The development physics e-module based PBL–Integrated STEM to improve higher-order thinking skills on static fluid material

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Ayu Novitasari Pane[1], Doni Andra[1], I Wayan Distrik[1]

[1]Department of Physics Education Universitas Lampung, Indonesia
Jl. Prof. Dr. Sumantri Brojonegoro No. 1 Bandar Lampung, Lampung, Indonesia.

*Corresponding author: ayunovitasaripane01@gmail.com

Abstract. One of the skills of the 21st-century in the era of the industrial revolution 4.0, namely higher-order thinking skills. According to TIMSS, high-level thinking skills in Indonesia are still low. Teaching materials that do not contain 21st-century skills will have an impact on the effectiveness of achieving competence in learning. This study aims to analyze the need for e-modules as teaching materials and to determine the teacher's response to the STEM integrated e-module. This research uses mixed methods. This research was conducted in several high schools in the Lampung area with 20 physics subject teachers as the research subjects. Data collection techniques using questionnaires and interviews. The object of this research is high-level thinking, Problem Based Learning model, and STEM integrated e-module analysis. The results showed that teachers need e-modules as a learning resource that is integrated with STEM to improve higher-order thinking skills. The e-module is expected to be a learning resource that can integrate text, animation, video, and audio and can explain abstract concepts in physics learning. So, in further research, an e-module based on Problem Based Learning with STEM integration can be developed to improve high-level thinking skills.
Keywords: E-module, Problem Based Learning, STEM, Higher-order Thinking Skills

1. Introduction

The 21st-century is a transition of learning in which the curriculum developed at this time requires educational institutions to change the instructional approach centered educator (teacher-centered learning) to teaching approaches are a learner(student-centered learning).[1]. Some of the 21st-century skills challenges in education, namely: 1) "learning and skills" innovation(critical thinking skills, creative, innovative, communicative, and collaborative in solving problems), 2) "information, media, and technology skills" (information literacy, media literacy, and information and communication technology literacy). 3) "life and career skills" (flexibility and adaptability, initiative and self-respect, social and cultural skills, productivity and accountability, as well as leadership and responsibility. [2] High-level thinking skills are one of the most indispensable potentials. by students during the development of science [A1] and technology as it is today because, in addition to the results of science and technology that can be enjoyed, it turns out that several problems arise for humans and the environment. This increase in higher-order thinking skills will lead to increased learning outcomes for cognitive students. [3] Higher-order thinking skills are defined as the broad use of the mind to find new challenges. This higher-order thinking ability requires a person to apply new information or previous

knowledge and manipulate information to reach possible answers in new situations [4]. One way to improve students' higher-order thinking skills is when students are faced with a problem that they have not yet previously met, this is where the high-order thinking processes of students will be trained. [5] This shows that the importance of teaching materials and learning media in providing knowledge to students to achieve 21st-century skills to face the challenges of the industrial revolution 4.0. High-level thinking skills or often called HOTS (Higher-order Thinking Skills), can make an individual interpret, analyze or manipulate information that can be seen from the abilities of students at the level of analysis, synthesis, and evaluation [6].

Teaching materials are an important factor in supporting the learning process [8]. Teaching materials are all forms of material used to assist teachers in implementing teaching and learning activities, one of which is in the form of modules. [7] Students need cognitive assistance in learning physics, one of which is by using modules that can be used by students to learn independently. [8] According to research conducted by Shurygin, the results obtained prove the importance of being developed in physics studies in the context of increasing the efficiency of students' independent work to increase their competitiveness. [9] The module currently used is an electronic module. The advantage of this electronic module is that students will be familiarized with seeing a real problem in the form of animation, pictures, or videos. Efforts to apply the scientific approach in the learning process are a hallmark of the 2013 curriculum. The scientific Approach is believed to be a bridge for the development and development of students' attitudes, skills, and knowledge. A learning model that is seen in line with the principles approach scientific one of Problem Based Learning. [10] Problem Based Learning is contextual learning that links learning material with the real-world context of students. [11] Scientific learning requires a process that can stimulate students to learn through various real problems in everyday life. The problem is often related to the knowledge that has been or will be learned. The problem-based learning model is a model that uses a scientific approach. [12] Students will try to learn to solve problems by developing the ability to analyze and manage information based on experiences they have had or new experiences faced by students themselves. [13] This model can also help develop students' independent learning skills. [14] So, the PBL model is suitable to be applied in learning physics considering that physics material is in the form of concepts, laws, principles, and theories related to everyday life. So it is necessary to prepare appropriate teaching materials to support the PBL learning model [15].

The world of education, especially in developing countries, applies to STEM a lot in learning so that STEM can be integrated as an approach, learning model, or inserted into subject matter through teaching materials [16]. STEM can develop if it is associated with the environment, to create learning that presents the real world experienced by students in everyday life [17]. Physics learning following the ability of students to support creativity abilities students are learning that trains 21st-century life skills. This is by integrated learning STEM (Science, Technology, Engineering, and Mathematics) which in this learning links the material taught to the realms of science, technology, engineering, and mathematics [18]. 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 [19-20], but there are no teaching materials that support students to study science using the STEM approach. STEM is an important issue in education today [21]. STEM is an integrated learning approach from Science, Technology, Engineering, and Mathematics that is associated with learning material problems in everyday life and can improve student achievement in the fields of Science and Mathematics. [22] One of the physics concepts that students master weakly is the concept of static fluids. Many of the basic concepts of static fluids that are not well mastered by students [23] STEM can affect learning outcomes not only understanding but students' 21st-century skills that can be explored through the characteristics of STEM itself as a tool to solve problems in life globally with various situations. [24] Learning with the STEM approach is to apply and practice the basic content of STEM in situations they face/find in life. [25] The material presented in the E-module STEM thesis Static Fluid which includes hydrostatic pressure, Pascal's Law, and Archimedes Law. The choice of this material is due to the many applications in everyday life related to this material. Also, the Static Fluid material can be taught using the approach STEM, namely science in finding the concept, in terms of technology it can be taught by explaining

various applications of technology related to the material, through techniques students can be taught to make simple tools related to material and mathematics used to formulate mathematical equations related to the concept of matter and in terms of calculations. Based on the analysis of the teacher needs of 20 physics teachers in Lampung, a STEM integrated problem-based learning-based e-module design research will be carried out to improve higher-order thinking skills.

2.Research Method

This study uses a mixture consisting of qualitative and quantitative data. This research was conducted in several high schools in Lampung on physics. Data collection techniques using interviews and questionnaire instruments. The data analysis technique was done quantitatively with the percentage technique from the questionnaire result data, the interview results were analyzed qualitatively. The questionnaire instrument was given to 20 physics teachers to reveal the need for teaching materials in the form of an e-model based on STEM integrated PBL in physics learning through. Interviews were conducted with 2 teachers to find out what forms of teaching materials are often used in learning physics.

Table 1. Interpretation of Teacher's Perception of E-Module Based on Integrated PBL-Based STEM

Interval%	Positive	Negative statement
75 <X ≤ 100	Strongly agree	Strongly disagree
50 <X ≤ 75	Agree	Disagree
25 <X ≤ 50	Disagree	Agree
0 <X ≤ 25	Strongly disagree	Strongly agree

Table 2. List of Respondents Questionnaire

Score	Statement
8	Strongly agree
6	Agree
4	Disagree
2	Strongly disagree

Table 3. List of Respondents Teacher Interviewer

Respondents	Pass	Teaching Experience
AW	S2	31 years
EY	S1	25 years

3. Results and Discussion

Research results regarding the design of the e-module based on STEM integrated PBL as a learning resource for physics is shown in the following table.

Table 4. Results of the Teacher's Questionnaire Regarding the E-Module Design Based on PBL-Based STEM Approach on the Static Fluid Material

No	Statements	%	Category
1	Systematics presented in the e-module design is appropriate.	65%	Agree
2	The contents presented in the e-module design are appropriate.	40%	Agree
3	The layout presented in the e-module is appropriate.	92%	Strongly agree

No	Statements	%	Category
4	Learning Activities 1 has the potential to improve the ability to analyze the concept of hydrostatic pressure and pressure and formulate hydrostatic pressure equations.	87%	Agree
5	Learning activity 2 has the potential to increase the ability to visualize the application of the Archimedes law about submarines to be able to regulate density in the water.	76%	Agree
6	Learning Activity 3 has the potential to improve the ability to analyze the concept of Archimedes law.	45%	Agree
7	Learning activity 4 has the potential to improve the ability to evaluate submarine parts.	55%	Agree
8	Completeness of the contents of each activity is appropriate.	95%	Agree
9	Overall learning activities contain STEM components.	55%	Strongly Agree
10	E-module based on integrated PBL STEM has a design that has the potential to improve students' higher-order thinking skills on static fluid material.	60%	Agree

Table 4 shows that the e-module systematic design, completeness of the contents, and layout of the e-module developed are appropriate. The teacher agrees that the learning activities in the e-module to be developed already contain STEM and can improve higher-order thinking skills.

Based on the results of interviews with physics teachers, it was found that teachers only used teaching materials in the form of books and other references such as modules and school student workbook (EY). Teachers rarely use other media such as the use of laptops or smartphones during learning, so laptops and smartphones are only used to search for information on the internet (AW). The teacher states that there is a need for teaching materials that can take advantage of the use of laptops and smartphones to make it easier for students to understand the learning material (EY). The two teachers interviewed said that they had never used e-modules as a learning resource.

The teacher delivers one of the difficult materials in physics, namely static fluid (EY). So far, the teacher only teaches difficult material by using the help of several other teaching materials and the internet. The solution that teachers can use in teaching materials that are difficult to understand is to create interesting teaching materials/media to be presented in learning such as visualizing them in the form of videos, animation, simulation, and pictures.

Based on the results of questionnaires and interviews that have been conducted, teaching materials in the form of e-module MSI are rarely used. This shows the lack of knowledge of teachers in using various teaching materials. Problem Based Learning teaching materials have not been used. The author feels that STEM is one of the right approaches to improve higher-order thinking skills. The use of teaching materials in the form of STEM integrated PBL-based e-modules is suitable for use in learning because schools in general already have supporting media such as computers and androids. Students are allowed to use an Android cellphone if learning requires media in the form of a cellphone. Based on the results of the above research, an e-module design chart is made as shown in Figure 1.

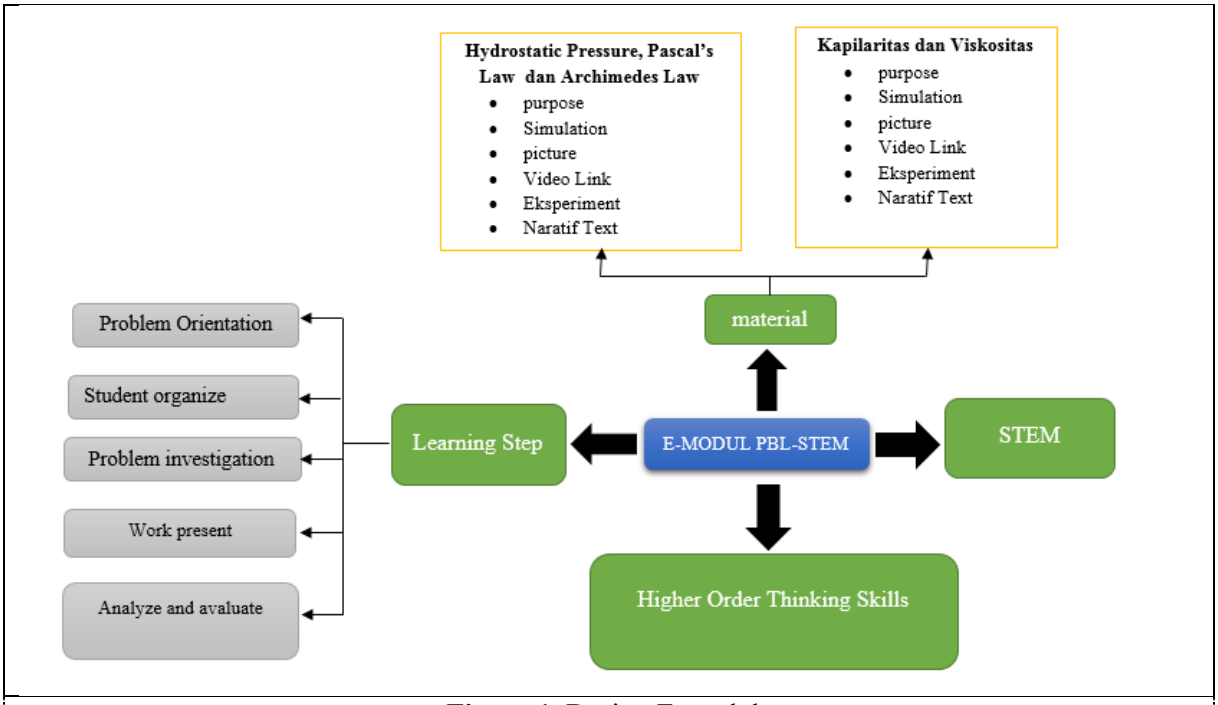

Figure 1. Design E-module

4. Conclusions

Based on the results of the questionnaire and teacher interviews, the teacher has not applied teaching materials based on science, technology, engineering, and mathematics (STEM) in learning. To support STEM learning in the curriculum, interactive teaching materials are needed which can contain core competencies, basic competencies, indicators, objectives, concept maps, pictures, videos, animations, questions, internet links, and material that is explained in detail. The physics material expected in STEM learning is static fluid material. Teaching materials developed based on e-learning. It is necessary to have teaching materials in the form of e-modules which refer to 21st-century skills in the form of higher-order thinking skills.

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