Need assesment and design of e-modules to stimulate HOTS on dynamic fluid materials with the STEM approach

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Abstract. Learning resources are very important in learning physics, then, the purpose of this study is to develop e modules with the STEM approach to stimulate students' HOTS on Dynamic Fluid. The research method used is the research and development (R&D) with ADDIE models which have five stages: analysis, design, development, implementation, and evaluation. The first two stages of this article will be reported analysis and design stage. The instrument used was a product needs analysis questionnaire and the practitioner validation sheet using a Likert scale. The data needs analysis phase was sourced from high school level students and physics teachers in Lampung province. The validators of product design are professional physics teachers with the Masters in Physics Education qualifications. Google form as a media for data collection is then analyzed using descriptive quantitative. The results showed that the E-Module to stimulate HOTS on dynamic fluid material was highly needed. E-module that have the potential to stimulate HOTS in dynamic fluid material consist of seven learning activity that contain the STEM component. In conclusion, E-Module based on STEM dynamic fluid material has the potential to simulate students' HOTS.
Keywords: Dynamic fluids, E-module, HOTS stimulus, STEM approach.

1. Introduction:

The 21st century is marked by the era of the industrial revolution 4.0 as a century of openness, meaning that human life underwent fundamental changes that prioritize the quality of ideal education [1,2]. However, critical thinking skills in the field still show some weaknesses that physics teachers must innovate to be able to create a state of learning that directs students to foster students' HOTS abilities [3]. Therefore, curriculum improvement was formed in Indonesia to achieve competency in knowledge, scientific work, and technology. The curriculum is known as the 2013 curriculum (K-13).

Implementation of K-13 applies learning in the categories of critical thinking, collaboration, communication, and creativity (4C) [4]. Critical thinking as one of the competencies in higher order thinking skills (HOTS). HOTS is a skill that must be achieved in 21st century learning with indicators of analyzing, evaluating and creating [5-7]. Nevertheless, the learning process is still a teacher center, learning physics is not related to everyday life, difficult to understand because it only contains formulas, and not interesting [8,9]. Education in the revolutionary era 4.0 has utilized many digital technologies to support learning. Digital technology is able to create learning resources that have the potential to stimulate HOTS, one of which is an interactive e-module [10,11]. This is because interactive modules have characteristics including: can direct learning, be interactive, can provide feedback to readers and can provide holistic experience through simulations or learning videos.

The importance of learning resources in supporting the education of students needs to be well designed and have the same ability in every place, one of which is integrating learning resources with

technology, information and communication (ICT) [12-14]. According to some experts that: Learning resources in the form of e-modules can optimize the ability of HOTS [15]. The success of research that has been done by previous researchers with the title "Development of Learning Tools to Increase HOTS in the Competency of Building Flat Side Space," and the results of its development in the form of syllabus learning tools, lesson plans (RPP), and student activity sheets (LKS) which valid, practical, and effective, and evaluation instruments in the form of valid and reliable tests. The results of field trials show that the Experiment class is better than the Control class in terms of competency attainment, and the HOTS of students in the Experiment class reaches the minimum category B [16].The characteristics of the interactive modules have followed the development of the globalization era making it easier for students to understand the material. Current learning needs to follow the development of the globalization era, one of which is by integrating science, technology, engineering, and mathematics (STEM) [17-19]. So the novelty of this study from previous research and to achieve ideal educational and learning goals in accordance with k-13 requires an introduction to learning about the needs of educators for learning resources that can help students to stimulate HOTS, the responses of responden regarding the availability of learning resources used , analysis of the implementation physics learning in SMA Negeri Lampung andvalid design for creation of e-module.

2. Methods

The method used in this research is the R&D model with ADDIE type (Analysis, Design, Development, Implementation, Evaluation), but this article is limited to the design stage. This is based on the importance of having a valid design in order to create an effective product shown in figure 1.

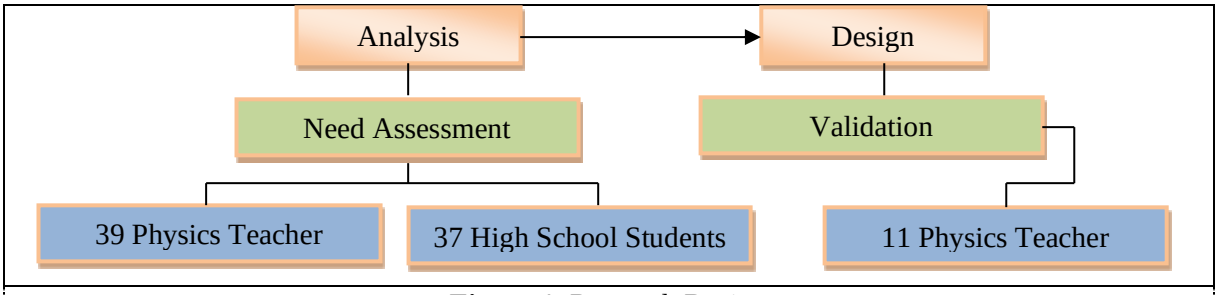

Figure 1. Research Design

The first phase is analyzing. The analysis was conducted to determine the physics teacher needs and students about learning resources that have the potential to help students stimulate HOTS, physics teacher responses and students regarding the availability of learning resources used, and the implementation of physics learning analysis.

Data needs analysis was obtained from a questionnaire distributed via google form to 37 high school students and 39 physics teachers in Lampung. The next step is design. The design was validated by 11 physics teacher experts conducted in the field of physics education to create content and systematics that are in line with interactive learning activities that have the potential to stimulate HOTS. Design validation is done by filling in the assessment questionnaire via google form and analyzed according to the average then converted into score in the following table 1.

Table 1. Assesment and Decision Score

Average Score	Decision
4,20-5,00	Very suitable for stimulating HOTS
3,40-4,19	Suitable for stimulating HOTS
2,60-3,39	Enough suitable for stimulating HOTS
1,80-2,59	Less suitable for stimulating HOTS
1,00-1,79	Not suitable for stimulating HOTS

3. Result and Discussion:

Based on Table 1, a needs analysis is obtained which is reviewed from the results of preliminary research through a google form filled by physics teacher, showing that the learning process is in accordance with the provisions of the minister of education and has implemented a curriculum that fits the needs of K13, but in fact not all students master the thinking skills high level in the learning process, there are some students who master and there are also some who do not master. This is allegedly due to students having different HOTS skills and the low HOTS skills of students not yet able to be solved by learning resources that are commonly used in the learning process, and the learning process is still memorizing, theoretical and still centered on the teacher center so that it has not been able to stimulate HOTS learners. Therefore, with the development of STEM-based e-modules this dynamic fluid material is supported by all physics teachers. The result of the physics teachers needs analysis is seen in Table 2.

Table 2. Results of the physics teacher need analysis

No		Statement Analysis
1	97,4 %	Physics teacher have implemented the K 13 revision in schools.
2	97,4 %	Physics teacher provide questions that contain of the higher order thinking skills (HOTS).
3	100 %	Physics teacher provide opportunities for students to find information with friends when discussing.
4	100 %	Physics teacher give students the opportunity to exchange ideas and discuss with them.
5	100 %	Physics teacher give students the opportunity to analyze the problems given during learning.
6	97,3 %	Physics teacher give students the opportunity to look for other sources in improving students' critical thinking ability.
7	100 %	Physics teacher gives students the opportunity to communicate Physics material being studied.
8	100 %	Physics teacher gives students on the opportunity to solve problems in to their own way.
9	100 %	Physics teacher gives students the opportunity to carry out experiments.
10	94,7 %	Physics teacher gives students the opportunity to display the results of their experiments in class.
11	100 %	Physics teacher gives students the opportunity to complete experiments with the concept of physics.
12	100 %	Physics teacher uses a scientific approach to learning.
13	97,4 %	Physics teacher uses media in learning.
14	100 %	Physics teacher applies fun physics learning.
15	44,75 %	Physics teacher had e-module with based learning of the resource infrastructure.
16	89,5 %	Physics teacher has heard about learning resource infrastructure based on electronic modules.
17	79 %	Physics teacher has used the STEM learning approach.
18	48,6 %	Physics teacher have developed e-module learning resources with the STEM approach to stimulate HOTS.
19	100 %	Physics teacher needs e-module learning resources with the STEM approach to stimulate HOTS.
20	92,1 %	Physics teacher is willing to apply e-module learning resources with the STEM approach to stimulate HOTS.
21	100 %	Physics teacher hopes that e-module learning resources with a STEM approach are effective for stimulating HOTS.
22	100 %	Physics teacher hopes that e-module learning resources using the STEM approach can be used in the learning process.
23	100 %	Physics teacher hopes that the e-module makes students interested in learning physics.
24	100 %	Physics teacher is interested in using varied learning resources.

No		Statement Analysis
25	100 %	Physics teacher needs e-module learning resources with an effective STEM approach to stimulate HOTS.
26	89,5 %	Physics teacher deliver dynamic fluid material thoroughly.
27	81,6 %	Physics teacher provides experiments on dynamic fluid material.
28	43,2 %	Physics teacher uses e-modules when learning dynamic fluid material.
29	84,2 %	Physics teacher provides questions related to higher order thinking skills in learning dynamic fluid material.
30	63,18 %	Physics teacher has stimulated higher order thinking skills with the STEM approach to students on dynamic fluid material.

The result of student's need analysis is seen in Table 3.

Table 3. Results of student's need analysis

No		Statement Analysis
1	78,4 %	Students stated that they liked Physics.
2	81,1 %	Students state physics is a difficult subject.
3	59,4 %	Students feel that learning physics is boring.
4	56,7 %	Students feel lazy to learn physics.
5	59,4 %	Students will give up if the physics problem given is too difficult to solve.
6	83,8 %	Students can work on questions that are classified as high-level thinking skills.
7	100 %	Students are given the opportunity to look for information with friends when discussing.
8	91,9 %	Students are given the opportunity to exchange ideas and discuss them.
9	91,1 %	Students are given the opportunity to analyze the problems given by physics educators while learning.
10	91,9 %	Students are given many opportunities by physics teacher to look for other sources.
11	88,9 %	Students are given the opportunity by physics educators to communicate the results of the discussion.
12	97,3 %	Students are given the opportunity by physics educators to solve problems in their own way.
13	86,5 %	Students are given the opportunity to conduct experiments in physics.
14	83,4 %	Students are given the opportunity by physics educators to display their work in the classroom.
15	86,5 %	Students are given the opportunity by physics educators to complete experiments using physics concepts.
16	75,7 %	Physics teacher use interesting physics learning resources.
17	81,1 %	Physics teacher always do physics learning by linking science, technology, engineering, and mathematics.
18	81,1 %	The concepts of physics learned can be applied to science, technology, engineering, and mathematics.
19	81,1 %	Physics concepts that I learned can be applied in everyday life.
20	86,5 %	Physics learning will be effective when using interesting e-module learning resources.
21	83,8 %	Students are interested in the e-modules used when learning physics.
22	88,56 %	Students feel confident that learning physics using e-module learning resources will be interesting.
23	73 %	Students feel that dynamic fluid material is boring.
24	86,5 %	Students agree if physics lessons especially dynamic fluid material is presented with e-module learning resources.
25	89,2 %	Students can understand dynamic fluid material if using an interesting e-module.

The analysis results referred to in table 3 can be analyzed that students assume physics is a difficult

subject, and have not obtained maximum results when working on problems classified as higher-order thinking skills, these findings are consistent with the results of to the previous studies [20-22,]. Learners agree if physics lessons especially dynamic fluid material is presented using e-module learning resources. Therefore, researchers consider it important to design e-modules that are valid, effective and practical, so as to make physics learning more interesting, and able to stimulate HOTS of students.

The e-module is designed to be able to stimulate the ability to analyze, evaluate and create dynamic fluid material with the STEM approach. Therefore, each learning activity presented contains STEM components in dynamic fluid material. The completeness of the STEM components in the learning activity has the potential to stimulate the entire HOTS indicator so that the research objectives will be fulfilled.

For example, in learning activity 4 that is designed with the STEM component aims to stimulate the ability to evaluate pitot tube technology as follows. **Science:** Narration about continuity equations and Bernouli's law relating to pitot tubes. Measuring the value of the pressure by reviewing the change in height experienced by the fluid and the principle of velocity based on the pitot tube flow. **Technology:** Technology visualization of several types of pitot tubes consisting of simple pitot tubes, static sources, and pitot-static tubes along with audios as an introduction. **Engineering:** Narration that contains the workings of the application of the pitot tube by analyzing the parts of the pitot tube. **Mathematics:** The formulation of quantities and units involved in the equation of fluid flow velocity on the pitot tube and its mathematical reduction. Furthermore, students will be asked to evaluate the type of pitot tubes that are often used in daily life.

Evaluation of the e-module design is carried out on the systematic presentation of the module, the design of learning activity (learning objectives, subject matter, learning instructions, appearance, subject matter, formative tests, and reflection), the suitability of the STEM components that exist in each learning activity, and the appropriateness of the design e-module with STEM approach to stimulate HOTS. The results of the assessment of the e-module design are presented in table 4.

Table 4. Result of the e-module design assessment

No	E-module Design		Average Score
1	Systematics	Cover, foreword, table of contents, pictures list, table list, e-module usage guide, basic competencies and indicators, learning objectives, concept maps, introduction, learning activity 1 to 6 (contains objectives, subject materials, study instructions, display, presentation of material, summary, formative tests, reflections), summary, summative evaluation, bibliography.	4,6
2	Learning Activity	Analyzing the concept of dynamic fluid and types of fluid flow. (learning activity 1).	4.6
		Evaluate the technology pitot tubes, perfume sprayers, aircraft wings, and motorboats. (learning activity 4, learning activity 5 and learning activity 6)	4.33
		Creating a simple practicum tool about technology torque and technology venturimeter. (learning activity 2 and learning activity 3).	4.31
3	STEM	Suitability of STEM components in each learning activity.	4.45
4	Feasibility	The feasibility of e-module design with the STEM approach to stimulate HOTS.	4.36

Table 4 shows the results of the assessment of the e-module design of all components assessed to have a score above 4.31. Then this e-module design is declared to be very suitable and can be used with students in the learning process to stimulate HOTS especially on dynamic fluid material.

The benefits and characteristics contained in e-modules are different. If reviewed based on the benefits of electronic e-modules can make the learning process more interesting, interactive, can be done

anytime and anywhere and can improve the quality of learning [23,24]. In addition, of course, reduce the use of paper in large numbers. Through video and animation can facilitate students in understanding abstract concepts in physics learning, especially the concept of dynamic fluid and can be used independently. Suggestions from some experts that: Overall the design is systematic but there are some things that need to be improved, namely formative tests on learning activities (in the form of multiple choice or essay). Therefore, it is necessary to strengthen in exploring the basic mathematical abilities of students so that it will facilitate the physics teacher in guiding the learning process of students to apply the existing equations in dynamic fluid material in the e-module as well as working on questions that are classified as HOTS skills. Based on the results of the design assessment, an e-module design chart is made as shown in to see in figure 2.

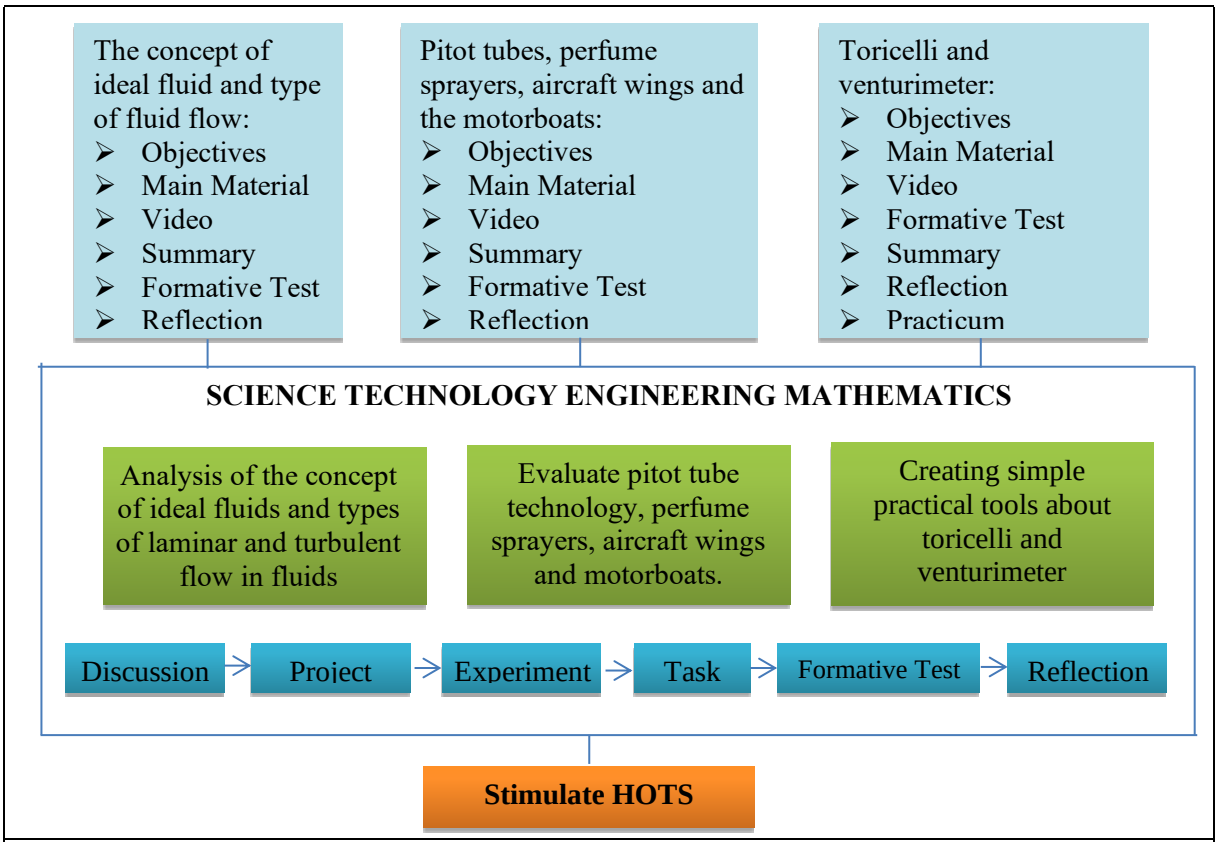

Figure 2. Diagram of e-module design

In addition to prioritizing the contents of the material, this e-module also prioritizes how it looks. The intention is to make students interested in using e-module learning resources. Using e-modules students can learn in a fun way and acquire new skills, interesting and not only contain interactive buttons but also contain simple material and videos in the hope of being able to improve students' reading performance and stimulate students' HOTS.

The result of this study are in accordance with the success of previos research on learning physics using the STEM approach to improve students' problem solving skills in dynamic electricity material, while the result of the study show that learning using the STEM approach can improve problem solving skills in dynamic electrical material [25].

4. Conclusion and Suggestion

Two conclusions were obtained based on the results of this study. First, at the analysis stage it was known that the development of STEM-based e-modules was needed to stimulate student HOTS in dynamic fluid material. Second, at the design stage, it was found that the e-module design being developed was valid so that it was ready to proceed to the development stage. This study has loosened

assumptions and limitations for further research by looking for sufficient respondents so that the data collected is more complete and examining other parts of physics material so that problems in learning physics can be solved thoroughly.

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