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The Impact of Basic Physics E-Module Using Problem Oriented on Critical Thinking Skilss of Physics Teacher Candidate Students

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Abstract: The aim of this work was to investigate the effect of problem-oriented basic physics modules on improving the critical thinking skills of physics teacher candidate students. The type of research used was semi-experimental in two different classes. The next target of this research was the students of Samudra University's FKIP Physics Graduate Program. The data collection tools and techniques used in this study are basic physics questions that enhance critical thinking through problem-based basic physic e-modules. The results of this study, namely the hypothesis test results, were obtained sig (2-tailed) = 0.000 < 0.05, when testing the hypothesis that H_0 is rejected and Ha is accepted. Therefore, it can be concluded that the e-module of basic physics has a problem-based effect on the critical thinking skills of physics teacher candidate students. Effect size value is d = 2.90 > 0.08, so it can be considered high. Therefore, it can be concluded that there is an influence of the electronic module of basic physics using a problem-oriented approach on the critical thinking skills of prospective physics teacher students. This research shows how effective E-modules are in fostering critical thinking abilities.

Keywords: Critical Thinking Skills, Basic Physics E-Modul Using Problem Oriented

Introduction

Rapid technological changes in the 21st century require people to be able to maximize existing technological developments to sustain their lives. This technological change is based on the foundation of the Industrial Revolution 4.0 in the world. The industrial revolution 4.0 is the change and development of the industrial field leading to digital with a system directly connected to the internet. The Industrial Revolution 4.0 has a great influence on all areas of human activity, not just education (Rahman & Lena, 2023). As technology develops, teachers must be able to manage technology as a tool in the teaching and learning process. Teachers must be able to maximize learning by mastering computer devices and making classroom learning enjoyable for students. In the learning process in the 21st century, the teacher must also strive to be able to have teaching skills, namely giving learning experiences that are more critical, innovative, and meaningful with the use of information and Communication Technology (ICT), so that learning students can achieve thinking skills at the 4C level, namely critical thinking, Communication, Collaboration, creativity, and Innovation (Martatiyana et al., 2022). Students who are able to think critically are better prepared to compete worldwide and meet the challenges of the twenty-first century. Due to this, developing critical thinking abilities is now prioritized in educational goals and is included in a new core curriculum (Suryani et al., 2020).

One of the skills that future physics teachers in the 21st century must possess is critical thinking. Critical thinking skills can be one of the factors that support successful learning. Many people believe that one of the

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characteristics of intelligent people is the ability to think critically. Critical thinking is a way of thinking at a higher level by producing the ability to identify problems, analyze them, determine steps for solving them, draw conclusions, and make decisions (Unwaru et al., 2023). People who have the ability to think critically are able to analyze arguments, raise problems, and reason coherently and logically. Meanwhile, a person with critical thinking skills tends to create something critical and original. Both types of thinking are very important for future physics teachers (Hidayat & Santoso, 2021).

Critical thinking is learning in which students draw conclusions or solve problems. Students can solve the problem if the learning process provides an opportunity to think critically, which is a self-directed, self-monitoring, and self-regulating process (Kustijono & Hakim, 2020). In critical thinking, there are aspects that support students' ability to think critically so that, after studying the material, they can not only understand but also be able to conclude what they have obtained. This type of research and test development to determine students' critical thinking skills had previously been carried out by Ennis (1987); this time the same test would be carried out with reference to aspects of critical thinking in physics education students (Syifa & Sudarti, 2021). Learning activities can help students strengthen their critical thinking abilities. Students are required to actively participate in their education and exercise independence. Including real-world questions with feedback is one way to put your critical thinking skills to the test. Students should be able to determine the truth underlying an occurrence through the use of critical thinking. In order for it to fully grasp (Saputri et al., 2020).

Based on the researchers' observations, the critical thinking ability of the candidates for physics professor at Ocean University is weak. Students' low critical thinking skills are due to a lack of study materials, which can increase the interest and enthusiasm of future physics teachers to learn so that they can improve their critical thinking skills. of future physics teachers. This is consistent with the study conducted by Maguna et al. (2019) which found that the critical thinking ability of the 2014 student physics teacher candidates was limited to the electrodynamic device classified as very low critical. The results of the interviews show several factors that influence students' low critical thinking skills, namely that students tend to provide information related to a given problem by writing based on what comes to their mind, not with the knowledge that the student really knows the answer to the problem given. In addition, students' lack of knowledge, both in understanding concepts and equations, is the cause of their low critical thinking skills. Research results also show that the value of each indicator used is in the least important category. The highest score on the indicators used is for analytical skills.

A good learning model is one that encourages and stimulates students' interest in learning (Apriani & Yulikifli, 2021). To improve the critical thinking skills of physics teacher candidates, interactive learning media are needed. To be able to learn independently, it is vital to build digital teaching resources that include student-centered learning models. One of the digital teaching materials that focuses on enhancing student independence in learning and has a brief discussion of it is the electronic module, or the electronic module for short (Apriani & Yulkifli, 2022). Learning modules are created to organize learning materials systematically by field of study in accordance with the guidelines of cutting-edge specialists, with the goal of enhancing effectiveness and efficiency and raising students' interest in further learning (Susanti et al., 2021).

E-Modules are books in the form of soft files that can be opened and read by students anywhere and anytime. The e-module is also a display of information that can be read via a computer in a book format that is presented electronically (Malina et al., 2021). An electronic module (e-module) is a form of self-learning material that is systematically divided into smaller learning units to achieve specific learning objectives and is presented electronically in electronic form (digitally) (Elvinawati et al., 2022). E-Modules are books in the form of soft files that can be opened and read by students anywhere and anytime.

E-modules have the potential to be more multimedia-rich learning materials than the typical print media module. Multimedia is the seamless integration of two or more media elements, such as text, images, graphics, photography, sound, film, and animation. Both teachers and students benefited from multimedia because it made learning more engaging, interactive, and time-efficient while also improving learning quality and allowing for flexible implementation (Sukarmin & Sani, 2023). E-modules can help students better understand the material being studied. This requires teachers to seriously prepare and develop teaching materials so that students have more interest in learning physics and really understand the material presented. E-Module use that incorporates science process skills might enhance students' critical thinking abilities and learning drive (Widiyanto et al., 2021).

Electronic teaching aids in the form of electronic modules are more convenient and efficient and can support all the multimedia components required for learning. Advantages of electronic modules over conventional modules include: a) e-modules are considered more attractive because they are equipped with pictures, videos, and so on; b) they are paper-free because they are electronic; c) they are multiplatform because they can be used via computers, laptops, and cellphones.

Building on the foregoing, the purpose of this study was to determine the effect of the Basic Physics Electronics Module using a problem-oriented approach on the critical thinking skills of teacher students and future physicists.

Method

This study was conducted as part of the physical education program at Samudra University. This study was conducted in May–June 2023. The population is the subject of the study. In planning this study, the population included all physics education students at Samudra University. The sample is part of or representative of the population being studied. The sampling technique in this study uses random sampling, which is a random sampling technique that does not follow a specific criterion. The samples for this study were the 2021 class of physical education students and the 2022 class of physical education students.

The research method used in this study is the quasi-empirical method. Experimentation is a quasi-testing method that does not allow the researcher to have complete control over the experimental variables and conditions. The non-equivalent control group design used in this study The study design can be seen in the following table 1.

Table 1. None-equivalent Control Group Design

Group	Pretest	Treatment	Posttets
Experiment	O_1	X_1	O_2
Control	O_3	X_2	O_4

(Farell et al., 2021)

Information:

O_1 : Pretest given to the experiment group before being given treatment.

O_2 : Posttest given to the experiment group after being given treatment.

O_3 : Pretest given to the control group before being given treatment

O_4 : Posttest given to the control group after being given treatment.

X_1 : The treatment with basic physics e-module using problem oriented in the experiment class.

X_2 : Treatment of conventional learning models in the control class.

This study includes independent (X) and dependent (Y) variables. The independent variable is the basic physics e-module using a problem-oriented approach, and the dependent variable is the critical thinking ability of the physics teacher candidate. The research procedure is as figure 1.

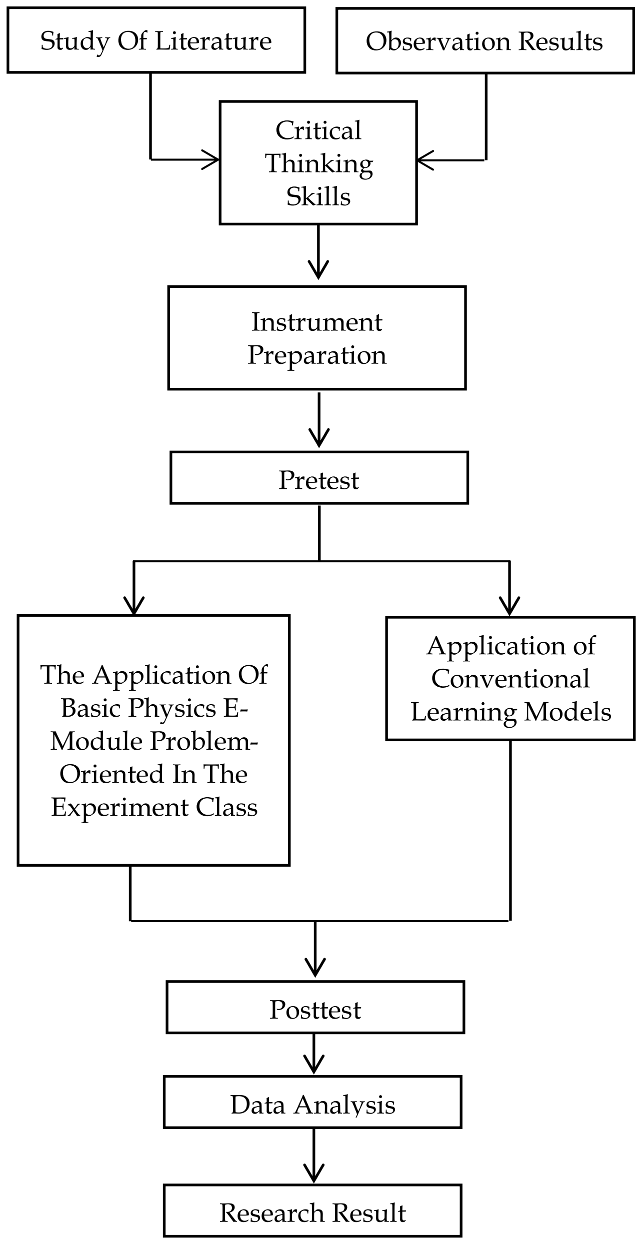

Figure 1. Flow Chart Of Research Stages

The techniques used to collect data in this study were experimental, observational, and documentary. Data obtained through research tools is processed and analyzed with the aim of answering research questions and testing research hypotheses. Data analysis aims to derive meaning from the experimental data that has been collected. The data analysis techniques used in this study are as follows:

Increase (N-gain)

Normal gain is calculated to determine the difference (increase or decrease) between pre-test and post-treatment results. The calculation of N-Gain can be done using the equation:

$$N\text{-}Gain = \frac{Final\ attitude\ score - initial\ attitude\ score}{maximum\ score - initial\ attitude\ score} \quad (1)$$

Table 2. N-Gain Interpretation Criteria

N- Gain	Category
g > 0.7	High
0.3 ≤ g ≥ 0.7	Medium
g < 0.3	Low

Prerequisite Analysis Test

To test the hypothesis that there is an impact of the basic physics e-module using a problem-based approach on improving the critical thinking skills of students who are prospective physics teachers, an experiment was conducted. Hypothesis testing was performed. Data processing for hypothesis testing using IBM SPSS 22.

Normality Test

The normality test is an attempt to determine whether the variable data we have is close to a normally distributed population or not. In other words, to test the normal distribution of the data to be analyzed The normality test with Shapiro-Wilk was used because, in this study, the number of samples was <100. The Shapiro-Wilk test will be normally distributed if the significance value is > 0.05, but if the significance value is < 0.05, then the distribution is not normal.

Homogeneity Test

The homogeneity test is a test to determine whether the variances of two or more distributions are identical. A homogeneity test was conducted to find out if the effect size category was the same (homogeneous) population or not. On the basis of the calculation of the homogeneity test on SPSS IBM 22 , if the significance value is above 0.05 then the variance data is homogeneous, and vice versa.

Test The Research Hypothesis

After normality testing was performed, hypothesis testing was performed using SPSS IBM 22 with parametric hypothesis testing, namely an independent sample t test. The independent sample t test is a parameter test used to determine the difference between two asymmetric groups. If Ho is accepted, the sig value (2-tailed) α = 0.05, and if Ho is rejected, the sig value (2-tailed) = 0.05. To test the hypothesis to be studied, namely:

H_0: $\mu_1=\mu_2$: There is no effect of basic physics e-module using problem-oriented on the critical thinking skills of physics teacher candidates.

H_a: $\mu_1\neq\mu_2$: There is an effect of basic physics e-module using problem-oriented on the critical thinking skills of physics teacher candidates.

Effect Size

To see the effect of the basic physics e-module using the problem-oriented approach on improving the critical thinking skills of prospective physics teacher students, the effect size calculation is used as follows:

$$d = \frac{M_1 - M_2}{\sqrt{\frac{SD_1{}^2 + SD_2{}^2}{2}}} \quad (2)$$

Information:

d = Effect Size

M_1 = The average value of N-Gain in the experimental class

M_2 = N-Gain average value in the control class

SD_1 = Standard deviation in the experimental class

SD_2 = Standard deviation in the control class

Table 3. Effect Size Category

Effect Size	Category
0 ≤ d ≤ 0.20	Low
0.20 ≤ d ≤ 0.80	Medium
d ≥ 0.80	High

(Izzah et al., 2021)

Result and Discussion

The respondents were 15 physics teacher candidates in the experimental class and 10 physics teacher candidates in the control class. Assessment of students' critical thinking is grouped by focus, reasoning, situational, clarity, and understanding. Improvement of Critical Thinking (N-Gain) of Physics Teacher Candidates After Implementation of Elementary Physics Modules in Experimental Lessons with Problem Orientation and Application of Traditional Models for Physics Teachers The growth (N gain) in both categories is as follows:

Table 4. Critical Thinking Skills in Control and Experiment Classes

Indicator	Group	Pretest	Posttest	N-gain	Category
Focus (F)	Control	1.80	3.60	0.22	Low
	Experiment	3.60	8.93	0.83	High
Reason (R)	Control	1.70	4.10	0.28	Low
	Experiment	3.07	9.27	0.89	High
Inference (I)	Control	1.90	3.10	0.14	Low
	Experiment	3.13	8.93	0.83	High
Situation (S)	Control	9.20	12.30	0.10	Low
	Experiment	12.93	31.13	0.67	Medium
Clarity (C)	Control	3.90	7.00	0.19	Low
	Experiment	9.00	16.40	0.65	Medium
Overview (O)	Control	1.60	3.80	0.26	Low
	Experiment	3.33	8.93	0.83	High
Average	Control	20.10	33.90	0.20	Low
	Experiment	35.0	83.59	0.78	High

Based on Table 4, in the 6 criteria for assessing critical thinking skills in each class, both experimental and control classes have an increase in value (N-gain). The mean N gain in the control class was 0.20 in the low class, and the mean N gain in the experimental class was 0.78 in the high class. It can be concluded that the basic electronic physics module with a problem-oriented approach can improve the critical thinking skills of prospective student physics teachers. Think critically based on the analysis completed in line with the indicators to ensure that it satisfies all of the requirements for thinking about FRISCO (Astiantari et al., 2022). In the experimental class, students are able to solve problems right away without having any difficulty understanding them. Students are capable of making sound plans, carrying them out coherently, and coming up with quick solutions to issues. Students double-check their responses as well.This is in line with research done by Prabasari et al. (2021) that shows how effective E-modules are in fostering critical thinking abilities. The findings of this study are also consistent with research done by Saputra et al. (2023), who found that modules are useful teaching aids that may be utilized to make sure that learning occurs in a structured way. The module can help students learn science information independently and in a more pedagogically sound manner.

The ability to conceptualize, analyze, synthesize, conceptualize, analyze, and evaluate information to arrive at solutions or conclusions is called critical thinking (Rizki et al., 2021). This is consistent with the opinion of Wahyuni et al. (2020), who found that one of the factors affecting the participants' critical thinking skills in physics material is the teaching materials. Critical thinking abilities have both immediate and long-term effects on students' learning outcomes and problem-solving abilities. In the near term, they help students handle difficulties they encounter in daily life and make wise decisions (Kurniawan et al., 2023). The graph of the average score of students' critical thinking skills as physics teachers is as follows:

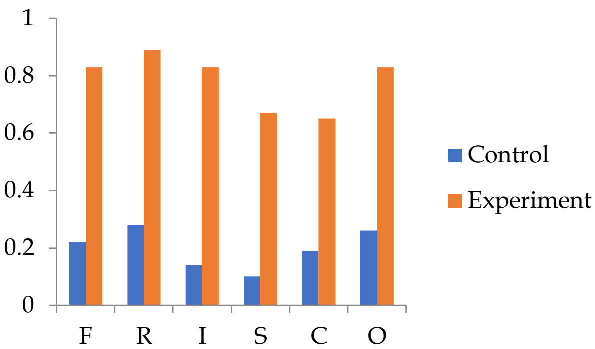

Figure 2. Critical Thinking Skills In Both Grades

After using the N-gain test, the normality test and the homogeneity test were performed. This is done. to find out if the study data are normal and homogenous or vice versa. The results of testing for normality and homogeneity are presented in the table 5.

Table 5. Normality and Homogeneity Test Critical Thinking Skills

Group	Test of Normallity Shapiro-Wilk			Test of Homogenity of Variances
	Statistic	Df	Sig.	Sig.
Control	0.915	10	0.314	0.675
Experiment	0.930	15	0.277	

Based on table 5, the normality test for critical thinking skills in the control class is sig 0.314 > 0.05, so it is normally distributed. The normality test for critical thinking skills in the experimental class has a sig value of 0.277 > 0.05, so it is normally distributed. The homogeneity test for both classes is sig 0.675> 0.05, so it is homogeneous.

Furthermore, a parametric test was carried out for normally distributed and homogeneous data using an independent sample t-test. The test was carried out in two classes with different treatments; the experimental class was given a basic physics e-module using a problem-oriented approach, while the control class was given a conventional learning model. The results of the independent sample t-test are shown in the following table 6.

Table 6. Independent Sample T-Test

Group	N	Mean	SD	Std. Error	Sig (2-tailed)
Control	10	33.90	4.46	1.41	0.000
Experiment	16	83.60	4.62	1.19	

Based on the table 6, in the experimental and control classes, the sig value (2 tailed) is 0.000 < 0.05, and the hypothesis test is that H_0 is rejected and H_a is accepted. Therefore, it can be concluded that there is an influence of the basic physics module using a problem-oriented approach on the critical thinking skills of physics teacher candidates. This is consistent with the study conducted by Paramitha et al. (2021) which applied this e-module to physics learning to make the teaching and learning process more effective and impact critical thinking skills.

To investigate the effect of using the problem-oriented Basic Physics e-Module on the critical thinking skills of prospective physics teachers, the scale of influence was measured. The scale of influence in this study is as follows:

Table 7. Effect Size

Control		Experiment		SD	d	Category
N	N-Gain	N	N-Gain			
10	0.20	15	0.78	0.20	2.90	High

Based on Table 7, the obtained effect size value is d = 2.90 > 0.08, so it can be considered high. Therefore, it can be concluded that there is an influence of the electronic module of basic physics using a problem-oriented approach on the critical thinking skills of prospective physics teacher students.

The results of this study are in agreement with the study conducted by Wahyuni et al. (2020) which showed that electronic modules based on linear motion and parabolic motion hardware problem-solving can develop aspects of X-grade high school students' critical thinking skills on transfer hardware. linear motion and parabolic motion.

A logical and coherent mentality can be developed via the use of critical thinking abilities, which are higher-level cognitive processes that provide the basis for assessing one's arguments, produce insights from each meal, and are able to interpret (Liana et al., 2022). The ability to critically evaluate gathered and interpreted information and decide its applicability in issue solving is known as critical thinking (Asrizal et al., 2023). The concept of critical thinking has multiple dimensions, including cognitive, dispositional, motivational, attitudinal, and metacognitive processes (Lestari & Apsari, 2022). The ability to think critically is not always there at birth. However, through the direct experience of students solving problems, critical thinking skills can be developed. Students' poor critical thinking skills are influenced by a number of variables, including lecturers who continue to use boring teaching methods that require them to do nothing but take notes and listen to lectures. The application of interesting learning strategies by lecturers will help students become interested more quickly. To help students understand and improve their critical thinking skills, instructors need to find and use interesting learning resources. To help students develop their critical thinking skills, instructors must provide a learning environment in which they can be encouraged to do so (Adhelacahya, 2023). So based on the results of the study, the problem-oriented basic physics e-module can improve the critical thinking skills of prospective physics teacher students. The results of research conducted by Paramitha (2021) that electronic modules (e-modules) are a learning alternative for teachers as well as simple and useful instructional resources for developing students' critical thinking abilities. The utilization of e-modules makes them more effective and efficient for students to use by allowing them to study instructional material on their own (Nugroho et al., 2022).

Conclusion

Based on the results of the research, the effect of the basic physics module on the critical thinking of teachers of future physics students is problem-oriented. This can be seen in the gain (N-Gain) obtained in each statistic. There was a significant difference in the critical thinking of future physics teachers in the experimental class and the reference class. In addition, the results of the hypothesis testing show that the value of sig (2-tailed) = 0.000 < 0.05 means that H_0 is rejected and H_a is accepted. As a result, it can be concluded that the basic physics module, using a problem-oriented approach, has an impact on the critical thinking of physics teacher candidates.

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Authors Contribution
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Conflicts of Interest
The conduct and publication of this work do not include any conflicts of interest.

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