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Interactive E-Modules as Teaching Materials on Diffraction and Interference Materials: A Feasibility Test

Putri Nur'aini Kasanah[1]*, Nuryuana Dwi Kusumawati[2]

[1,2]Department of Physics Education, Yogyakarta State University, Indonesia

ABSTRACT

The selection of learning teaching materials must be carried out as needed and can also utilize technology as a means of making interesting teaching materials. One of the learning teaching materials that can be used to easily understand the concepts of diffraction and interference and utilize technology is an interactive e-module equipped with learning videos. This is because learning about diffraction material and interference with physics requires visualization to improve students' understanding of the material. The research method used is Research and Development or R&D (Research and Development) with the ADDIE (Analysis, Design, Development, Implementation, Evaluation) model. Research and development of education (research and development) aims to produce new products through the development process. In this study, there was a limitation of steps from five steps to four steps to due diligence according to development needs. The results showed that the interactive e-module on the diffraction and interference material made by the researcher was suitable for use.

INTISARI

Pemilihan bahan ajar pembelajaran harus dilakukan sesuai kebutuhan dan juga dapat memanfaatkan teknologi sebagai sarana pembuatan bahan ajar yang menarik. Salah satu bahan ajar pembelajaran yang dapat digunakan agar mudah memahami konsep difraksi dan interferensi serta memanfaatkan teknologi yaitu dengan e-modul interaktif yang dilengkapi dengan video pembelajaran. Hal ini dikarenakan pembelajaran pada materi difraksi dan interferensi pada fisika membutuhkan visualisasi untuk meningkatkan pemahaman siswa terkait materi. Metode penelitian yang digunakan adalah *Research and Development* atau R&D (Penelitian dan Pengembangan) dengan model ADDIE (*Analysis, Design, Development, Implementation, Evaluation*). Penelitian dan pengembangan pendidikan (*research and development*) bertujuan untuk menghasilkan produk baru melalui proses pengembangan. Dalam penelitian ini terdapat pembatasan langkah-langkah dari lima langkah menjadi empat langkah sampai uji kelayakan sesuai kebutuhan pengembangan. Hasil penelitian menunjukan bahwa e-modul interaktif pada materi difraksi dan interferensi yang dibuat peneliti layak digunakan.

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* Corresponding author:
Putri Nur'aini Kasanah, Department of Physics Education, Yogyakarta State University, Indonesia
✉ Putrinuraini.2020@student.uny.ac.id

A. Introduction

The development of science supports the creation of technological advances that mark the era of globalization. In short, current technological advances have really been recognized and felt to provide a lot of convenience and comfort for human life [1]. In the era of globalization, developing technology has entered the digital stage in every field, including in the field of education. Education in various parts of the world uses technology to support the implementation of learning. Technology is the result of the development of science, which means that it comes from the world of education. Thus, education should also use technology to support the implementation of learning. This is in accordance with the opinion of Tondelur et al (in Selwyn) [2] which states that digital technology has now begun to be used in educational institutions as a means to support learning, either as an information tool (i.e. as a means of accessing information) or as a learning tool (i.e. as a means of supporting learning activities and assignments). One of them is technology that can be used in the manufacture of teaching materials.

The use of technology in the world of education is used as a means of making teaching materials that are increasingly interesting/creative. In line with the research conducted [3] explained that teaching materials are an important part in determining the quality of learning. The teaching materials used will determine the achievement of each defined basic competency. Teaching materials that meet good criteria will give birth to an effective learning process [4]. On the other hand, if the teaching materials do not meet the criteria, various problems in learning will emerge.

The definition of teaching materials according to Hall [5] is all forms of materials used to assist teachers or instructors in carrying out the teaching and learning process. Meanwhile, according to Sudjana [6] The learning process is an activity to implement the curriculum of an educational institution, in order to influence students to achieve the educational goals that have been set. Teaching materials are all materials (both information, tools, and texts) that are systematically arranged, which displays a complete figure of competencies that will be mastered by students and used in the learning process with the aim of planning and reviewing learning implementation [7].

The teaching and learning process adopted in the 2013 Curriculum is as stated in the National Education System Law no. 20 of 2003 article 1 states that "The learning process is student-centered, where students are required to actively seek solutions to problems encountered related to the learning process" [8]. This means the selection of teaching materials must be done in accordance with the needs so that the quality of education is increasing so that learning objectives can be achieved. However, science learning in high school is still passive due to the limitations of the teaching materials used, including in physics learning physical optics.

Physics is a branch of natural science that is closely related to the phenomena that occur in the natural environment. According to Chodijah et al [9] physics is a

science that studies natural phenomena, events or phenomena, and reveals all the secrets and laws of the universe. Therefore, in the physics learning process, teaching materials are needed as intermediary media such as pictures, videos, animations to visualize the material so that it is easily understood by students. Based on this, learning physics cannot be separated from mastering concepts, applying them in solving physics problems, and working scientifically. However, physics learning in today's classrooms tends to emphasize mastery of concepts and override students' physics problem solving abilities [10].

One of the teaching materials that can be used in the physics learning process is e-module. E-module or electronic module is a module in digital form, which consists of text, images, or both containing digital electronics material accompanied by simulations that can and are suitable for use in learning [11]. The module is one of the teaching materials that has the characteristics of the principle of independent learning. Independent learning according to Oka [12] is a way of active learning and participation to develop each individual self that is not tied to the presence of teachers, lecturers, face-to-face meetings in class, the presence of school friends. It is also supported by the rapid development of technology. Most students, especially high school students, are familiar with currently developing information technology such as computers or other electronic media.

Based on research conducted by Suryadie [13], electronic modules are innovative media that can increase student interest in learning. Improved learning outcomes can be realized with the support of appropriate learning guidelines in the teaching and learning process. So that there is an innovation in teaching materials in the form of interactive e-modules that it can be equipped with animated images or videos that can visualize physical optics material.

B. Method

This research uses part of Research and Development or R&D (Research and Development). This method is a research method used to produce certain products and test the effectiveness of these products. This research is not to test the effectiveness of certain products but only to test the feasibility of certain products. Research and development of education (research and development) aims to produce new products through the development process. The research product that we will produce is in the form of an interactive learning e-module. The development procedure carried out in this study is part of the ADDIE model (Analysis, Design, Development, Implementation, Evaluation) developed by Dick and Carry (1996) in Mulyatiningsih [14].

1. Analysis

The analysis phase of this researcher was carried out by analyzing the teaching materials and media used in learning. At this stage the researchers also made observations on teaching and learning activities carried out in the classroom on physical optics subjects. This observation activity has the aim of knowing the obstacles that occur when the lesson is carried out, the material presented, and the media used.

2. Design

At this stage the researcher determines the elements that will be included and developed into the learning media. Researchers create a concept map that forms the basis of media content in general, which includes the design of templates and materials that fill the media. The manufacture of these products is guided by the design and concept maps that have been made.

3. Development

This stage is the creation of interactive learning e-modules. Researchers create media according to concept maps and designs that have been made with the Canva application for e-modules and videos using PowToon.

4. Feasibility Test

The media that has been developed is then tested for feasibility to physics education students of UNY 2020 by filling out a questionnaire made with a google form. Questions contained in the google form include (1) Design cover and content display of the interactive learning e-module, (2) Clarity and suitability of images presented in the interactive learning e-module, (3) Suitability of interactive learning e-modules to improve student understanding, (4) Suitability, completeness and collapse of physical optical materials presented in interactive learning e-modules, (5) Conformity of images with the content of the material presented in the interactive learning e-module, (6) Effectiveness of delivery of physical optics material in the form of interactive learning e-modules to help improve student understanding, (7) Suitability of the use of words and sentences in interactive learning e-modules with PUEBI rules, (8) Feasibility of using interactive learning e-modules as learning materials independently, (9) Overall video design, (10) The suitability of the content of the material on the video with the content of the material on the interactive learning e-module, and there are also criticisms and suggestions in the last item. The questionnaire has 10 questions that include aspects of appearance, aspects of content, aspects of language, aspects of interactivity, and aspects of media as in table 1.

Table 1. Media Feasibility Aspects

Aspect	Number	Total
Display Aspect	1.2	2
Content Aspect	3,4,5,6	4
Language Aspect	7	1
Interactivity Aspect	8	1
Media Aspect	9, 10	2
	Total	10

This study uses a google form questionnaire to collect data on variable X which consists of 10 questions. Researchers grouped the answers or responses from each item into 4 levels of answers based on the rating scale as shown in Table 2.

Table 2. Rating Scale

Answer	Score
Very Worthy	4
Worthy	3
Not feasible	2
Very Inappropriate	1

At the feasibility analysis stage of the learning e-module using the ideal standard deviation (SBi) with several stages as follows:

a. Calculating the average score of the assessment aspect [15]

$$\overline{X} = \frac{\sum X}{n}$$

Information:

$\overline{X}$ = average score

x = total score

n = number of raters

b. Converts scores to a 4 scale

The reference for changing the score to a scale of 4 is to calculate the ideal average (Mi) with the formula:

$$\text{Mi} = (\text{ideal max score} + \text{ideal min score})\frac{1}{2}$$

After finding the value of Mi, proceed with finding the value of SBi with the formula:

$$SBI = \frac{1}{6} \text{ (ideal max score – ideal min score)}$$

c. Determining the Assessment Criteria

The assessment criteria based on the SBI calculation can be seen in the following table

Table 3. Quantitative score range

Quantitative Score Range	Category
X Mi + 1.5 SBi	Very Worthy
Mi + 1.5 SBi X Mi	Worthy
X > M Mi – 1.5 SBi	less worthy
Mi - 1.5 Sbi > X	Not feasible

The calculation of the assessment criteria is changed in a scale range of 1-4 in the following way:

$$Mi = (4 + 1) = 2.5$$
$$SBi = (4-1) = 0.5$$

Based on these calculations, the assessment criteria for research are obtained, namely in the following table [15]:

Table 4. Quantitative score range

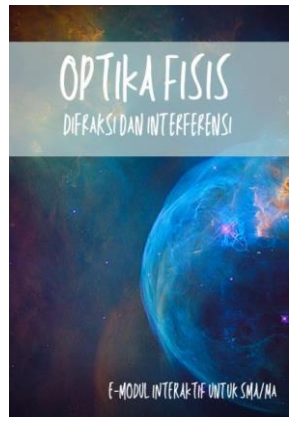
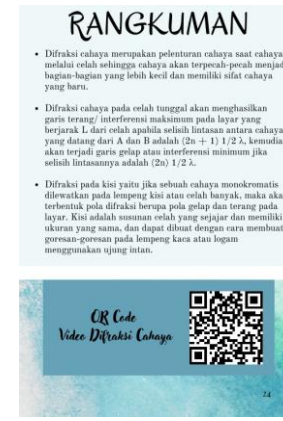
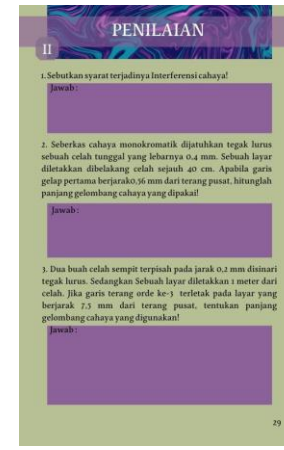
Quantitative Score Range	Category
X 3.25	Very Worthy
3.25 X 2.5	Worthy
2.5 > X 1.75	less worthy
1.75 > X	Not feasible

C. Results and Discussion

In the first stage of the initial analysis, there are obstacles in the physical optics learning process, namely the difficulty of understanding diffraction and interference materials. The learning that is carried out is less interesting and monotonous, and there is no visualization related to the material. Interactive learning teaching materials are in the form of interactive e-modules equipped with QR barcodes containing learning videos using PowToon.

In the second stage, the design stage was carried out in the form of an initial design of interactive learning e-modules, table learning, the initial design of learning media made using a module design application using Canva and video using PowToon.

Table 5. Product Design

Page	Product Design	Page	Product Design
Cover		3	
1		4	
2		Tutorial video	

In the third stage, namely the development of this research in the form of interactive teaching materials. These teaching materials are improved based on assessments in the form of suggestions and constructive criticism from students majoring in physics education as respondents. The feasibility of the interactive e-

module equipped with a QR code containing the learning video was calculated using the ideal standard deviation of the responses of physics education students as respondents on a scale of one to four. The analysis of the feasibility test for teaching materials in the form of interactive e-modules equipped with a QR code containing learning videos on diffraction material and physical optical interference shows the aspects of appearance, content, language, interactivity, and media.

The results of the analysis of the feasibility test of the interactive e-module equipped with a QR code containing learning videos on diffraction and physical optical interference materials are as follows:

Table 6. The results of the feasibility analysis of the interactive e-module equipped with a QR code containing learning videos on diffraction material and physical optical interference

Aspect	Average value	Category
Appearance	3.59	Very Worthy
Contents	3.61	Very Worthy
Language	3.64	Very Worthy
Interactivity	3.51	Very Worthy
Media	3.70	Very Worthy

The results obtained from the analysis of the feasibility test for interactive e-module teaching materials equipped with a QR code containing learning videos on diffraction and physical optics interference obtained the average value of all aspects, namely 3.62 with a very feasible category.

Interactive e-module teaching materials equipped with QR codes containing learning videos on diffraction and physical optical interference have been carried out in three stages of development, namely Analysis, Design, and Development. The work on interactive e-module teaching materials is first done by determining the basic competencies, indicators, and learning objectives and then determining the e-module concept so that it can be understood by students.

The design of e-module teaching materials is done using the Canva application for e-module editing and the PowToon application for editing learning videos which will later be obtained in the form of an interactive e-module design draft equipped with a QR code containing learning videos on diffraction material and physical optical interference. Feasibility test of interactive e-module interactive learning media equipped with a QR code containing learning videos on diffraction material and physical optical interference with data collection using a questionnaire containing aspects of appearance, content, language, interactivity, and media. All of these aspects

serve as guidelines in determining the feasibility of the interactive e-module which the researcher tested its feasibility.

In this study used data in the form of qualitative data. The study was conducted on students of Physics Education UNY academic year 2020. Researchers conducted a feasibility test through a questionnaire for 32 physics education students. The data obtained is then described with the criteria of very feasible, feasible, not feasible, and very inappropriate by choosing one of these criteria.

In the aspect of display, it has indicators, namely the first cover design and display of the contents of the interactive learning e-module, the second is the clarity and suitability of the images presented in the interactive learning e-module. The first indicator based on the respondent's assessment gets an average of 3.54 in the very feasible category. The second indicator gets an average of 3.64 with a very decent category. In the aspect of content it has indicators, first the suitability of interactive learning e-modules to improve students' understanding, both the suitability, completeness and coherence of the physical optics material presented in the interactive learning e-module, the third suitability of the image with the content of the material presented in the interactive learning e-module, the fourth the effectiveness of delivering physical optics material in the form of an interactive learning e-module to help improve participants' understanding educate. The first indicator based on the respondent's assessment got an average of 3.74 in the very feasible category. The second indicator gets an average of 3.77 with a very decent category, the third indicator gets an average of 3.58 with a very decent category, the fourth indicator gets an average of 3.35 with a very decent category. The language aspect includes the suitability of the use of words and sentences in the interactive learning e-module with the PUEBI rules. Respondents' assessment of these questions is in the very appropriate category with an average of 3.64. The Interactivity Aspect contains the feasibility of using interactive learning e-modules as independent study materials. Respondents rated the category very feasible with an average of 3.51. From this assessment, this e-module is suitable to be used as an independent study material. The media aspect has two indicators, namely the overall video design and the suitability of the video content with the content of the material in the e-module. An interactive e-module equipped with a QR code containing learning videos on diffraction and physical optics interference can increase understanding and knowledge of physical optics so as to motivate students to learn about interference and diffraction. The video in this e-module is considered very interactive so that it can instill an in-depth understanding of the concept of the material. The Media Aspect has an average of 3.70 with a very decent category.

D. Conclusion

Based on the results of analysis, design, and development, interactive learning teaching materials in the form of interactive e-modules equipped with QR codes containing learning videos on diffraction and interference are solutions that can help students understand diffraction and interference materials in physical optics. The results of the feasibility test for interactive learning e-module teaching materials equipped with QR barcodes containing learning videos on diffraction and interference materials were considered very feasible.

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