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Development of an Android-based physics e-module on the subject of elasticity in high school physics learning

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Abstract
The research aims to analyze the validity and effectiveness of the Android-based physics e-module. This type of research is Research and Development (R&D) with a Nieveen development research design consisting of preliminary research, prototyping stage, and assessment stage. The research was carried out at Ngoro Jombang State High School. The research subjects were class XI MIPA 1 students for the 2021/2022 academic year. The results of the research show that the validity of the android-based physics e-module received a score of 89% and was considered very valid, while the effectiveness of the android-based physics e-module was based on the N-gain test with a value of 0.52, which shows the physics e-module android-based is effective in the medium category for use in the physics learning process.

Keywords: e-module, Andromo, elasticity

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I. Introduction

Learning is the process of teacher interaction with students and learning resources in a learning environment. The main learning components are students, teachers, and teaching resources [1]. Physics learning invites students to learn physics concepts related to nature [2]. Physics is presented and then translated into mathematical form so that it is easy to understand and prove through research, experiments, measurements, and mathematical presentation. Physics is important to study because many natural phenomena that occur can be explained through physics [3].

Teaching materials are part of learning resources. Teaching materials play an essential role in helping students achieve their learning goals. Teaching materials developed with various variations will make learning activities more attractive [4]. Modules are an example of developing teaching materials. Learning modules are prepared based on the principles of module development, including needs analysis, module design development, implementation, assessment, evaluation, and validation, as well as quality assurance. The module allows students to learn in a more focused and systematic way to master learning competencies [5]. However, students' modules are mostly printed, which tend to be informative, have simple illustrations, and only contain practice questions. However, some students still need to be able to study independently using printed modules, making it challenging to develop the knowledge that students have [6].

The COVID-19 pandemic is a health crisis that the world is currently facing. The impact of the spread of COVID-19 is changing the system in all aspects of human life, one of which is changes in the field of education [7]. The government issued a policy for learning to be carried out online so that students and teachers are required to use technology in the online learning process due to COVID-19. Therefore, information and information and communication technology is essential in education [8]. The development of information

technology has a significant influence on the learning process. One of the impacts of the development of information technology is the increasing development of varied and innovative learning media. Learning media, which were originally printed, have changed to electronic. So, the module can be presented in electronic form, called E-Module. Electronic modules are independent teaching materials that are prepared systematically, structured, and interactive and can be used as a source of independent learning without a teacher as a source of information, which can help students improve competence or understanding. It can be used anywhere because of the practicality of the modules [9]. In efforts to develop module teaching materials in electronic form, the technology that can be used is the Internet and the Android operating system on smartphones [10]. Android-based interactive learning enables students to learn with high motivation because of their interest in multi-product systems. Android-based interactive e-modules are modules that are considered quite ideal products nowadays. Because it supports the use of multi-products (audio-visual integration in the form of video), high interactivity, and multi-source learning (with an internet network connection), it can complement the shortcomings of textbooks [11].

Research on learning by applying Android-based e-modules has been carried out by several researchers before. The results of research conducted by Gustiningrum stated that learning by implementing android-based e-modules increased students' interest and understanding through independent learning with a feasibility scale of 94% for material experts and 76.67% for media experts [10]. Further research conducted by Sidiq produced an android-based interactive e-module that has been validated, meets the criteria for good learning media, and is suitable for use in learning with a presentation score of 93% validation by material experts, 82% validation by learning design experts, and 86% validation by media experts [11]. It can be concluded that Android-based e-modules are suitable for use in learning.

Elasticity is one of the physics materials that students need help understanding. Elasticity measures an object's ability to return to its original shape after being subjected to a force [12]. ased on the results of previous research, Wenno stated that as many as 69.2% of students had difficulty mastering the concept of elasticity, and only 30.8% had no difficulty understanding the concept of elasticity [13]. Similar research by Oktavia stated that 85% of students had difficulty learning elasticity material. These difficulties include difficulty mastering concepts, connecting relationships between concepts, and mastering formulas and operating formulas in solving problems. Any difficulties students have in understanding elasticity material will impact student learning outcomes. One thing that influences students' understanding of the concept of elasticity is that the teaching materials used are not sufficient to study elasticity material because they still have shortcomings, namely not being able to teach students independently and not being able to stand up alone. The way to overcome this problem is to use appropriate learning teaching materials. [14].

Andromo is an application that can be used to create Android applications. Andromo aims to make it easier for ordinary people to develop an Android-based application without coding and can be used freely [15]. An android-based physics e-module was used in this research to look for the validity and effectiveness values of the e-module.

Based on the background description, researchers researched physics learning by implementing an android-based physics e-module. This research aims to produce an android-based physics e-module that is valid and effective for learning. The final result of the research in the form of an android-based physics e-module can be used as a reference and an innovation in developing teaching materials for learning.

II. Methods

Research and Development (R&D) with a Nieveen development research design is the type of research carried out. According to Nieveen, there are three stages of development research: preliminary, prototyping, and assessment. The research was carried out at Ngoro Jombang State High School. The research subjects were class XI MIPA 1 students participating in product trials at Ngoro Jombang State High School for the 2021/2022 academic year.

E-module Validity

The method used to measure the validity of the e-module is by administering a questionnaire to two physics education lecturers at the University of Jember and a physics teacher at Ngoro Jombang State High School as an expert validator and user. Validators provide input for improvements to the e-module being developed. The questionnaire contains 20 validation instrument statements. The score assessment consists of a scale of 1 to 4, each showing the criteria for the assessed product (1: invalid, 2: less valid, 3: valid, 4: very valid). The results

of the score assessment are then calculated using the module validity calculation formula in equation (1), namely:

$$V_{ah} = \frac{T_{se}}{T_{sh}} \times 100\% \quad (1)$$

Where V_{ah} is Expert validity, T_{se} is the Total achieved score, and T_{sh} is the Total expected score.

The average score results from the total assessment by the three validators can be concluded by looking at the validity criteria table in Table 1.

Table 1. Module Validity Criteria

Score Interval (%)	Level of Validity
85.01 - 100.00	Very valid or can be used without revision
70.01 - 85.00	Valid or usable and needs minor revision
50.01 - 70.00	Less valid and is recommended not to be used because it needs major revisions
01.00 - 50.00	Invalid and should not be used

[16].

E-module Effectiveness

The method used to measure the effectiveness of e-modules is by giving tests to students in the form of pre-tests and post-tests. Test product effectiveness using a one-group pre-test and post-test design. The pre-test is carried out before treatment, and the post-test is carried out after treatment. So that the treatment results can be known more accurately and compared with the situation after being treated. Design image for one group pre-test post-test research in Figure 1.

O_1	X	O_2

Figure 1. One Group Pre-Test Post-Test Design

Where O_1 is the Pre-test, O_2 is the Post-test, and X is Learning using an Android-based physics e-module [17].

The effectiveness of the android-based physics learning e-module was analyzed quantitatively based on student pre-test and post-test data using equation (2) normalized gain $\langle g \rangle$, as follows:

$$\langle g \rangle = \frac{S_f - S_i}{S_{\max} - S_i} \quad (2)$$

S_i is the Pre-test average, and S_f is the Post-test average.

The N-gain score results are then concluded by looking at the criteria table in Table 2.

Table 2. N-gain Score Criteria

N-gain Score	Criteria
$\langle g \rangle \geq 0.7$	High
$0.7 > \langle g \rangle \geq 0.3$	Medium
$\langle g \rangle < 0.3$	Low

[18].

III. Results and discussion

This research uses the Nieveen development research design, which has the following three stages:

Preliminary Research

The preliminary research began with interviewing one of the physics teachers at Ngoro Jombang State High School. Interview activities were conducted to obtain information about the problems existing at the school.

Especially student problems in the learning process during the COVID-19 pandemic. The data obtained was then reviewed and analyzed by researchers. Questions asked during the interview included how the physics learning process was implemented at Ngoro Jombang State High School, student participation, difficulties in the learning process during the COVID-19 pandemic, and the teaching materials applied along with student learning outcomes. The interview results show that students must refrain from participating actively during online learning. Students only learn when the teacher gives assignments, but after that, students will not pay attention to the material presented by the teacher. For example, students play on their smartphones and even sleep in the middle of learning. This attitude is one of the causes of obstacles in the learning process during the COVID-19 pandemic, so it influences student learning outcomes that are not optimal. Teachers have a very important role in the learning process. The teacher has carried out his role well. Even though many obstacles occur, the teacher tries to convey the learning material as best as possible so that students continue to have enthusiasm for learning and get good learning results. Apart from that, the choice of learning material was due to students still needing help understanding the concepts of elasticity and operating formulas in solving problems. The next stage was a review of theories from several previous researchers related to the problems that occurred. Several references were produced at this stage regarding learning modules used in physics learning, especially when learning is online, namely android-based e-modules.

Prototyping Stage

The prototyping stage consists of product design and validation. The stage begins with designing the product to be developed, namely an android-based physics e-module. The e-module consists of instructions for using the e-module, competency achievements, learning material for the elasticity chapter, practice questions and assessments. Then, learning material on the elasticity chapter will be given to students learning physics by implementing an android-based physics e-module.

The e-module that has been developed is then validated. Expert validators and user validators will assess the validity of the e-module. The creation of e-modules was created using the andromo.com application on the internet, which can be accessed for free. The results of the design of the Android-based e-module (andoromo) can be seen in Figures 2 to 9 below.

The results from the three validators are processed and averaged to obtain the final validation value. The final validation value obtained is then concluded per the module validity criteria to determine the android-based physics e-module's validity level. The following is a summary of the validation results of the Android-based physics e-module, shown in Table 3.

Table 3. Android-based physics e-module validation results

Aspect	Expert and User Validation Value Average	Percentage	Category
Appropriateness of the content	3.66	91.50%	Very Valid
Language	3.25	81.25%	Valid
Presentment	3.67	91.75%	Very Valid
Learning independence	3.66	91.50%	Very Valid
	3.56	**89%**	**Very Valid**

The validation value of the android-based physics e-module from expert and user validators obtained an average of 3.56 with a percentage of 89%. Based on Table 1, the e-module is declared very valid for learning. This followed Himmah's research, which found that the e-module was declared very valid after a validity test with an average score of 85% by expert and user validators [19]. Similar research by Pramadanti obtained validation results of 92.18% with a valid validity level [20]. The validation results of the Android-based e-module meet the criteria for good learning and are suitable for use in learning [11]. The android-based learning media developed has very valid quality so that it can be used as student teaching material [21]. E-modules in the assessment score interval between 85.01% - 100% are declared able to be used in learning without revision [16].

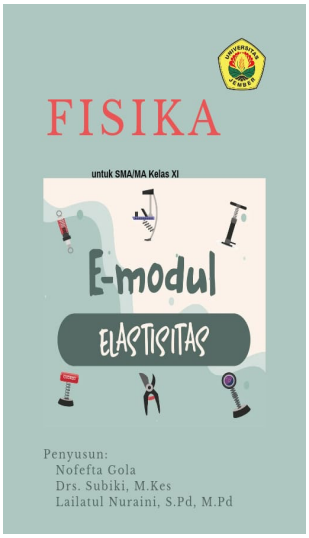

Figure 2. Cover

Figure 3. Main view

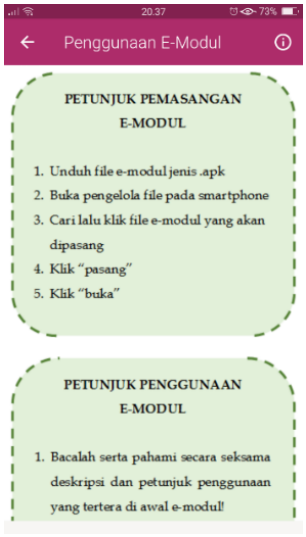

Figure 4. E-module instructions

Figure 5. Competency achievement

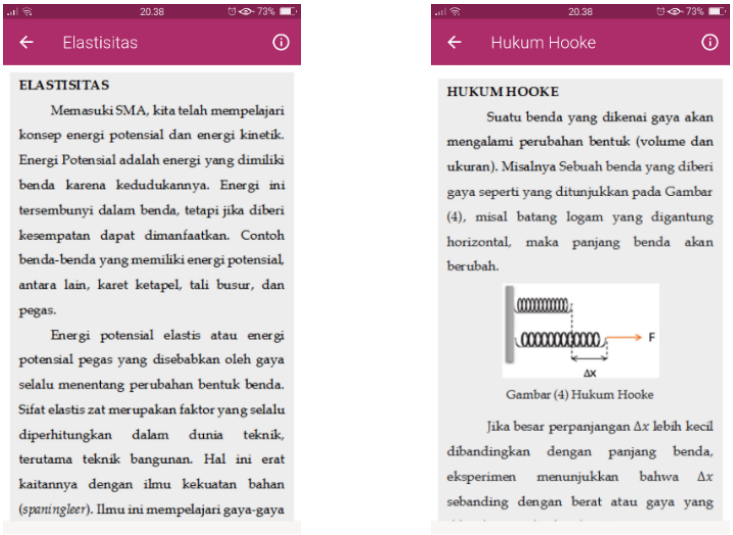

Figure 6. Elasticity material

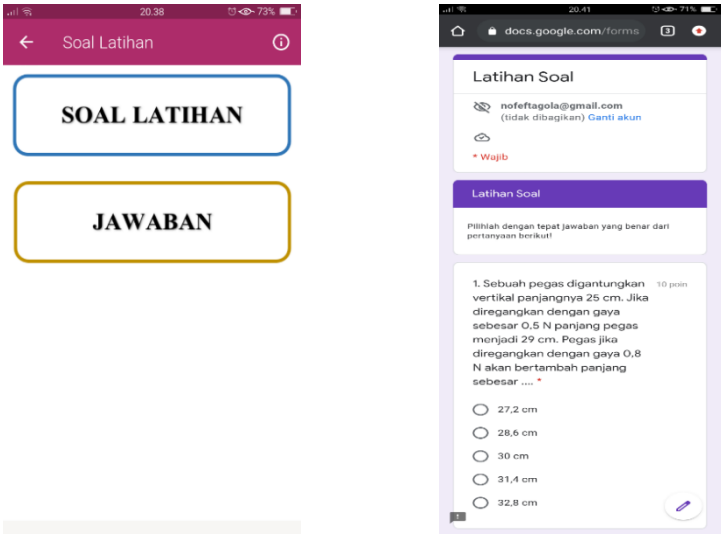

Figure 7. Practice questions

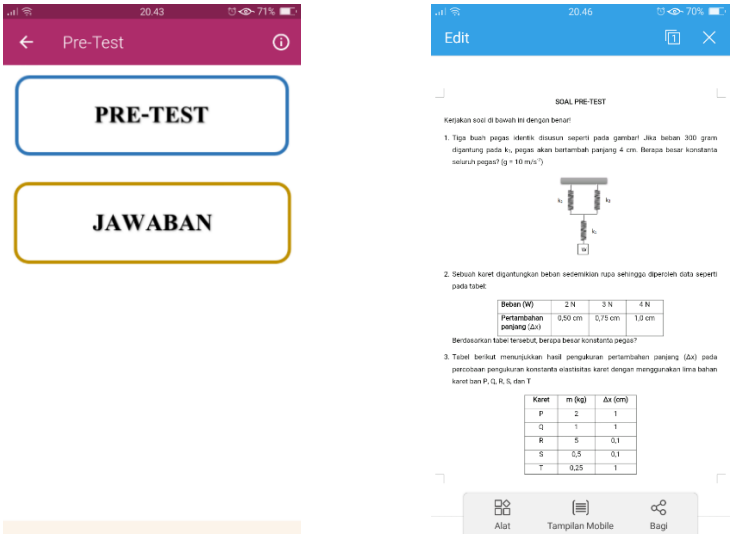

Figure 8. Pre-test

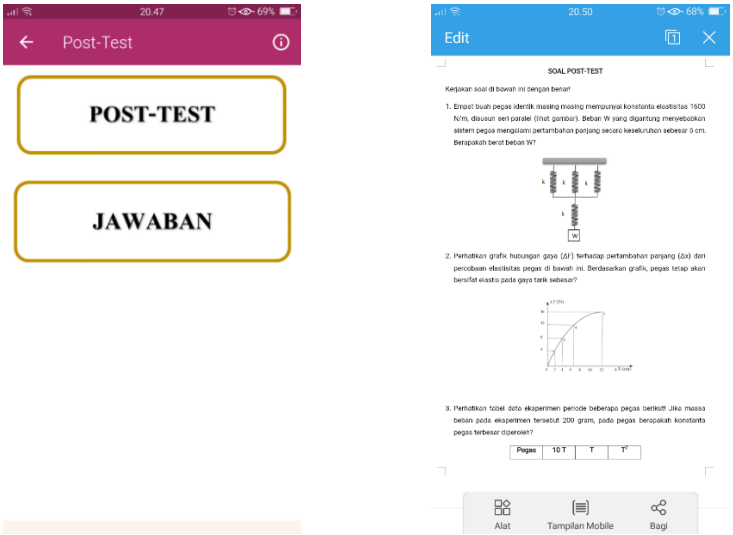

Figure 9. Post-test

Assessment Stage

The validated e-module is then tested for effectiveness after being used in physics learning at school. The e-module effectiveness test was conducted at Ngoro Jombang State High School in class XI MIPA 1 with 32 students. Learning is carried out in two meetings, each lasting 90 minutes. In the first meeting, the activity began with giving a pre-test to students to determine the extent of students' knowledge about elasticity material. Next, students use an Android-based physics e-module to study elasticity material. During learning, students observe the learning videos in the e-module and then discuss them with the group. At the second meeting, continue studying elasticity material and practice questions. The second meeting of learning activities ended with a post-test. The following are the N-gain values shown in Table 4.

Table 4. Average Student Learning Outcomes

Pre-test	Post-test	N-gain	Criteria
40.78	72.97	0.52	Medium

Based on Table 4. the data shows that the average pre-test score is 40.78 and the post-test score is 72.97. Pre-test and post-test scores are used to determine the increase in student learning outcomes before and after learning using e-modules in the cognitive domain. Next, analysis was carried out using the N-gain test, and a score of 0.52 was obtained in the medium category, according to Table 2. The number of students who obtained N-gain scores based on the low, medium, and high categories out of 32 students was 1 in the low category, 29 in the medium category, and 2 in the high category. This data shows that most students have increased scores in the moderate category. During the learning process, using teaching materials can improve students' ability to master concepts, as indicated by the acquisition of an N-gain value of 0.43 in the medium category [22]. In similar research by Kamila, there was an increase in student learning outcomes with an N-gain value of 0.36 in the medium category [23]. After analyzing the student learning results, it was found that several students still had difficulty working on and understanding questions, especially questions with the C4 classification. There needs to be more than the example questions in the e-module to help students solve these questions.

On the other hand, the material content in the e-module is to the learning objectives, and students' enthusiasm for using the e-module in learning can improve student learning outcomes. This is in line with Midroro's research, which shows that the excitement or response of students to using digital modules makes it easier for students to measure their level of understanding [24]. Apart from that, the images and videos contained in the e-module also help students understand the material. This shows that multimedia-assisted learning can be applied to physics learning [25]. E-modules can be effective if they positively impact student learning outcomes [26]. Using e-modules is one innovation that can improve student learning outcomes [27]. So, android-based e-modules can be used as alternative teaching materials in schools [28]. During the research, several students experienced problems, namely, needing help opening or accessing the e-module because the operating system on the smartphone was not Android. So, improvements are needed in the physics e-module developed to be used on various types of smartphone operating systems. However, learning using Android-based physics e-modules is effective.

IV. Conclusions

The android-based physics e-module developed has a valid and effective category at the medium stage. Based on these results, the android-based physics e-module can be applied to physics learning.

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