International Journal of Education and Teaching Zone, Volume 1 (Issue 2): 08-10 (2022)
DOI: https://doi.org/10.57092/ijetz.v1i2.43

THE JOURNAL OF IJETZ
(International Journal of Education and Teaching Zone)
P-ISSN: 2963-7899 I E-ISSN: 2830-7925
jurnal.yayasannurulyakin.sch.id/index.php/ijetz

Development of an Android-Based Physics Interactive E-Module Equipped with Problems with Scaffolding in Applying the Concept of Light Waves

Alvia Quthrotun Nada[1, 2*], Muhammad Reyza Arief Taqwa[1], Edi Supriana[1], Purbo Suwasono[1]

[1]Faculty of Mathematics and Natural Sciences, Universitas Negeri Malang, Jawa Timur, Indonesia
[1,2]SMA Dr. Musta'in Romly, Jawa Timur, Indonesia

Article History:
Received: September 12, 2022
Revised: September 28, 2022
Accepted: October 03, 2022
Published: October 08, 2022

Keywords:
Android, E-Module, Light Wave, Scaffolding

***Correspondence Author:**
alvianada34@gmai.com

Abstract: The purpose of this study was to develop and determine the validity and practicality of learning media in the form of an Android-based E-Module equipped with questions with scaffolding on light wave material. In this study, the Research and Development (R&D) model with the 4-D method was used. The stages of 4D development include define, design, develop, and disseminate, but in this study only up to the design stage with validity and practicality tests. Product validation was carried out by three media and material expert validators, namely 1 lecturer and 2 high school physics teachers, while the practicality test was carried out by 48 students of class XI MIPA SMAN 1 Paciran. The research results obtained quantitative and qualitative data. Analysis of quantitative data using percentages and categorized criteria of validity and practicality. The results of this research and development are in the form of an Android-based physics interactive E-Module product with light wave material. From the validation test by the validator, the average percentage of results for media and material validation is 90% with very valid criteria. This shows that the material presented is in accordance with the curriculum so that it can support student learning. In the validation test results of practice questions with scaffolding, the average percentage is 97% and the percentage of evaluation questions is 96% with very valid criteria. This shows that the practice questions and evaluation questions that have been made valid are used by students in studying light waves and are validly included in the developed e-module. From the results of the practicality test, an average percentage of 85% was obtained in the very practical category. This shows that the product developed is very valid and very practical so it is worth investigating its effectiveness so that it can further support physics learning in understanding the concept of light waves, both used independently and in school learning.

INTRODUCTION

Physics is a lesson that can train thinking and reasoning in learning knowledge about the universe, so that with reasoning abilities that are often trained, the power of thinking and knowledge will develop (Supardi et al., 2015). Physics is part of science which teaches humans to understand the process of natural law working with all its regularities (Lutfia &

Putra, 2020). One of the important lessons learned to help students have the ability to think and act scientifically is physics. Physics belongs to the family of science subjects which is the basis of the development of advanced technology and the concept of living with nature (Sarjono, 2017), so it is necessary to get the correct scientific concepts to understand more advanced physics concepts in the future.

According to Sutopo (2016) by studying the concepts of light, electricity and magnetism well, it will make it easier for students to learn other related materials. The material concepts of mechanical waves, wave propagation, sound waves and light are some of the wave concepts that according to students are very difficult to learn (Fatmah et al., 2019., Wahyuni, 2018) . Based on research conducted by Lutfia & Putra (2020) , that students' understanding of the concept of light waves, especially light diffraction and light interference, is still low. Concept understanding is very important in learning physics for students who are learning material concepts in physics (Sutrisno et al., 2015). Some of the factors in learning physics that are less than optimal are that students consider physics lessons to be boring, the teaching materials used are less attractive so that it is difficult to obtain material in the learning, so students expect teaching materials to be added with animation or other media so as not to cause boredom with monotonous learning . Sari et al., 2022; Supardi et al., 2015) . So, teachers must consider the use of media properly in order to support student learning motivation. One of the things that can improve the learning experience and can help students learn the material at the next meeting first is to choose media as a source of independent learning (Puspitasari, 2019) . Learning media in the form of interactive electronic modules is one of the efforts to help ease learning in growing the quality of learning (Lilik Sufiyah & Sumarsono, 2015). The learning process can take place effectively if it is supported by media that can support learning, one of which is the electronic module (R. Puspitasari et al., 2020).

The electronic module is an independent learning material packaged in an electronic format that contains audio, animation, navigation, so that students can be more interactive in accessing the program (Sugianto et al., 2017). Interactive in question is that users experience interactions in using programs such as being active in paying attention to colorful, moving images and writing, as well as sound, animation and even videos and films (Firdaus, 2021). The application of information technology in the form of *smartphones* must be maximized as a learning resource or learning media in order to improve the quality of student learning (Sari et al., 2021) . *Smartphones* can also be used easily to help teachers and students (Hidayat & Prasetya, 2019). Through *smartphone devices* , students can access learning resources easily both on the internet and special applications such as certain learning platforms, so that students' knowledge insights are growing and increasing. One of the devices that can be used to understand physics material and can create fun in learning physics is the android application (Adhi et al., 2017). In accordance with research conducted by (Setyahandani et al., 2018)that students feel interested when using android-based learning media in learning physics because they can be accessed anytime and anywhere.

There are several previous studies that have developed physics *e-modules , including the development of* an android-based *e-module in research (* Liana et al., 2019) on dynamic

electrical materials and research (Suryaningtyas et al., 2020)on light wave material , there are already practice questions. but not accompanied by *feedback* . Then the development carried out by (Tazkiyah et al., 2020)is to develop an android-based electronic module with *feedback* , in this study it is said that a *feedback feature is needed* in a teaching material to help students' difficulties in teaching materials. However, this study did not specify the type of *feedback* used. In addition, the development carried out by Sari et al., (2022) is developing an *e-module* using a *professional flip pdf application* on fluid materials, where the *e-module* can only be accessed using a computer. The use of computers is considered less effective because not all students have computers but almost all students have androids (Sujanem et al., 2019). The development of *e-modules* in some of the studies above have provided practice questions, but some have not been accompanied by *feedback* and some have *feedback* but have not specified the type of *feedback* used. Giving *feedback in the* form of *scaffolding is* only given if students experience difficulties, so that if students can solve their own problems the *feedback* will be dismissed (Santoso, 2013). Based on this description, this research will develop an Android-based interactive *e-module equipped with practice questions with feedback in the* form of *scaffolding* to help understand the concept of light wave material.

The existence of practice questions in the *e-module* aims to help students understand the concept of the material. However, if only multiple choice questions are felt to be lacking, it needs to be added with *feedback* . It is hoped that by giving practice questions along with *feedback in the* form of *scaffolding* , it can really help students to direct them to the right and right answers.

This study aims to develop an Android-based interactive physics *E-Module that is more attractive and practical and to know the level of* validity and practicality of the learning media that is made to facilitate students' understanding of concepts, and make it easier to carry out the learning process anywhere and anytime effectively and efficiently. Students can study at home first before learning activities, so that when learning takes place students easily understand what is being learned. In addition, it is equipped with questions with feedback in the form of *scaffolding* , so that it can help students understand physics concepts and can also measure the level of achievement of learning outcomes and student understanding.

THEORETICAL SUPPORT

Interactive E-Module

E-Module or electronic module is a module in digital form which includes images, text or images and text accompanied by a simulation. Electronic modules can be in the form of documents or articles that are not in print, so students can take them anywhere easily, because the E-Module can be accessed through students' electronic devices anywhere and anytime the user needs (Solikin, 2018).

E-Modules or Electronic Modules can be used flexibly, which can be used anytime and anywhere and at an affordable cost. E-Module has advantages such as being able to present videos and music and can be integrated with the internet. Meanwhile, one of the weaknesses of the electronic module is that not all students can use the electronic module

due to limited facilities and the absence of a special place to take personal notes (Puspitasari, 2019) . The E-module component consists of a cover or front page, concept maps, instructions for using the module, material descriptions, evaluation questions, answer keys and bibliography (Ula & Fadila, 2018).

E-module is one of the teaching materials in digital form consisting of text, images or a combination of both (Wijaya & Vidianti, 2019). This android-based interactive E-Module that was developed is a module in digital form consisting of text, images, animated videos, navigation packaged in android form so that users can be more interactive in learning.

Scaffolding

Based on Vygotsky's theory, scaffolding is an effort or assistance to construct student abilities which is carried out when experiencing difficulties in independent learning (Dintarini & Zukhrufurrohmah, 2021). The principle of scaffolding is to provide sufficient assistance to students, so that if students' difficulties can be overcome, the provision of scaffolding can be sufficient or abolished (Hermkes et al., 2018).

Scaffolding is one of the efforts or assistance that can be given to students in the form of giving examples, motivation, instructions, warnings that can allow students to learn independently (Hasan, 2014). Scaffolding is only given when students are able to solve problems independently (Santoso, 2013). Scaffolding aims to provide assistance to students who have difficulty in solving a problem and making students understand a certain concept (Diani et al., 2019) . The scaffolding used in this study was made as feedback from practice questions.

Light Wave

The material used in this development research is light waves. The light wave material is contained in KD 3. 10, namely applying the concepts and principles of light waves in technology. The light wave section consists of light spectrum material, light diffraction, light interference and light polarization.

Based on research conducted by Lutfia & Putra (2020) , in light wave material, students' conceptual understanding is still very low, especially in light interference and diffraction. Most students have misconceptions about this light wave material. The biggest misconception is regarding the concept of minimum light diffraction. Students experience misconceptions about light wave material in determining the order of interference and light diffraction (Lutfia & Putra, 2020) . In addition, according to research conducted by Nova et al. (2020) the level of understanding of concepts that students have on light wave material is very low, so it is necessary to find a solution to overcome the low understanding of the concept of light waves.

METHOD

The method used in the development of this learning media is the research and development method . One of the research methods used to produce certain products is *Research and development (R&D)* (Sugiyono, 2013) . The research and development design uses a 4-D model (*Define, Design, Develop, and Disseminate*). This model was

developed by S. Thiagarajan, Dorothy S. Semmel, and Melvyn I Semmel (1974: 5). One of the advantages of the 4-D model is that it can be used as a basis for developing learning tools, not for developing learning systems.

The following are the stages of the 4D learning model:

a. *Define*

In the *define stage* , product needs analysis is carried out through interviews and literature studies. This is done to determine the needs of the subject in the field. From the results of interviews with the teacher and several students , it was found that the media used in learning activities used learning resources in the form of package books and modules , but the media used were still monotonous and only reading , so it was necessary to have interesting learning media accompanied by animation . and interesting audio and required practice questions accompanied by certain *feedback* to help students' difficulties in understanding physics material. Meanwhile , the results of a literature study of several research journals showed that one of the materials that is difficult to understand is the material of light waves. Some students' understanding is still low and they still have misconceptions about light wave material , especially light interference and light diffraction.

Based on the results of interviews and literature studies that have been carried out, it is necessary to develop an *Android -based electronic module* equipped with practice questions with *feedback in the* form of *scaffolding* to help students understand the concept of light waves. In addition, the *e-module* also emphasizes material that is difficult for students to understand such as the order of interference and diffraction by adding a more detailed explanation. This electronic module is more practical and flexible and can be an alternative to study anywhere and anytime. Can be accessed before learning begins, in order to better understand the learning that will be studied in class.

b. *Design* (design)

At the design stage, the initial design of the learning media was made. The applications that will be used to create this *e-module* are *Microsoft Power Point* , *ispring* and *Website 2 Apk Builder* . The design of the *e-module* that will be made is as shown in Figure 1.

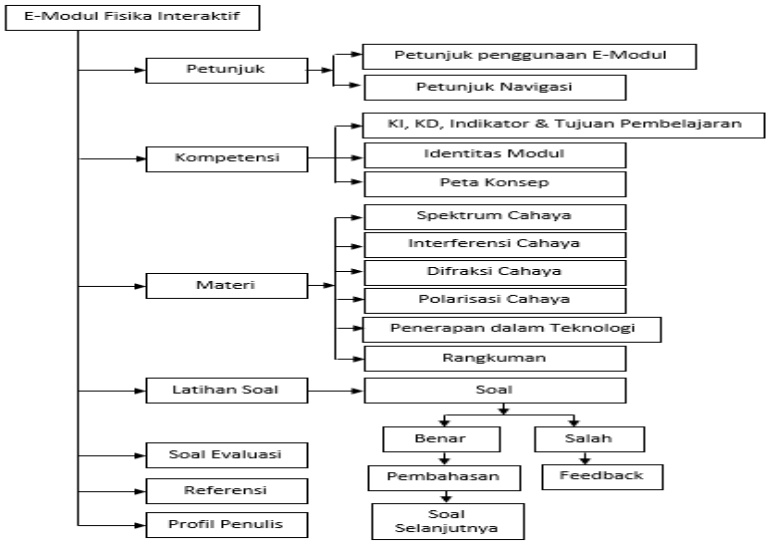

Figure 1. Lightwave *E-Module* Design

c. *Develop*

At the development stage, it begins with the manufacture of *e-module products* based on the designs that have been made at the *design stage* to the form of learning media products that have been finished and validated by experts. The systematics *of the e-module* made is that on the first page there is a cover, then the next page contains menus such as competencies, instructions, materials, practice questions, evaluation questions, developer profiles and references. In the material menu, there are several choices of materials, namely light spectrum, light interference, light diffraction and light polarization.

After product development, proceed with the product validation process. There are two validation steps, namely Expert validation (done before the trial) which serves to validate teaching materials or the content of materials and media used in the application. Then the student's practicality test (tested directly to students) to get input and assessment related to the learning media made , namely the product practicality test.

In this study, the model used only reached the *Develop stage* , namely product development or testing , so that researchers did not examine it until the *disseminate* or dissemination stage. This research was conducted in one of the schools in Lamongan Regency, namely SMAN 1 Paciran. The research subjects were 48 students of class XI IPA who were taking light waves.

The data collection technique in this study used a *check list* questionnaire or a questionnaire with a Likert scale. The assessment instrument consists of media validation and question validation, as well as product practicality tests. Media validation and validation are addressed to physics lecturers and teachers, while the practicality test is aimed at students.

The media validation instrument consists of three aspects, namely conformity to the curriculum, appearance, and language. As for the assessment of the validation questions, it consists of aspects of the suitability of the questions with indicators, students' cognitive criteria and answer keys, the language used and the discussion of the questions given. Validity data is obtained based on the validation of the validator. Then analyzed, there are two data analysis techniques, namely quantitative and qualitative data. Quantitative data in the form of a validity test questionnaire aimed at material experts and media experts compiled using a Likert Scale (Saski & Sudarwanto, 2021) . While qualitative data in the form of suggestions and comments from media and material experts.

Table 1. Product Validity Criteria

Criteria	Score
Valid	4
Quite Valid	3
Less Valid	2
Invalid	1

Calculations to obtain validation values from material experts and media experts can be calculated by calculating the percentage of all indicators using the following formula

$$Validitas = \frac{Total\ skor\ yang\ diperoleh}{Total\ Skor\ Maksimal}\ x\ 100\%$$

Table 2. Media Validity Criteria Based on Expert Score Percentage

No	Expert Score Percentage	Validity Level
1	81.25% < score 100 %	Very Valid/Very Eligible
2	62.5% < score 81.25 %	Valid/Eligible
3	43.75% < score 62.5 %	Invalid/Infeasible
4	< score 43.75%	Invalid/Invalid

Source: (Safitri et al., 2021)

Furthermore, the product practicality test questionnaire was compiled based on the Likert Scale. If the answer choices with the largest percentage are Agree and Strongly Agree, then the student's response to the learning media can be said to be practical. The Likert Scale display is shown in Table 3.

Table 3. Likert scale

No	Answer	Score
1	Strongly agree	4
2	Agree	3
3	Don't agree	2
4	Strongly Disagree	1

The data obtained, namely the student response questionnaire, was analyzed by calculating the total score obtained and then calculating the percentage of all indicators using the following formula.

$$P = \frac{TSe}{TSh} x100\%$$

Information:
Q: Percentage of practicality
TSe : Total Student Answer Score
TSh : Total Expected Maximum Score
After obtaining the percentage results, the practical results can be categorized into several criteria based on Table 4.

Table 4. Product Practicality Criteria

No	Percentage	Criteria
1	81.25% < score 100 %	Very Practical
2	62.5% < score 81.25 %	Practical
3	43.75% < score 62.5 %	Less Practical
4	< score 43.75%	Not Practical

Adapted from (Safitri et al., 2021)

RESULT AND DISCUSSION

The developed *E-Module consists of several* components including instructions, introductions, competencies, materials, sample questions, summaries, practice questions, evaluation questions, references, and developer biodata.

E-Module developed has the following specifications:

a) Products can be accessed via Android-based *smartphones* other than the Samsung HP brand.
b) The resulting product is in *apk format* with a size of 13 MB. Here is the link *of the E-Module* that has been developed https://www.mediafire.com/file/p8gsw0lei0hrarp/E-

MODULE_INTERAKTIF_FISIKA_BERBASIS_ANDROID__GELOMBANG_LIGHT_1_1.0.apk/file

c) Products can be run *online* or *offline* .
d) The product contains the concept of light wave material that is adapted to the core competencies and basic competencies in the 2013 curriculum.
e) The product contains practice questions accompanied by *feedback in the* form of *scaffolding* and scored evaluation questions.
f) The product contains animation, audio, video that can make it easier for students to understand the concept of light waves.
g) The product made is an Android-based Physics *E-Module which is equipped with questions with feedback in the* form of *scaffolding* on light wave material.

The product that has been developed has the following features.

1. Initial View (*Cover*)

The start page or *cover* is designed with a display that contains the module title, author's name, subject, class and is equipped with *a start button* . The title *of the E-Module* is " Light Wave Physics *E-Module ".* The selected background color is blue. The following is an image of the initial display (*cover*) in Figure 2.

Figure 2. Appearance *Cover E-Module*

2. Main Menu Page

The menu page contains instructions, introductions, materials, practice questions, evaluation questions, references, and author biodata. In the instructions menu there are two parts, namely instructions for using the *E-Module* and navigation instructions. The menu is equipped with a *hyperlink* to go to the intended page. The main menu display is shown in Figure 3.

Figure 3. Main Menu Page

3. Hint Page

The help page contains instructions for using the module and instructions for using navigation. The display of instructions is presented in Figure 4.

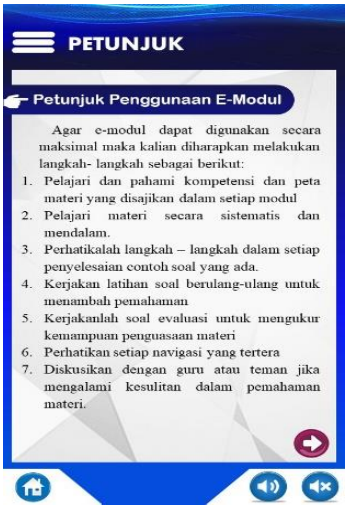

Figure 4. Hint Page

4. Competence

E-Module is equipped with competencies that include core competencies, basic competencies, indicators, learning objectives and concept maps. Concept map aims to provide an overview of the material and the relationship between concepts that exist in the material. Competencies are presented in Figure 5.

Figure 5. Competency Page

5. Material Menu

The material menu is presented in the form of a list of materials by utilizing the *hyperlink feature* to the desired material page. The material menu is presented as Figure 6.

Figure 6. Material menu

6. Material Description

The material description contains the elaboration of the concept of light waves equipped with example questions along with discussions and summaries. Description of the material is presented as in Figure 7.

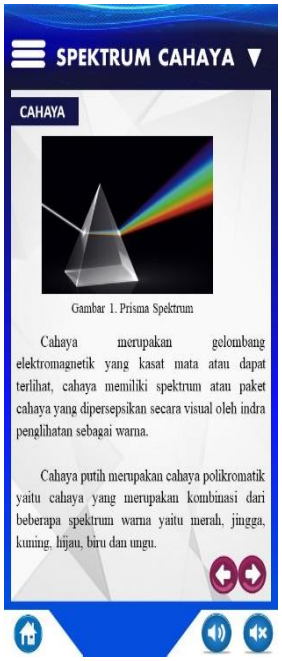

Figure 7. Material description

7. Exercises

The practice questions consist of 10 questions equipped with *feedback in the* form of *scaffolding* with the aim of providing assistance to students in finding the correct answer. Students can move on to the next question if they have answered correctly. The display of practice questions is presented as shown in Figure 8.

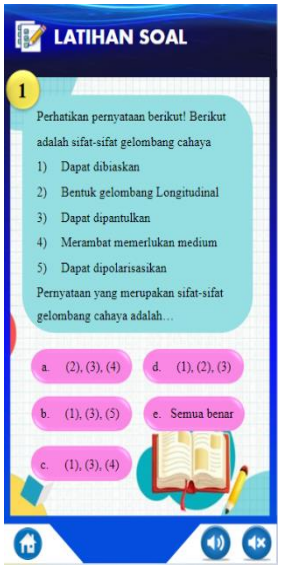

Figure 8. Display Practice Questions

After product development is carried out, it is continued with the development of research instruments. The research development data consists of 2 aspects, namely media validation tests and questions and product practicality tests. Question validation consists of practice validation of 10 multiple-choice questions and 10 multiple-choice evaluation questions. The validation test was obtained from the validation of media and material experts, namely 1 physics lecturer at the State University of Malang and 2 high school teachers and the practicality test was obtained from students of class XI IPA at SMAN 1 Paciran. The research data obtained are quantitative data and qualitative data, quantitative data in the form of a *checklist questionnaire* with a Likert scale while qualitative data in the form of suggestions and comments from a team of media experts during product validation. The data from the validation results are presented in Table 5.

Table 5. Media Validation Result Data

No	Aspect	Percentage (%)
1	Compliance with curriculum	92%
2	Appearance	89%
3	language	89%
	Average	90%

There are two validation assessments, namely media validation and question validation. There are three aspects of media which include conformity to the curriculum, appearance, and language. Based on the validator's assessment in the aspect of curriculum suitability which includes the suitability of the material with KD, the truth of the concepts presented, the coherence and clarity of the material, as well as the suitability of the material and sample questions with the truth of physics theory, an average percentage of 92% is obtained. This shows that *the E-Module* made is in accordance with the applicable curriculum, competencies and physics concepts. Based on the results of the assessment on the display aspect which includes the suitability of the text color with the background, the type of font and size used, the suitability of the visual and verbal illustrations displayed, the ease and clarity of the media in operation or access, the accuracy of the *layout*

proportions in each section of the media and the completeness of the components or buttons. The display shows that the average percentage of 89% is included in the very valid category. This shows that the display of the created *E-Module* can be read and the navigation buttons can function properly, making it easier for users to access *the E-Module*. This is in accordance with the interactive nature of the *E-Module* , which makes it easier to navigate, can display/load images, audio, video and animation and is equipped with tests or quizzes with direct feedback (Suarsana & Mahayukti, 2013)

Based on the linguistic aspect, which includes the language used is communicative and easy to understand, language that does not have multiple meanings and does not cause misconceptions as well as conformity with good and correct Indonesian language rules, the average percentage result is 89% with very valid criteria. This shows that *the E-Module* made is in accordance with the applicable Indonesian language rules. The total percentage in media aspect is 90%. This percentage is included in the very valid category. Suggestions and comments given by media validators are expected to pay attention to the writing because some are too big, some overlap, the concept map is not legible because it is blurry, some writings are cut off due to differences in *smartphone use* . Therefore, the media was improved by changing the menu title font and clarifying the concept map.

Table 6. Validation results of scaffolding questions

No	Aspect	Percentage (%)
1	Suitability of questions with indicators	99%
2	Conformity with students' cognitive criteria	100%
3	The suitability of the answer key with the question	98%
4	The language used is clear and does not have multiple interpretations	96%
5	The discussion given is clear	92%
	Average	97%

Question validation consists of practice questions with *feedback* with *scaffolding* and evaluation questions. The aspects assessed in the practice questions are the suitability of the questions with the indicators, the suitability of the questions with the students' cognitive criteria, the suitability of the answer keys to the questions, the language used is clear and does not have multiple interpretations, and the discussion given is clear. Meanwhile, in the evaluation questions, the aspects assessed were the suitability of the questions with the indicators, the suitability of the questions with the students' cognitive criteria, the suitability of the answer keys with the questions, the language used was clear and not multiple interpretations.

Based on the results of the validation of practice questions with *feedback in the* form of *scaffolding* , an average result of 97% was obtained. This percentage is based on the validity criteria and is stated to be very valid. The practice questions consist of 10 multiple choice questions regarding the concept of light waves. For each question number, there is *feedback in the* form of *scaffolding* , where if students answer incorrectly, they will get *feedback* in the form of instructions or *scaffolding* to get the correct answer as shown in Figure 9. If the answer is correct as in Figure 10, then the student has the right to continue to the next question. . *Feedback* is made different for each wrong answer, with the aim of

leading to the correct answer. This is in accordance with research which explains that *scaffolding* is given if students experience difficulties and if students can solve problems independently the *scaffolding* can be dismissed (Santoso, 2013) .
Here's a look at the *feedback exercise* with *scaffolding*.

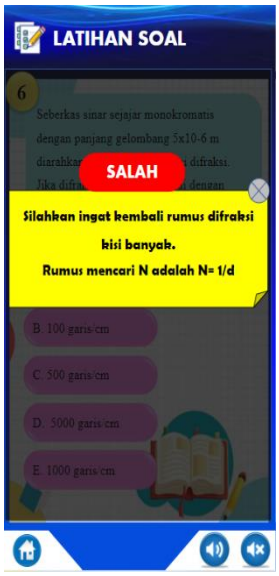

Figure 9. Display *feedback scaffolding* wrong answer

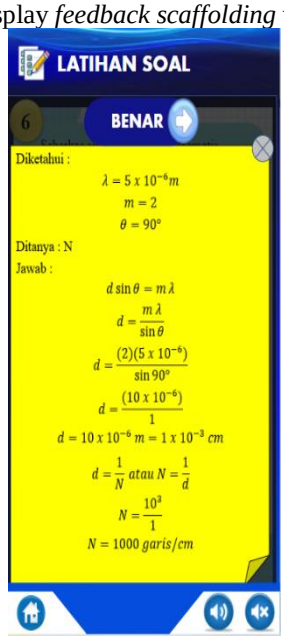

Figure 10. Display *feedback* correct answer

One of the questions presented was regarding the concept of light interference, because according to previous research, data was obtained that many students had misconceptions and did not even understand how to determine the interference order (Lutfia & Putra, 2020) . Therefore, *feedback* is given to correct and incorrect answers, namely students are given instructions on how to determine the order of interference first so that students can find the wavelength. So that students are helped by the concept and can solve the problem with the right answer. Students who have difficulties need guidance

or *scaffolding* (Haniin et al., 2017) because *scaffolding* aims to provide assistance to students who have difficulty so that students can solve a problem and make students understand a certain concept (Diani et al., 2019) . In addition to the questions, in the explanation of the material it is also explained how to determine the order of interference so that students are not confused so that they can work on the questions and understand the concept of the material well. Suggestions and comments given by the validator are to change the discussion in the practice questions

Table 7. Validation Results of Evaluation Questions

No	Aspect	Percentage (%)
1	Suitability of questions with indicators	88%
2	Conformity with students' cognitive criteria	96%
3	The suitability of the answer key with the question	100%
4	The language used is clear and does not have multiple interpretations	99%
	Average	96%

Based on the results of the validation of the evaluation questions from the validator, the average validation percentage is 96%. This percentage includes very valid criteria. Evaluation questions consist of 10 multiple-choice scores. Students cannot *submit* if they have not done all the questions. The evaluation questions cover the entire material of light waves. The evaluation question aims to determine the level of understanding of the concepts possessed by students. One of the questions presented is about the concept of light diffraction, because according to a study conducted by Puspitaningtyas et al., (2021) the difficulty of students in this light wave material is one of the relationships between wavelength and light center width of single slit diffraction. Therefore, one of the evaluation questions presented is about how to determine light waves in light diffraction. Evaluation questions are something that is used to measure the achievement of the learning objectives that have been formulated (Setiadi & Zainul, 2019) . The results of student answers after working on evaluation questions are sent to the developer's email, so it can be seen how much level of understanding the students get.

Product Revision Results

Based on the results of validation by a team of media and material experts, media revisions were carried out to improve some parts that were lacking in the *E-Module* . Revisions are made based on the consideration of suggestions and comments from the validator. The results of the product revision from the validator include 1) the discussion of practice question number 1 is replaced by mentioning all the properties of light waves, 2) the menu title writing such as the introductory instructions is too large, 3) the concept map is not legible. When zoomed in, it's blurry. Then the developer fixes the suggestions and comments from the validator.

Products that have been repaired based on material and media experts are then tested as material for consideration of product feasibility. The trial was conducted by 46 students of class XI SMAN 1 Paciran as a product practicality test. Questionnaires distributed to

students will produce quantitative data. This practicality test data aims to determine the practicality of using an Android-based *E-Module* .

TABLE 8. Summary of Practicality Test Results

No	Aspect	Average (%)	Practicality category
1	Installation Aspect	89%	Very Practical
2	*Usability* Aspect	86%	Very Practical
3	Language Aspect	85%	Very Practical
4	Display Aspect	82%	Very Practical
5	Aspects of Questions	83%	Very Practical
	Average	85%	

Based on Table 8, the results from product trials show that the developed *E-Module* is classified as a very practical product criteria. Aspects of Installation with a percentage of 89% means that *the E-Module* developed is easy to install. *Usability* aspects include the navigation buttons can function properly and the developed *E-Module makes it easier to find learning resources.* The percentage of the second aspect is 86% in the very practical category, meaning that students can easily access *the E-Module* . The display aspect includes the suitability of the type and size of the font, the clarity of the colors used and the images and animations that are clear and easy to understand. Percentage Aspect display is 82% very practical category. The language aspect is the clarity of the language used, with a percentage of 85%. Aspects of questions include examples and practice questions that are presented to help understanding concepts and *feedback* on practice questions can be a motivation in working on questions. This aspect of the question produces a percentage of 83%. The percentage of all aspects is 85%, which is included in the very practical category. From the results of validation by experts and practicality tests by students, it can be seen that the product is included in the very valid and very practical criteria so that it is suitable for use in learning.

DISCUSSION

The results of research and development are in the form of a product, namely an Android-based Physics *E-Module which is equipped with questions with feedback in the* form of *scaffolding* on light wave material. This product has been developed through stages of development and has been validated by media and materials experts.

A module is one of the teaching materials designed to help students master specific learning objectives. The components that must exist in *the e-module* include introduction, competence, instructions for using the module, material description, summary, test and evaluation (Rahdiyata, 2016) . In the developed product, there are advantages that distinguish it from other *e* -modules, namely the existence of practice questions accompanied by *feedback in the* form of *scaffolding* and evaluation questions accompanied by scores. Practice questions with *feedback scaffolding* with the aim of helping students' difficulties in working on problems.

The *e-module components* include the title page, instructions for using the module, concept maps, material descriptions, evaluation questions, answer keys and bibliography (Ula & Fadila, 2018) . Based on this opinion, the components of the *e-module* developed

are *cover* , instructions for using the module, competencies, material descriptions, summaries, practice questions accompanied by *feedback* , evaluation questions, references and developer biodata.

The characteristics of the module include *self-instruction* (can be used for independent learning), *self-contained (* complete), *stand-alone* (not dependent on other media, *adaptive* (according to technological developments) and *user friendly* (friendly to users) (Rahdiyata, 2016) . that are made are in accordance with the characteristics of the module, so students can learn independently using this *e-module* because it already has complete features according to the characteristics of the module. Besides that, it is also used on android so that it can be accessed anytime and anywhere. This *e-module* in the form of interactive, which means that learning is carried out in two directions so that when students find it difficult to work on problems, there is *feedback in the* form of *scaffolding* that can help students overcome these difficulties and there are scored evaluation questions that can measure how much students understand the light wave material.

Based on the background of the problem regarding misconceptions or lack of understanding of the concept of light wave material, especially light interference and diffraction, it is necessary to include things that need to be considered in *the E-Module* . One of the difficulties faced by students in light interference material is that students do not know and do not understand what order of interference is formed. Therefore, an explanation of the interference order in the developed *E-Module* is listed in detail. In addition, in practice questions using *feedback in the* form of *scaffolding* so that students can better understand the concept of light waves, especially interference and light diffraction materials.

Based on the results of the research conducted, the results of the media validity test obtained an average percentage of 90%, the results of the validity test of the practice questions obtained an average percentage of 97% and the evaluation test results obtained an average percentage of 96% with very valid criteria. While the results of the practicality test of students showed a percentage of 85%. This according to (Safitri et al., 2021) is included in the very valid and very practical category.

From the results of research conducted, students feel that they get the benefits of learning by using this developed *e-module* . In addition, the media products that have been created have been tested by media and materials experts and produce products that are very valid and very practical. Based on this, this *e-module* can be tested further regarding its effectiveness in learning.

CONCLUSION

This research and development product is in the form of an android apk format . *in the* form of an interactive *E-Module* on light wave material. In *the E-Module* there is an explanation of the material accompanied by animations, pictures, videos, and practice questions with *feedback in the* form of *scaffolding* . The material contained in the product is arranged based on basic competencies which contain material on the light spectrum, light dispersion, light interference, light diffraction and light polarization as well as the

application of light waves in technology. The purpose of this product is to help students understand the concept of light waves.

Testing this product through validity tests by lecturers and physics teachers and practicality tests by students. The results of the media validity test obtained an average percentage of 90% with very valid criteria. This shows that the material presented is in accordance with the curriculum and can help students understand the concept. The results of the validity test of practice questions with *feedback in the* form of *scaffolding* obtained an average percentage of 97% with very valid criteria, while the results of evaluation tests obtained an average percentage of 96% with very valid criteria. This shows that the questions made are suitable for students to use to help understanding concepts. The results of the practicality test of students showed a percentage of 85% so that the product was stated to be very practical to use in understanding light wave material. This shows that the product developed is very practical and deserves further research to what extent the impact is on students so that it can support physics learning in understanding the concept of light waves, both used independently and in school learning.

REFERENCE

Adhi, S., Marhadini, K., Akhlis, I., & Sumpono, I. (2017). Pengembangan Media Pembelajaran Berbasis Android pada Materi Gerak Parabola Untuk Siswa SMA. *UPEJ Unnes Physics Education Journal*, *6*(3), 38–43. https://doi.org/10.15294/upej.v6i3.19315

Diani, R., Khotimah, H., Khasanah, U., & Syarlisjiswan, M. R. (2019). Scaffolding dalam Pembelajaran Fisika Berbasis Problem Based Instruction (PBL): Efeknya Terhadap Pemahaman Konsep dan Self Efficacy. *Indonesian Journal of Science and Mathematics Education*, *2*(3), 310–319. https://doi.org/10.24042/ijsme.v2i3.4356

Dintarini, M., & Zukhrufurrohmah, Z. (2021). Analisis Pemberian Scaffolding Melalui Online Form Untuk Mengatasi Kesulitan Berpikir Spasial Mahasiswa. *Delta: Jurnal Ilmiah Pendidikan Matematika*, *9*(2), 221. https://doi.org/10.31941/delta.v9i2.1414

Fatmah, S. N., Mastuang, M., & Salam, A. (2019). Pembelajaran Berbasis Learner Autonomy Topik Gelombang Cahaya Untuk Melatihkan Keterampilan Proses Sains. *Vidya Karya*, *33*(2), 154. https://doi.org/10.20527/jvk.v33i2.5880

Firdaus, I. (2021). *Validitas Modul Interaktif Berbasis Android pada Siswa Kelas VII SMP Negeri 2 Sungayang* [IAIN Batu Sangkar]. https://repo.iainbatusangkar.ac.id/xmlui/bitstream/handle/123456789/21083/1621839855152_skripsi cetak isranN.pdf?sequence=1&isAllowed=y

Haniin, K., Diantoro, M., & Handayanto, S. K. (2017). Pengaruh Pembelajaran Tps Dengan Scaffolding Konseptual Terhadap Kemampuan Menyelesaikan Masalah Sintesis Fisika Ditinjau Dari Pengetahuan Awal Siswa. *Jurnal Pembelajaran Sains*, *1*(2), 6–14. http://journal2.um.ac.id/index.php/jpsi/article/view/545/3306

Hasan, M. R. (2014). *Implementasi Sistem Informasi Manajemen Berbasis Ict Dalam Meningkatkan Efektifitas Kegiatan Belajar Mengajar dan Administrasi Di Sekolah Islam* (Issue 12710014). Universitas Islam Negeri Maulana Malik Ibrahim Malang.

Hermkes, R., Mach, H., & Minnameier, G. (2018). Interaction-based coding of scaffolding

processes. *Learning and Instruction*, *54*, 147–155. https://doi.org/10.1016/j.learninstruc.2017.09.003

Hidayat, A., & Prasetya, E. R. (2019). Belajar Reflektif Berbasis Sistem Android Untuk Meningkatkan Pembelajaran E-Learning. *Gammath*, *4*(2), 79–87.

Lilik Sufiyah, & Sumarsono, H. (2015). Pengembangan Media Pembelajaran Modul Elektronik Interaktif Pada Mata Pelajaran Ekonomi Untuk Kelas X Lintas Minat Ekonomi SMA Laboratorium UM Kota Malang. *Jurnal Pendidikan Ekonomi*, *8*(2), 64–74.

Lutfia, W., & Putra, N. M. (2020). Analisis Profil Pemahaman Konsep Dan Model Mental Siswa Di Sma Kesatrian 2 Semarang Pada Materi Interferensi Dan Difraksi Cahaya. *UPEJ Unnes Physics Education Journal*, *9*(1), 27–35.

Nova, N. R., Z, F., & Yennita, Y. (2020). Analysis Understanding of Concept in Sound Wave Materials and Light Waves in Class Xi Senior High School Students Tampan Pekanbaru. *Jurnal Geliga Sains: Jurnal Pendidikan Fisika*, *8*(1), 33. https://doi.org/10.31258/jgs.8.1.33-41

Puspitaningtyas, E., Putri, E. F. N., Umrotul, & Sutopo. (2021). Analysis of high school students' mastery in light wave theory using structured inquiry learning assisted by a virtual laboratory. *Revista Mexicana de Fisica E*, *18*(1), 10–22. https://doi.org/10.31349/REVMEXFISE.18.10

Puspitasari, A. D. (2019). Penerapan media pembelajaran fisika menggunakan modul cetak dan modul elektronik pada siswa SMA. *Jurnal Pendidikan Fisika*, *7*(1), 17–25. http://journal.uin-alauddin.ac.id/indeks.php/PendidikanFisika

Puspitasari, R., Hamdani, D., & Risdianto, E. (2020). Pengembangan E-Modul Berbasis Hots Berbantuan Flipbook Marker Sebagai Bahan Ajar Alternatif Siswa Sma. *Jurnal Kumparan Fisika*, *3*(3), 247–254. https://doi.org/10.33369/jkf.3.3.247-254

Rahdiyata, D. (2016). *Teknik Penyusunan Modul*. http://staff.uny.ac.id/sites/default/files/penelitian/dr-dwi-rahdiyanta-mpd/20-teknik-penyusunan-modul.pdf

Safitri, N., Alim, J. A., Noviana, E., Ibrahim, B., & Hermita, N. (2021). Pengembangan Media Pembelajaran Interaktif Materi FPB di Sekolah Dasar. *Jurnal Penelitian Ilmu Pendidikan*, *4*(2).

Santoso, B. (2013). *Diagnosis kesulitan siswa dalam menyelesaikan soal cerita materi SPLDV serta upaya mengatasinya menggunakan Scaffolding*. Universitas Negeri Malang.

Sari, M. N., Daud, M., & Faradhillah. (2022). Pengembangan E-Modul Fluida Untuk Pemahaman Konsep Siswa Menggunakan Aplikasi Flip Pdf Professional. *Jurnal Hasil Kajian, Inovasi, Dan Aplikasi Pendidikan Fisika*, *8*(1), 35–44.

Sari, N. A., Yulianto, Y., & Yuliani, H. (2021). Studi Literatur Media Pembelajaran Interaktif Berbasis Adobe Flash Professional CS6 Pada Pembelajaran Fisika di Indonesia. *Jurnal Ilmiah Pendidikan Fisika*, *5*(1), 18. https://doi.org/10.20527/jipf.v5i1.2791

Sarjono. (2017). Internalisasi Berpikir Kritis Dalam Pembelajaran Fisika. *Jurnal Madaniyah*, *7*(2), 343–353.

Saski, N. H., & Sudarwanto, T. (2021). Kelayakan Media Pembelajaran Market Learning Berbasis Digital Pada Mata Kuliah Strategi Pemasaran. *Jurnal Pendidikan Tata Niaga (JPTN)*, *9*(1), 1120.

Setiadi, T., & Zainul, R. (2019). Pengembangan E-Modul Asam Basa Berbasis Discovery Learning Untuk Kelas XI SMA/MA. *EduKimia*, *1*(1). https://doi.org/10.24036/ekj.v1i1.104019

Setyahandani, U., Darmawan, H., & Matsun. (2018). Pengembangan Media Pembelajaran Fisika Berbasis Android Pada Materi Gelombang Cahaya Di Kelas XI SMA Negeri 2 Ketapang. *Jurnal Pendidikan Sains Dan Aplikasinya (JPSA)*, *1*(1), 32–38. https://journal.ikippgriptk.ac.id/index.php/JPSA/article/view/910

Solikin, I. (2018). Implementasi E-Modul pada Program Studi Manajemen Informatika Universitas Bina Darma Berbasis Web Mobile. *Resti*, *2*(2), 492–497. http://jurnal.iaii.or.id/index.php/RESTI/article/view/393

Suarsana, I. M., & Mahayukti, G. A. (2013). Pengembangan E-Modul Berorientasi Pemecahan Masalah Untuk Meningkatkan Keterampilan Berpikir Kritis Mahasiswa. *Jurnal Nasional Pendidikan Teknik Informatika (JANAPATI)*, *2*(3), 193. https://doi.org/10.23887/janapati.v2i3.9800

Sugianto, D., Abdullah, A. G., Elvyanti, S., & Muladi, Y. (2017). Modul Virtual: Multimedia Flipbook Dasar Teknik Digital. *Innovation of Vocational Technology Education*, *9*(2), 101–116. https://doi.org/10.17509/invotec.v9i2.4860

Sugiyono. (2013). *Metode Penelitian Pendidikan*. Alfabeta.

Sujanem, R., Suswandi, I., & Yasa, P. (2019). Pemanfaatan Media Pembelajaran Fisika Berbasis Android Bagi Guru-Guru Fisika SMA. *International Journal of Community Service Learning*, *3*(4), 279. https://doi.org/10.23887/ijcsl.v3i4.22551

Supardi, S. U. S., Leonard, L., Suhendri, H., & Rismurdiyati, R. (2015). Pengaruh Media Pembelajaran dan Minat Belajar Terhadap Hasil Belajar Fisika. *Formatif: Jurnal Ilmiah Pendidikan MIPA*, *2*(1). https://doi.org/10.30998/formatif.v2i1.86

Suryaningtyas, A. D., Permana, H., & Wibowo, F. C. (2020). Pengembangan E-Modul Berbasis Android Dengan Metode Fodem Pada Materi Gelombang Bunyi Dan Gelombang Cahaya. *Prosiding Seminar Nasional Fisika (E-Journal)*, *IX*, 169–176. https://doi.org/10.21009/03.snf2020.02.pf.25

Sutopo. (2016). Students' Understanding of Fundamental Concepts of Mechanical Wave. *Jurnal Pendidikan Fisika Indonesia*, *12*(1), 41–53.

Sutrisno, A. D., Samsudin, A., Liliawati, W., Kaniawati, I., & Suhendi, E. (2015). Model Pembelajaran Two Stay Two Stray (Tsts) Dan Pemahaman Siswa Tentang Konsep Momentum Dan Impuls. *Jurnal Pengajaran Matematika Dan Ilmu Pengetahuan Alam*, *20*(1), 38. https://doi.org/10.18269/jpmipa.v20i1.560

Tazkiyah, A., Sulur, S., & Fawaiz, S. (2020). Pengembangan Modul Elektronik Dengan Feedback Berbasis Android Materi Suhu Dan Kalor Untuk Siswa SMA/MA. *Jurnal Pendidikan Fisika Dan Teknologi*, *6*(1), 31–38. https://doi.org/10.29303/jpft.v6i1.1731

Ula, I. R., & Fadila, A. (2018). Pengembangan E-Modul Berbasis Learning Content Development System Pokok Bahasan Pola Bilangan SMP. *Desimal: Jurnal*

Matematika, *1*(2), 201. https://doi.org/10.24042/djm.v1i2.2563

Wijaya, J. E., & Vidianti, A. (2019). Pengembangan Bahan Ajar Modul Elektronik Interaktif Pada Mata Kuliah Inovasi Pendidikan Program Studi Teknologi Pendidikan Universitas Baturaja. *Jurnal Pendidikan Glasser*, *3*(2), 142. https://doi.org/10.32529/glasser.v3i2.334