



Development of e-Module based on Simulation PhET Fluid Material Dynamic in Senior High School

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ABSTRACT:

The facts obtained in the field are that technology-based learning media has not been used, there is a lack of teaching materials in the learning process, and inadequate laboratory facilities. The aim of this research is to design an e-module based on PhET simulation in fluid dynamics material for Senior High School and determine its feasibility. The method used in this development research (R&D) is which refers to the development model developed by Alessi and Trollip which consists of three stages including (1) Planning, (2) Design and (3) Development. The research subjects consisted of 3 media experts and 3 material experts. The instrument used is a validation sheet. Data collection was carried out through questionnaires and analyzed descriptively qualitatively. The product resulting from this research is an e-module based on PhET Simulation Fluid Dynamic Material in senior high school. The results of material expert validation were obtained with a total percentage of 88.25%, while media expert validation obtained a total percentage of 97.62%. The resulting categories are classified into feasible criteria. The results of this research can be used as a solution to be applied in the learning process.

INTRODUCTION

Physics is the science that studies the universe and all the interactions in it that humans can observe. Media in physics learning is a component that needs to be developed at this time to complement existing facilities/infrastructure, namely the availability of sufficient teaching materials. This is very important because, with sufficient teaching materials, students can study and discuss material before learning. In addition, the teaching materials that will be developed should motivate students to dig up even more information from their environment (Mogi et al., 2021; Khair et al., 2021).

The problems that often arise and are encountered by students in learning are misunderstandings when studying physics material. The reason is that the teacher only teaches abstract physics through classroom learning, is not equipped with experimental processes in the laboratory, and utilizes the help of technology-based learning media (Susanti et al., 2020; Sukroyanti, 2020).

As technology develops at this time, the teaching materials used are also increasingly developing, such as the module itself, which has also developed following technological advances, where usually using printed modules and now developed into electronic modules. This electronic

module or e-module can help make the learning process interesting because this E-module can present material in images or videos and be studied repeatedly by students (Puspitasari, 2019). This e-module can make it easier for students during the distance learning process and can be used through various devices such as laptops, smartphones, and computers, which can be accessed anywhere and anytime so that it can make students motivated in learning physics (Oktaviana et al., 2020; Purwaningsih et al., 2023).

Based on the needs analysis that the researchers obtained at Seunagan 3 State High School on material difficulties by distributing questionnaires to students to get data that students had difficulty understanding dynamic fluid material from the questionnaires distributed to students. This material is one of the materials for class XI in odd semesters and is classified as difficult for students to understand. From the results of observations, researchers have obtained data that during the learning process, technology-based learning media have not been used in learning as they wish to apply to education that is developing at this time besides that students' interest is still very low this is because learning physics is lacking preferred by students, lack of teaching materials in the learning process, inadequate laboratory facilities so that it becomes an obstacle for students to do practicum and limited time is also one of the reasons for not using technology-based learning media. Therefore, in conducting a physics practicum, an alternative media is needed, one of these media is PhET simulation (Basri, 2020; Lestari et al., 2022; Putri, 2018; Sari et al., 2022).

Based on previous research conducted by Asyana & Arini (2020), the results show that using the PhET Simulation application has good satisfaction from respondents, meaning that this application is very helpful and comfortable to use in the online practicum learning process. Furthermore, research conducted by Sujanem et al (2022), the results showed that using the PhET-assisted Problem-based module E in the online PBL model was able to effectively improve the critical thinking skills of class XI MIPA high school students. Another study, namely by Nafaida et al (2015), the results of the study shows that using this PhET-based E-module can improve students' understanding of concepts significantly. Learning by using PhET-based module teaching materials can create active learning so that it can motivate students to study physics.

The difference between the research that has been done before and the research that the researcher will carry out is the difference in the title of the research, the time and place of the research, the learning materials, and the research model used, namely Alessi and Trollip because by using this research model the products are produced in electronic form and not printed. In e-modules developed previously during the video playback process, it can not be directly played in e-modules but requires the help of other applications, namely YouTube, so researchers are motivated to develop e-modules based on PhET simulation on dynamic fluid material.

The focus of the issues to be discussed in this research is regarding the design of PhET simulation-based physics learning e-modules on dynamic fluid material and assessing the level of feasibility of developing PhET simulation-based physics learning e-modules on dynamic fluid material.

RESEARCH METHODS

Research Approach

Research and development (R&D) method is a research method to produce specific products and test the effectiveness of the products that have been produced. In this module development research, the research model used was Alessi and Trollip. This development research uses the research steps of the Alessi and Trollip models namely, three steps must be applied: planning, design, and development (Sugiyono, 2013).

Research Participants

The product research and development process involves several media expert validators and material experts:

1. Media expert

Media experts consist of three lecturers in Information engineering Education who are experts in the media field. This media expert will become a validator to assess the suitability of the media and provide criticism and suggestions for product design.

2. Material expert

Material experts consist of three physics education lecturers who are experts in matter. This material expert will become a validator to assess the suitability of the material and provide criticism and suggestions on the content and product materials.

Research Instruments

The research instrument used to test the feasibility of the product in this study is in the form of a validation sheet for the validator to measure the feasibility of the e-module based on PhET simulation dynamic fluid material in Senior High School where on the validation sheet, experts can provide criticism or input so that researchers can repair or revise the e-module so that it is suitable for use in the learning process.

1. Material expert validation sheet
2. Media expert validation sheet

Data Collection

The data collection technique used in this study is to find out whether the product is in the form of an e-module suitable for use or not, namely by filling out a questionnaire in the form of a validation sheet, then the validation sheet is tested by material experts and media experts by giving criticism and giving input or suggestions. On the developed e-module so that researchers can improve the e-module. In the data collection technique, the validator assessment measure consists of Not Eligible with a value of 1, Less Eligible with a value of 2, Eligible with a value of 3, and Very Eligible with a value of 4.

1. Material expert validation

Material expert validation was carried out by 3 Physics Education Lecturers at Arraniry State Islamic University. The purpose of validation is to collect data from users to find out whether learning materials are suitable for use in the learning process.

2. Media expert validation

Media expert validation was carried out by 3 Information Technology Education Lecturers in the technology field at Arraniry State Islamic University. This aims to determine the feasibility of learning media from the appearance and program aspects.

Data Analysis

Data analysis techniques in this study used descriptive qualitative analysis in the form of critical assessments and input or suggestions given by the validator on the validation sheet. While the data used in validating the module's development is quantitative. The size of the validator assessment, according to Firmansyah (2020), consists of the following:

Table 1. Validator assessment size

Response Classification	Value Weight
Very Eligible	4
Decent	3
Less Eligible	2
Not feasible	1

To calculate the value of the validation sheet with the value contained in the table above, we can figure it out using the formula that has been set, namely:

$$\bar{X} = \frac{\sum x}{N}$$

Meanwhile, to change the average score of the experts' assessment to know the eligibility/validity of the module. The results of the development of the e-module, which were initially valuable in the form of scores, were converted into qualitative data using the percentage formula:

$$\text{Percentage of feasibility} = \frac{\text{Average} - \text{overall average of the}}{\text{the highest score on the assessment}} \times 100\%$$

the data calculated from the percentage formula is then obtained by the following criteria for evaluating the feasibility of the e-module (Wulandari & Purwanto, 2017).

Table 2. e-Module eligibility criteria

Scale (%)	Eligibility Criteria
0-44	Not feasible
45-64	Deserves the predicate enough
65-84	Deserves a good predicate
85-100	Deserves the title of very good

RESULTS AND DISCUSSION

This research produced an e-module product based on PhET Simulation on Dynamic Fluid material, making it easier for students to understand material that is considered difficult to understand through the e-module based on PhET simulation. The development of the e-module based on PhET simulation on Dynamic Fluid material was designed based on the steps following the Alessi and Trolip development procedures, namely planning, design, and development.

Results

1. Planning

The researcher carried out three planning stages in the planning stage: Needs Analysis. During the learning process, technology-based learning media had not been used in learning as it was intended to be applied to education that was developing at this time. Students' interest in learning was still very low, and this was because students did not like physics learning, lack of teaching materials in the learning process, inadequate laboratory facilities that became an obstacle for students to do a practicum, limited time is also one of the reasons for not using technology-based learning media. The second stage is determining the material, basic competencies, and indicators of competence achievement by distributing questionnaires to students. The distributed questionnaire contained five learning materials in class 2nd grade of state high school 3 Seunagan to determine the difficulty level of material that was difficult for students to learn. Based on the analysis of the results of material difficulty, it is known that the material considered difficult by students is dynamic fluid because many students still do not understand the material.

2. Design

In the second stage namely, design, the author designs a product in the form of a module with four stages, namely developing the concept, where the writer develops the concept by uniting the loaded components consisting of the material presented in the e-module is discharge material,

continuity equation, and the Bernoulli principle, videos, pictures, competency tests, glossaries, worksheets, lesson plans, and so on. The second stage is to determine the appearance design of the module. The PhET Simulation-Based e-Module on Dynamic Fluid Material in Senior High School is designed using Microsoft Word, starting from the front cover to the back cover. The selection of various color formats also matches the base color, yellow. The module title for each sheet is at the top of the contents in the module. The next step is to determine the software to use and validate the instruments of media and material experts.

The developed E-modules consist of 92 pages with an attractive front cover. In e-modules contain flowcharts, descriptions of e-modules, concept maps, instructions for using e-modules, the material on dynamic fluids, lesson plans, students worksheet, summary, competency tests, glossary, bibliography, author profile, and end with an interesting rear cover.



Front Cover



Flowchart E-module



Learning Materials



Back Cover

Figure 1. E-module design display that has been developed

3. Development

The development stage, where the author develops a product in the form of an e-module with 3 stages, namely: Making a PDF module, namely At this stage the development is carried out, namely the process of making a PhET Simulation-Based module, which was originally in word form and then converted into PDF form. The second stage of making e-modules using Flip PDF Professional is the creation of e-modules based on Phet Simulation, which was originally in PDF form and then uploaded to Flip PDF Professional, which then produces a product in the form of an e-module that has been developed according to the design that has been prepared. Researchers and the feasibility test stage, namely in the third stage, the feasibility test by three material experts and three media experts on the e-module that has been developed by giving criticism and suggestions so that researchers can revise the e-module based on input that experts have given so they can find out whether e -the module is feasible to use or not.

The feasibility of the PhET Simulation-Based E-module product that has been designed and developed is then determined based on the feasibility test results by three material expert validators and three media expert validators. It can be seen that the results of the overall percentage of the feasibility of the PhET Simulation-Based E-module are as follows:

Table 3. Validator Percentage Data

No.	Validator	Presents	Criteria
1	Material expert	88,25%	Deserves the title of very good
2	Media expert	97,62%	Deserves the title of very good
	Total average score	92,93%	Deserves the title of very good

From Table 3. It can be seen that the development of the PhET Simulation-based e-module is feasible to use with a very good predicate with a feasibility percentage of 92.93%, but this e-module will continue to be improved following the suggestions and criticisms that the validator has given.

Discussion

1. Planning

Needs analysis was carried out to find out the problems in learning Physics in the field, so it needed the development of PhET Simulation Based e-modules. The analysis was carried out by observing the ongoing learning process. Based on the results of observations that researchers have obtained to obtain data that during the learning process, technology-based learning media have not been used in learning as they wish to apply to education that is developing at this time, students' interest in learning is still very low this is because learning physics is lacking preferred by students, lack of teaching materials in the learning process, inadequate laboratory facilities so that it becomes an obstacle for students to do practicum and limited time is also one of the reasons for not using technology-based learning media.

Material difficulty analysis is carried out to discover problems in physics learning in the field so that dynamic fluid material development is needed. Analysis of material difficulties was carried out by distributing questionnaires to students. The questionnaire that was distributed contained five learning materials in class XI to determine the level of difficulty of material that was difficult for students to learn. Based on the analysis of the results of material difficulty, it is known that the material considered difficult by students is dynamic fluid material because many students still do not understand the material.

2. Design

Developing the concept, namely the stage where writing develops the concept, is done by bringing together the components contained in the e-module consisting of learning material based on Basic Competence 3.4, then the selected video according to the material, pictures, competency test, glossary, students worksheet, lesson plan, and so forth. These components are then used as materials in the manufacture of e-modules.

The e-module based on PhET Simulation on Dynamic Fluid Material in Senior High School is designed using Microsoft Word starting from the front cover, the contents to the back cover. The selection of various color formats also matches the base color, yellow. The selection of colors for various content sections to attract students' attention, namely by mixing yellow, cream, and brown. At the top of the contents of the module is written the module title for each sheet then the software used in the process of making Phet Simulation-Based e-modules plays a very important role because it is used in product development, namely by using Flip PDF Professional and research instruments designed for product development in the form of validation questionnaires material experts and media experts used to measure the quality of the PhET simulation based e-module. Media expert and material expert instrument validation was carried out to find out whether the validation instrument was valid or not used to test the feasibility of the PhET Simulation-Based e-Module. In this study, instrument validation was checked by asking experts' opinions. The validation instruments were then examined and given input and suggestions so that the resulting instruments were following their needs.

3. Development

At this stage, the development is carried out, namely the process of making a PhET Simulation-Based module that has been designed and developed, which was originally in Word form and then converted into PDF form so that it is easy to upload in the specified software. In the next stage, the PhET Simulation-Based e-module was created, initially in PDF format, then opened the Flip PDF Professional application and entered the PhET Simulation-based e-module PDF file on Dynamic Fluid material and videos that had been previously prepared in the edit pages menu, which were then edited, published online to produce a product in the form of an E-module that has been developed according to the design prepared by the researcher.

In the third stage, three material experts and three media experts tested the feasibility of the e-module that had been developed by providing criticism and suggestions so that researchers could revise the e-module based on the input that had been given by experts so that they could find out whether the e-module was PhET-based. Simulation on the Dynamic Fluid Material is suitable for use or not before the product is tested.

An assessment of the feasibility of the PhET Simulation-Based E-module was carried out by six lecturers at UIN Ar-Raniry Banda Aceh. Data from the assessment results are in the form of scores converted into four categories: Very Eligible, Eligible, Fairly Eligible, and Inadequate. The score obtained is then processed into a percentage for the eligibility criteria.

The feasibility of the material contained in the PhET Simulation-based E-module was assessed by three material experts: Mr. Muhammad Nasir, M.Si., Mrs. Zahriah, M.Pd., and Mr. Drs. Soewarno. S., M.Sc. Based on the results of validation by material experts regarding the development of PhET Simulation-Based e-modules in the Dynamic Fluid material as a whole, we obtained a score of 88.25% with proper criteria with a very good predicate.

The eligibility of the media contained in the PhET Simulation-based e-module was assessed by three media experts consisting of Ms. Nurrizqa, S.Pd., MT, Ms. Nurrisma, S.Pd., MT, and Mrs. Raihan Islamadina, ST, MT. Based on the validation results by media experts regarding the development of PhET Simulation-Based e-modules on Dynamic Fluid material as a whole, obtaining a score of 97.62% with feasible criteria with a very good predicate with assessments given by validators media experts and material experts proving that this E-module is suitable for use by students in the learning process at the senior high school level.

The result of this study is in line with previous research, which explains that phet simulation-based e-modules are feasible to use in conducting virtual practicum activities and students need 1-3 hours to do practicum and make reports, as explained by previous researchers with e-modules phet simulation based can increase student reasoning and effective in improving students critical thinking skills (Marfuah et al., 2015; Nikita et al., 2018; Prihatin et al., 2021; Putri et al., 2022).

E-modules have been validated by three material experts and three media experts to assess the feasibility of e-modules as explained by previous researchers, and the results of the acquisition of an

average score of 3.50 in the very high category. Furthermore, e-modules are said to be practical, with a score of 3.55, which is in the very good category. The module developed was declared feasible based on the media experts and could make students interested in learning. (Marfuah et al., 2015; Pynka et al., 2018; Prihatin et al., 2021; Putri et al., 2022).

The difference in development that has been made earlier with the development of PhET simulation based e-modules, which is found in the e-module development design, the software used and lies in the video playback process directly in the e-module sign must contain other applications while in the previous development, the video playback process is can't immediately rotated in e-module.

CONCLUSIONS

This research is produced as an e-module based on PhET Simulation. In this e-module, material and simulation can be used as a virtual practicum in the learning process. The feasibility of the PhET simulation-based e-module on dynamic fluid material in Senior High School can be seen from the results of validation by material experts with an eligibility aspect of content 87%, an eligibility aspect of presentation 92.25% and a feasibility aspect of language 85.50%, with a total percentage obtained a percentage of 88.25%. The validation of media experts with the feasibility aspect of display is 96.5%, and the feasibility aspect of programming is 98.75%, with a total percentage of 97.62%. The resulting categories fall into the appropriate criteria for use with a very good predicate.

Based on the results of research and discussion from the development of PhET simulation-based e-modules in the dynamic fluid material of senior high school, researchers put forward several suggestions including the results of this study can be used as one of the solutions that can be used in the learning process, especially in a dynamic fluid material. Researchers hope that further research can develop e-modules based on PhET simulation on different material, the author hopes that further research can continue this research until the stage of implementing e-module products based on PhET simulation on dynamic fluid material in the learning process at school.

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