance area H_i, $H_i$meaning that they are accepted.

This study used a quasi experimental method (quasi experimental design) using the posttest only design. The two groups in this study, namely the control and experimental groups, were given different treatments. the group with the control variable is the group that uses teaching materials in the form of textbooks and learning is still conventional, while the experimental variable group, learning uses STEM-integrated e-modules. This opinion is reinforced by that this design is also influenced by other variables and not solely by treatment. This study aims to directly test the effect of a variable on other variables and test the hypothesis of a causal relationship. A quasi-experiment is a type of research that is used to examine a group that cannot fully control external variables. The initial step in this study was to randomly select the experimental group and the control group.[18]

The e-module has been validated by Physics lecturers. However, there are still a number of schools that have not implemented STEM. On the subject of sound and light waves as well as optical devices. From this research, the final product is supported by *professional flipbook* media equipped with videos and STEM learning. This research has not tested its effect in class, so researchers are interested in testing this product at Senior High School , in order to see the effect on students' creative thinking abilities[17].After being given different treatment to the two groups, both groups were given a final test (posttest) to determine the creative thinking ability of each group. According to the authors, this research is very important because it can determine the Effect Of The Stem Integrated Physics E-Module in Class XI at Senior High School.

This research is only to find out that there are differences in students' creative thinking abilities in terms of knowledge using e-modules and not using e-modules in Class XI. Besides that, the prosessing of the data obtained according to the authors of this study is very important because it can determine the effect of the STEM Integrated Physics e-Module in class XI in SMA. The initial condition of knowledge of the two sample classes has the same ability. The results of data analysis before determining the sample class, the value of $t_{hitung}$the two sample classes is 2,76447344937274 After being treated in the form of STEM integrated e-module in the experimental class, the valuet_{hitung} as big as 2,7644 The difference in t_{hitung}these values indicates that there is a significant effect of using STEM integrated physics e-modules on student knowledge.

IV. CONCLUSION

The purpose of this study was to see the effect of the STEM Integrated Physics E-Module to improve the Creative Thinking Ability of Class XI Students of. A trial was conducted regarding the effect of STEM-integrated sound and light wave e-modules on students' creative thinking abilities. After analyzing the data, two conclusions were obtained in this study.

1. The STEM integrated sound and light wave e-module has a significant influence on student knowledge which can be seen from student learning outcomes.
2. The STEM integrated e-module has a significant influence on improving students' creative thinking abilities in terms of knowledge in problem solving based on the posttest questions given. Based on the conclusions, it is hoped that the STEM integrated e-module can be used as a source of independent learning for students in achieving learning goals so that meaningful learning is realized, and the formation of students who are able to compete with current advances in knowledge and technology.

ACKNOWLEDGMENT

The researcher thanked the supervisor for writing this article. Researchers would like to thank those who have helped carry out this research so that researchers can complete this research properly. Hopefully, this research is useful for other researchers and can do better research in the future

REFERENCES

[1] N. Nazifah, A. Asrizal, and F. Festiyed, "Analisis Ukuran Efek Pengaruh Penggunaan Bahan Ajar Terhadap Kemampuan Berfikir Kreatif Siswa," *J. Pijar Mipa*, vol. 16, no. 3, pp. 288–295, 2021, doi: 10.29303/jpm.v16i3.2419.

[2] P. N. Ananda, A. Asrizal, and U. Usmeldi, "Pengaruh Penerapan PjBL terhadap Keterampilan Berfikir Kritis dan Kreatif Fisika: Meta Analisis," *Radiasi J. Berk. Pendidik. Fis.*, vol. 14, no. 2, pp. 127–137, 2021, doi: 10.37729/radiasi.v14i2.1277.

[3] I. Wilujeng, T. Suci, and Y. Putri, "Development of SETS E-Module Integrated with POE Model for Science Learning," vol. 6, no. 2, pp. 252–264, 2020.

[4] A. I. Safitri, Festiyed, A. Putra, and F. Mufit, "Desain Modul Interaktif Menggunakan Aplikasi Course Lab Berbasis Pendekatan Saintifik pada Materi Usaha, Energi, dan Momentum," *J. Pillar Phys. Educ.*, vol. 12, no. 3, pp. 433–440, 2019, [Online]. Available: Safitri, A. I., & Festiyed, F. (2019). Desain Modul Interaktif menggunakan Aplikasi Course Lab berbasis Pendekatan Saintifik Pada Materi Usaha, Energi, dan Momentum. Pillar of Physics Education, 12(3).

[5] A. Asrizal, A. Amran, A. Ananda, and F. Festiyed, "Effectiveness of Adaptive Contextual Learning Model of Integrated Science by Integrating Digital Age Literacy on Grade VIII Students," *IOP Conf. Ser. Mater. Sci. Eng.*, vol. 335, no. 1, 2018, doi: 10.1088/1757-899X/335/1/012067.

[6] H. City Council, "Some curriculum implications," *Support. Child. with Dyslexia*, pp. 40–40, 2020, doi: 10.4324/9780203821411-19.

[7] P. E. Pengayaan *et al.*, "FAKTA TERHADAP KETERAMPILAN BERPIKIR KRITIS DAN KREATIF PESERTA DIDIK KELAS X SMAN 2 PADANG Staf Pengajar Jurusan Fisika , FMIPA Universitas Negeri Padang," vol. 13, no. 2, pp. 289–296, 2020.

[8] Hufri *et al.*, "Analysis of basic electronics 2 textbook reviewed from the aspects of creative thinking in the Physics Department of FMIPA UNP Padang," *J. Phys. Conf. Ser.*, vol. 1481, no. 1, 2020, doi: 10.1088/1742-6596/1481/1/012124.

[9] S. R. Putri and Festiyed, "Meta-Analisis Implementasi Landasan Ilmu Pendidikan Dalam Pengembangan E-Modul Fisika Berbasis Pendekatan Sets (Science Environments Technology Society) Pada Pembelajaran Fisika," *J. Penelit. Pembelajaran Fis.*, vol. 5, no. 2, pp. 57–64, 2019.

[10] I. Rahayu and S. Sukardi, "The Development Of E-Modules Project Based Learning for Students of Computer and Basic Networks at Vocational School," *J. Educ. Technol.*, vol. 4, no. 4, p. 398, 2021, doi: 10.23887/jet.v4i4.29230.

[11] R. Zaputra, F. Festiyed, Y. Adha, and Y. Yerimadesi, "Meta-Analisis: Validitas Dan Praktikalitas Modul Ipa Berbasis Saintifik," *Bio-Lectura*, vol. 8, no. 1, pp. 45–56, 2021, doi: 10.31849/bl.v8i1.6039.

[12] Y. Mardyansyah, Asrizal, and Yulkifli, "Pembuatan Modul Fisika Berbasis Tik Untuk Mengintegrasikan Nilai Pendidikan Karakter Dalam Pembelajaran Siswa Sman 10 Padang Kelas X Semester 1," *Pillar Phys. Educ.*, vol. 1, no. April, pp. 30–38, 2013.

[13] Asrizal, A. Maharani Zan, and V. Mardian, "The Impact of Static Fluid E-Module by Integrating STEM

on Learning Outcomes of Students," *J. Educ. Technol.*, vol. 6, no. 1, pp. 110–118, 2022, [Online]. Available: https://dx.doi.org/10.23887/jet.v6i1.4

[14] Permendikbud, "Undang-Undang Republik Indonesia Nomor 21 Tahun 2016 tentang Standar Isi Pendidikan Dasar dan Menengah," *Internatinal Sci.*, vol. 5, pp. 1–238, 2016.

[15] J. Jurnal Kajian Teknologi Pendidikan, R. Rahman Sutrisno, and G. Hamdu, "APLIKASI MOBILE LEARNING MODEL PEMBELAJARAN STEM UNTUK GURU SEKOLAH DASAR Article History," *Agustus*, vol. 3, no. 3, pp. 227–238, 2020, doi: 10.17977/um038v3i32020p227.

[16] P. Z. Maharani Sastra, Y. J. Jalis Putri, F. Pratama, and D. Desnita, "Meta-Analysis of the Effect of STEM Approach on Students' Creative and Critical Thinking Skills in Physics Learning in Senior High School," *J. Geliga Sains J. Pendidik. Fis.*, vol. 10, no. 1, p. 61, 2022, doi: 10.31258/jgs.10.1.61-73.

[17] N. Nazifah and A. Asrizal, "Development of STEM Integrated Physics E-Modules to Improve 21st Century Skills of Students," *J. Penelit. Pendidik. IPA*, vol. 8, no. 4, pp. 2078–2084, 2022, doi: 10.29303/jppipa.v8i4.1820.

[18] Sugiiyono, "Metode Penelitian Kuantitatif Kualitatif dan R&D." p. 444, 2019.

[19] S. Siswanto and E. Susanti, "Evaluasi Program Pendidikan Islam," *Paramurobi: Jurnal Pendidikan Agama Islam*, vol. 2, no. 1. pp. 65–74, 2019. doi: 10.32699/paramurobi.v2i1.817.