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Improving Critical Thinking Skills Students Through Problem Based Learning E-Module

Alhaerani Sianti Sulhan[1*], Insih Wilujeng[2], Zuhdan Kun Prasetyo[3]

[1] Magister of Physics Education, Faculty of Mathematics and Natural Sciences, Yogyakarta State University, Yogyakarta, Indonesia.
[2] Science Education Department, Faculty of Mathematics and Natural Sciences, Yogyakarta State University, Yogyakarta, Indonesia.
[3] Physics Education Department, Faculty of Mathematics and Natural Sciences, Yogyakarta State University, Yogyakarta, Indonesia.

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Corresponding Author:
Alhaerani Sianti Sulhan
alhaeranisianti.2022@student.uny.ac.id

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Abstract: This study aims to determine the improving in students' critical thinking skills through problem based learning e-modules on momentum and impuls material. The method used in this study was a pre-experimental design with a one-group pretest-posttest design. The research sample was X MIPA SMAN 1 Depok, totalling 35 students. Collecting data on critical thinking skills using essay tests. The research data was collected from the pretest and posttest of critical thinking skills on momentum and impuls material. The results showed the difference in pretest and posttest averages for each indicator of critical thinking skills, namely the indicator of formulating problems 6.57, evaluating logical arguments 5.83, making conclusions 5.19, and analyzing facts 5.09. Furthermore, the critical thinking skills of students experienced an increase after learning activities were carried out using problem-based learning e-module momentum and impuls with an N-gain value obtained of 51.41% in the medium category. Problem based learning can improve students' critical thinking skills.

Keywords: Critical thinking skills; E-module; Problem based learning

Introduction

The education system affects the progress of the region. Each region has an education system that aims to prepare the next generation for scientific skills. So far, the learning process has been controlled by the teacher so that it does not provide opportunities for students to develop independently through a process of discovery and thought (Setyorini et al., 2011). Minister of National Education of the Republic of Indonesia No. 41 of 2007 states that learning in educational units is carried out interactively, inspiring, fun, challenging, motivating students to participate actively, and providing sufficient space for initiative, creativity, and independence according to students' abilities, interests, and psychology.

Education in Indonesia must keep up with the times, namely education in the 21st century. Therefore, Indonesian education has made several changes to the education system and now uses the 2013 curriculum system (Kemendikbud, 2013). The system in the 2013 curriculum does not only focus on mastering the material being taught, but also on building good character. One of the abilities that students must have in the 2013 curriculum is critical thinking.

Critical thinking helps students analyze their thinking when making decisions (Turan et al., 2019) and draw conclusions from various aspects and perspectives encountered (Rizaldi & Mawardi, 2021). Likewise, learning physics requires critical thinking skills (Asrial et al., 2020). The main goal for learning physics leads to cognitive knowledge (Maynes, 2015) and conceptual knowledge that can benefit the abilities of students (Suana et al., 2017), to direct students to a higher level of knowledge (Sarwar & Trumpower, 2015) who can develop critical thinking skills in accordance with the curriculum (Maynes, 2015). By increasing the ability to think critically, the concepts taught will be easily understood by students.

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One of the subjects that applies to real life and can be explained scientifically is physics. Physics is a branch of science that studies natural phenomena or processes for the development of advanced technology and the concept of living in harmony with nature (Agustia & Fauzi, 2020). Students' difficulties in applying concepts on impulse and momentum material to everyday problems (Lawson & McDermott, 1987) students are weak in physics equations with the principles in everyday reality, for example students misinterpret the momentum and kinetic energy of colliding objects because they do not yet have expertise in the impulse momentum theorem and the energy work theorem in compression collisions (Lawson & McDermott, 1987). Students still have difficulty understanding the concepts of momentum and energy.

Critical thinking skills are essential for growth in environmental learning, as environmental attitudes are influenced not only by a student's ability to master knowledge. Critical thinking skills, also known as high-level processing skills, help people connect knowledge and information from various sources and experiences to gain a broader perspective and understanding (Fikriyatii et al., 2022). Critical thinking skills are essential skills to cope with the challenges of the 21st century and help students to be responsible, conscientious, trustworthy and able to solve problems in everyday life and thereby strengthening their autonomy (Bendraou & Sakale, 2023).

Critical thinking ability can be measured using several indicators:

Table 1. Indicators of Critical Thinking Skills

(Ennis, 1993)	(Krulik & Rudnick, 1995)	(Facione, 2011)	Synthesis Results
Formulate the main problem	Identify and interpret information	Interpretation: clarifying meaning through categorization and translation	Analyzing facts
Reveal existing facts	Analyze information	Analysis: identify and examine ideas and arguments	Formulates problems
Selecting logical arguments	Evaluating evidence and arguments	Evaluation: assessing arguments	Evaluating logical arguments
Detects bias with different viewing angles		Explanation: justifying the result, argument, or procedure	Making a conclusion
Making a conclusion		Self-regulation: self-assessment and reflection	

So that this study is guided by the results of the synthesis of indicators: analyzing facts, formulating problems, evaluating logical arguments, and making conclusions. Students' critical thinking skills have not been optimally developed through the physics learning process. Sulardi et al., (2015) conducted a pre-survey on his research, it was found that out of 20 students in class XII IPA SMAN 1 Muara Lawa who had studied physics material, only 3 students were skilled and able to answer questions on the critical thinking ability test correctly, this indicated that students' abilities in analyzing problems using critical thinking skills is still low (Miharja et al., 2019).

Based on the results of a preliminary study conducted at SMAN 1 Depok class X, several findings were obtained regarding the low ability to think critically, including: students were less able to give arguments, only a few students gave arguments about the material being discussed, in learning process students have difficulties in deducing an event or phenomenon, and students have difficulty analyzing data and are less able to decide solutions based on theory of the problem.

To overcome these problems, the problem-based learning model is one of the learning methods that can help students develop critical thinking skills in learning (Muchib, 2018). This learning allows students to learn independent of the problems given (Maharani et al., 2023). Problem-based learning is a learning model that trains students to work on authentic, student-centered problems (Yuan et al., 2020). Problem based learning can also be interpreted as a teaching model that uses problems as a focus to improve critical thinking skills (Aji et al., 2017). Problem-based learning is a set of strategies used as a "trigger" to develop students' higher-level skills, educational goals, and out-of-the-box thinking (Bendraou & Sakale, 2023). Problem based learning has 5 syntax. The five syntax include students' orientation to the problem, organizing students to learn, guiding individual and group investigations, develop and present the work and analyzing and evaluating the problem-solving process (Fadilla et al., 2021).

The development of science and technology always influences learning media like e-modules. E-module as a module based on technology, information and communication, has advantages compared to print modules in that it is interactive in nature, facilitates navigation, allows displaying/loading images, audio, video and animation and is equipped with formative tests or quizzes that allow immediate automatic feedback (Suarsana & Mahayukti, 2013). E-modules tends to be flexible and adaptable to a variety of

approaches (Yuningtyas et al., 2023). E-module is one learning media that can improve critical thinking skills (Kusmaharti & Yustitia, 2022).

The characteristics of the electronic module are adapted from the characteristics of the module, including self-instructional, self contained, stand alone, adaptive, and user friendly (Rozi et al., 2022). E-module is a learning tool or facility that contains material, methods, limitations and ways of evaluating that are designed systematically and interestingly to achieve the expected competencies according to the level of complexity electronically (Ramadayanty et al., 2021). Using Anyflip gives users the opportunity to save their work in the account they created. The product distribution process is also easier because it can be accessed online and there is no need to download files (Miskiyyah et al., 2023)

As previously explained, the reason for choosing problem-based learning is because it is a learning model that can help students improve their abilities their critical thinking skills. From the five syntax of problem-based learning that have been stated previously, you can: It can be seen that during the learning process, students are more dominant than teachers.

Method

This study used the pre-experimental design method with one group pretest and posttest design with research subjects in class X MIPA 3 SMAN 1 Depok Academic Year 2022/2023 consisting of 35 students. The subjects in this study used problem based learning e-modules in the learning process. Learning was measured before and after treatment. Thus, the results of the treatment can be known more accurately because they can be compared with the conditions before being given treatment (Sugiyono, 2014). Research flow can be seein in the Figure 1.

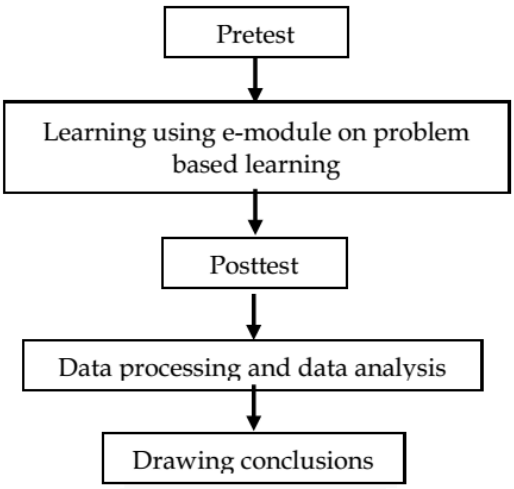

Figure 1. Research flow

The following is a table 2 of the one group pretest and posttest research design.

Table 2. One Group Pretest and Posttest Design

Pretest	Treatment	Posttest
O_1	X	O_2

Information:

O_1 :Test before using e-module

X : Learning using e-modules on problem based learning

O_2 : Test before using e-module

This study uses instruments in the form of questions in the form of essays which are structured based on indicators of critical thinking skills, namely: analyzing facts, formulating problems, evaluating logical arguments, and making conclusions.

To find out the improve in critical thinking skills that is measured, the calculation of the normalized average gain (N-gain) score data developed by Hake, (1999) is used with the equation:

$$g = \frac{S_{post} - S_{pre}}{S_{m\ ideal} - S_{pre}} \quad (1)$$

The obtained average N-gain value is then interpreted based on Table 3 below:

Table 3. N-Gain Score Category

N-Gain Value	Category
$N - gain < 70\%$	High
$30\% < N - gain < 70\%$	Medium
$N - gain < 30\%$	Low

Furthermore, statistical tests were carried out by conducting prerequisite tests, namely the normality test and Wilcoxon test.

Result and Discussion

Implementation of learning begins with pretest activities to determine students' initial abilities. Furthermore, learning is carried out using e-modules based on problem-based learning on momentum and impulse material, then at the end of learning a post-test is carried out. The results of the pretest and posttest for each indicator of critical thinking ability are presented in Figure 2.

Based on Figure 2 the lowest indicator is formulating the problem because in working on the problem, many students still have not fully written down the steps that should be taken in solving the problem. In accordance with research by Rahayu et al. (2018) 13.73% of students are in the low category for indicators of analysis or formulating problems because

some students don't even write down the steps to solve the problem at all. Then the average difference coefficient of students on the indicators of formulating problems before and after being given treatment is 6.57. Then for indicators evaluating logical arguments of 5.83. The indicator makes a conclusion of 5.29. And the indicator analyzes the facts of 5.09.

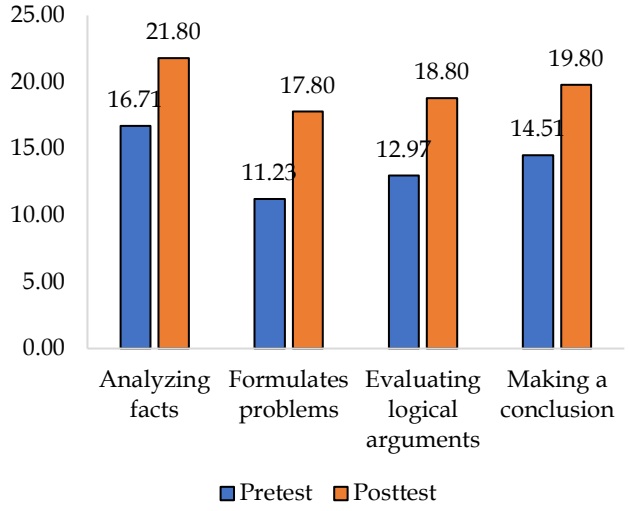

Figure 2. Pretest and Posttest analysis for each indicator of critical thinking skills

To find out whether the data is normally distributed or not, the normality test is carried out as follows.

Table 4. Normality Test Results

	Statistic	df	Sig.	Category
Pretest	.245	35	.000	No normally distributed
Posttest	.238	35	.000	No normally distributed

From table 4 it can be seen that the significance of the pretest and posttest in the normality test is 0.000 <0.05 so it can be concluded that the pretest and posttest data are not normally distributed. Then the Wilcoxon test was carried out to determine the value of the average difference. In allignment with other research (Hariandi et al., 2023; Ricky et al., 2023; Anggraini et al., 2022) carry out hypothesis testing using the Wilcoxon Signed test Rank Test because the data does not normally distributed. The results of the Wilcoxon test analysis are as follows:

Table 5. Wilcoxon Test Results

Test Statistics	
	Posttest – Pretest
Z	-5.172[b]
Asymp. Sig. (2-tailed)	.000

Based on the Wilcoxon test it is known that the pretest and posttest data have a significance level of 0.000 according to the test criteria if sig <0.05 then Ha is accepted. So, it can be concluded that there is an average difference after being given treatment using problem based learning e-module.

The improving in critical thinking skills for each indicator can be seen from the score obtained for each question based on the respective question indicators. The following is the percentage increase in indicators of critical thinking skills, which can be seen in table 6.

Table 6. N-gain Score

Indicator of Critical Thinking Skills	N-gain (%)	Category
Analyzing facts	61.45%	Medium
Formulates problems	46.60%	Medium
Evaluating logical arguments	48.12%	Medium
Making a conclusion	49.48%	Medium
Average	51.41%	Medium

The results of table 6. Show that the lowest change occurs in the indicator for formulating the problem, however, the increase in change is still in the moderate category, where this change still allows for an increase. So that the N-gain value obtained was 51.41%, this value indicated that the increase in critical thinking skills after being given treatment using problem-based learning-based e-modules occurred by 51.41% in the medium category. In accordance with the research of (Yulia & Salirawati, 2023) stated that the increase in students' critical thinking skills was included in the moderate improvement category after using the physics e-module. In alignment with other research, that problem based learning can be improve critical thinking skills (Adhelacahya et al., 2023). Good critical thinking skills will require students to analyze every condition in the social or natural environment (Indah & Kusuma, 2016). Based on this, learning activities using e-modules can be a pretty good solution to improve students' critical thinking skills.

Conclusion

Based on the results of the research that has been explained that problem based learning model improve students' critical thinking skills. the difference in pretest and posttest averages for each indicator of critical thinking ability is the indicator of formulating problems 6.57, evaluating logical arguments 5.83, making conclusions 5.19, and analyzing facts 5.09. Furthermore, the critical thinking skills of students experienced an increase after learning activities were carried out using problem-based learning e-modules momentum and impulse. This is seen from the increase in pretest and posttest results using the N-Gain obtained by 51.41%.

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Author Contributions
Theory analysis; data collection; analysis and paper writing, A. S. S.; supervision and review of writing, I. W and Z.K.P.

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Conflicts of Interest
The authors declare no conflict of interest.

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