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The Development of Physics E-Module CTL-Based for Reflection and Refraction of Light Topic

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Abstract

This study aims to develop an e-module based on Contextual Teaching and Learning (CTL) as a physics learning media and to test its feasibility. The study employed a research and development method (R & D). This research produces a digital learning media for the Physic topic of reflection and refraction of light, which can assist students in studying independently by following the syntax of CTL. The e-module combines video, audio, and interactive quiz features. The development process was conducted through the ADDIE model, where the researcher evaluated every step in the development process. The e-module was developed according to the syntax of CTL. Validation of the e-module was conducted during the development steps. The validation results by the material expert gained a score of 85.09%, while the media expert gained a score of 82.14%. The e-module was implemented in a small group of nine students and gained a score of 84.71%. These scores mean that the e-module was considered feasible and very good.

Keywords: contextual teaching and learning, e-module, reflection, refraction

INTRODUCTION

Physics is often considered one of the most challenging subjects. One factor that affects students' learning difficulties in physics is an aspect of motivation. The motivation aspect has medium and low averages due to students' lack of interest in studying physics (Sari, Sunarno & Sarwanto 2018). Physics theories and concepts are abstract and complicated for students to learn. The illustration is given to help students to understand it. However, it still feels hard to study physics. Therefore, students sometimes struggle to study physics (Hasse 2015).

The physics curriculum for senior high schools in Indonesia explains many topics ranging from classical, modern, and quantum physics. One of them is the topic of reflection and refraction of light. Light has the most interesting phenomenon among physics concepts. The data reveal a low understanding of the phenomenon of light (Cvenic et al. 2021), which is related to the instructional tools and strategies teachers use (Ndihokubwayo et al. 2020). Students confuse reflection and refraction of light. They also struggle to understand the total internal reflection and scattering of light. Therefore the teacher needs to choose the right teaching media to minimize student confusion related to the reflection and refraction of light.

Physics lessons should have been presented with attractive media and learning models (Rezeki & Ishafit 2017). The media, which is based on the implementation of information and communications

technology (ICT) (Budi et al. 2021) could have been used to create more physics lessons meaningful, thus could give a positive impact on students, which can be seen from student's motivation and learning outcomes and student's competencies as well. The development of ICT has given a huge effect on the lesson. In addition, when the Covid-19 pandemic hit the world, the way to conduct lessons changed to distance learning (Jatmiko et al. 2021). Distance learning depends on the presence of IT which can help to bridge the interaction between teacher and students. The use of ICT during the pandemic has been pushed to improve technology literation which led to new habits in the future learning process (Latip 2020).

The improvement of information and communications technology literation has affected the development of various learning media and gives ease of access for students as the source of self-teaching materials. One of the teaching materials is a module (Maison et al. 2022). The development of ICT makes altering printed modules into electronic modules (e-module) possible. E-module is a learning medium that can make the learning process more fun and interactive. The use of e-module, which are integrated with internet connection and supporting applications, will enable us to play video and music or audio. The use of e-module as learning materials effectively increases students' motivation. They were not get bored to study physics because they can explore each topic using their own gadget (Puspitasari 2019).

In the learning process besides the importance of learning media, learning models also play an important role in achieving learning objectives. Learning models that connect students' daily experiences and environment with learning concepts or materials will make students motivated so that learning becomes more meaningful. They will truly understand and apply their knowledge in life. The learning model in accordance with the description above, uses the Contextual Teaching and Learning (CTL) learning model (Selvianiresa & Prabawanto 2017). The CTL learning model is effective in improving student learning outcomes because they experience learning, and have their own activities to gain experience, knowledge, understanding and other behaviors, not just reading or listening to teacher lectures (Desnita et al. 2022).

To support the explanation above, a preliminary study carried out which was followed by some high school students. The analysis result stated that 85% of students considered physics difficult to understand. 100% of students need fun and interesting learning media. 90% of students expect that there will be electronic learning media. 100% of students expect to have experience with contextual learning models. Moreover 90% of students said they have never used e-module based on contextual teaching and learning in a physics lessons. This is in line with research conducted by Rahmawati (Rahmawati 2018) who said that students understanding of physics concept still needs to improve, thus students learning outcomes are also low.

According to the explanation above, an idea occurs to develop an electronic learning media in the form of E-module based on contextual teaching and learning. This e-module is expected to be an independent physics learning media that can increase student's interest of physics lesson and increase student's understanding of physics.

METHODS

This research used a research and development method. This research aims to produce a product of an Electric Module or e-module based on contextual teaching and learning. The research model that was used to make products was the ADDIE model. This model has five stages: analysis, design, development, implementation, and evaluation. The development model's flowchart was adapted from similar research (Sari, Susilawati & Anwar 2021). At the same time, researchers continue to evaluate and make revisions in each stage that is passed in making a product. In general, the whole stages of the ADDIE model are presented in FIGURE 1. The explanation for each stage is explained below:

1. The research starts from the Analysis stage. The analysis is carried out to determine learning needs and identify problems. At this stage, it was concluded that to overcome learning during a pandemic and with the increasing use of ICT, researchers will create e-modules.
2. The second stage design. At this stage, it is concluded that the e-module created will use the CTL approach. Implementing the CTL model in the learning process must reflect the concepts

and principles of CTL (Bakri & Muliyati 2018). Seven CTL principles must be considered in developing this e-module, as shown in TABLE 1.

3. The third stage is development, besides compiling the draft e-module with the software. One of the activities carried out at this stage is validation. A media expert and a physics expert validated the product. The purpose of validation is to know the feasibility of the e-module. The application specification to make the product is shown in TABEL 2. Validation of the physics expert and media aspect was carried out in this research to ensure that the e-module could answer the formulated problems. The suggestion from the experts was used as the basis of revision before the e-module was implemented in the small group test. The outline of each instrument is presented in TABLE 3 and 4.
4. After the development stage is completed, proceed with the implementation stage. A small-scale test was carried out for nine high school students at the implementation stage. Nine students did the small group test with low, medium, and high physics ability. Three students belonged to the category low, three were categorized as medium, and the last three were high academic level. An instrument of small group test questionnaires were developed and presented in TABLE 5.

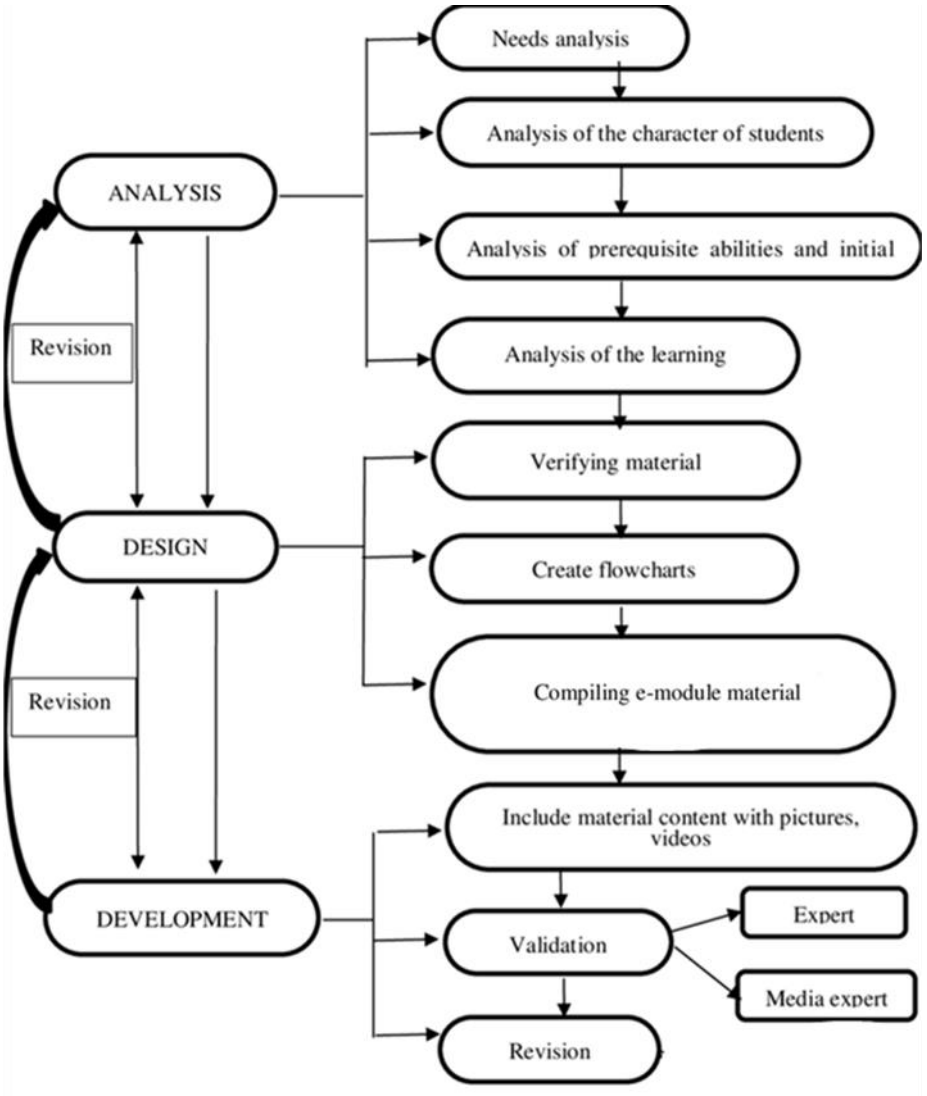


FIGURE 1. The ADDIE Model Stages in developing the e-module (Sari, Susilawati & Anwar 2021)

TABLE 1. Principles of CTL in the E-Module

Principles of CTL	Description of CTL principle in the e-module
Constructivism	Pictures and videos related to daily life were added to the e-module and supported by straightforward explanation narration to understand. Topics in the e-module were arranged in order from easy to challenging levels of knowledge. Therefore, students could construct their knowledge.
Inquiry	Students are encouraged to be able to construct knowledge and skills through practical activities and modeling.
Questioning	The exercise was given in each learning activity to check students understanding to find out issues related to the topic.
Learning Community	The e-module is completed with space for students to have a group discussion.
Modeling	Demonstrations and examples were given in the e-module as references for students to solve problems related to the topic.
Reflection	The e-module is equipped with reflection activities at the end of learning activities. These activities help students to check their understanding.
Authentic assessment	At the end of each learning activity, there is a follow-up statement so students can refer to it to know their understanding level, and they will notice what to do if their score percentages are either high or low.

TABLE 2. Product Specifications using Flipbook Application

Component	Information
Navigation	Animation operational standard/ video display
File type	HTML
Display	The dual page or function one page with zoom in
Video	Mpeg, Flv
Audio	Standard audio (mp3, wav)
Picture	Jpeg
Other features	Search, table of content, thumbnails, go to next page, social share

TABLE 3. Content Outline of Validation Test Instrument (physics expert)

Aspect	Indicator
Content feasibility	Topic relevant with basic competence, indicator and learning objectives
E-module's Component	Learning instructions, introduction, order of topic, topic description, problems example, test formative, summary, mark scheme, follow up activity
Content's Accuracy	Definition, answer key for exercise, illustration, video, equation, physics symbols, physics terminologies, practical activities, FYI activities, DIY activities.
Contextual	Constructivism, inquiry, questioning, learning community, modeling, reflection, authentic assessment
Language	Communicative, interactive, effective

TABLE 4. Content Outline of Validation Test Instrument (media expert)

Aspect	Indicator
Display	Color composition, layout, background, and graphic relevance with the topic
User-friendliness	Arrangement of content, easy to access, easy to play video, table of content, features function, gadget friendly, test formative accessible
Graphics	The attractiveness of pictures, video, font, design
Usefulness	Self-learning media, in-text questions, student's activeness, digital learning media
Consistency	Terminology, font, layout

TABLE 5. Content Outline of Small Group Test

Aspect	Indicator
E-module's Component	Learning instructions, learning objectives, topic arrangement, example, exercise, test formative, mark scheme, follow up
Graphics	Design, pictures, fonts, videos
Presentation	User-friendliness, students' motivation, physics concepts, fun learning media
Language	Communicative, interactive, effective

The data were analyzed quantitatively descriptively to determine the feasibility of the e-module. The questionnaire provided five alternative options for the respondents to give feedback according to the Likert Scale (Siregar 2014). The score was classified into five categories. They were very high, high, moderate, low, and very low, with scores of 5, 4, 3, 2, and 1, respectively. The percentage of

success of the e-module was calculated using this EQUATION 1. The data obtained was then measured to check the interpretation of the score, as shown in TABLE 6.

$$P = \frac{S}{N} \times 100\% \quad (1)$$

Where,
P: Percentage of success
S: Total score
N: Total max score

TABLE 6. The score conversion

Percentage	Interprets
0 % - 20 %	Very bad
21 % - 40 %	Bad
41 % - 60 %	Moderate
61 % - 80 %	Good
81 % - 100 %	Very good

RESULTS AND DISCUSSION

The product of this research was a physics e-module based on CTL on reflection of light and refraction of light to be used in high school as a digital learning media. The e-module was divided into two learning activities, they were a reflection of light and refraction of light. The components of the e-module are presented in FIGURE 2a-2h.

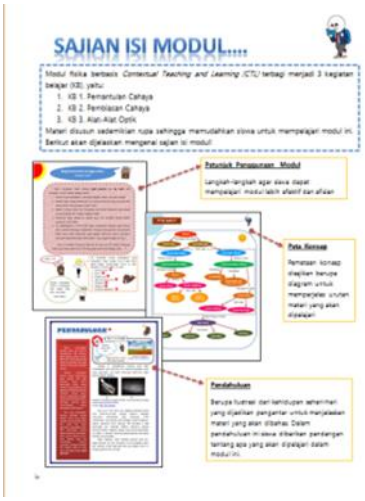


FIGURE 2. a. e-module content menu

FIGURE 2. b. How to use e-module

FIGURE 2. c. Introduction

FIGURE 2. d. Cover of Learning activity

FIGURE 2. e. Practical

FIGURE 2. f. Summary

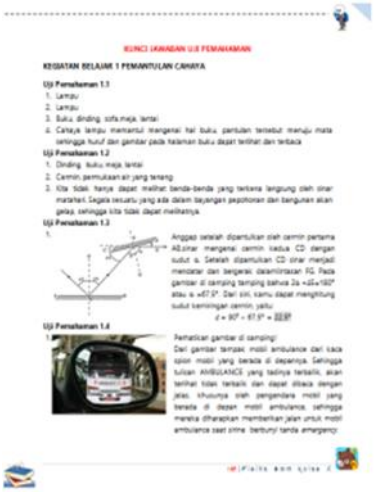
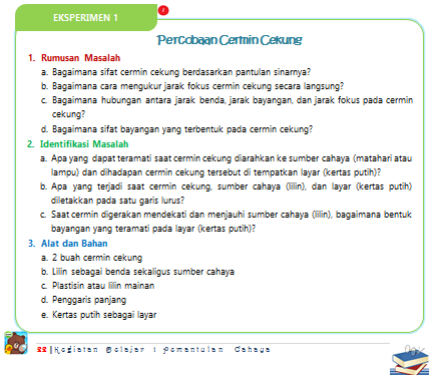
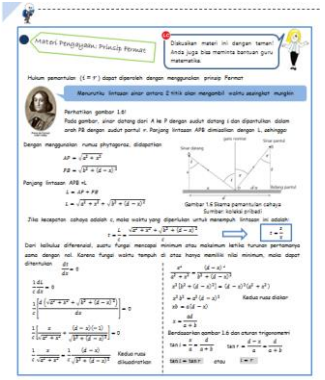


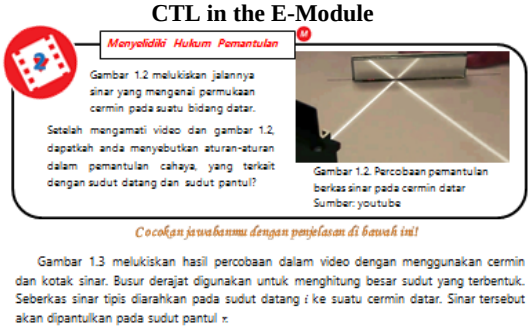
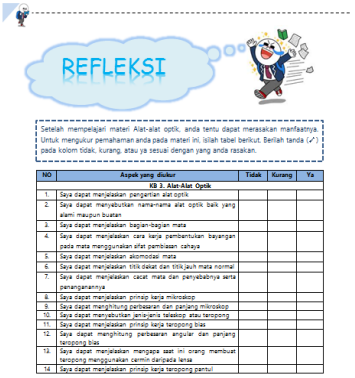
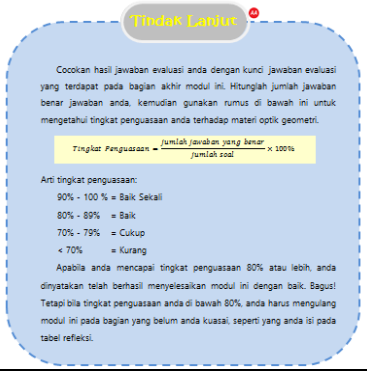
FIGURE 2. g. Answer Keys

FIGURE 2. h. Glosarium

The e-module was developed to refer to the seven principles of contextual teaching and learning (CTL). The appearance of each principle of CTL in the e-module was shown using a symbol. Each component in the e-module is shown in TABLE 7.

TABLE 7. Seven CTL Principles in the E-Module

No.	7 CTL Principles	CTL in the E-Module
1.	Constructivism	
2.	Inqury	
3.	Questioning	
4.	Learning Community	

No.	7 CTL Principles	CTL in the E-Module
5.	Modelling	
6.	Reflection	
7.	Authentic Assessment	

The final product was validated by media and physics experts to test its feasibility. To validate the e-module, a questionnaire was given to each expert using Likert Scale with the score of 1-5 from very low to very high. The validation test by physics expert aims to determine the level of validity of the e-module based on CTL in terms of the topic of reflection of light and refraction of light. This test contains 33 indicators: content feasibility, e-module's component, content's accuracy, contextual, and language. The data obtained in TABLE 8:

TABLE 8. Validation Test Results by Physics Matter Expert

No	Measured Aspects	Percentage	Interpretation
1	Content feasibility	80%	Good
2	E-module's Component	86%	Very good
3	Content's Accuracy	88%	Very good
4	Contextual	90%	Very good
5	Language	80%	Good
	Average of all aspects	85%	Very good

The validation results by physics matter expert as shown in the TABLE 8 obtained percentage of 85% for average of all aspects. Therefore, the e-module based on CTL categorized as very good in terms of e-module's component, content's accuracy, and contextual. While, content feasibility and and language categorized as good.

TABLE 9. Validation Test Results by Media Expert

No	Measured Aspects	Percentage	Interpretation
1	Display	85%	Very Good
2	User-friendliness	86%	Very good
3	Graphics	80%	Good
4	Usefulness	80%	Good
5	Consistency	80%	Good
	Average of all aspects	82%	Very good

Along with validation test with physics expert, validation test with media expert was also carried out (Lina & Desnita 2022). The validation test by media experts aims to get information about the level of validity of e-module based on CTL as a digital source learning material. The test using a questionnaire which had in total 22 question. The statements in the validation sheet were developed based on the outline that include aspects of display, user-friendliness, graphic, usefulness, and consistency. The data media expert validation was recorded as shown in the TABLE 9.

The validation results by media expert as shown in TABLE 9, obtained average percentage of all aspects of 82%. Therefore, the e-module based on CTL is very good in terms of content display, user-friendliness, graphic, usefulness, and consistency. The media expert suggested adding some audio features in page which contain video to inform students to watch the video provided. This suggestion was performed before the e-module was implemented in a small group test.

After the feasibility of the e-module was categorized as very good, the e-module proceeded to the revision process. This process was done according to the suggestion of a media expert. The-e-module was ready to be tested in the small group. the purpose of the small group tests is to find out what needs to be improved (Heidari Darani, Morady Moghaddam & Murray 2022). The results of the small group test will be taken into the calculation and the suggestions provided will be used for the final revision. E-module is revised based on student suggestions/comments in the small group and must be carried out before this e-module is disseminated in public.

In the small group test, the students filled out the questionnaire with 20 questions. The questionnaire was developed and referred to the indicators of small group test instruments, which included components of e-module, graphics, presentation, and language. The small group test data can be seen in TABLE 10. Previously, samples taken in field trials totaled nine people with different levels of understanding. Three students from the lower class, three from the middle class, and three from the upper class. After the data was processed and displayed in TABLE 10, the researcher found that wherever the students' understanding of physics came from, students liked learning using the developed e-module. Even after using the product, the researcher conducted interviews about students' motivation to learn physics and what needs improvement. From these results, students felt that learning delivered using e-modules was more apparent and exciting, adding enthusiasm to studying physics.

TABLE 10. Small Group Test Results by Students

No	Measured Aspects	Percentage	Interpretation
1	E-module's Component	89%	Very Good
2	Graphic	83%	Very good
3	Presentation	80%	Good
4	Language	87%	Very good
	Average of all aspects	85%	Very good

Therefore, CTL-based e-modules are very good regarding e-module components, graphics, presentation, and language. The added value of our e-modules is that they are rich in dynamic images, animations, and visuals. where images, dynamic visuals, animations, and simulations activate the visual system in the human body, increase one's capacity to store more information, and improve cognitive processes (Banda & Nzabahimana 2022). The use of good animation and visuals in the e-module is expected to be able to assist teachers in teaching reflection and refraction materials. This can be used as an adequate teaching tool and strategy to help students capture and understand the phenomenon of light. This is to avoid some of the potential misconceptions of students who have difficulty distinguishing light reflection and refraction (Ndihokubwayo et al. 2020).

CONCLUSION

This study aims to develop an e-module based on CTL as a physics learning media and test its feasibility. The topics chosen to be developed in this e-module are reflection and refraction of light. Media and physics experts validated this study to check its feasibility. Based on the validation test, it can be concluded that the e-module is feasible and categorized as very good. The average percentage of material physics experts is 85%, while that of media experts is 82%. The e-module is then implemented in small groups. Tests were conducted to get responses from students. Nine high school students took the small group test with different levels of academic achievement. This small group test obtained a score of 85%, so it was categorized as very good. Besides that, after conducting interviews with students with different levels of academic achievement, they said learning by using CTL e-module as teaching media could increase learning motivation. In the future, it is hoped that the developed e-module will be useful to the public, likely, making it easier for students to understand light reflection and refraction. Also for the teachers, with this e-module, it is hoped that it can be used as an alternative media in class.

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