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Multirepresentation-Based Physics E-Module Development

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Abstract

This research is a research and development with the final result of developing a multi-representation-based Physics E-Module. The development of the Physics E-Module aims to produce innovations in teaching materials that can be applied to the learning process and to support independent or student-centered learning. The Physics E-Module was developed on a multi-representational basis. Multirepresentation aims for students to get various representations of a material. The development research method used is the ADDIE design development method. This method was chosen because it is one of the basic development methods and is easy to implement. The ADDIE design development stages include *Analyze, Development, Implementation*, and *Evaluate*. The product feasibility test was carried out by involving 16 Tadris IPA Biologi UIN Mataram students. The Flip PDF Corporate supports the appearance of the multi-representation-based Physics E-Module so that the appearance of the Physics E-Module has an effect like opening a printed book. The multi-representation used in the Physics E-Module is verbal, graphic or image, and audio-visual representations. Expert validators in the media and material carry out the feasibility test. The feasibility test results in the media sector are 90%, with a very feasible category. The feasibility test results in the material sector are 94.6%, with a very feasible category. The scores of the student's responses to the development of multi-representation-based Physics E-Modules range from 3.5 to 4, with a maximum score of 4. The results of this study have implications for the provision of valid and feasible Basic Physics teaching material for use in learning, especially online learning.

INTRODUCTION

Difficulties or misconceptions in physics material are the foundation for developing learning in a better direction[1]. Two factors cause misconceptions in students: internal and external [2]. Some internal factors that influence students' misconceptions are that they have brought misconceptions about the material, they bring an incomplete understanding of concepts, and they believe that the concepts they have learned are correct [1], [2]. Some external factors that influence students' misconceptions are books read by students, educators, and the surrounding environment[2]. So that researchers can develop better learning following the needs of students both in terms of delivery of material and learning media used.

Basic physics materials must be mastered by students, especially those who choose the concentration of natural sciences[3]. This material is a basis or guideline for studying physical phenomena that can be used in an integrated manner. The material in basic physics is classical mechanics material in general. Classical mechanics consists of quantities and units, vectors, one-

dimensional motion, two-dimensional motion, laws of motion, energy conservation, collisions and linear momentum, rotational motion, angular momentum, elasticity, gravity, and fluids[4].

There are still many misconceptions about classical mechanics. Misconceptions about this material are generally due to students' inability to read data presented graphically. There is also because students have misconceptions about the material, making it difficult to make sense of the problem. It turns out that students are also not used to solving problems if the representation of questions is presented differently. In addition, mathematical representation is also an obstacle for students[5].

Based on the problems regarding these misconceptions, learning media can be an alternative to reducing misconceptions. Learning media is a means or tool to provide information about subject matter [6] easily. Learning media consists of print and non-print learning media. Print learning media includes modules, textbooks, and LKS. Meanwhile, non-printed learning media can be in the form of teaching aids or sets of practicum tools and technology-based learning media, for example, interactive learning videos or practicum simulations, with the help of certain applications.

Researchers want to develop learning media as a physics module in this development research. The module was chosen because it has criteria as an independent learning medium. Independent in this case is student-centered-based learning where students can use modules with or without help from educators[7],[8]. Besides that, modules are learning media that are developed systematically and structured and use language that is easy to understand[9].

Based on this description, researchers will develop digital modules (Electronic modules) based on multi-representation to get students varied representations and modules that can be accessed anywhere. Multirepresentation presents concepts in various forms, namely in verbal, diagrammatic, and mathematical forms[10]. Using a multi-representation basis in elaborating material is believed to facilitate students' understanding of physics material[11]. As we know, physics material is quite difficult to understand if only in one concept presentation. The presentation used in developing this module utilizes technology, namely developing conventional modules into digital modules because digital modules are more interactive and can be accessed anywhere and anytime[9].

METHOD

This type of research is research and development. This study uses a research and development design adapted from the ADDIE design. Selection of design development taking into account simpler and not complicated but systematic stages. This design's stages consist of analysis, development, implementation, and evaluation [12].

The data obtained from this study is qualitative data on the feasibility of the product. The data obtained from the questionnaire instrument were analyzed using the following equation[13].

$$P = \frac{\sum x}{\sum x_i} \times 100\% \qquad (1)$$

Information :

P : Percentage of feasibility scores (%)

$\sum x$: The number of respondent's answers in one item

$\sum x_i$: Total ideal score for each item

The feasibility criteria for the module from the media and material aspects can be determined based on equation (1). The following are the feasibility criteria for the module[13].

Table 1. Feasibility Criteria

Intervals	Criteria
0%-20%	Very Unworthy
21%-40%	Not feasible
41%-60%	Decent Enough
61%-80%	Worthy
81%-100%	Very Worth it

At the implementation or product trial stage, learning is carried out using the developed multi-representation-based Physics E-Module. After that, a survey of student responses was carried out after using the multi-representation-based Physics E-Module during the learning process.

RESULT AND DISCUSSION

In developing this e-module, researchers used research and development methods using the ADDIE design[12].

Analyze

At this stage, before developing the module, the researcher analyzes what needs are needed by students to support learning. A needs analysis was carried out by researchers by triangulating data from interviews and observations and filling out questionnaires. The analysis can support the module's maximum development.

The data obtained from the needs analysis results show that students find it difficult to learn classical mechanics material. Students have difficulties reading and presenting graphs and mathematical functions in two-dimensional motion. Based on the results of the needs analysis on the material, it is necessary to develop a multi-representation-based learning media so that students have an understanding of various concepts[10].

The data obtained from the needs analysis of learning media shows that students need learning media that can be accessed anywhere and anytime. In addition, the learning media needed are learning media that can support independence in the learning process. Based on this analysis, the researchers developed learning media as electronic modules. Electronic modules are learning media that can be accessed anywhere and support the independence of the learning process for students[7],[8].

Based on the triangulation data, it can be concluded that the modules developed must be interactive and easy to understand. From these conclusions, the researcher decided to create a multi-representation-based module. Multirepresentation was chosen as the basis for module development because multirepresentation is capable of presenting more than elaboration[10]. To be able to help students to understand material[14].

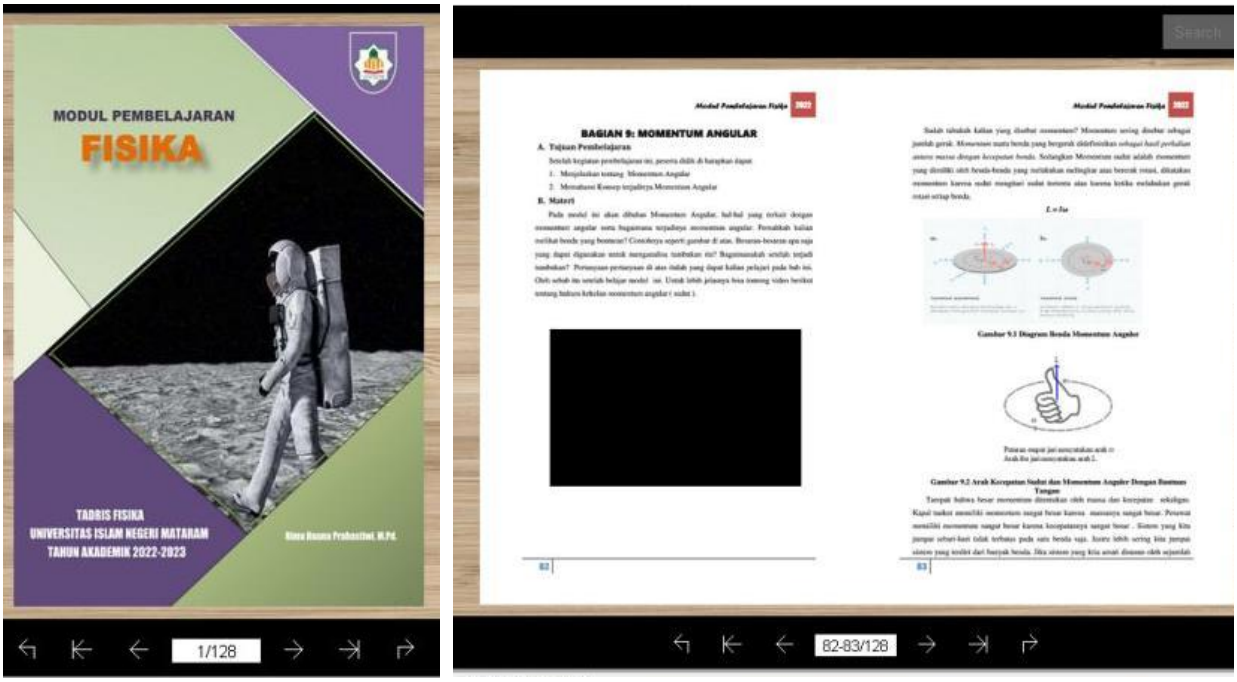
At this stage, the researcher also made a research instrument in the form of a module feasibility questionnaire. The module feasibility questionnaire contains the feasibility of learning media and the suitability of the material. The research instrument was also validated; each instrument and criteria were validated by two validators who were experts in their respective fields.

Design

After going through the analysis phase, the researcher makes a framework design containing the module display layout and the content to be loaded. The content that will be filled in is in the form of material in the form of writing, images, graphics, or explanatory videos. In addition to material, researchers also provide practical simulations on modules that can be done independently. The module also includes examples and practice questions so that conceptual understanding can be honed independently.

Development

After deciding on the module's content framework, the researcher developed it using the Flip PDF Corporate application. This application was chosen because the learning modules created can be published online(bit.ly/modulmultirepresentasi). It can be accessed anywhere and anytime [9]. Apart from that, this application can edit the appearance by adding various features such as video and sound and giving effects such as opening a book. The following shows the multi-representation-based physics module that has been developed.



(a) (b)

Figure 1. Display of Multirepresentation Based Physics E-Module: (a) Cover View and (b) Multi-representation View

.

At this stage, before implementation, the researcher validates the modules that have been developed. In this case, two criteria were validated: material suitability and media validation, with each criterion validated by two expert validators in their field. The results obtained have a very decent category: % of the material field is 94,6%, and the media field is 90%.

Following are the results of material and media validation which can be seen in Table 2.

Table 2. Material and Media Validation Results

No.	Indicator	Validator Score	Max Score
1.	Material Suitability	3.8	4
2.	Appearance	3.5	4
3.	Utilization	4	4
4.	Language	3.8	4

Based on the results of the feasibility validation of the module on the material and media criteria, it is in the very feasible category. The multi-representation-based E-Module can be implemented for students. However, there were several comments and suggestions from the validator that the E Module was still not accessible online, and it was suggested that it could be improved so that it could be accessed online.

From the suggestions given by the validator, the researcher revised according to what was suggested to make the E-Module display online so that it was easily accessible anywhere and anytime[9]. The following shows the website for E-Module development.

(a)

(b)

Figure 2. E-Module Display: (a) Before Revision (Offline) and (b) After Revision (Online)

(a)

(b)

Figure 3. Website Display: (a) Main Page and (b) Menu

Based on Figure 2 and Figure 3, the multi-representation-based Physics E-Module can be accesed online by scanning the QR-Code in Figure 4 below.

Figure 4. QR-Code Multirepresentation Based Physics E-Module

Implementation

At this stage, the researcher implements the modules that have been developed. The modules that have been developed can be tested further. Implementation is done by learning with E-Modules.

Implementation is done by providing an E-Module link and explaining how to use it. Students can access the E-Module correctly. The implementation stages can be seen in Figure 5 below.

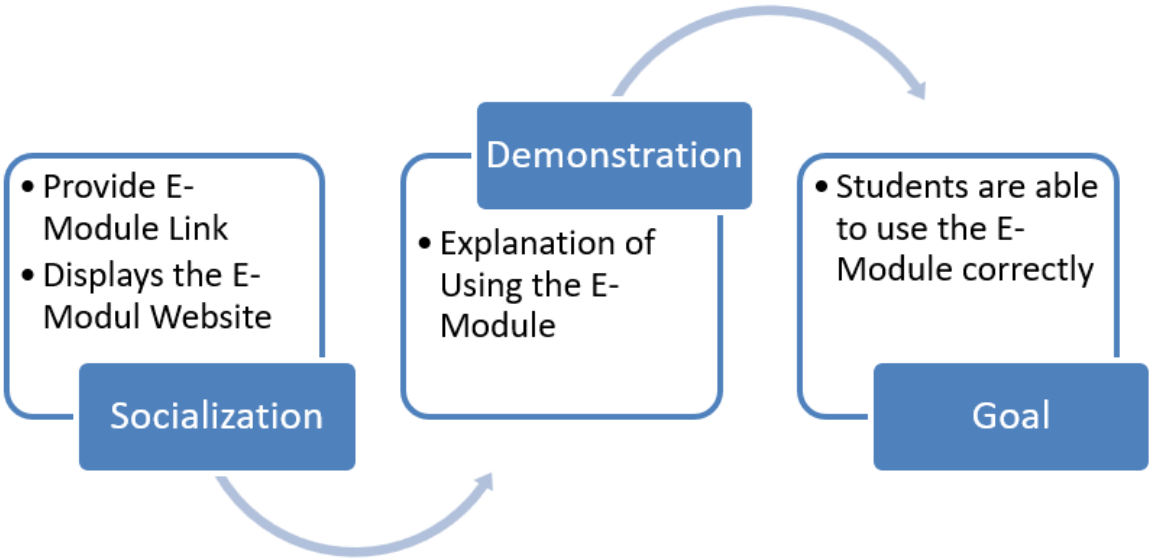


Figure 5. Implementation Stages

Evaluate

The evaluation stage here is carried out at each stage of module development. It starts from the analysis, design, development, implementation, and evaluation stages. The evaluation stage aims so that at each stage of development, obstacles can be resolved immediately[12].

In the analysis stage, after obtaining the data, students' needs are evaluated through data triangulation. To obtain valid student needs data. Based on the analyzed results, the developed media must be interactive and easily understood. Therefore, E-Modules are developed in the form of multi-representation[15].

The evaluation stage of the design is to determine the framework and layout, which is the appearance of the E-Module. Arranging videos, images, practicum simulation, and practice questions makes this display as attractive as possible. The appearance of the E-Module is not monotonous.

The evaluation stage of development is by entering the contents of the E-Module into the flipbook pdf corporate application. The contents of the E-Module are in the form of materials, videos, images, practicum simulation, and practice questions. After the E-Module content is loaded, the next step is to publish E-Module in flip form. At this stage, the obstacle faced was being unable to go online, so an evaluation was carried out by uploading the E-Module file presented with the flipbook pdf corporate application to the website. The E-Module can be accessed anywhere and anytime.

The evaluation stage on implementation is by implementing E-Module in learning so that learning leads to student centered[9]. There are several obstacles at this stage, namely inadequate internet signal the E-Module can be used. In addition, demonstrations of the use of modules in class were also held so that students could use the E-Modules correctly.

Based on the results of the presentation of data regarding the development of E-Modules, it can be concluded that the development of E-Modules is carried out o improve the learning process. Developing E-Modules can also change the learning process from teacher-centered to student-centered [7]-[9]. In addition, this E-Module is also being developed towards an interactive digital module based on flipbook, which is believed to provide a new atmosphere in the physics learning process.

In addition to developing flipbook-based interactive E-Modules, this research also combines the development of multi-representation-based E-Modules. Multirepresentation is a way of presenting material in various ways, namely verbally, graphically, and mathematically[10]. This combination is done so that the learning process becomes interactive.

Student Response Survey

After the development of the E-Module is complete, the researcher conducts a survey of the E-Module used. The survey was conducted to determine student responses to E-Modules' development and use. The use of E-Module in learning has a good response. It starts from the display

and use of media, context, constraints, and benefits of using E-Modules. Of the 4 maximum scores, a range of 3.5 to 4 is obtained from the average score of the survey that has been conducted.

In general, the response to the development of the E-Module was very good. The appearance of the E-Module in the form of a flipbook can attract students' interest[7]. The flipbook effect is like opening a printed book. E-Module media is easy to use because it can be accessed anywhere as long as there is an electronic device in the form of a cellphone or personal computer connected to the internet[9]. The appearance make of the media is very attractive.

Presentation of varied material can make students motivated in learning. Because as we know, the development of this E-Module is based on multi-representation. Multi-representation, namely the presentation of material in various forms ranging from verbal, visual, and audio-visual[9], [10], [13], [15]. Besides, the presentation of the material has been associated with everyday life.

Based on the student's responses regarding the development of the generally good E-Module, it turned out that there were still obstacles. The obstacles faced were generally related to an inadequate internet signal. Therefore it is suggested that when learning, E-Modules can be used in groups so that all students can use them.

CONCLUSION

E-module development produces innovations in teaching materials that can be applied to the learning process and to support independent or student-centered learning. The Physics E-Module was developed on a multi-representational basis. The aim is that students have a variety of representations of a material. One interactive learning medium is using media, which is becoming a trend and can make students interested. This multi-representation-based e-module can be further developed in terms of other materials in physics learning.

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