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DEVELOPMENT OF E-MODULE USING AUGMENTED REALITY IN PHYSICS TEACHING AT THE HIGH SCHOOL OF MANOKWARI REGENCY

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Abstract

The development of the physics E-Module at this time needs to be done because of the rapid development of information technology and coupled with the Covid-19 pandemic situation, which requires the availability of the physics E-Module so that it can assist students in learning physics both face-to-face and virtual learning. Based on preliminary observations made in public high schools and private high schools, it was found that the physics module used was a conventional module, namely the printed version of the physics module, and the printed year of the module was out of date, so the module is less relevant when used today. The aim of this research is to develop a high school Physics e-module in Manokwari Regency so that it becomes a valid, effective, and practical e-module. The method used is the four-D (4D) method. The population of this study was students of class XI IPA 4 at SMA Negeri 1 Manokwari and class XI IPA at SMA YAPIS Manokwari. This research produces an E-Module of Rotational Dynamics and Rigid Body Equilibrium using Augmented Reality (AR), which can be used interactively by students via mobile devices or computers, where in this E-Module, there are simple experiments presented in the form of PhET Simulations, videos, animations using AR, in learning physics concepts that can be accessed anywhere and anytime so that it can improve the physics learning outcomes of class XI IPA students. The purpose of this research is to produce E-Modules using AR in physics lessons that are practical and effective and can improve student learning outcomes.

Keywords: Physics E-module, augmented reality

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INTRODUCTION

Scientific learning is carried out in dire need of supporting equipment in the form of learning media, teaching materials, or educational strategies. The quality of learning that will be carried out is strongly influenced by the availability of learning facilities, the use of time, and the use of learning media or teaching materials. So that in the end, the achievement of activities in education can improve skills in cognitive, psychomotor, and affective aspects in order to achieve maximum learning outcomes (Assriyanto et al., 2014; Nugroho et al., 2019; Widyaningrum et al., 2013). In learning activities, media is really needed, where there are learning media in forms such as hard files such as modules, worksheets, materials, and handouts (Anomeisa & Ernaningsih, 2020; Kurniawan et al., 2018). Of course, learning media needs to be developed so that it can achieve the competencies needed by students and can be used independently by Nieveen (1999: 127-128) that the quality of a product or learning tool resulting from development must fulfill three aspects, namely valid, practical, and effective.

Decent media is media that is easy to apply, then the instructions given are easily understood by students. The forms of soft file learning media include e-modules, e-books, and slides (Simarmata et al., 2017; Winaya et al., 2016). E-Modules (electronic modules) using AR are electronic modules using AR able to combine the real world and the virtual world that are interactive, where students can more easily understand physics concepts through videos, animations, virtual experiments, and additional material supplements. Benefits of applying AR in the physics E-Module studied 1) Able to combine the real world and the virtual world, meaning that abstract forms of physics concepts can be realized in virtual form; 2) Able to provide the information interactively and in real time, meaning that the form of information displayed is more detailed and can be displayed at any time; 3) Able to display in three-dimensional form, meaning that the shape of the resulting virtual image looks more real because it is realized in three dimensions (Ilmawan Mustaqim, 2016). In addition, E-Modules are easier to operate via computers/laptops anytime and anywhere. Students do not experience difficulties in obtaining material in learning, so they can improve student physics learning outcomes.

Based on observations made by researchers at school SMA Negeri 1 Manokwari, SMA Negeri 2 Manokwari, SMA Advent Manokwari, SMA Santo Paulus Manokwari, dan SMA YABT Manokwari in May-June 2022. It was found that the physics modules used in these schools were still conventional modules, 90% of modules were in book form, and the year the module was published was out of date. Obstacles encountered when using conventional modules are students quickly feeling bored and less interested in studying the material contained in the module because it is only in the form of text and images; this will certainly affect student learning outcomes. Then another obstacle is that the costs incurred are quite expensive to get a printed version of the module and require a lot of space and manpower to store and carry the module. Based on the description above, the researcher determines the formulation of the research problem, are 1) What are the students' learning outcomes in the E-Module learning using AR in physics subjects at Senior High Schools in Manokwari Regency? 2) What is the effectiveness and practicality of using the E-Module using AR in physics subjects at Senior High Schools in Manokwari Regency? So that this research can run according to the problem, the researcher carries the research title Development of E-Module Using Augmented Reality in Physics Lessons at Senior High Schools, Manokwari Regency.

METHOD

The method used in this study is the Research and Development method, using the four-D (4D) model, including the Define, Design, Development, and Disseminate stages. The learning tools developed include the Rotation Dynamics E-Module and Rigid Body Equilibrium Using AR, practicality and effectiveness questionnaires for using the E-Module, and evaluation instruments (pretest and posttest questions). The subjects in the study were students of class XI Science at SMA Santo Paulus Manokwari, used as test subjects and research subjects in the form of dissemination involving students of class XI Science 4 SMA Negeri 1 Manokwari and XI Science students at SMA YAPIS Manokwari. The pilot design was used to test the Rotation Dynamics and Rigid Body Equilibrium E-Module Using AR, which had been developed and tested in one class XI Science SMA Santo Paulus Manokwari, using a one-group pretest-posttest design. The pretest (O_1) is then followed by a certain treatment (X) and then given a posttest (O_2) (Sugiyono, 2014).

The target of this research is to ensure that the E-Module of Rotation Dynamics and Rigid Body Equilibrium Using AR that has been made can be declared valid, practical, and effective so that it can improve student learning outcomes. To achieve the research objectives, instrument validation is needed using the Content Validity Ratio (CVR) and the Content Validity Index (CVI). CVR analysis is used to analyze content validation results by experts aimed at knowing the validity of a test so

that it is able to measure what you want to measure, and CVI Analysis is used to test the validity of the learning media content used. The data collection technique used a purposive sampling technique by determining students of class XI Science 4 of SMA Negeri Manokwari as representatives of public high schools and students of class XI Science of SMA YAPIS Manokwari as representatives of private high schools. The procedure for collecting data is through pretest-posttest, direct learning in class using the developed Physics E-Module, then distributing practical and effective questionnaires online.

Research Design

The design of the research development carried out using the four-D model is described with a flowchart in Figure 1. Stage Development of a four-D (4D) development model: 1) Define in the form of make analyze material, Analyze the specification of learning objectives; 2) Design in the form of Designing an E-module in the form of storyboards, Creating E-module using Canva, Compiling questionnaire instruments, namely practicality and effectiveness; 3) Development in the form of Media expert validation is performed, Material expert validation is carried out, Validation practitioner; 4) Disseminate in the form of carried out the dissemination of ready-made products.

The device was tested on students in class XI Science SMA Santo Paulus with 18 respondents consisting of 4 men and 14 women.

Research Objectives

This research was conducted in the second semester of the 2022 academic year with the target research subjects namely high school students in class XI Science consisting of students in class XI Science 4 SMA Negeri 1 Manokwari, a total of 32 people consisting of 7 men and 25 women and students of class XI IPA SMA YAPIS Manokwari, totaling 28 people consisting of 16 men and 12 women.

Data Collection Technique

Data collection begins with ensuring the learning tools used are valid. Learning tools that have been validated are E-Module Validation (Table 1) Consists of three aspects, and the average is declared valid by two validators. Pretest and Posttest Question Validation (Table 2) Consisting of 10 questions, distributed five questions on rotation dynamics questions and five equilibrium questions for rigid objects, pretest questions, and posttest questions, each totaling ten questions with the same indicators, and the validation results of the average pretest-posttest questions are declared valid. Practicality Questionnaire Validation (Table 3) Consisting of 13 distributed statements of 11 positive statements and two negative statements, the validation results of both validators, on average state very valid. And Effectiveness Questionnaire Validation (Table 4) Consisting of 10 distributed statements of nine positive statements and one negative statement, the validation results of both validators on average state very valid. All instruments were validated by 2 Validators consisting of a physics education lecturer at FKIP UNIPA and a physics teacher at SMA Negeri 1 Manokwari. Learning devices that are declared valid mean that learning devices can be used in research. However, before being used, the researcher tested the device on students of class XI science SMA Santo Paulus Manokwari, with the aim of the respondents in the actual research that it was expected that it was in accordance with the conditions of the students at the testing stage of the learning device, are students who were in class XI science.

RESULTS AND DISCUSSION

The results of the learning device trials on students were declared Valid and Appropriate to use the E-Modules that were made and other supporting instruments. So that the spread of the use of the E-Module was carried out at SMA YAPIS Manokwari and SMA Negeri 1 Manokwari, the researcher acted as a teacher in the class and taught the E-Module directly to students. For example, the E-Module can be seen in the screenshot of Figure 2. In the picture, there is a QR code for AR applications for mobile phones, then accompanied by learning materials and AR QR codes to be read on a mobile phone-installed AR to display three-dimensional images in reality. Student learning outcomes were obtained using the E-Module on pretest-post-test questions at SMA YAPIS Manokwari with the student's name abbreviated as SYM followed by the student's serial number (Figure 3). The average score of the student pretest was obtained at 38.57. After being given E-Module learning using AR, an average posttest score of 59.52 was obtained, an increase in average learning outcomes of 20.95. The best posttest score was obtained by two people out of 26 participants. Learning outcomes at SMA Negeri 1 Manokwari with the student's name abbreviated as SNS followed by the student's serial number (Figure 4) the average score of student pretest was obtained at 41.56, after being given E-Module learning using AR, an average post-test score of 60.31 was obtained, an increase in average learning outcomes of 18.75. The best post-test score was obtained by four people out of 32 people who participated. Pretest and post-test questions using paper sheets. The results can be seen in the two

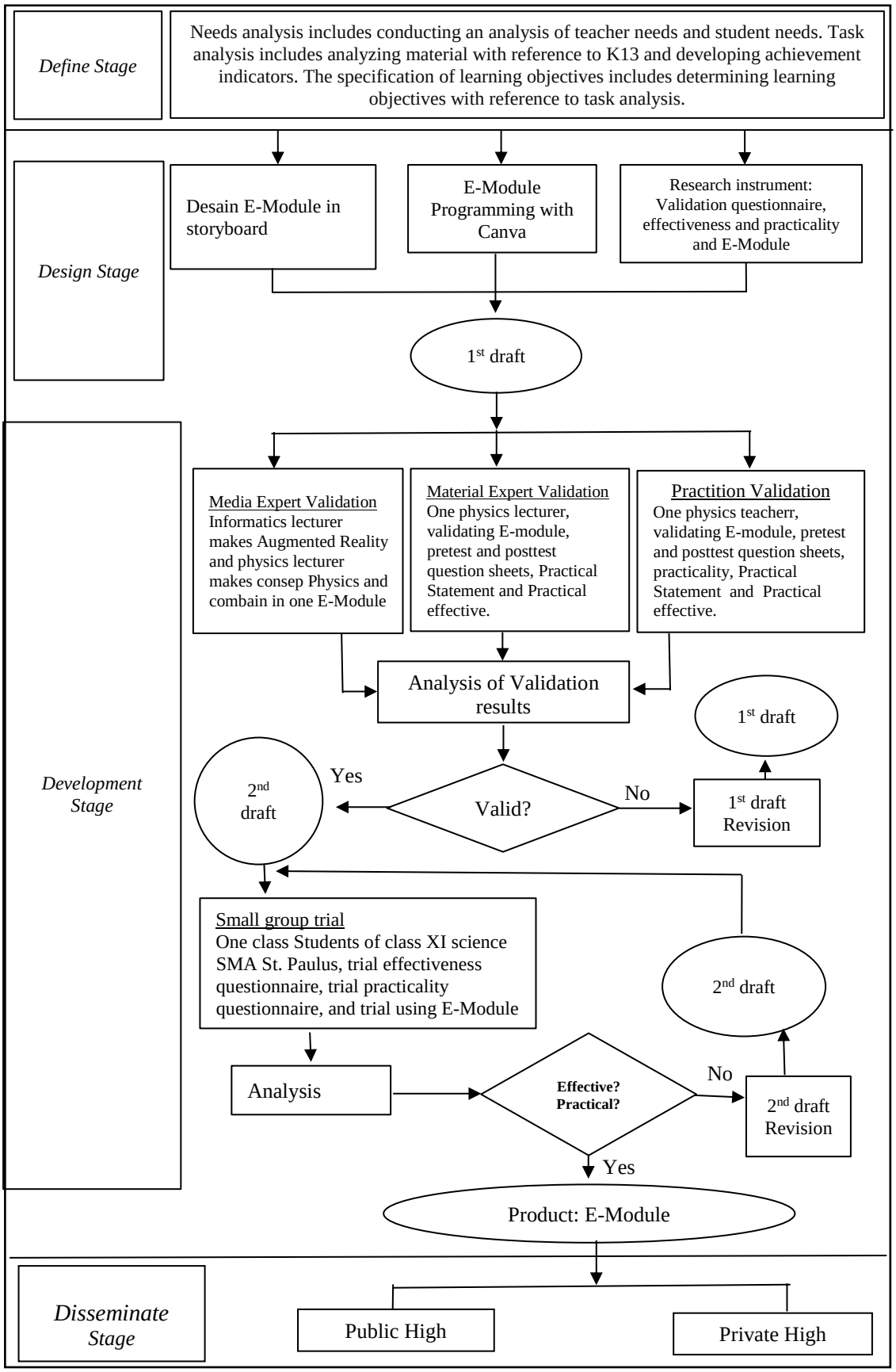

Figure 1. Research Flowchart Development of four-D (4D) E-Module

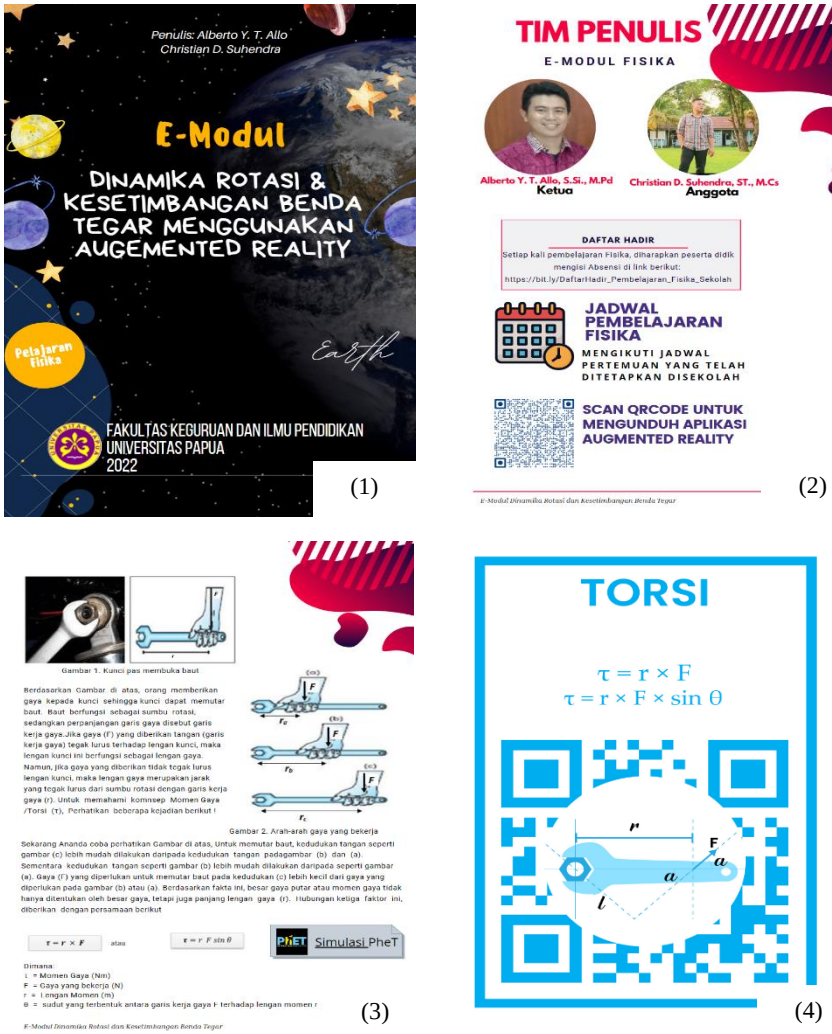

Figure 2. Screenshot of the E-Module: (1) Cover, (2) AR QR code application for Mobile Phone, (3) Physics material, (4) AR QR code to display in mobile phone three-dimensional images in reality.

graphic images that student learning outcomes have increased after being given learning using the E-Module.

To see the practicality and effectiveness of the E-Module used, students were given an online questionnaire on the practicality and effectiveness of using the Physics E-Module. The results of the practicality questionnaire (Figure 5) show the results that the percentage of students, in general, answered agreeing 59% and strongly agreeing 26%, which means that E-Modules are practically used in learning with an assessment percentage of 85% of all 60 student respondents. The results of effectiveness questionnaire (Figure 6) show the results that the percentage of students, in general, answered agreeing 68% and strongly agreeing 10%, which means that the E-Module is effectively used in learning with an assessment percentage of 78% of all 60 student respondents. The practicality questionnaire and effectiveness questionnaire by google form, the two questionnaires show that the use of the Rotation Dynamics and Rigid Body Equilibrium E-Module using AR is practical and effective.

Table 1. E-Module Validation Results

Aspect	Score		CVR	CVR Criteria	CVI	CVI Criteria
	V1	V2				
Content Component	3,38	3,44	1	Valid	1	Very Valid
Language Component	3,73	3,20	1	Valid	0,82	Valid

Serving Components	3,27	3,55	1	Valid	1	Very Valid
Average	3,46	3,39	1	Valid	0,94	Valid

Ket:V1=Validator 1; V2=Validator 2

Table 2. Pretest and Posttest Validation Results

Aspect	Score		CVR	CVR Criteria	CVI	CVI Criteria
	V1	V2				
Average	3,78	3,67	1	Valid	1	Very Valid

Table 3. E-Module Practicality Validation Results

Aspect	Score		CVR	CVR Criteria	CVI	CVI Criteria
	V1	V2				
E-Module Practicality Questionnaire	4,45	4,40	1	Valid	1	Very Valid

Table 4. E-Module Effectiveness Validation Results

Aspect	Score		CVR	CVR Criteria	CVI	CVI Criteria
	V1	V2				
E-Module Effectiveness Questionnaire	4,441	4,18	1	Valid	1	Very Valid

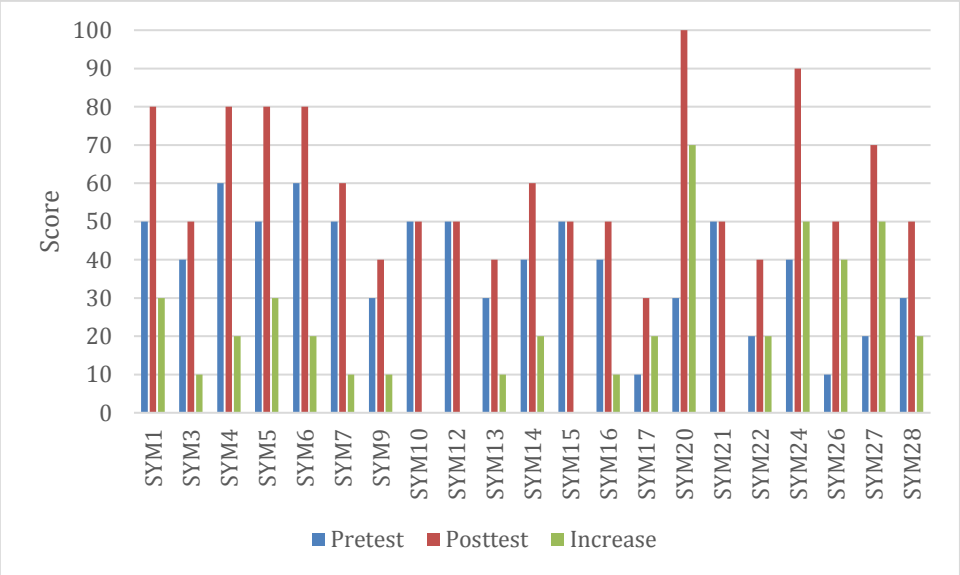

Figure 3. Student Learning Outcomes E-Module using AR at SMA YAPIS Manokwari

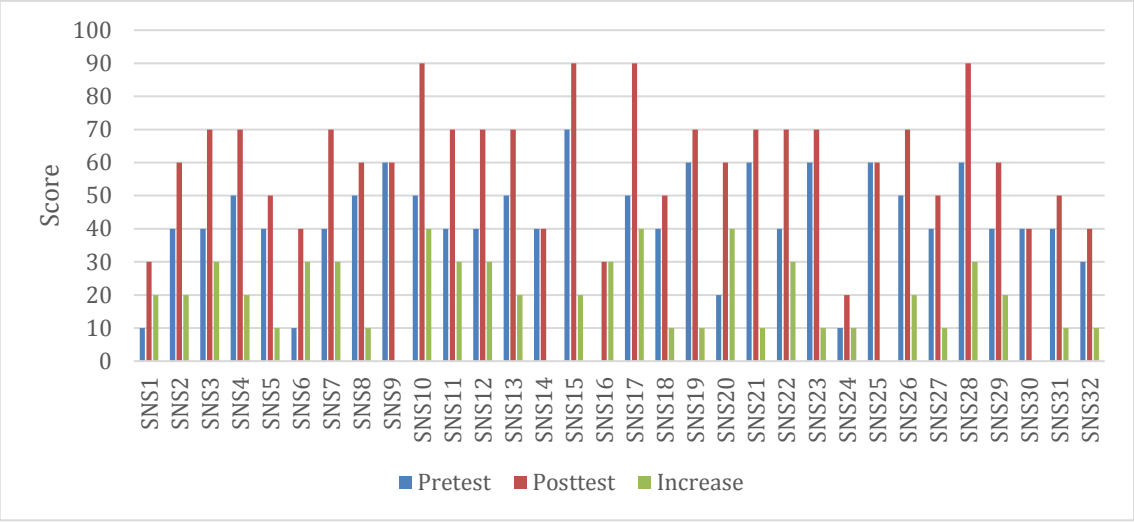

Figure 4. Student Learning Outcomes E-Module using AR at SMA Negeri 1 Manokwari

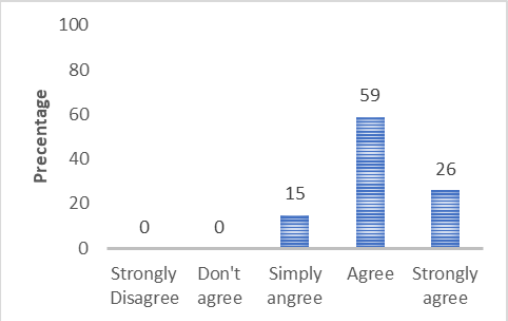

Figure 5. Results of the E-Module Practicality Questionnaire

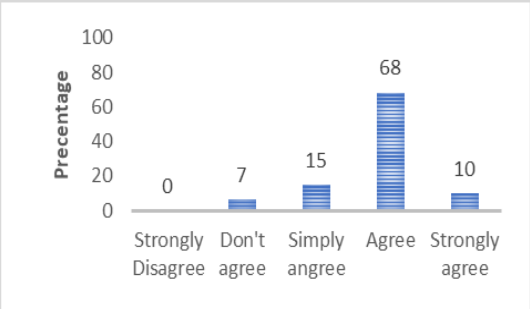

Figure 6. Results of the E-Module Effectiveness Questionnaire

CONCLUSIONS AND SUGGESTIONS

Conclusion

The conclusion from this study is that the E-Module of Rotational Dynamics and Rigid Body Equilibrium using Augmented Reality has been Valid, Effective, and Practical to use and can improve student learning outcomes in Physics learning at Senior High Schools in Manokwari.

Suggestions

Suggestions from researchers are that if you are going to do research on E-Module using Augmented Reality, you can take other material in learning physics and thank you to the Institute for Research and Community Service, the University of Papua, for funding this research.

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