Design of PhET Simulation Assisted Experimental E-Module on Elastic Materials and Hooke Law in High School Students

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Abstract. This research is aimed to determine the design by the results of the validity of the design PhET simulation-assisted physics experimental e-module. This research is an experimental e-Module design that was validated by 1 media expert to assess the appearance and suitability of the e-module, as well as 1 material expert to assess the depth of the content of the designed e-module who was a lecturer at Medan State University. The instruments used in the study were media expert validation questionnaires and experimental expert validation questionnaires. The results obtained from the validity aspect which was designed from input by media experts, an average score of 92.05% was obtained in the very feasible category and for the expert assessment of the perimeter, the average score was 94.46% in the very feasible category. Based on the results of the study, it was concluded that the designed PhET simulation-assisted physics experiment e-module was valid.

Keywords: Design, physics experiment e-module, PhET simulation

1. Introduction

The Ministry of Education and Culture of the Government of Indonesia has implemented a policy, namely changing the Education Unit Level Curriculum to the 2013 Curriculum which began to be practiced in the 2013/2014 academic year. The 2013 curriculum is an improvement of the Education Unit Level Curriculum which does not play a role in the development of Indonesian education. The 2013 curriculum is implemented to train process skills that can be seen in learning activities. The process skills implemented are observing, questioning, collecting data, associating as well as communicating what is called a scientific approach [1].

One form of teaching material is modules. Modules are teaching material compiled by educators themselves whose purpose is to make it easier for students to learn the subject matter independently. In the world of education, there are 2 types of modules developed, namely

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electronic modules and printed modules. The use of electronic and printed modules is based on the analysis of problems and needs of students. Both electronic modules and print modules are needed as learning innovations for students. Especially the need for electronic modules based on computerization to answer the needs of the millennial generation [2].

The birth of the millennial generation is one of the reasons to change the vision of education, thus leading to a new learning process [3]. Teachers must be able to design and implement learning in the classroom by the needs of students and technological developments. Technological advances have resulted in online-based learning resources and media with e-learning and attractive blended applications. E-learning provides purely e-learning through the internet, intranet, or multimedia networks [4].

Students in carrying out practicum activities have not referred to problem-solving problems but are only invited to prove the concepts presented by educators when learning. Learning refers more to the teacher's explanation without allowing students to solve problems, find facts, concepts, and theories that are the result of their findings. This condition must be considered, one of which is through increasing learning activities by applying the science process skills approach [5]. One of the student's processes skills can be measured using experimental methods. This method can present a certain process that the student then follows or tries to do. Students can experience and discover physics concepts for themselves by conducting an experiment or experiment so that students' understanding and memory are higher. Students' interest in learning motivates students, improving abstract ideas in learning activities [6]. It's good when the school has facilitated the needs of the process of teaching and learning activities so that teachers can take advantage of existing facilities to prepare students to face industrial revolution 4.0. Teachers must be able to make an innovation in learning by developing learning media that is packaged in such a way that learning is more interesting, interactive, effective, and efficient in its use. [7][8]

Along with the development of technology, practicum activities can be carried out in a simulated manner using a virtual lab operated using a computer. One virtual lab that can be used is PhET. PhET is an interactive physics simulation software available on the site that can be downloaded for free and can be run online or offline [9]. Computer-aided simulations and interactive learning activities can encourage collaboration between digital skills and student process abilities [10]. The existence of virtual lab simulations is beneficial because the combination of online learning media is effective and can improve student learning outcomes. The software can be run by students to do a practicum simulation before experimenting but students need an E-Module as a guide for experimental practicum in the implementation of physics practicum, so an experimental e-module assisted by PhET simulation is needed to support student learning in class [11].

Research using PhET in learning can train science process skills effectively. Student learning outcomes increased due to the existence of PhET simulation media in physics subjects based on the 2013 curriculum [12-14]. The existence of an experimental e-module with steps for approaching science process skills can be used as a guide that leads students to apply the scientific method in understanding, developing, and discovering science so that it is expected to contribute to improving students' science process skills and improving students' mastery of the material, especially of the material elasticity and Hooke's law.

This research is an experimental e-Module design that was validated by 1 media expert to assess the appearance and suitability of the e-module, as well as 1 material expert to assess the depth of the content of the developed e-module who was a lecturer at Medan State University.

2. Methods

This research was carried out from May 2022 to July 2022, while the stage of preparing the report was carried out in July 2022. The creation of e-module products uses PhET simulations, Flip PDF, and PowerPoint software, combining all the materials that have been made ranging from designs, materials, animations, supporting images, and video simulations following the stages of science process skills and mastery of student materials.
The product will be validated by 1 media expert to assess the appearance and suitability of the e-module, as well as 1 material expert to assess the depth of the content of the designed e-module who was a lecturer at Medan State University.
Questionnaires for media experts and material experts are used as guidelines for product improvement. The results of the expert validation are then adjusted to the validation criteria in Table 1 [15].

Table 1. Validation Test Percentage

No.	Validation Percentage	Validation Level
1.	**85,01% - 100,00%**	**Highly Valid (can be used without revision)**
2.	70,01% - 85,00%	Valid (can be used with minor revisions)
3.	50,01% - 70,00%	Less Valid (can be used with major revisions)

3. Result and Discussion

3.1. Design E-Module

The design of the content of teaching materials in the form of e-modules uses the approach of students' science process skills, determines the subject matter to be developed, namely elasticity material and Hooke's law studied in class XI SMA, determines KI, KD, indicators of competency achievement and learning objectives. The delivery of the material is displayed in 3 learning activities and each activity is arranged by applying stages using the student's science process skills approach.
The initial design of teaching materials in the form of e-modules is prepared using module elements according to the Ministry of National Education so that an initial design is produced, namely covers, prefaces, table of contents, list of images, table of tables, learning instructions for teachers and students, competencies to be achieved, material content, instructions/work procedures, worksheets, exercises, and evaluation sheets. The resulting initial design was as follows:

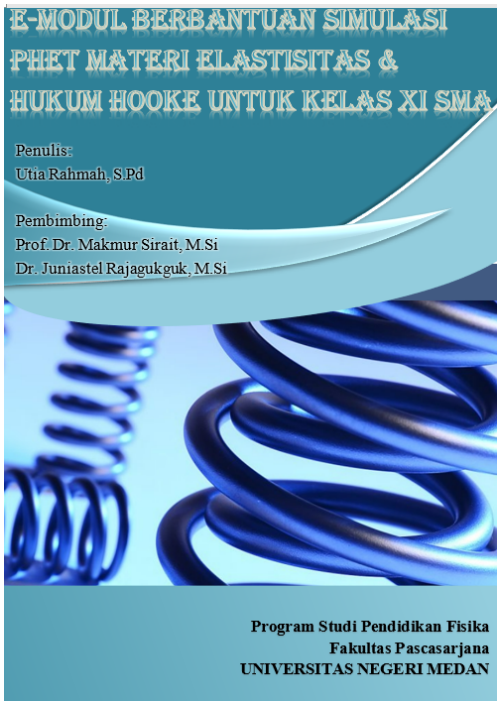

Figure 1. Cover Design

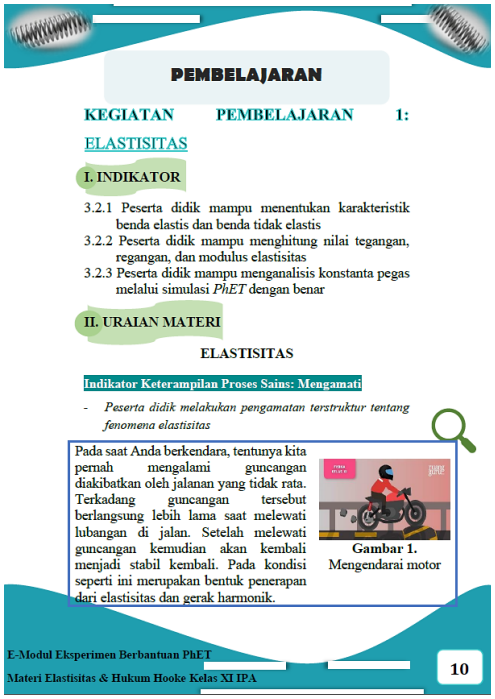

Figure 2. Design Of The Observing Stage

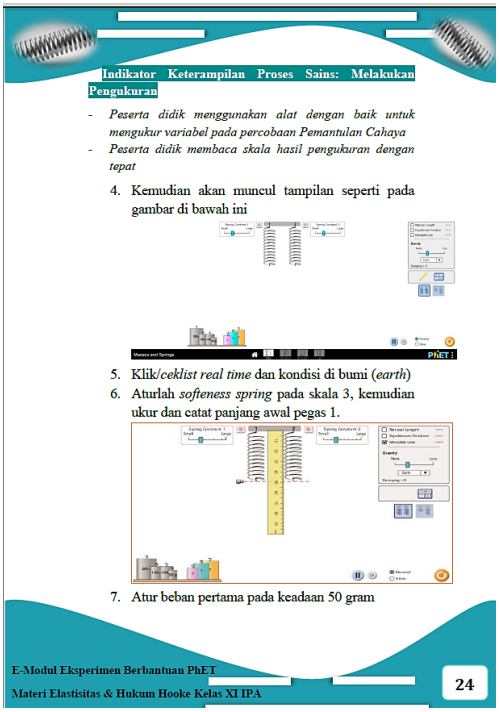

Figure 3. Design Stage of Taking Measurements Using PhET

3.2. Media Expert Validation Result Data

The validation of media experts on the design of the Physics experiment E-Module assisted by PhET simulation on Elasticity material and Hooke's law was carried out by 1 media expert. The assessment of the product is intended to obtain information that will be used to improve the feasibility of the E-Module of physics experiments on the material of Elasticity and Hooke's law.

The average percentage of the results of the assessment of learning media experts on the E-Module that has been designed can be seen in Table 2.

Table 2. Average Percentage of Media Expert Assessment Results

No.	Assessment Indicators	Average Percentage	Criterion
1.	**Aspects of Content Quality and Purpose**	**85%**	**Highly Valid**
2.	Instructional Quality Aspects	91.6%	Highly Valid
3.	Technical Quality Aspects	91,6%	Highly Valid
4.	Completeness of E-Module Instruments	100%	Highly Valid
Average		92.05%	Highly Valid

The results of the assessment of learning media experts on the e-module of physics experiments on the material Elasticity and Hooke's law have an average percentage of 92.05%. This means that the average percentage of assessment indicators belongs to the category of "Highly Valid" and can be used in the learning process as well as being feasible for field trials based on the responses of learning media experts.

3.2. Material Expert Validation Result Data

After the validation test of media experts, it was also designed with the validation of experimental experts on the design of an e-module of physics experiments assisted by PhET simulations on elasticity materials and Hooke's law. The validation of experimental material experts was carried out by 1 media expert. The assessment of the experiment is intended to obtain information that will be used to improve the feasibility/accuracy of the material present in the PhET simulation-assisted physics experiment e-module on elasticity matter and Hooke's law.

The average percentage of the results of the experimental expert's assessment of the E-Module that has been designed can be seen in the following Table 3.

Table 3. Average Percentage of Experimental Expert Assessment Results

No.	Assessment Indicators	Average Percentage	Criterion
1.	**Linguistic Aspects**	**95%**	**Highly Valid**
2.	Aspects of Presentation Feasibility	91,6%	Highly Valid
3.	Aspects of Completeness of Science Processes	96.8%	Highly Valid
Average		94.46%	Highly Valid

From the results of the experimental expert's assessment of the experimental E-Module designed in Table 3 above the average percentage of assessment, respectively, 95% of feasibility in the language aspect, 91.6% in the presentation aspect, and 96.8% in the completeness aspect of the science process. Overall, the three aspects belong to the "Very Valid" category with an average percentage figure of 94.46% which means e-module PhET simulation-assisted physics experiments on elasticity matter and Hooke's law can meet the demands of learning needs and are worth using.

4. Conclusion

The validity aspects of the PhET simulation-assisted physics experiment e-module on elasticity material and Hooke's law designed from input by media experts obtained an average score of 92.5% with a very valid category and for the assessment of experimental experts an average score of 94.46% with a very valid category.

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