The development of e-modules using Kodular software with problem-based learning models in momentum and impulse material

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Abstract. This research aims to the development of an e-module using Kodular software with a Problem-based Learning model on the momentum and impulse material. This study used the Research and Development method which is a research method used to produce a certain product and test the effectiveness of the product. The development procedure used a 4-D model. The 4-D model consists of 4 main stages, namely: Define, Design, Develop, and Disseminate. The data collection instrument used was a questionnaire given to the material expert and media expert to test the quality of e-module learning media using Kodular software with the Problem-based Learning model on momentum and impulse material. The final product produced has met the eligibility criteria with an average score of the assessment of material expert, 86.8%, media expert 84.8%, and education practitioner/teacher 87.2% in the highest feasible, category percentage for small group trial 86.8% and field trial 86.5%. The result of this research was an e-module with a Problem-Based Learning model that has been developed using Kodular software that accessible via smartphone.

Keywords: e-modules, kodular software, problem-based learning model

1. Introduction
In the 21st century, science and technology (IPTEK) are growing very rapidly. The development of science and technology can change the mindset of society in seeking and obtaining information [1]. The development of science and technology influences the education field [2]. The use of science and technology in education will make teachers easier to deliver the material and students to understand the subject [3]. According to national policy, a curriculum design should match current and future needs [4]. The 21st-century learning paradigm suggests that a teacher must use digital technology, means of communication, and/ or appropriate networks to access, manage, integrate, evaluate and create information to function in the learning process. One of the contents of the standard of the primary and secondary education process is the use of information and communication technology to increase the efficiency and effectiveness of learning [5].

With the development of technology, everything that people want can be fulfilled easily as in the field of education [6]. The development of science and technology causes significant changes in the existence of learning models and patterns. The development of science and technology introduces paperless and mobile learning models and patterns such as e-learning, video conferencing, electronic books, and so on. This situation encourages someone to have gadgets such as computers, laptops,
smartphones, and others [7]. Computers, laptops, smartphones, and others as learning media have the aim to make learning easier for students [8].

Another factor that influences the success of students in learning is the existence of attractive learning models that exist within the scope of education so that students will be easier to understand the material presented by the teacher and create active students so that the learning objectives are achieved. Problem-Based Learning is a teaching approach that uses real-world problems as a context for students to learn about critical thinking and problem-solving skills, as well as to acquire essential knowledge and concepts from the subject [9,10]. The Problem-based Learning Model is expected to provide opportunities for students to be able to improve their scientific work skills [11]. The Efforts to implement learning through the Problem-based Learning model require teaching materials that are following the demands of the curriculum by paying attention to the students’ needs. One of the forms of teaching material is module [3].

Nowadays, most modules are made in print. Print modules tend to be monotonous and affect students' interest and enthusiasm for using them. One of the ways to make the module more attractive to students is to create a module in electronic form that can be used as an interactive medium because other media such as images, animation, audio, and video can be inserted. Also, in line with the rapid development of technology today, almost all students, especially high school students, are familiar with computers or other electronic media [12–14]. The implementation of the 2013 curriculum requires teachers to increase student activity in the learning process. The 2013 curriculum emphasizes student activities, so the development of the e-module is one of the supporters of the implementation of the 2013 curriculum [15]. The e-modules can be combined with innovative learning models that are thought to enhance learning [16].

This e-module can be inserted into a multimedia technology so that it can be a better learning source than the printed one. According to Cecep Kustandi, multimedia is a tool that combines two or more media elements, including text, images, graphics, photos, sound, film, and animation in an integrated manner. Multimedia provides benefits for educators and students including the learning process can be more interesting and interactive, more time saving, improving the quality of teaching and learning process, and also can be done anywhere and anytime [5,17]. This e-module that can be accessed on mobile is very beneficial for students. When students need the learning module they want, they can find the learning sources easily. With the e-module, readers do not need to carry books wherever they want to go. It is also more economical because they can access modules or knowledge for free [6,18,19].

After conducting observation activities at Senior High School, Surakarta, data was obtained from teacher interviews and distributing questionnaires to students of class X, XI, and XII MIPA shows that learn by using e-modules has never been done before, even though the school had good and complete educational facilities. Teachers have used learning media during learning activities, but the media used are less varied. They still use the lecture method and sometimes only use PowerPoint slides during the learning activities. This is unfortunate because if we can use the technology well, it will improve the quality of education itself. Lack of learning media used in learning activities causes students to have difficulty when the material is delivered which can make them lack of understanding the material with contextual concepts and less active in the teaching and learning process. With the development of science and technology, it encourages progress in education. One of them is the innovation of attractive learning media so that students are more enthusiastic and active in the learning activities. E-modules can be used as an alternative learning media so that students do not get bored in the learning process. The e-module that will be created includes the material, practice questions, summaries, and online tests, the learning process can be done anywhere and anytime between the teacher and students.

The e-module needs analysis study that has been done by the researcher at 3 high schools in two provinces of Surakarta and Lampung, with preliminary observations and distribution of questionnaires to the teachers by using Google Form. Based on the findings in the field and the distribution of the questionnaire, it was explained that many physics teachers still use the lecture method and rarely use learning media because of the limited time. Teachers have not used teaching materials in the form of
modules and the materials used are purchased from the publisher. They stated that the existing teaching materials did not meet the needs of learning physics following the 2013 curriculum. In the initial analysis of the existing modules, it was concluded that the existing modules had not yet adopted the steps of Problem-based Learning, have not used interactive sentences predominantly, and have limited display or layout. Therefore, the e-learning module was developed to be used as supporting learning media with the assumption that it would improve the quality of the student learning process.

The considerations for choosing Kodular software as an e-module format are (1) a large number of supporting devices available; (2) user-friendly (3) the format is widely supported and has included audio, video, and image features in the creation of the e-module. The target of this research was the feasibility of using a physics e-modules by using Kodular on momentum and impulse material based on the validity and practicality of the physics e-module using Kodular software which was tested on high school students.

2. Research Methodology

This study used a research and development method (Research and Development) which is a research method used to produce certain products and test the effectiveness of these products [20]. The development procedure used a 4-D model. The 4-D model was developed by S. Thiagarajan. The 4-D model consists of 4 main stages, namely: Define, Design, Develop, and Disseminate [21].

![Image of 4-D model development research procedure]

The 4-D method and model were chosen because it aims to produce a product in the form of e-module using Kodular software with a problem-based learning model for class X SMA on momentum and impulse material [22]. The product development design is following the procedure at the stages described in Figure 2.

Data collection techniques in this study consisted of observation, interview, questionnaire, and documentation. The data collection technique through the questionnaire was done during the validation of media and material experts, and in the field trial, the questionnaire was filled in by students. The observation was used to determine the description of physics learning activities by using an e-module. The instruments used as data collection were module validation sheets for media and material experts, teacher, and student response questionnaires. This instrument must be validated by an expert. The instruments used for data collection were module validation sheets for media and material experts, teacher, and student response questionnaires. The instrument must be validated by an expert.

The e-module feasibility data analysis technique used a Likert scale. The score obtained is then converted into a four-point Likert scale. The feasibility of the results of the e-module development
from both the material and media aspects, from the data in the form of a score, is converted into qualitative data on a scale of four. The reference for changing the score to a scale of four is as follows.

| Table 1. Likert Scale Scoring Rules |
|-------------------------------------|
| Category   | Score |
| SB (Excellent) | 4     |
| B (Good)    | 3     |
| K (Poor)    | 2     |
| SK (Very Poor) | 1    |

Calculating the percentage of the feasibility of each aspect using the Likert Scale formula.

$$x_1 = \frac{\sum S}{S_{\text{max}}} \times 100 \%$$

Information:
- $S_{\text{max}}$ = maximum score
- $\sum S$ = Total score
- $x_1$ = Questionnaire eligibility value for each aspect

Calculating the average percentage of all respondents:

$$\bar{x} = \frac{\sum_{i=1}^{n} x_i}{n}$$

Information:
- $\bar{x}$ = Final average
- $x_i$ = Questionnaire eligibility value for each aspect
- $n$ = Number of statements

Changing the average score was obtained into a qualitative value following the assessment criteria in the table.

| Table 2. Feasibility Scale of Learning Media |
|---------------------------------------------|
| The Feasibility Score of Learning Media      |
| Criteria                                    |
| 0 - 20 %                                    | Highly Not Feasible |
| 20,01 % - 40 %                              | Not Feasible        |
| 40,01 % - 60 %                              | Fairly Feasible     |
| 60,01 % - 80 %                              | Feasible            |
| 80,01 % - 100 %                             | Highly Feasible     |

With the Likert scale table, the researcher can see the percentage of the assessment results of whether the product is feasible or not to be used as a learning media [23].

3. Results and Discussion

3.1 Results of the Define Stage
Research on the development of the 4-D model began with a defining stage. This stage aimed to analyze problems and needs in the field. The results of this defining stage were used as a basis for developing products to overcome problems encountered. This stage was done by distributing a media needs questionnaire to the students and also interviews with the teacher. The results of the define stage that have been done are as follows:
3.1.1 The results of the distribution of questionnaires and interviews with the teacher
The results of observations of questionnaires and interviews with teachers were done to obtain information related to problems and needs that exist in the school. The distribution of questionnaires and interview were done on 3 teachers from Senior High School, the conclusions obtained based on the results of the questionnaire and interview are as follows: (1) Lack of learning media used in learning activities causes students to have difficulty when the material is delivered which can make them lack of understanding the material with contextual concepts and less active in learning. (2) Learning using the e-module has never been done before though the school has good and complete educational facilities. Teachers have used learning media during learning activities but the media are less varied. (3) Teachers still use the lecture method and sometimes only use PowerPoint slides during learning activities.

3.1.2 The results of the student questionnaire analysis
This analysis was conducted to determine the problems that were obtained from the results of questionnaires to the students and interviews with teachers. The questionnaire was presented in closed form with "YES" and "NO" options. The respondents of the student questionnaire analysis were students of class X MIPA, XI MIPA, and XII MIPA, totaling 75 students. The conclusions from the student questionnaire analysis are as follows. The summary of the results of the needs analysis questionnaire is presented in Table 3.

| Student Answers |
|-----------------|
| 1. 75% of the students were given modules to study physics material. |
| 2. 78% of the students have difficulty in understanding the material through the teaching materials and the methods/models applied by the teacher. |
| 3. 87% of the students need alternative teaching materials that can be used to learn physics material concepts easier and more interesting |
| 4. 83% agree that it is necessary to develop teaching materials such as e-module using Kodular software with a problem-based learning model so that the concept of physics will be easy to understand |

3.2 Design Stage Results
One of the stages that aim to produce the product to be developed is the design or design stage. This design stage consists of three parts, namely selecting the product format, collecting reference materials, and making the initial design of the product called the e-module draft which will be consulted with the supervisor so that the first revised e-module product was created. The results of the design stage that have been done at each stage are as follows:

3.2.1 Format Selection
The format selection was made to determine the e-module format that will be developed. The e-module format was developed according to the needs at the planning stage. The e-module design used the module writing format proposed by the Ministry of National Education [24]. Following is the developed e-module format:
3.2.2 Collecting Reference Material
Collecting reference material was done to collect various information and references related to the e-module being developed. The developed e-module was the momentum and impulse e-module which consists of sub-materials, namely momentum and impulse, the law of conservation of momentum, and types of collisions, which will be determined indicators of competency achievement in these sub-materials.

3.3 Develop Stage Results
The development stage is the stage of making detailed product specifications based on the planning stage. The product design included a support system for product manufacture, product layout creation, and making components of the developed e-module learning product content. E-Module was made using a Windows 10 computer operating system laptop with supporting software for product manufacturing, namely Microsoft Word 2010, Corel Draw, and Kodular software.

3.3.1 E-Module Validation
After the product has been successfully developed, the next step was to conduct an e-module feasibility test utilizing product validation. Product validation was done after initial product creation. The validation was done by 3 experts, consisted of 2 material experts, 1 media experts, and 3 education practitioners teachers, and 3 peers (peer review). The results of validation by material experts on the e-module are presented in the table 5.

### Table 5. Results of the Material Expert Validation Assessment

| No | Aspect of Assessment                  | Percentage | Criteria       |
|----|---------------------------------------|------------|----------------|
| 1  | Content Feasibility                   | 85.4%      | Highly Feasible|
| 2  | Presentation Feasibility              | 87.5%      | Highly Feasible|
| 3  | Language Eligibility                  | 88.9%      | Highly Feasible|
| 4  | Contextual Assessment                 | 84.7%      | Highly Feasible|
| 5  | Assessment of the Problem-based Learning Model | 87.5% | Highly Feasible |
| Average |                                     | 86.8%      | Highly Feasible |

The feasibility percentage of the average material expert validators assessment is 86.8%. So that the assessment achieved by the material expert validator got a "highly feasible" average score. The results of validation by media experts on the e-module are presented in the table 6.
Table 6. Results of the Media Expert Validation Assessment

| No | Aspect of Assessment      | Percentage | Criteria       |
|----|---------------------------|------------|----------------|
| 1  | E-module Size             | 75 %       | Feasible       |
| 2  | E-Module Cover Design     | 88.9 %     | Highly Feasible|
| 3  | E-Module Content Design   | 90.8 %     | Highly Feasible|
|    | **Average**               | **84.8 %** | **Highly Feasible** |

The feasibility percentage of the average media expert validator assessment is 84.8%. So that the assessment achieved by the media expert validator got a “highly feasible” average score.

The results of the validation by education practitioners/teachers and peers (peer review) on the e-module are presented in the table 7.

Table 7. Evaluation Results of the education practitioners/teachers validation and peers (peer review)

| No | Aspect of Assessment     | Percentage | Criteria       |
|----|--------------------------|------------|----------------|
| 1  | Kelayakan Isi E-Modul   | 89.9 %     | Highly Feasible|
| 2  | Kegunaan E-Modul         | 89.1 %     | Highly Feasible|
| 3  | Kelayakan Bahasa E-Modul | 82.9 %     | Highly Feasible|
|    | **Average**              | **87.2 %** | **Highly Feasible** |

The feasibility percentage of the average practitioners/teachers' validation and peers (peer review) assessment is 87.2%. So that the assessment achieved by practitioners/teachers validation and peers (peer review) validators got a "highly feasible" average score.

3.3.2 Limited and Field Trial

After the e-module design was validated and revised based on expert and teacher suggestions, then it can be seen as the weaknesses of the e-module. These weaknesses were then corrected to produce better and more effective products and then tested on the students. For the e-module trials are done in small scale tests and field trials [25].

A small trial was done on 15 students of class X MIPA 1 SMA N 12 Bandar Lampung. In this trial, each respondent was given a questionnaire consisting of several question criteria. This trial aimed to determine the readability and students' response to the e-modules that have been developed. The results of the assessment are presented in the following figure 2:

![Figure 2. Small-Group Graph at SMA N 12 Bandar Lampung](image)

A field trial was done at SMAN 12 Bandar Lampung class X MIPA 3. In this trial, each respondent was given a questionnaire consisting of several question criteria. The results of this trial were used as
supporting data for assessing student responses in previous trials. The results of the assessment are presented in the following figure 3:

![Figure 3. Field Trial graph at SMA N 12 Bandar Lampung](image)

Based on the stages that have been done in this study, this e-module learning has very good quality and is suitable for use by students in the physics learning process. It is known that of the 3 aspects of assessment that are e-module interests, the e-module material, and the e-module language eligibility, the proportions are very feasible. In the small group trial, there were 85.6% e-module interest, 85.8% e-module material, and 88.8% e-module language eligibility with an average of 86.8%. Whereas in the Field Trial, e-module interest was 87%, e-module material was 87.3% and e-module language eligibility was 85.4% with an average of 86.5%. It is also supported by the student's Suggestions and comments that give a positive response to the developed e-modules. That these e-modules are a practical source of learning because students can learn whenever and wherever no longer riveted learning in the classroom. The e-modules can be accessed by students using smartphones so they can easily learn and practice problems. The following are some views of the e-module.

**Table 8. The Display of the E-Module with Problem-based Learning Model**

| No | Views/Looks | Information |
|----|-------------|-------------|
| 1  | ![Image](image) | The E-Module icon on the smartphone display |
| 2  | ![Image](image) | • The cover of the module consists of the following components:  
1) the title of the e-module, that is "Momentum and Impulse Physics E-Module Based on Problem-based Learning for Class X of SMA/MA".  
2) a picture of the pendulum about impulse and momentum.  
3) the author’s name.  
• The main menu page in the Physics E-Module application application |
consists of some menus, they are:
1) Introduction, 2) KI and KD, 3) Instructions for Use, 4) E-Module, 5) Exercises, 6) Biography.

The introduction page consists of an e-module title and author's name.

Pages of KI and KD (core competencies and basic competencies) consist of core competencies, basic competencies, indicators of competency achievement, and concept map from momentum and impulse material.
This page contains the instructions for using an e-module that make it easier for students to learn.

The e-learning activity page in this module is divided into 3 sub-materials, such as momentum and impulse, the law of conservation of momentum, and types of collisions. The components of this learning activity, such as knowledge Warehouse, physics notes, Activity 1. problem orientation, Activity 2. defining problems, Activities 3. conducting experiments, Activity 4. presenting data results, Activity 5. analyzing and evaluating, evaluating learning activities.

The last page consists of several components, namely: 1) summary, 2) the exercises in the form of multiple-choice and answer keys, 3) References
3.4 Dissemination Stage Results
This dissemination stage is the final stage of this study. The weaknesses of the e-module which has been revised according to the expert judgment, practitioner educator, limited and field trial, and the student responses after using e-modules. It can be concluded that the e-module using Kodular software with a problem-based learning model on momentum and impulse material has been developed into the final product.

4. Conclusion
Based on the study that has been done, it can be concluded that: the results of the validation of the material experts got an average percentage of 86.8%, and the validation of media experts got an average percentage of 84.8%. The average percentage from the education practitioners/teachers and peers (peer review) was 87.2%, the average percentage from small group trials was 86.8%, and the average percentage from the field trial was 86.5%, and were categorized as highly feasible. According to the conclusion above e-module developed by the researcher could be additional learning media on the learning process that simplifies the students to use in the classroom and it could be independent learning material at home. This e-module facilitates the teachers in teaching momentum and impulse material to the learner. So that the suggestion from the researcher is an e-module is on the momentum and impulse material only, so it is expected to the next researchers that they will develop others learning e-module. E-module can run into the development that is supposed to more improvement such as add pictures and videos that supporting better learning.

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