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Problem Based Learning in E-module as An Effort to Improve Student Learning Outcomes: A Design of Innovation in Physics Teaching Material

Pembelajaran Berbasis Masalah dalam E-modul sebagai Upaya dalam Meningkatkan Hasil Belajar Siswa: Sebuah Desain Inovasi Bahan Ajar Fisika

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Abstract

Physics learning cannot be separated from mathematical learning, so students tend to get bored more quickly if the teaching materials and learning models are not appropriate, resulting in low student learning outcomes. In solving this problem, there is a need for technological development. Teaching materials are increasingly referred to as digitalization so that they are more interactive. The use of e-modules, which can contain pictures, animations and video learning, so that students are more interested in learning, and the use of learning models also supports the achievement of learning objectives. A learning model that can be used to make students active in the learning process is problem-based learning. This research aims to produce an e-module with problem-based learning to improve student learning outcomes. This research type is development research. The development model used is a prototype model. Namely, the first stage is listening to customers. The second stage is building/revising the mock-up (design); the next stage is the customer test driver mock-up (evaluation). This e-module is designed with the Canva application to create the cover and module display, and the flipbook hygiene helps make the module display more interactive.

Keywords: *design, physics, e-modules, problem-based learning,*

Abstrak

Pembelajaran fisika adalah pembelajaran yang tidak terlepas dari pembelajaran matematis, sehingga siswa cenderung lebih mudah bosan jika bahan ajar dan model pembelajaran yang digunakan tidak sesuai, sehingga mengakibatkan rendahnya hasil belajar siswa. Dalam menyelesaikan permasalahan ini, perlu adanya perkembangan teknologi, perangkat pembelajaran semakin mengacu pada digitalisasi seperti bahan ajar yang digunakan sudah mulai berbasis digital sehingga lebih interaktif seperti penggunaan e-modul, yang dapat memuat gambar, animasi, audio dan video pembelajaran, agar siswa lebih tertarik untuk belajar, selain bahan ajar model pembelajaran juga menunjang tercapainya tujuan pembelajaran, model pembelajaran yang dapat digunakan supaya siswa aktif dalam proses belajar, yaitu pembelajaran berbasis masalah. Penelitian ini bertujuan untuk menghasilkan desain e-modul fisika sebagai pembelajaran berbasis masalah guna meningkatkan hasil belajar siswa. Penelitian ini termasuk penelitian pengembangan. Model pengembanagn yang digunakan adalah prototipe model yaitu tahap pertama listen to customer, tahap kedua, yaitu *build/revise mock-up* (perancangan dan tahap selanjutnya yaitu *customer test driver mock-up* (evaluasi). E-modul ini didesain dengan aplikasi *Canva* untuk mendesain cover dan tampilan modul dan bantuan *Hyzine Flipbook* untuk membuat tampilan modul lebih interaktif.

Kata Kunci: desain, fisika, e-modul, pembelajaran berbasis masalah

1. Introduction

Physics learning is dependent on good math skills, reasoning and logic. Therefore, students are expected to interpret physics concepts. In this way, students are expected to foster logical thinking skills, communication, and problem-solving and be able to apply physics in the environment (Martin, 2020). In the learning process, physics learning requires appropriate approaches and methods to achieve learning objectives (Nikat et al., 2021). In addition to selecting approaches and methods, teaching materials are necessary to fulfil learning objectives. Apart from being used in the classroom, students can also use teaching materials for personal development outside the classroom (Silitonga, 2018). Teaching materials are components arranged coherently in the form of material containing concepts that direct students to achieve learning objectives (Fahmi et al., 2022).

Various teaching materials include modules, worksheets, and handouts (Sari & Sumarni, 2023). Teaching materials are written in detail and structured to create favourable learning conditions for students and teachers (Aisyah et al., 2020). Each teaching material has its components, principles, benefits and ways of use. This understanding makes it clear that teaching materials must be produced following the principles of education. Teachers use teaching materials to support learning (Syahroni, 2020). Along with the development of science and technology, one of its effects in the world of education is teaching materials that have begun to be digitized, one of which is an electronic module (e-module).

E-modules are learning tools that can facilitate their use in meeting learning objectives. Systematically arranged based on its constituent components to achieve learning objectives and presented in electronic form containing images, animations, audio, and learning videos.dan video pembelajaran (Nuraeni, 2021). The characteristics of electronic modules are adapted from the characteristics of modules, including (1) instructionally independent, (2) independent, (3) stand-alone, (4) adaptive, (5) user-friendly. According to (Kemendikbud, 2017), Electronic modules can interactively combine materials, images, animations, evaluation questions, and videos. Through more interactive electronic modules, students are more interested in learning to achieve their learning goals (Kemendikbud, 2017). Using electronic modules in learning activities can reduce student boredom and make students interested in learning the material presented so that there is an increase in student learning outcomes (Nuraeni, 2021).

In addition to selecting teaching materials, a teacher can also organize a learning model so that the material can be adequately conveyed. One of the learning models that can improve problem-solving is the PBL model, which is able to enhance problem-solving so that student learning outcomes increase (Kurniawan, 2022). The PBL model is a model that focuses activities on each student so that students will recognize problems related to the subject. Through these learning activities, students' knowledge can be built, and students are encouraged to real problem situations so that they can be solved (Noer & Gunowibowo, 2018)

The conditions in the field are not ideal based on research conducted through observations and interviews with physics teachers at Pertiwi 1 Padang High School. Observations and interviews were conducted related to physics learning, especially to explore information about (a) material that is difficult for students, (b) teaching materials applied, and (c) learning models applied. The observation found that the teacher still dominated the learning process at SMA Pertiwi 1 Padang. The learning model used was a direct learning model using the lecture method, and the teaching materials used were still limited. The teaching materials used are printed teaching materials such as LKS package books. This causes a lack of student interest in learning and low learning outcomes.

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Based on teacher interviews and student needs questionnaires, it is found that the material that is difficult for students to understand is balance and rotational dynamics because the material is too much, so students find it challenging to understand the material and do not understand the problems presented in the issue. This aligns with research by Amalia (2022), who stated that many students still had difficulty solving physics problems about balance and rotational dynamics at MAN 2 Pontianak. This is reinforced by the low scores of students' daily tests on rotational dynamics material from three classes: XI MIPA 1, XI MIPA 2, and XI MIPA SMA Pertiwi 1 Padang. The average test scores were 59, 34 and 52, respectively, with a KKM of 79. It can be seen from the average student's test scores still do not meet the KKM. Based on this description, to overcome the low learning outcomes, the suitable teaching materials are needed in the form of e-modules to increase learning outcomes with the research title physics e-module design as problem-based learning to improve student learning outcomes.

2. Literature Review

2.1 Teaching Materials

Teaching materials are a series of learning components organized to help students better understand the material they have learned (Magdalena et al., 2020). Structured teaching materials allow students to learn quickly, understand the material, and apply norms related to the material (Mahan, 2022). Components of teaching materials include introduction, content, and closing sections (Ahmat Fatoni Rizal et al., 2021). Teaching materials can be developed by paying attention to several things, such as variety, practicality, fun, and motivation, and they can meet different learning styles (Maiti & Bidinger, 1981). Various teaching materials, such as printed and electronic, contain videos, audiovisuals, and images (Cahyadi, 2019). Suitable teaching materials are ideal teaching components and can adjust to students' character in achieving competence effectively (Eliyanti et al., 2020). From the description above, it can be concluded that teaching material is a set of teaching materials that will be presented to students in a structured, systematic manner referring to learning principles and objectives.

2.2 E-Module

E-Modules are components containing material, principles and methods of assessment that are arranged coherently to achieve the skills to be acquired (Ramadayanty et al., 2021). E-Modules can be used by educators for independent teaching materials for students. E-modules are expected to help increase student knowledge and foster a spirit of independence in learning (Suci Agustia et al., 2020). E-modules can contain audio, video, animation, and images, making teaching materials more interactive and making students attractive to learn (Aryawan et al., 2018). It can be concluded that the electronic module is an open document that contains documents arranged in an orderly, orderly, and systematic manner to increase student knowledge.

2.3 Problem-based Learning (PBL) Model

Problem-based learning is a learning model that is focused not only on solving problems but also on increasing students' knowledge (Panggabean & Sembiring, 2022). PBL is teaching that puts environmental problems at the centre of learning (Kusmiati et al., 2019). This PBL model begins with presenting the problem, and then the teacher as an instructor explains the solution to the problem obtained (Suliyati et al., 2018). The PBL model is expected to make students more interested in increasing their knowledge, improving higher-order thinking skills and fostering their confidence (Harapit, 2018). From the previous review, it can be concluded

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that PBL is a learning model that is not solely focused on solving problems but also on improving students' knowledge and skills.

2.4 Learning outcomes

Learning outcomes are the results and achievements that students achieve or create after participating in learning activities (Rahman, 2021). Learning outcomes can be understood as changes that occur in each student after the learning process (Handayani & Subakti, 2020). Learning outcomes can be influenced by how actively students participate in learning activities, whether actively asking questions, answering, and taking tests or exams seriously. (Somayana, 2020). From the above observations, it can be obtained that learning outcomes are the results obtained by students after completing learning activities, which can affect the seriousness of students' learning activities.

3. Metode Penelitian

The prototype development model is the research method used to develop educational materials in this study. With this prototype model, a prototype will be obtained as a link between developers and customers so that they can discuss the process of developing the right product (Purnomo, 2017). According to (Kondaveeti et al., 2021) *The prototype model is a model that is made systematically, consisting of several stages, as shown in Figure 1.*

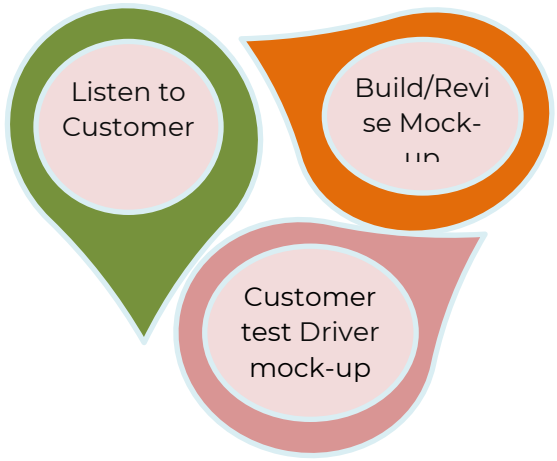

Figure. 1. Stages of Prototype Model Development

The first stage is to listen to customers. This stage aims to obtain information related to primary and secondary data. Secondary data is obtained through observations of schools by interviewing physics teachers and providing needs questionnaires to students. Secondary data is obtained through a literature review. The second stage is to build/revise the mock-up (design), starting from designing storyboards and then designing e-modules using Canva and Heyzine Flipbooks to make e-modules more interactive. The next stage is the customer test driver mock-up (evaluation), which evaluates the e-module design prototype that has been made. Furthermore, it will be evaluated by several parties, namely the customer. Testing using black box testing techniques if it is not appropriate, the developer will repeat from the first stage.

This research involved students and SMA Pertiwi 1 Padang physics teachers to collect information about the e-modules to be developed. Data collection methods are interviews and

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observations by distributing questionnaires to students. The data analysis technique is descriptive data analysis technique. The following is a flowchart display of the E-module Display Flow.

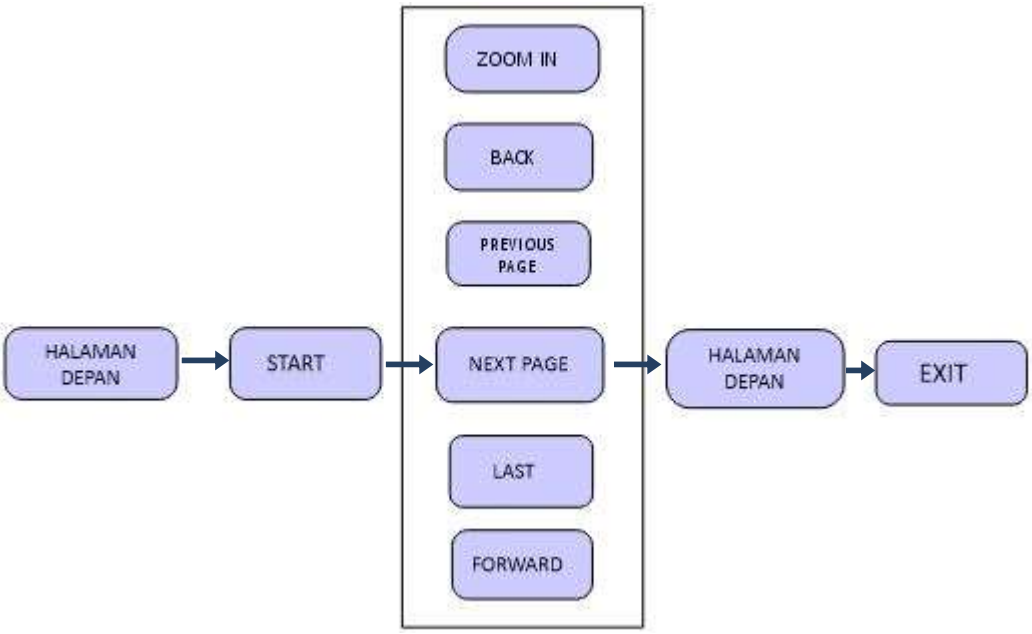

Figure. 2. Flowchart of E-module Display Flow

In Figure 2 flowchart of the e-module display flow which consists of several navigation buttons, namely the start button. The next page button functions to the next page and back to return to the previous page. The last button is to the last page, and the forward button is to return to the first page.

4. Results and Discussion

This research includes several stages, starting from needs analysis, including the design of educational materials to be developed with the help of the Canva application, testing of e-modules that have been designed, and implementation and evaluation of teaching material designs.

4.1 *Listen to Customer*

This stage aims to obtain data, both primary and secondary data. Preliminary data was obtained by observation of the school. The school observed was SMA Pertiwi 1 Padang. After interviewing teachers and giving questionnaires to students of SMA Pertiwi 1 Padang, it was found that the teaching materials used did not motivate students to learn. The learning approach used is also inappropriate. Learning activities have not been implemented in a student centre. As a result, students are not active in the learning process, so student test results have not met the KKM. After distributing questionnaires, students are interested in learning with e-modules with rotational dynamics material, so it is necessary to develop electronic teaching materials like physics e-modules with problem-based learning models to improve student learning outcomes.

4.2 Build/Revise Mock-up

The creation of teaching materials begins with creating a storyboard, then proceeds with the design of all components of the e-module with the Canva and Heyzine flipbooks applications. Here's how it looks in Figure 3.

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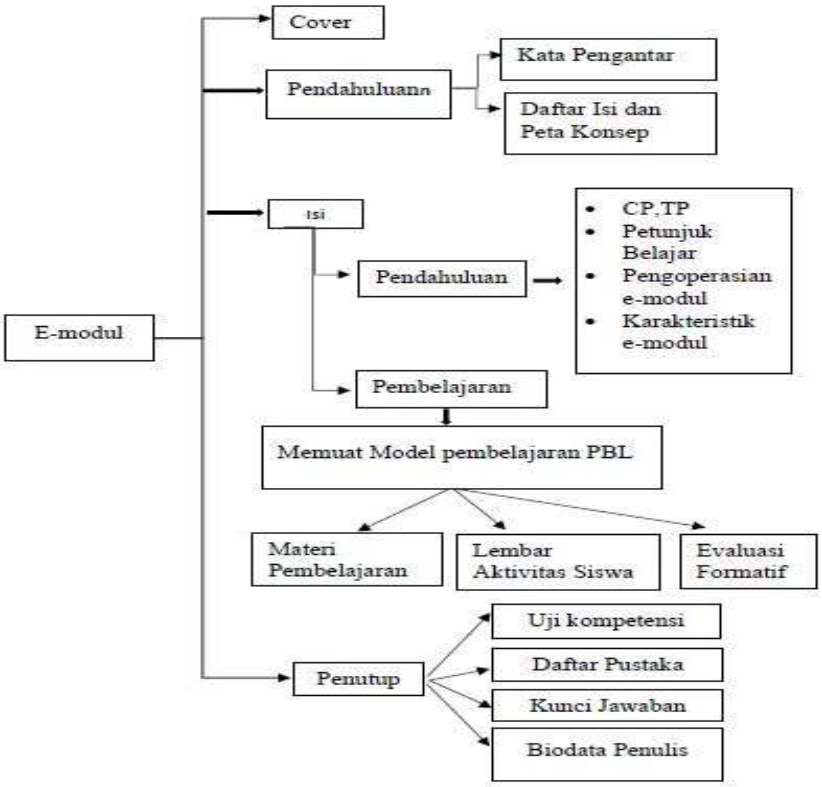
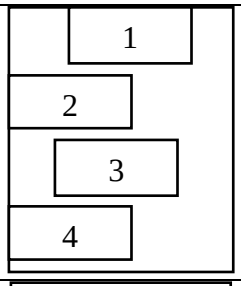
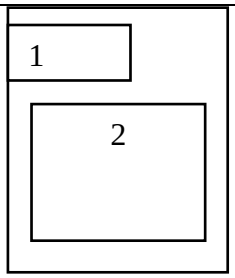


Figure. 3. Specifications of the E-module to be designed

4.2.1 *Storyboard Creation*

Before making e-modules, make a Storyboard to make it easier and minimize errors in the placement of components when making e-modules. A storyboard is a reference for placing components in e-modules of problem-based learning models. The storyboard design can be seen in Table 1.

Table. 1. *Storyboard* e-module

StoryBoard	Description
	Cover page 1. Logo to be included 2. Short description 3. Title of the e-module 4. Name of the author
	Introduction page 1. Title 2. Contents 3. E-module page number

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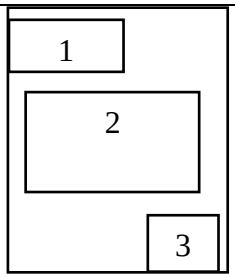
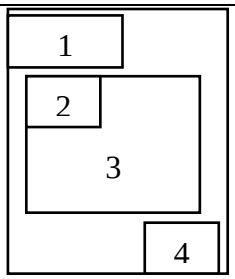
	Introduction (contents), learning activities, and Bibliography 1. Sub-title 2. Contents 3. e-module Page Number
	Author Identity 1. Title 2. Author's Photo 3. Description of Author's identity 4. Page number

Making this storyboard is expected to facilitate the design of physics e-modules and avoid errors in the placement of each component. Then, proceed with the design of e-modules with predetermined software, namely Canva and Heyzine Flipbooks.

4.2.2 Creating an e-module Design Using the Canva Application

After the storyboard has been designed, the e-module will be designed using the Canva application. The Canva application is very suitable for creating teaching material because many good design templates are available and easy to use.

4.2.2.1 *Cover Page Creation Process*

The process of making the cover was created using the Canva application. First, the colour of the cover slide was selected, and then the title compound, the author's name, the logo of the institution, and images related to the title were added. The display can be seen in Figures 1a and 1b.

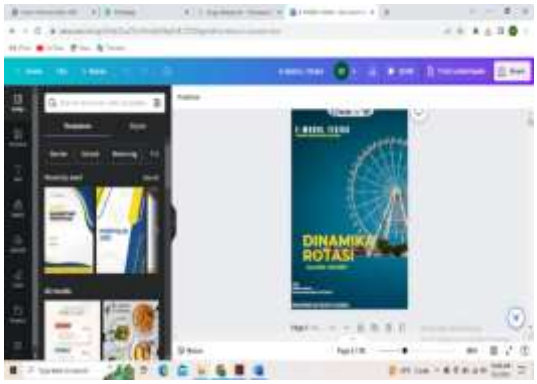


Figure. 1a. Cover making process

Figure. 1b. Completed cover

Figure 1a is the process of making a cover with Canva; the design is adjusted to the material of rotational dynamics. The selection of the Ferris wheel image on the cover is due to its working principle following the concept of rotational dynamics, which rotates around its axis. Figure 1b is the cover page that has been designed according to the storyboard.

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4.2.2.2 Selecting Colors from Pages and Creating a Preliminary Design

The page colour used is a combination of blue and yellow. After selecting the page colour, write the e-module introduction design consisting of a preface, table of contents, and a concept map. The appearance can be seen in Figure 2.

Figure 2a. E-Module Page Color Design

Figure 2b. E-Module Foreword Design

Figure 2c. Design of E-Module Table of Contents

Figure 2d. E-Module Concept Map Design

Figure 2 is the introduction section. Before starting the introduction design, the template colour selection is carried out, as shown in Figure 2a. Figure 2b is the design of the e-module preface. Figure 2c is the table of contents of the e-module. Figure 2d is an e-module concept map.

4.2.2.3 Pembuatan Bagian Pendahuluan Isi

The introduction consists of e-module identity, instructions for using the module and e-module characteristics. The e-module identity has the title of the material, lesson hours, and study prayers; there are instructions for using the module, as well as the characteristics of the e-module, which is based on the problem-based learning model, can be seen in Figure 3.

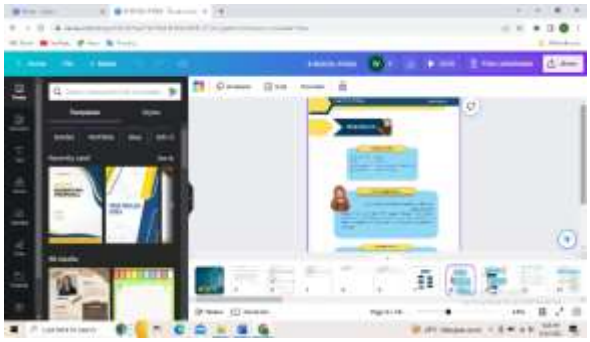

Figure 3a. E-module Identity Design

Figure. 3b. Learning Outcomes Design

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Figure. 3c. E-module Operation Design

Figure. 3d. E-module Characteristic Design

4.2.2.4 Design and Creation of Rotational Dynamics Materials

After selecting the paper theme, then, include rotational dynamics material for two hours of learning, for learning 1, namely the material of moments of force, moments of inertia and the relationship between moments of force and moments of inertia, accompanied by student activity sheets. Learning activity 2 consists of rotational kinetic energy, rolling objects and angular momentum and is accompanied by a student activity sheet. The display can be seen in Figure 4.

Figure. 4a. Material Design of the Organizing Towards the Problem Syntax

Figure. 4b. Material Design for Organizing Students to Learn Syntax

Figure 4c. Material Design for the Syntax of Guiding Individual Group Investigations

Figure 4d. Material Design of Syntax for Developing Work

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Figure. 4e. Material Summary Design Learning Activity

Figure. 4f. Exercise Design and Creation Learning Activity Questions

Based on Figure 4, the material included in the e-module is rotational dynamics material, which consists of two learning activities: the first learning activity is related to the Moment of Force & Moment of Inertia, and the second learning activity is related to rotational kinetic energy and circumferential motion. Figure 4a is a design of material organizing students towards the problem, where, in making this design, a video related to the material is added. Figure 4b material design organizing students to learn, at this stage is the design and creation of materials related to torque, moment of inertia, and the relationship between torque and moment of inertia. Figure 4c Syntax material design guiding individual and group investigations. Figure 4d syntax material design developing and presenting work at this stage, namely making data tables and question questions. Figure 4e is a design of the material summary of learning activities, at this stage, namely, making a summary during learning activities. Figure 4f: Design and create practice questions for learning activities and evaluation questions that are included in accordance with the material and lesson objectives.

4.2.2.5 Design and Manufacture of E-module Cover Section

The closing section consists of a formative test comprised of questions following the learning objectives, answer keys to the productive questions, a glossary or keywords contained in the e-module, and a bibliography along with the identity of the e-module author. The display can be seen in Figure 5.

Figure. 5a. Design and Creation of Evaluation Questions

Figure. 5b. Design and Creation of Answer Keys for Evaluation Questions

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Figure 5c. Glossary Design and Creation

Figure 5d. Design and Bibliography

Figure 5e. Author Identity Design and Creation

Figure 5 is the design and creation of the e-module cover. In Figure 5a, the design and creation of evaluation questions are shown. Figure 5b Design and manufacture of answer keys to evaluation questions. Figure 5c: Design and creation of a glossary. Figure 5d the creation of a bibliography taken from class XI physics books. Figure 5e is the creation of the e-module author biodata.

4.2.2.6 Creating E-modules Using Heyzine Flipbooks Software

After the module has been designed with the Canva application, the e-module is inputted into the Heyzine Flipbooks software. The e-module display is made more interactive so that students are more interested in learning. The module is made more interactive using Hyyzine Flibooks software. This can be seen in Figure 6.

Figure. 6a. E-modules Imported into Heyzine Flipbook

Figure. 6b. Addition of learning videos

Figure. 6c. Theme or Background for E-Module Display

Figure. 6d. Display of E-Modules that Have Been Made into Flipbooks

Figure 6 is making the e-module display more interactive using Heyzine Flipbooks. Figure 6a shows all e-module components entered into the Heyzine Flipbooks application. Figure 6b e-modules that have been imported are added to the video—figure 6c selection of themes or backgrounds for a more attractive e-module display. Figure 6d After completion, the e-module is saved and shared with students by copying the link.

4.3 *Customer Test Driver Mock-up*

P e-module testing uses black box testing techniques and electronic module testing techniques developed to determine whether all navigation buttons can operate normally.
Table 2. Black Box Testing Results.

Page	Brief description	View	Conclusion
Cover page	The cover page is successfully displayed, and you can switch to the next page.		*Success*
Introduction page	The introduction can be displayed, and you can navigate to the previous and next pages.		*Success*
Contents introduction page	The cover page is successfully displayed, and you can switch to the next page.		*Success*
Content page	The cover page is successfully displayed, the video can be played correctly, and you can switch to the next page.		*Success*
Page Student activity sheet	The cover page is displayed successfully, it can navigate to the next page, and the phetcoloredo link can be opened correctly.		*Success*

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Barcode link page student activity sheet	The page is successfully displayed, and the student activity sheet barcode link can be opened correctly.		*Success*
Practice question page	The page is successfully displayed, and the barcode link can be opened correctly.		*Success*
Summary Page	The page is successfully displayed, and you can switch to the next page		*Success*
Question evaluation page	The page is successfully displayed, and the barcode link for collecting answers to evaluation questions can be opened properly.		*Success*
Cover Page	The page is successfully displayed, and you can switch to the next page		*Success*
Author identity page	The page is successfully displayed and can move to the next page.		*Success*

5. Conclusion

The research results obtained are the design of physics e-modules as problem-based learning to improve student learning outcomes. The resulting e-module can be used well and support the learning process in achieving the predetermined learning objectives. The operation is also easy because it has instructions for using e-modules. Making e-modules using Canva and Heyzyn Flipbooks software is relatively more effective in making learning tools, especially making electronic teaching materials. After this design is finalized, the validation test will be carried out. After the e-module is valid, then the practicality will be carried out to find out whether the e-module is practical or not to improve student learning outcomes.

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