
Physics E-Module Based on Science, Technology, Engineering, and Mathematics to Improve Learning Outcomes of High School Students at SMA N 1 Deli Tua

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Abstract

This development research aims to produce a Science, Technology, Engineering, and Mathematics (STEM)-based e-module to determine the feasibility, practicality, and effectiveness of a STEM-based physics e-module on the topic of work and energy for 10th-grade students. The research design used in this study was research and development (R&D) using the ADDIE model to develop the e-module on the topic of work and energy based on STEM. The population and sample of this study were 10th-grade students at SMAN 1 Deli Tua, and the sample consisted of 10th-grade students in the MIA 3 class at SMAN 1 Deli Tua. Based on the data analysis, the results of expert validation yielded a material expert validation score of 88.16% with a category of very feasible, and a media expert validation score of 90.7% with a category of very feasible. The results of the practicality test on a small scale showed that the ease aspect obtained a percentage of 91.3%, the attractiveness aspect obtained a percentage of 91.8%, and the usefulness aspect obtained a percentage of 90.2%. The results of the large-scale trial showed that the e-module obtained a highly practical category, reaching 92.6%. The ease aspect obtained a percentage of 93.2%, the attractiveness aspect obtained a percentage of 94%, and the usefulness aspect obtained a percentage of 90%. Both small and large-scale tests yielded a highly practical category. The effectiveness test showed that the average pre-test score obtained by students was 37.66, and the average post-test score was 89.6%. Based on the N-gain test, it was found that the average N-gain score of students was 0.84 or 83.94%, which is interpreted as having high effectiveness. Therefore, the product developed in this study is considered feasible, practical, and effective in supporting students' self-directed learning process on the topic of work and energy and can improve students' learning outcomes.

Keywords: E-module, STEM, Feasibility, Practicality, Effectiveness.

INTRODUCTION

The development of a country is determined by the education implemented in that country. Education is the fundamental foundation for building quality human beings and therefore plays a role in developing independent, creative, and critical thinkers. The goal of Indonesia's National Education is to enrich the life of the nation and to educate the entire Indonesian people to be faithful and devoted to the One Almighty God, have noble character, knowledge, and skills (UU Sisdiknas No. 20, 2003).

Physics is one of the subjects included in the 2013 curriculum and plays a crucial role in the development of science and technology. Physics' contribution to other fields can give rise to new areas of knowledge. Issues faced by students in learning physics include difficulties in understanding physics materials, considering physics as a very challenging subject due to its seemingly complicated content, which consequently affects their learning outcomes. Students also struggle with comprehending the concepts and applying them in their daily lives. The lack of contextual learning in physics instruction and the perception of being less talented or lacking interest and motivation in learning physics due to its difficulty further contribute to these problems (Samudra et al, 2014).

The issues identified at SMAN 1 Deli Tua during the preliminary study conducted through direct interviews with one of the physics teachers, Mr. Drs. Naksir Barus, were as follows: the students did not focus their attention while studying physics, the teaching materials used by the teachers were solely from the school-provided textbooks, the teachers had not developed any other teaching materials to enhance students' interest in learning, such as digital or electronic learning materials. Furthermore, based on a questionnaire distributed to 30 students, it was found that generally (80%), students experienced difficulties in learning physics and did not like it because they perceived physics as difficult. The explanations provided by the teacher were hard to understand, which made the students feel bored. Additionally, during an interview with another physics teacher at SMAN 1 Deli Tua, it was mentioned that the lack of alternative teaching materials apart from the school-provided textbooks made it challenging for students to learn the subject easily. According to the students, the appearance of the textbooks was monotonous and unappealing.

One of the efforts to create quality education is the implementation of the STEM approach in teaching, which stands for Science, Technology, Engineering, and Mathematics (Handayani, 2022). The use of the STEM approach is intended to equip students with skills and understanding in all four interconnected aspects of STEM within a particular subject matter. This approach can help students solve problems and draw conclusions by applying knowledge through science, technology, engineering, and mathematics. The STEM approach can be implemented by developing learning modules (Muminah et al., 2019). With the development of educational technology in the current digital era, modules can be developed in electronic (digital) form, known as e-modules. According to Rahmi (2018), an e-module is a form of self-directed learning

media presented in digital format, aiming to achieve learning competencies and promote student interactivity through its use. Based on the description above, the researcher is interested in conducting a study on "Physics Science, Technology, Engineering, and Mathematics E-Module in Improving Learning Outcomes of Students at SMA N 1 Deli Tua."

METHOD

This research will be conducted at SMAN 1 Deli Tua, located at Jln. Pendidikan No. 01, Kec. Deli Tua, Kab. Deli Serdang, Prov. North Sumatra. The research will take place in the even semester of the academic year 2022/2023, starting from March to April 2023. The population and sample of this research will be the students of class X at SMAN 1 Deli Tua, specifically students from class X MIA 3 of SMAN 1 Deli Tua.

The research design used for this study is Research and Development (R&D) aimed at developing an e-module based on STEM for the topic of work and energy. Several methods will be used in its implementation, namely descriptive, evaluative, and experimental methods. The descriptive method will be used to analyze the educational needs in accordance with technological developments. The evaluative method will be employed to test the validity of the developed e-module by subject matter experts and media experts. The evaluation results will be used to improve the e-module, ensuring it is suitable for testing with students. The data collection techniques used in this research will include observation, interviews, questionnaires, and written tests (pre-test and post-test) to measure the students' initial abilities before participating in the learning activities. The post-test will be conducted after the students have learned independently.

RESULTS AND DISCUSSION

Result

1. Analysis

An initial analysis was conducted to identify the issues present in physics education at SMA N1 Deli Tua, concerning the aspects that will be developed in the research, namely e-modules as teaching materials. In this analysis phase, the techniques used were observation and interviews, which were carried out during school observations. The purpose of this analysis phase was to understand the physics learning process used in the school, including the teaching activities and

materials employed. This analysis stage is necessary to analyze the problems arising in the school and to serve as a reference for future research.

2. Design

The stages of design include the preparation of a draft that will serve as a reference for the feasibility and quality of the STEM-based physics e-module. This includes aspects such as content, language, presentation, and the graphics of the e-module. The result is the initial design of a STEM-based physics e-module on the topic of work and energy, serving as the initial product

3. Development

In this development stage, the researcher carries out the development of the e-module until it reaches the feasibility test. Some of the outcomes of this stage include: The criteria for the feasibility of the e-module, which has been revised and deemed suitable for use, can be progressed to the next stage. In this phase, the researcher develops the STEM-based e-module based on the content and format that was prepared in the previous stage, which is the design phase. The development is done by working on the e-module, and from this stage, a draft I of the e-module is produced, which will be given to two expert professors, namely the subject matter expert and the media expert, for the feasibility test.



Figure 1 The Validation of Content Results

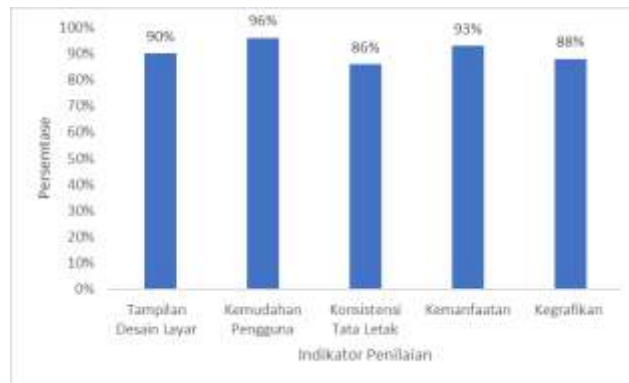


Figure 2 The Validation Results by Media Expert

4. Implementation

After going through the development stage and making improvements, the e-module is then implemented in small-scale testing and large-scale testing.

a) Assessment of Product Practicality Based on Student Responses

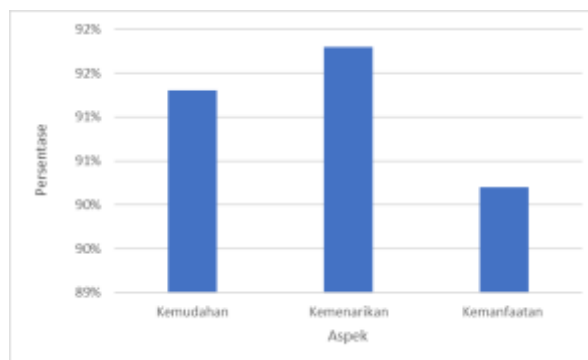


Figure 3 Results of Small-Scale Testing

Based on the results of the small-scale testing, it was found that the aspect of ease of use obtained a percentage of 91.3%, the aspect of attractiveness obtained 91.8%, and the aspect of usefulness received 90.2%. Therefore, the total average percentage of the small-scale testing results is 91.1%, which falls under the category of very practical.

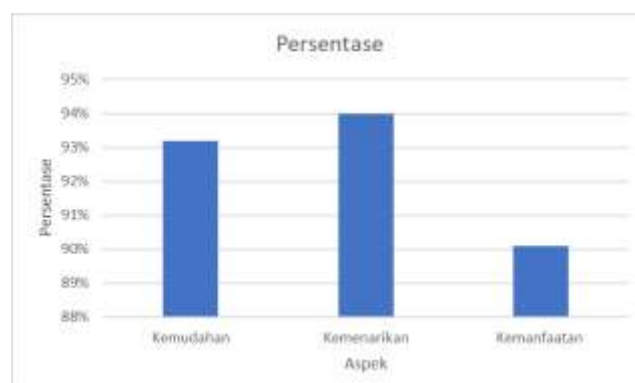


Figure 4 large scale test

Based on the results of the large-scale testing, it was found that the e-module obtained the category of very practical, reaching 92.6%. The aspect of ease of use obtained a percentage of 93.2%, the aspect of attractiveness obtained 94%, and the aspect of usefulness received a percentage of 90%.

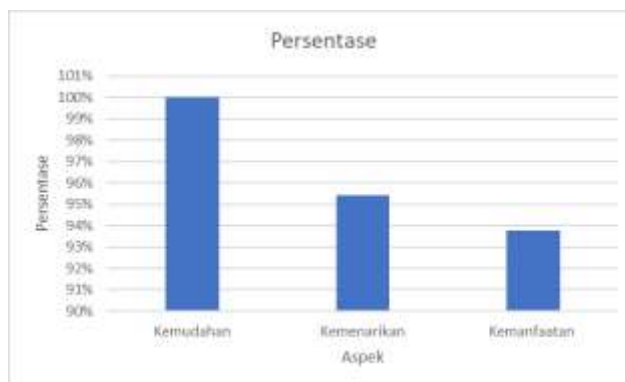


Figure 5 Teacher Questionnaire Response Results

The analysis of responses from subject area teachers aims to gather information to improve the quality of the developed e-module. Based on the analysis of the teacher response test results, it was found that the e-module was deemed highly practical, with a percentage of 95.83%. The aspect of ease of use obtained a percentage of 100%, the aspect of attractiveness received 95%, and the aspect of usefulness received 94%.

b) E-Module Effectiveness

Based on the criteria for achieving learning objectives, the final average value of the post-test of students is described in the very good category. Based on the pre-test and post-test scores obtained, the level of product effectiveness in this study can be determined, namely by using the N-gain formula. Based on the description in the table, the N-gain score obtained is 0.84 or 84.21%, which is interpreted as having high effectiveness. Therefore, the product made in this study is effectively used to support the students' self-learning process on effort and energy material and can improve student learning outcomes.

Table 1 N-Gain Test Results

Deskripsi	Nilai	
	Pre-test	Post-test
Jumlah nilai	840	1990
Rata-rata nilai	38,18	90,45
Skor <i>N-gain</i>	0,84	

Persentase skor <i>N-gain</i>	84,21%
Tafsiran <i>N-gain</i>	Tinggi

5. Evaluation

The evaluation stage is a stage that controls each research implementation in each phase. Evaluation is carried out by analyzing the data then discussing it with the supervisor before finally drawing conclusions. The data obtained will then be discussed and processed again to improve the quality of the final product. Input and suggestions from expert lecturers with a percentage of feasible categories and continued to user responses which also get categories of easy, very interesting and useful, then the e-module is obtained as the final result of this research.

Discussion

Based on the research that has been done, the results of the validation of material and media experts show that the product made is very feasible. Based on the feasibility test by material experts, it was found that the material validation obtained a percentage of 88.16% with a very feasible category, with each aspect also declared very feasible. 88% presentation feasibility aspect, 92.3% linguistic feasibility aspect, and 86% STEM approach aspect. The results of the media expert validation showed a percentage of 90.7% with a very feasible category. With each aspect declared very feasible, namely aspects of the feasibility of the appearance of the e-module design 90%, aspects of the feasibility of user convenience 96%, aspects of the feasibility of layout consistency 86%, aspects of the feasibility of usefulness 93%, and aspects of the feasibility of graphics 88%. After making revisions to product validation, researchers conducted a small-scale test on 8 students of class X MIA 3 SMA Negeri 1 Deli Tua. The small-scale test was conducted using a user response questionnaire.

Based on the results of the study, it was found that the product made was very practical with a total average percentage of the results of the small-scale trial of 91.1%, with a very practical category. The acquisition of each aspect, namely the convenience aspect, obtained a percentage of 91.3%, the attractiveness aspect obtained a percentage of 91.8%, and the usefulness aspect obtained 90.2%. Therefore, the e-module prepared is suitable for large-scale trials. The results of the teacher response test showed that the e-module was very practical, with a percentage reaching 95.83%. The convenience aspect obtained a percentage of 100%, the attractiveness aspect obtained a percentage of 95%, and the usefulness aspect obtained a percentage of 94%.

Based on the results of the large-scale trial, it was found that the e-module obtained a very practical category, which reached 92.6%. The ease aspect obtained a percentage of 93.2%, the attractiveness aspect obtained 94%, and the usefulness aspect obtained a percentage of 90%. Based on the research results, it was found that the e-module obtained a very practical category, which reached 92.6%. The convenience aspect obtained a percentage of 93.2%, the attractiveness aspect obtained 94%, and the usefulness aspect obtained a percentage of 90%. The level of practicality of the product shows that the e-module is feasible to use in supporting students' independent learning process on the material of effort and energy.

After the pre-test, students studied the physics e-module independently. E-module. After studying the physics e-module, students are directed to do post-test questions at the end of the lesson to support the learning evaluation process. Based on the results of the study, the average value of students' post-test was 90.45 with the highest score of 100, and the lowest score was 80. 8 students with a post-test score of 100, 7 students with a score of 90 and 7 students with a score of 80. Based on the N-gain test, it was found that the average value of students' N-gain was 0.84 or 84.21, which is interpreted as having high effectiveness. Therefore, the product made in this study is feasible, practical and effective to be used to support students' self-learning process on effort and energy material and can improve student learning outcomes.

CONCLUSION

Based on the results of the research and data analysis conducted, it is concluded that the STEM-based physics e-module is declared feasible, practical and effective to use on the material of effort and energy class X SMA. The suggestions that can be conveyed by the author are that independent learning should still be accompanied by direct supervision to the school and carried out regularly, so that all students can study the module properly.

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