

# Development of Problem Based e-Module to Train Higher Order Thinking Skills on Temperature and Heat Material

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**Abstract.** The development of science and technology has become very sophisticated, where science and technology has had a significant impact on various areas of life, especially education. In this modern era, teachers must be able to take advantage of developments in technology and information in learning, for example using it as a learning medium to convey learning material to students. In fact, in schools the use of learning media to attract students' attention has not been implemented effectively and efficiently. So this research aims to develop a valid, practical and effective problem-based e-Module on temperature and heat material to train students higher order thinking skills. This research uses the Design and Development Research type of research which consists of four research stages, namely analysis, design, development, and evaluation using assessments of validity tests, practicality tests consisting of readability tests, student response tests, and perception tests. teachers, the effectiveness test consists of a normality test, N-Gain, and Paired Sample T-Test. In the validity test results, an average score of 3.50 was obtained in the very valid category. The results of the practicality test in the readability test obtained an average score of 82.64, which was categorized as very readable, in the student response test, an average score of 82.7 was obtained, which was categorized as very good, and in the teacher perception test, an average score of 83,3 was obtained which is categorized as very good. Meanwhile, for the effectiveness test based on the results of the students' N-Gain pretest-posttest, an average score of 0.45 was obtained in the medium category.

*Keywords: e-Module, Higher Order Thinking Skills, Problem Based Learning.*

## 1. Introduction

The development of science and technology has had a huge impact on human life. One area that takes advantage of the impact of technological and information developments is the education sector. In this modern era, teachers must be able to take advantage of developments in technology and information in learning, for example using it as a learning medium to convey learning material to students. Technological developments provide rapid changes in the process of learning activities [1]. Various platforms can be used to carry out learning so they need to be supported by good learning facilities and the use of information technology.

21st century learning is learning that changes the learning approach in schools in accordance with the developed curriculum. The ability to be creative, think critically, communicate and collaborate are skills for students in the 21st century. This shows that learning must provide training not only for students' basic abilities in a subject, but also their higher order thinking skills. Higher order thinking skills (HOTS) are an important aspect of education. Students with higher order thinking abilities are more likely to be successful in learning [2]. Higher order thinking ability is an ability that students need to develop, especially in physics learning because physics learning contains problems that require solutions to be solved based on the experience they have and the knowledge gained through a problem. Students who have high-level thinking skills will be able to analyze complex conditions and can initiate good ideas and arguments.

Based on the results of observations from a needs analysis questionnaire related to learning on temperature and heat material, the teacher and student questionnaires were filled in by teachers and students from SMA Muhammadiyah 2 Bandar Lampung and SMAN 1 Abung Pekurun. The results of distributing teacher questionnaires show that the majority of teachers still use printed books in face-to-face and online learning, and most teachers during the learning process have not trained high-level thinking skills, and from the results of distributing student questionnaires, the majority of students stated that they had difficulty understanding the material temperature and heat. Media as a tool in learning can convey the teacher's message or information to students so that it can encourage learning motivation and the effectiveness of the learning process [3]. Learning media is a technology that can convey messages and be used for learning purposes [4]. The function of learning media is as a tool to assist teachers in learning which also influences the conditions and learning environment organized and created by the teacher. Learning media cannot be used without the help of other learning media. The use or combination of various media is known as multimedia. Multimedia is a means or media that combines text, images, audio, video and animation. A multimedia program is a combination of text, audio, video and animated graphics in a way that is easy to use [5]. Multimedia in education can be defined as a learning experience that involves more than one medium for delivering, organizing and presenting learning activities [6]. The use of multimedia-based educational programs is widely used in the field of learning and training because it stimulates new ways of conveying information with attention to accessibility and to meeting the needs of students [7]. Therefore, one way that needs to be done to overcome the learning difficulties experienced by students is to develop multimedia teaching materials, one example of multimedia teaching materials is e-Modules.

E-Modules are a form of presenting learning material that is systematically arranged into the smallest learning units, which are presented in electronic format where there are animations, videos, audio, and are easy to navigate [8]. e-Module is the presentation of teaching materials electronically and can be used independently, designed completely and systematically in a particular learning unit and presented in electronic format [9]. Learning resources in the form of e-Modules are needed to support learning effectiveness, material delivery and learning facilities. e-Modules are designed according to the curriculum and are made in the form of non-printed teaching materials using electronic devices such as computers or Android [10]. e-Module is a learning media that only contains one learning material [11]. Interactive learning media is one of the valuable learning media as an intermediary and teachers use it to obtain information with encouragement to start communicating with each other in the learning process [12]. can be heard accompanied by feedback so that it can generate a spirit of independence and minimize differences in understanding [13]. One learning application that can be used in e-Module development is the Flip PDF Corporate Edition application. Flip PDF Corporate Edition is software that can be used to open the pages of an e-Module like a book, where using Flip Pdf Corporate Edition students will be more interested in learning because the appearance of Flip PDF Corporate Edition is attractive [14]. Flip Pdf Corporate Edition is an accessible PDF development application that contains text, audio, video, images, and so on [15]. The Flip Pdf Corporate Edition application can be used to create an e-Module that can be inserted with text, images and videos so that innovations in the program can be applied, so that students will be more interested in studying temperature and heat material using the e-Module.

Based on the preliminary study that has been carried out, it is known that teachers and students need learning media that can be accessed via laptops or smartphones to facilitate the learning process. Therefore, development research was carried out entitled "Development of Problem Based e-Module to Train Higher Order Thinking Skills on Temperature and Heat Material"

## **2. Method**

This research is development research using the Design and Developments Research (DDR) approach adapted from [16] to create a product in the form of a problem-based e-Module to train higher order thinking skills on temperature and heat material. The development stages consist of 4 stages, namely analysis, design, development and evaluation. Meanwhile, the learning model syntax used is a problem-based learning model adapted from Arends.

The instruments used in this research were semi-structural interview instruments and questionnaires. Interviews were conducted to obtain accurate information about the learning process at school. Meanwhile, the questionnaires used consisted of needs analysis questionnaires, validity test questionnaires, readability test questionnaires, teacher perception test questionnaires and student response test questionnaires. The data collection technique used is data from validity tests carried out by 3 validators consisting of 1 physics education lecturer at the University of Lampung, and 2 physics teachers. Meanwhile, the practicality test is taken from 3 aspects, namely readability test, teacher perception test and student response test. Readability and student response tests were carried out by 25 class XI students at SMA Muhammadiyah 2 Bandar Lampung and teacher perception tests were carried out by 3 physics teachers in Bandar Lampung. The effectiveness test is taken from student learning outcomes through pretest and posttest scores.

### 2.1. *Validity Test*

This questionnaire aims to determine the level of validity of the problem-based e-Module so that it can provide information whether the e-Module is valid or not to be used as a teacher companion in learning activities. The scoring system tested was based on a Likert scale adapted from Ratumanan & Laurent (2011) [17]. The Likert scale is presented in table 1 below.

**Table 1.** Likert Scale Validity Test

Assessment Result Score Interval	Criteria
3,25 < score < 4,00	Very Valid
2,50 < score < 3,25	Valid
1,75 < score < 2,50	Less Valid
1,00 < score < 1,75	Invalid

### 2.2. *Practicality Test*

The practicality test consists of 3 questionnaires, namely a student readability questionnaire for problem-based e-Modules, a teacher perception questionnaire, and a student response questionnaire. The readability questionnaire is used to determine the level of ease with which students understand the contents of the e-Module. The teacher perception questionnaire is used to determine the level of implementation of the product to be implemented in learning. Filling out this questionnaire also aims to determine the level of product implementation so that teachers can later use it as a learning medium. Student response questionnaires are used to determine student responses after working on problem-based e-Modules. The scoring system uses a Likert scale adapted by Ratumanan & Laurent (2011) into 4 options which are presented in Table 6 below.

**Table 2.** Practicality test Likert scale.

Percentage	Criteria
0.00%-20%	Practicality is very low/not good
20.1%-40%	Low/poor practicality
40.1%-60%	Medium/fairly good practicality
60.1%-80%	High/good practicality
80.1%-100%	Very high/excellent practicality

The product being developed is said to be valid and practical if it has a score interval of assessment results that is in the range of  $2.50 < \text{score} < 3.25$  and practically is in the percentage of 40.1%-60%.

### 2.3. *Student Learning Outcomes*

The pretest and posttest question sheet instruments are used to measure the cognitive abilities of individual students, so that the e-Module developed can train students' higher order thinking skills.

### 3. Result and Discussion

Teaching materials have an important role in the physics learning process so that learning can be conveyed optimally. Teachers must be able to facilitate students as much as possible so that they can achieve the expected learning goals. The following is a picture of the teaching materials developed in Figure 1.

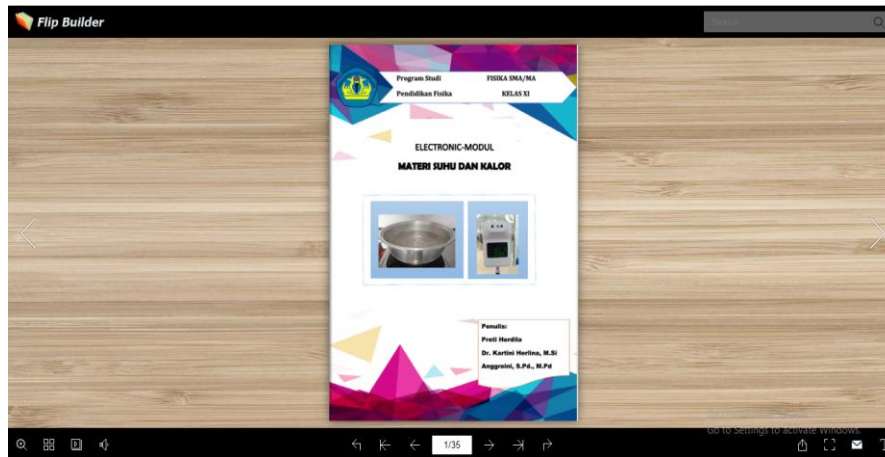


Figure 1. E-Module cover display.

Before the teaching materials/e-Modules are used, it is necessary to validate them first with 3 experts, where the experts consist of one physics education lecturer and 2 high school physics teachers, who are seen based on 2 aspects, namely media and design and material and construct. The results of the validity test from the three experts can be seen in table 3.

Table 3. Validation test results.

Aspect		Validator			Average Score	Category
		Expert 1	Expert 2	Expert 3		
Media and Design Validation	Media and Design Suitability	3.73	3.47	3.21	3.47	Very Valid
Material and Construct Validation	Suitability of Material and Construction	3.87	3.5	3.25	3.54	Very Valid
Total		3.8	3.48	3.23		Very Valid
Overall Average					3.50	Very Valid

Based on the results of the validity test questionnaire, it is known that media and design validation is categorized as very valid with an average score of all validators of 3.47, material and construct validation is categorized as very valid with an average score of all validators of 3.54, and the average a total of 3,50 which is categorized as very valid. The e-Module developed is suitable and can be implemented in learning and to train higher order thinking skills with several improvements. Next are the practicality test results which can be seen in the table below.

Table 4. Practicality test results.

No	Practicality Test Aspects	Percentage	Category
1.	Readability Test	82,64%	Very good
2.	Student Response Test	82,7%	Very good
3.	Teacher Perceptions	83,3%	Very good
	Percentage Mean	82,8%	Very good

Next, a practicality test was carried out on 25 students to determine the readability of the e-Module. The practicality test was carried out using a readability questionnaire, student responses and teacher perceptions consisting of 14 statements. The results of the practicality test show an average score of 82.88%, which means that the problem-based e-Module developed is very practical and can be used as teaching material on temperature and heat. The readability test score results are in accordance with the quote which reveals that teaching materials that are comfortable to use in teaching and learning activities must have a high readability score [18].

The product developed is considered very practical because this e-Module can help students understand the material which is equipped with pictures and videos so that it helps students understand the material. e-Modules are presented with clear grammar and then equipped with pictures, phenomena, and can make it easier for students to understand e-modules in learning activities.

The results of the effectiveness test of the problem-based e-Module assisted by Flip Pdf Corporate Edition in terms of students' higher order thinking skills. The effectiveness test was carried out on 25 class XI students of SMA Muhammadiyah 2 Bandar Lampung. Students are asked to work on the questions that are distributed. Data on students' higher order thinking skills was obtained through pretest and posttest tests. The data analysis technique for student learning outcomes uses the Paired Sample T-Test. Based on the research results, the N-gain value was 0.45 in the medium category. The results of the paired sample T-Test analysis show a significance value of  $0.000 < 0.05$ , which is in accordance with the test criteria, if the significance is smaller than 0.05, this means that  $H_1$  is accepted. This means that there is a real effect after implementing learning using problem-based e-modules. Thus, most students have higher order thinking skills.

The results of the effectiveness test for training higher order thinking skills on temperature and heat material can be seen through the results of the students' n-gain pretest and posttest. Where researchers apply problem-based learning in learning. Learning is carried out directly by researchers to determine the increase in students' higher order thinking skills as measured through pretest and posttest scores. The average initial ability of students before being given treatment was 48.3, while after being given treatment using the developed e-Module it was 72.5, where the research results showed that problem-based e-Modules were effective in improving higher order thinking skills. Interactive modules that are effectively used in classroom learning are modules that can improve students' problem solving or clarify concepts in the material [19]. In physics learning, teachers must try to minimize students' difficulties in learning by creating interesting learning situations for students [20].

The evaluation stage consists of formative evaluation and summative evaluation. Formative evaluation is carried out at each research stage, namely by improving the e-Module based on suggestions and input from validators during product validation. Summative evaluation was carried out after observing the responses of students who had worked on the e-module, showing that the problem-based e-module assisted by Flip Pdf Corporate Edition helped students understand temperature and heat material because it was easy to access, interesting and comfortable to use in learning. This e-Module also makes students' higher order thinking skills better after using it. So summative evaluations are no longer carried out because the results obtained are already very good.

Developed products definitely have advantages and disadvantages. The advantage of this problem-based e-Module assisted by Flip Pdf Corporate Edition is that it utilizes information technology which can be accessed anywhere and at any time. The e-Module is assisted by Flip Pdf Corporate Edition which can be accessed easily using the internet without having to download an application and can be used in online and face-to-face learning. The e-Module developed is able to train students' higher order thinking skills in terms of achievement of analyzing, evaluating and creating indicators. Apart from the advantages of the e-Module which have been described above, this e-Module also has disadvantages, namely that the platform used to create the e-Module does not yet have facilities for directly answering questions contained in the e-Module.

#### **4. Conclusion**

Based on the results of the explanation above, it can be concluded that the development of a problem-based e-Module to train higher order thinking skills on temperature and heat material is valid, practical

and effective to use. This is in accordance with the results of the validity test carried out by 3 experts, the results of the practicality test carried out by 25 students and 3 teachers and the results of the e-module trial through student learning outcomes. Through problem-based e-Modules to train high-level thinking skills, students are expected to be able to apply high-level thinking skills and the results of this development research are expected to be one of the bases for knowing the level of students' high-level thinking skills and then the school can facilitate teachers to develop e-Modules of higher order thinking skills on material and other lessons.

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