

Physics Problem Based E-Module Development to Improve Student's Physics Concept Understanding

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Abstract: This research was a development research that aims to: describe feasibility, practitioner assessment, effectiveness in learning, then produce a problem-based physics e-module. The subjects of this research were 33 students of class XI IPA MA DDI Alliritengae. This research used the ADDIE model development. The instruments that were used in this research were e-module validation sheets, practitioner response questionnaires (educators/teachers), and students' conceptual understanding test instruments. The eligibility criteria for e-modules can be seen from the aspect of validity. The practical criteria can be seen from the practitioner's assessment of the e-module, and the effectiveness criteria can be seen from the increasing students' concept understanding test results. Based on the results, it can be concluded: The developing problem-based physics e-module, based on expert judgment used the Aiken V index analysis, was declared valid and suitable for use with minor revisions; The problem-based physics e-module in terms of the response of physics teachers was in "very good" category; The students' conceptual understanding ability analyzed with N-gain obtained an average value of 0.42 that was in the medium category which means that there was an increasing in students' conceptual understanding abilities so that it can be concluded that The problem-based physics e-module developed was effective in improving students' conceptual understanding skills.

Keywords: E-module; Problem-based physics; Conceptual understanding ability.

Introduction

The development of the increasingly advanced information technology causes the changes in people mindsets in obtaining information. The technology development, especially the internet, provides the opportunities for the field of education to access various information in the form of texts, images, simulations, and sounds (Puspitasari, 2019). Education is a significantly impacted sector from the information technology development. In Law Number 20 of 2003 concerning the National Education System, it is stated that education is a process to assist the students in developing their potential so that they will be able to deal with any changes and make them think actively. The process has the elements such as: the educators as the source of information, the media as a tool of presenting ideas and materials, and the students themselves. Some of these elements get a touch of

information and communication technology which will spark the idea of e-learning (Amri, et al., 2015). Throughout technological development, learning methods must change for student learning but must improve the understanding of knowledge (Wati, et al, 2020).

At this time, one of the learning supports which need to be developed to complement the existing facilities/infrastructure is the availability of adequate teaching materials. By using the adequate teaching materials, students can learn and discuss the materials before studying (Satriawan, et al, 2016). In addition, the teaching materials are also able to provide obvious guidelines regarding the competencies which need to be achieved by students. The teaching materials are all forms of materials used to assist teachers or instructors in carrying out teaching and learning activities. In this point, a module is for example (Nugraha, et al, 2013). The purpose of making the module is the students will

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be easier to understand the materials from the teacher. Each module provides a context for understanding and applying a particular concept (Zulhaini, 2016).

The electronic module is a form of presenting self-study materials which are systematically arranged into the smallest learning units. This module aims to achieve certain learning objectives which are presented in the electronic format, includes animation, audio, navigation. Moreover, this electronic device will make the users more interactive with the program (Sugianto, 2013). Electronic books are developed by using software, for example, the Learning Content Development System (LCDS). By using the interactive book, students are able to study by themselves, anywhere and anytime. In order to accommodate it, the interactive book must be created and designed to accommodate it (Suyatna, et al, 2018). Purnama & Asto in Suhailah, et al, (2021) This interactive media can be designed using a software program, namely Articulate Storyline. The Articulate Storyline is software which have functions as a medium of communication or presentation. By using this software, the learning media is as interesting as other interactive media. The interactive media in the form of Articulate Storyline software has advantages such as a simple display like power point, complete features such as flash so that it can also create animations (Rianto, 2020).

The physics learning is the learning which involves understanding the concepts of physical events in life. Students are required to understand these concepts comprehensively (Nurazmi, 2019). Physics is a part of Natural Sciences, which studies symptoms, events or natural phenomena and reveals all the secrets and laws of the universe. Giancoli (2014) stated that physics is "a branch of basic science which studies the behavior and structure of matter". The substance of physics is the same as science, namely as a product (a body of knowledge), attitude (a way of thinking) and a process (a way of investigating) (Chiappetta, et al, 2010). The abstract nature of physics makes it impossible to understand all of these concepts directly, so it takes a long time to understand them (Bahri, et al, 2017). Mastery of some fundamental concepts is one of the main objectives of learning physics (Diyana, et al, 2020). The physics learning requires the active students to strengthen understanding of physics concepts. It is in accordance with the principles of constructivism. In this principle, the knowledge is built by the students themselves. The inactive students can't get knowledge directly from the teacher (Istiyono, et al, 2018).

In reality, the students only learn the science by memorizing concepts, theories, and laws from the teacher's explanations and reading from source books. They also don't involve in the learning process. Currently, the science learning tends to be test-oriented. As a result, the science as a process, attitude, and application is not achieved in the learning process. The

learning process is a teacher-centered, so students tend to be passive and not creative in learning, as a result the learning objectives are not achieved (Sakdiah, et al, 2018). The physics low results of students at this time are influenced by many factors, including student and family characteristics, reading comprehension, learning motivation, interests and self-concept, learning strategies, attendance levels, and a sense of belonging (Ikbal, et al, 2020). Based on the results of direct observations to the students at MA DDI Alliritengae, many problems occurred during the learning process. Such as, the inactive students who were very depend on teacher explanations. This condition is known as "teacher center learning". The teaching and learning process is centered on the educator as a material deliverer, while the students become passive listeners. The learning which does not involve students causes the students to be apathetic in learning process. Another problem in this research was the educators act as if students had the same abilities.

In addition, the teaching materials used in schools were also quite limited. It caused an uncondusive learning because some students had to share textbooks with two to three students, and they would not focus on learning activities. They would rather to do other activities than studying the material. Moreover, the students and educators had difficulties and limitedness in doing practicum independently, because the tools and materials in the laboratory were still relatively incomplete, so that the learning process would be ineffective. (Dwi, et al, 2013) stated that the efforts to design innovative learning by using effective strategies for students concepts understanding and problem solving abilities need to be carried out. Based on this statement, the PBL model is very suitable to be applied in physics learning considering that physics material is in the form of concepts, laws, principles, and theories which are closely related to the scope of problems in daily life. The dynamic electricity is one of the concepts which is very useful in everyday life; however, the students often have difficulty in building a complete understanding (Taqlwa, et al, 2019).

Based on the result of observations and interviews that have been conducted at MA DDI Alliritengae Maros, researchers found a understanding physics concepts of students in studying physics, this ca be seen from their daily scores is mostly in the less category there are 19 students (58%), while in the good category there are 5 students (15%) and in the fair category there are 9 students (27%). Based on the interview results with educators, it stated that when the students were given a test, some students only relied on their memorization abilities. When the teacher gave different questions, they had difficulty in solving them. Therefore, the ability of understanding the concepts was very important, so that they were able to solve physics tests. When the

understanding of concepts was low, the students would have difficulty in solving physics tests given in different forms. (Anderson, et al, 2010), stated that the students are said to understand if they can construct the meaning of learning messages, whether spoken, written, or graphically delivered through teaching, books, or computer screens. They understand when their new and old knowledge are connected. More precisely, the new knowledge is combined with existing cognitive schemas and frameworks.

According to Sujanem (2012), the packaging of physics teaching materials is still linear, namely: the teaching materials only present the concepts and principles, the examples of questions and their solutions, and the practice questions. The packaging of physics textbooks used as a guide for students and teachers has not been packaged comprehensively which contains real problems, misconceptions, essential concepts, conceptual and contextual examples, which integrate technology. One of the important aspects in teaching physics is the use of learning media, the physics learning media must be used in online learning. The learning media which is generally used is e-learning modules. E-learning modules include independent learning resources, and it could be learned anywhere, anytime, individually, and groups.

The results of the previous research by (Sari R, et al., 2021) conducted by developing a physics e-book using a storyline platform. It obtained the results for content validation and e-book media which were well qualified and suitable for use in learning. In addition, the readability level of the e-book was 90.44% and the students also positively responded to the developed e-book. Besides that, the results of the previous research by (Jumadi et al, 2021) After students are taught with PBL learning, there is an increasing in several aspects. Claims, data and backing aspects increased from "very low" to "low" level. Therefore, the problem-based physics e-module which would be developed with the help of articulate storyline 3 based on the previous curriculum analysis.

Method

This research was a Research and Development (R&D) with the ADDIE development model which was carried out to produce physics learning e-modules. The procedure of the problem-based physics e-module used the ADDIE development model. The stages of ADDIE research and development according to (Branch, 2009) can be seen in Figure 1.

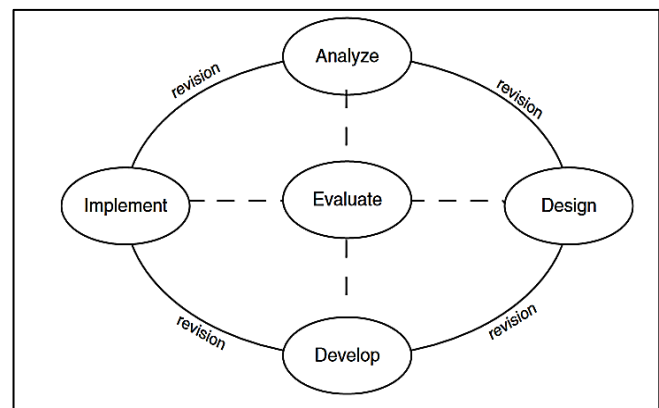


Figure 1. ADDIE Development Model

The researchers used the data collection techniques in the form of validation, questionnaires and tests of understanding physics concepts. This study used research subjects for class XI IPA MA of 33 people. It was held in the Even Semester of the 2021/2022 Academic Year in MA DDI Alliritengae located on Jalan Taqwa, Kec. Turikale, Maros Regency. In this research, the tests were carried out twice in the implementation phase or product testing. The trial design used is "Pre-test and Post-test Group". According to Arikunto (2010) the trial design is described as Figure 2.

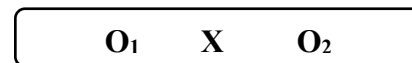


Figure 2. The Trial Design

Description:

- X : Treatment (independent variable)
- O₁ : pre-test (before module implementation)
- O₂ : Post-test (after module implementation)

The analysis used to determine the level of relevance by three experts used the coefficient of content validity (Aiken's V). The Aiken's V formula was used to calculate the coefficient of content validity based on the assessment results of each expert on an item using equation 1 (Azwar, 2012).

$$V = \frac{\sum s}{n - (c - 1)} \tag{1}$$

Description:

- V: Index of expert agreement regarding item validation
- s : The difference between the scores set by each expert with the lowest score in the category used
- s : r-Io
- r : Rater fixed score
- Io : The lowest rating score
- N : The number of experts
- c : The highest validity rating score

Aiken test requirement: after calculating, if $V \geq 0.4$, then the expert agreement index was valid. The practitioner's questionnaire assessment was carried out

by giving a score based on the provisions of Table 1 (Sugiyono, 2019).

Table 1 The Coding of Teacher and Learner Responses

Categories	The Score of Each Statement
Strongly agree	4
Agree	3
Disagree	2
Strongly Disagree	1

The percentage of practitioners' responses to each statement using the criteria according to Table 2 below which is adapted from Widoyoko (2022).

Table 2 The Criteria of Practitioner Assessment Score

Mean Scores	Classification
$X > 3.4$	Very good
$2.8 < X \leq 3.4$	Good
$2.2 < X \leq 2.8$	Fair
$1.6 < X \leq 2.2$	Less
$X \leq 1.6$	Very less

Description:

(Ideal Average): $\frac{1}{2}$ (ideal maximum score + ideal minimum score)

Sbi(ideal standard deviation): $\frac{1}{6}$ (ideal maximum score - ideal minimum score)

X : Empirical score

The effectiveness of the problem-based physics e-module could be seen from the score of students' conceptual understanding ability after being tested on the problem-based physics e-module. If there was an increase (effect or influence) on students' conceptual understanding abilities after using problem-based physics e-modules, it could be said to be effective for use in the teaching and learning process. The ability to understand the concept of students was tested using the assessment criteria according to Table 3, adapted from Riduwan (2013).

Table 3 The Criteria for The Score of Students' Concept Understanding Ability

Percentage (%)	Category
$19 < X \leq 24$	Very good
$14 < X \leq 19$	Good
$10 < X \leq 14$	Fair
$5 < X \leq 10$	Less
$X \leq 5$	Very less

To see the increase in the ability to understand concepts used N-Gain analysis. According to (Sundayana, 2014) the following formula was used to determine the N-gain:

$$\text{Normalized Gain (G)} = \frac{S_{\text{posttest}} - S_{\text{pretest}}}{S_{\text{max}} - S_{\text{pretest}}} \quad (2)$$

Description:

g : normalized Gain

S_{Pretest} : Pretest score (initial test)

S_{Posttest} : Posttest score (final test)

S_{max} : Ideal maximum score

Table 4 Normalized Gain Criteria

Normalized Gain Values	Interpretation
$0.70 < g \leq 1.00$	High
$0.30 < g < 0.70$	Average
$0.00 < g < 0.30$	Low
$g = 0.00$	No increase
$-1.00 \leq g < 0.00$	Decrease

Result and Discussion

The validation analysis results of the problem-based physics e-module validated by 3 experts were obtained as Table 5.

Table 5. The Validity Analysis Test of The Problem-Based Physics E-modules Content

Aspects	Total Validity Item Score	V	Category
Content Eligibility	13.11	0.82	Valid
Presentation Eligibility	11.78	0.74	Valid
Language Eligibility	15.22	0.76	Valid
Graphic Eligibility	6.33	0.79	Valid

In the content eligibility aspect, a validity index (V) was obtained with a mean score of 0.82 and in the valid category. For the presentation eligibility aspect, a validity index (V) was obtained with an average score of 0.74 and in the valid category. The language eligibility aspect shows a validity index (V) of 0.76 score and in the valid category. The last, for the graphic feasibility aspect, a validity index (V) was obtained with an average score of 0.79 and in the valid category.

The analysis results of the practitioner's questionnaire sheet on the problem-based physics e-module developed to see the practicality of the physics e-module are as follows:

Table 6 The Average Score of Practitioner's Assessment on the Quality of Problem-Based Physics E-module Development

The component of practitioner assessment	The Average Score
Content Eligibility	3.5
Presentation Eligibility	3.5
Language Eligibility	3.5
Graphic Eligibility	3.6
Total	3.5

The effectiveness of the problem-based physics e-module using N-Gain analysis for pretest and posttest is obtained.

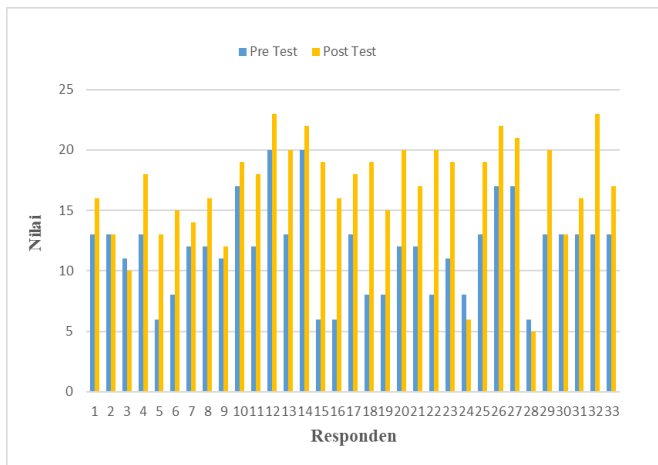


Figure 3. The graphic of the students' conceptual understanding

Based on the analysis results, it was found that the abilities of students' conceptual understanding increased from the test before and after using the problem-based physics e-module. Based on the line diagram, there were 6 students who had increased their ability to understand concepts in high category, 22 students in medium category, and 5 students in low category. Moreover, there were no students who fall into the category of decreased ability or stagnant ability.

Then, the N-Gain analysis was carried out to see if there was an increase in students' conceptual understanding. The analysis results obtained an average N-Gain value of 0.42. It means that there was an increase in the ability to understand the concepts of students in the medium category. Based on the statement, the problem-based physics e-modules with the support of the articulate storyline 3 software which had been developed were effective in improving students' conceptual understanding skills.

The results of the content validity test showed that the developed problem-based physics e-module had fulfilled the valid/ eligibility criteria. It was based on the analysis results of expert agreement index by using Aiken's V content validity coefficient, and it could be used as a learning resource in physics. The assessment of the practitioner's response to the developed problem-based physics e-module gave a positive response in the very good category.

The effectiveness of the problem-based physics e-module observed from the students' ability to understand the concepts which was analyzed by N-gain was in the medium category. It means that there was an increase in students' conceptual understanding abilities. As a conclusion, the developed problem-based physics e-module was effective in improving abilities to

understand the concepts of students in class XI IPA MA DDI Alliritengae.

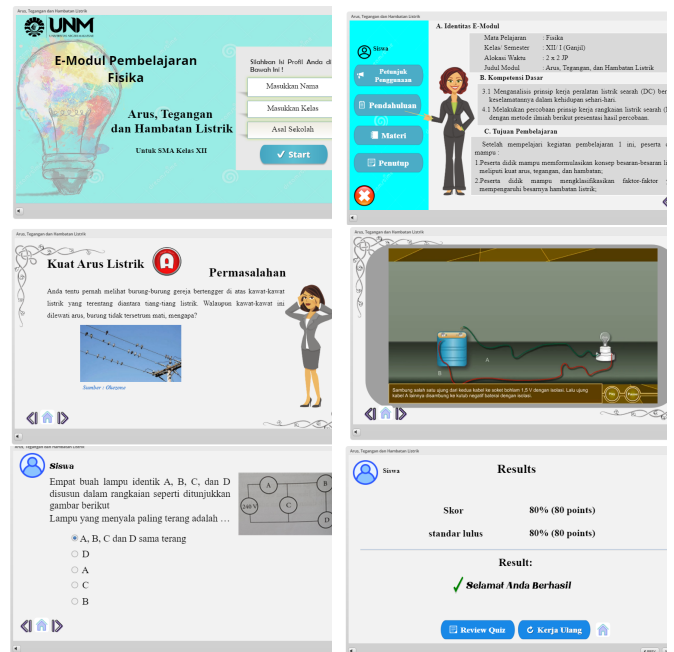


Figure 4. Example of the problem-based physics e-module.

Conclusion

Based on the literature study, it can be concluded that the developing problem-based physics e-module, based on expert judgment used the Aiken V index analysis, was declared valid. Besides that in terms of the response of physics teachers was in "very good" category, and for the effectiveness of the problem-based physics e-module related to the students' conceptual understanding ability analyzed with N-gain obtained an average value of 0.42 that was in the medium category which means that there was an increasing in students' conceptual understanding abilities so that it can be concluded that The problem-based physics e-module developed was effective in improving students' conceptual understanding skills.

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