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E-module development based on PBL integrated STEM assisted by social media to improve critical thinking skill: A preliminary study

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Abstract. This research aims to develop an electronic module (e-module) based on problem-based learning (PBL) integrated into Science, Technology, Engineering, and Mathematics (STEM) assisted by social media to improve students' critical thinking skills in a dynamic fluid material. The development of this research used a mixed-method consisting of qualitative and quantitative data. This study involved 308 students and 17 physics teachers in Lampung province. The results of the preliminary research conducted by only 12.5% of teachers used STEM integrated PBL-based e-modules to improve students' critical thinking skills and 46.6% of students stated that they only used printed books when physics learning. 100% of teachers and 88.2% of students stated that they need e-modules to make learning easier. 50% of teachers stated that they use social media as a learning tool. Based on the results of the preliminary study, the use of e-modules is needed by teachers and students. A need analysis needs to be done for the development of E-Module integrates STEM-assisted PBL-based social media to enhance students' critical thinking skills.

Keywords: Critical Thinking, PBL, Social Media, STEM

1. Introduction

Currently, we are in the 21st century which is a century with the development of science and technology that is very fast. In the 21st-century, we must be able to compete, for that we need skills to face the 21st century. Known 21st-century skills include critical thinking and problem-solving, creativity and innovation, communication, and collaboration [1]. Critical thinking skills are the most important skills to be successful in facing the 21st century. This is because critical thinking involves grouping, organizing, remembering, and analyzing information that can be internalized to students through systematic learning [2].

The ability to think critically in Indonesia is still not maximally learned. This can be seen from, 78% of Indonesian students who can only work on science questions which are in the low category, which is only knowing or memorizing [3]. The results of the 2015 PISA study [4] show that Indonesia's ranking in the field of science is ranked 61 out of 70 countries. Indonesia obtained a score of 401 while the average score of other PISA participants was 493.



Critical thinking skills can be learned through student-centered learning. Students are trained to practice their reasoning skills in dealing with various daily problems in groups or individually. The 2013 curriculum is a strategic step for the government to realize the challenges of the 21st century [5]. In the 2013 curriculum, there is a model that fits the characteristics of the scientific approach, one of which is problem-based learning [6].

The results of Arends's [7] study suggest that PBL helps improve the development of lifelong learning skills in an open, reflective, critical, and active learning mindset. PBL is learning based on problems. The problems that exist come from the surrounding reality and challenge students so that students can identify. Based on this process, the PBL learning model is implemented systematically by building student skills through problem-solving, identification, and solutions given in solving problems, especially in learning physics.

STEM-oriented PBL is one solution that can be applied to face the problems previously described because PBL is learning based on problems. by [8] shows that there is an increase in critical thinking skills through PBL models with outdoor learning. Through STEM learning, students have scientific and technological literacy that can be seen from reading, writing, observing, and doing science so that they can be used as provisions for living in society and solving problems faced in everyday life related to the STEM field of science [9]. [10] States that integrative STEM allows various learning methods to be used to support its application. Based on this, STEM can be oriented in the PBL learning approach. The STEM approach is expected to produce meaningful learning for students through systematic integration of knowledge, concepts, and skills besides the STEM approach, students can solve problems, become better, become innovators and inventors, are independent, logical thinkers, and are aware of technology [10].

This technological very rapid development provides opportunities for the world of education to make it easier to obtain information in the form of text, images, videos, and animations [11]. As an effort to adapt to the development of module technology to be made in the electronic form to make it more practical and efficient.

The module can be a solution because it has five characteristics main that become its advantages, namely self-instructional, self-contained, stand-alone, adaptive, and user friendly [12]. Besides, e-modules are very practical because they are easily accessed by students wherever and whenever [13]. This is in line with the results of cecep's research which states that e-modules are one of the easiest learning resources to use because they can be studied anywhere and anytime, are more interesting, interactive, and can improve learning outcomes. Also, e-modules can be used independently and are presented in an electronic format which includes animation, audio, navigation which makes users more interactive in learning [14]. The advantages of using E-Modules include being able to be integrated with the internet and directly playing videos [15]. Based on research conducted by [16] The use of E-Module can improve students' critical thinking skills and learning motivation.

However, based on the results of a preliminary study conducted by researchers on 308 students in Lampung, it was stated that it was very difficult to learn physics due to several factors such as the teacher only giving assignments without being explained, difficulties in doing assignments, too many assignments, less attractive teaching materials besides that students find it easier to understand the lesson if there are pictures or videos. To make learning easier, researchers use social media applications for learning online. Social media offers modern and creative ways to build a social learning environment [17]. Social media applications in the form of discussion groups can trigger and increase interactions between instructors and students [18]. By using social media supports the change from teacher-centered learning to student-centered [19]. and also improves student self-regulation [20, 21]. In line with Amry's research [22] states that learning using access chat can support an active learning process. The benefit of implementing learning mobile is that it provides a forum for students to discuss with each other and expand the learning environment anywhere and anytime [23].

Based on the above problems, the researcher wants to develop a teaching materials E-module based on STEM integrated PBL. The approach of the four aspects of Science, Technology, Engineering, and Mathematics (STEM) is a match between problems that occur in the real world and problem-based learning[24] [25]. Learning with the STEM approach is to apply and practice basic STEM contents in situations they encounter in life [26].

2. Method

This research uses mixed methods, consisting of qualitative data and quantitative data. The sampling technique was carried out by purposive sampling. Data collection was carried out by giving questionnaires to student teachers in Lampung province. Questionnaires were given to 308 students and 17 physics teachers. The instrument uses a Likert scale with four choices, namely (1) strongly agree, (2) agree, (3) disagree, and (4) strongly disagree. The e-module development is provided in full in the form of a file as an attachment to the assessment instrument. The development assessment instrument is provided in the form of a google form. The results of the respondents' assessment were analyzed by calculating the average score obtained for each component of the developed e-module, then converted into a qualitative statement according to Table 1.

Table 1. Assessment and Decision

Score Average Score	Decision
4.20-5.00	Very suitable
3.40-4.19	Suitable
2.60-3.39	Sufficiently suitable
1.80-2.59	Less suitable
1.00-1, 79	Does not match

3. Research Result and Discussion

The results of preliminary research based on the needs analysis were obtained from the google form filled in by physics teachers and students can be seen in Table 2 and Table 3.

Table 2. The results of the analysis of the physics teacher needs

N0	Statement For Teachers	Percentage
1	Physics teacher using modules e-learning in Physics	40%
2	Physics teacher to develop e-modules using PBL syntax	12.5%
3	Teacher of physics to develop e-module has been integrated STEM	12.5%
4	Physics teachers have used the STEM approach in learning	37.5%

N0	Statement For Teachers	Percentage
5	Teachers use learning media in learning physics	37.5%
6	Physics teachers present material related to the phenomena of everyday life	87.5%
7	Physics teachers allow students to seek information with friends when discussing	100%
8	Physics teachers allow students to analyze problems given during the learning	75%
9	Physics teachers allow students to find other sources to improve critical thinking skills	100%
10	Physics teachers allow students to solve problems first in their way	87.5%
11	The physics teacher allowed the participants to conduct an experiment	50%
12	Physics teachers allowed students to present the results of the experiment	50%
13	The problem-based learning model that physics teachers did make student learning outcomes increased by	85%
14	Physics teachers taught by utilizing existing technology and supporting	87.5%
15	Physics teachers guide students to develop scientific literacy in learning	50%
16	Physics teachers train students to make engineering techniques used in everyday life	50%
17	Physics teachers guide students to formulate experimental results mathematically	62.5%
18	Physics teachers use media learning to integrate science, technology, engineering, and mathematics to make it easier to understand physics concepts	50%
19	Physics teachers train questions that contain critical thinking skills to students	50%

N0	Statement For Teachers	Percentage
20	Physics teachers use E-Modules on dynamic fluid material to improve critical thinking skills students	12.5%
21	Physics teachers use social media as a means of teaching	50%
22	During a Coronavirus pandemic like today, e-modules are needed to make teaching online easier because they can be accessed anywhere and there are videos and pictures	100%

Table 3. Results of Student Needs Analysis

NO	Statement for Teachers	Percentage
1	I like learning physics	65%
2	I prefer playing social media than learning physics	48.5%
3	Teachers use e-modules in physics learning	51.5%
4	Teachers use e-modules to invites students to actively investigate physical phenomena	50%
5	I only use textbooks from school	46.6%
6	The teacher presents material related to the phenomena of everyday life	87.5%
7	The teacher allows students to seek information with their friends when discussing	93, 5%
8	Teachers allow students to analyze problems given during the learning	83.8%
9	Teachers allow students to find other sources to improve critical thinking skills	100%
10	Teachers give students opportunities to solve problems in their way	87 %
11	The teacher allowed the students to do the experiment	53.8%
12	The teacher gave the opportunity students to present the experimental results	59.2%
13	Teachers use problem-based learning models	85%
14	Teachers teach using existing technology and support	87.5%

NO	Statement for Teachers	Percentage
15	Teachers guide students to develop scientific literacy in learning	72.3%
16	Teachers train students to make engineering techniques that are used in everyday life	50%
17	I can mathematically formulate experimental results	62.5%
18	I can formulate a hypothesis	50%
19	I can conclude a physics concept by utilizing various information	50%
20	Based on the skills I have, I can understand the material delivered by the teacher	12.5%
21	Teachers use social media as a learning tool	50%
22	During the Coronavirus pandemic, e-modules are needed to make teaching online easier because they can be accessed anywhere and there are videos and pictures	100%
23	Online lessons carried out during the coronavirus pandemic like this it is difficult for me to learn physics	80.9%
24	The teacher only gives assignments when learning	57.7%
25	Electronic modules are needed when learning online because they are easily accessible on smartphones than on textbooks	88.2%
26	Teaching materials when learning online taste from package books alone	79%

Based on data in table 2 with 17 teacher respondents and table 3 with a total of 308 students, it is stated that an e-module is needed to facilitate the learning and teaching process online. Based on table 2, it shows that 40% of teachers have used e-modules in physics learning. Based on table 3, 46.6% of students only used textbooks from school and 57.7% stated that the teacher only gave assignments without teaching them first. This is why 80.9% of students find it difficult to learn physics online and as many as 48.5% of students prefer to play social media when learning physics. Based on table 2 only 12.5% of teachers developed the e-module own STEM integrated PBL based. Therefore, the researcher wants to develop an e-module based on integrated PBL STEM assisted by social media on dynamic fluid material to improve students' critical thinking skills. Each learning step and activity in the e-module contains PBL syntax with the STEM approach and accommodates students' critical thinking skills. So that the e-module is expected to be able to improve students' critical thinking skills. Assessment of development is an e-module carried out with the suitability of the e-module, the design of learning activities, the suitability of STEM components in learning activities, the feasibility, and the effectiveness of the developed e-module with STEM integrated PBL syntax to improve students' critical thinking skills. The results of the assessment of the developed e-module are presented in Table 4.

Table 4. Assessment results of E-Module

No	E-Module Development	Average score
1	Conformance E-Module	
	The activities in the LKPD were developed following the PBL syntax	4.35
	The images presented are in the context of the material	4,3
2	Teaching and Learning Activities	
	Orientation activities carried out have the potential to accommodate students to have critical thinking skills	4,2
	Organizing activities to facilitate students to have critical thinking skills	4,45
	Investigation activities can educate students' critical thinking to do experiments	4,24
	Through experimental activities, being able to train students in collecting data	4,5
	Experimental activities can train students in determining experimental variables	4.2
	Presentation activities can educate students' critical thinking skills in conveying rebuttals to something different from what they understand	4,3
	Variety of learning activities arranged according to PBL (problem-based learning) syntax	4,3
	Variety of learning activities arranged following STEM	4,5
3	PBL Model with STEM Approach	
	Various learning activities are arranged using the PBL model with STEM components included	4,3
4	Effectiveness E-Module	
	Various activities that have been designed have the potential to accommodate students' critical thinking skills	4,2

Based on the results of the development assessment in table 4, the suitability of the e-module with the syntax of the PBL learning model corresponds to an average value of 4.35. Student teaching and learning activities include orientation, organizing, guiding, developing, analyzing, and evaluating with an average value of 4.35. The results of the suitability of the activities in the e-module with the STEM approach obtained an average value of 4.3 and the effectiveness of the e-module with an average value of 4.3. Based on the results of the assessment, it shows that all components are assessed to get a score of 4.20-4.5. By

referring to Table 1, the development of this e-module is stated to be very suitable and can be used to improve students' critical thinking skills. The e-module development is designed to include learning activities with PBL syntax and using the STEM approach. The learning activities carried out aim to improve students' critical thinking skills with the help of social media.

4. Conclusion

Based on the data from the results of the needs analysis conducted by the researchers, it can be seen that the development of an E-Module based on STEM integrated PBL is necessary. The findings in the field that most of the learning resources used were textbooks from schools. Also, most teachers stated that they had not used modules that stimulated students' critical thinking skills. Therefore, the e-module that will be developed focuses on stimulating students' critical thinking skills.

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