Developing E-Module for fluids based on problem-based learning (PBL) for senior high school students

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Abstract. Technology in Information and Communication is growing rapidly. It also brings a tremendous impact on education. The aim of this research was developing e-modul based on Problem Based Learning. This research develops android-assisted learning media (e-module) which focuses on fluids materials for grade XI senior high school students. The research method used is Research and Development (R & D) with the ADDIE models (Analysis, Design, Development, Implement, and Evaluation). The validation results from the physics material experts was 86.3% with excellent interpretation, validation by the expert of instructional media was 83.3% with very good interpretation, validation result from the learning expert was 84.8% with very good interpretation and result of legibility test was 83% with very good interpretation. This indicate that e-module for fluids materials can be used by students as a material which fun and adds the knowledge for students.

1. Introduction
Physics subjects are considered important to be taught separately at the senior high school level. In line with the development of science and technology, physics subjects are expected to provide knowledge and foster learners’ ability to think critically to solve problems in daily life [1]. The internal and external challenges become basic part in improving the quality of the curriculum. The development of Information and Communication Technology (ICT) is an example of external challenge [2]. There are three ICT roles in the learning process. First, ICT is the educational media. It uses as the connector in delivering learning materials during teaching and learning process in class. Second, ICT is the source of information. An, the last, ICT is a learning system that supports the continuity and fluency of the learning process [3].

One of the technological devices used widely in the era of globalization is an Android smartphone. The data shows that based on the use of the Android operating system until the end of March 2016 the users is reached 71% of the Indonesian citizen. And predicted in 2017 there is 74.9% android user. [4] Mills stated that online learning resources and ICT enable the learning process to achieve "complex skills" needed in the global era while enabling student-centered learning [5].

The computer-based learning material is an example of ICT as a source of information. One of the teaching materials that can make learning more interesting and interactive is e-module. The e-module is a learning package needed for the learning of a particular subject that allows students to learn independently equipped with video, audio, simulation, quizzes, etc. [6] The use of educational applications in smartphones will be beneficial for educators and students to build the knowledge and
skills needed for work and life in the 21st century. [7] It is an instructional package with an integrated theme that provides the information needed to develop certain knowledge and skills. And it serves as one component of the total course or curriculum [8].

The observation about the importance of learning module in 17 school in Jakarta, Depok, Tangerang, and Bekasi shown that the teachers still use power-point (ppt), video, and simulation in delivering the learning materials. It means that many teachers have not utilized the teaching materials maximally especially those utilizing electronic media. An example can be seen in fluids materials on KD 3.3 class XI. There is no e-module for this material. The development of interactive modules is expected to increase students’ learning interest. Based on analysis of teachers’ needs from 26 physic teachers in Jakarta, Tangerang, and Bengkulu has shown that 57% of teachers strongly support the development of e-module based on Problem-Based Learning (PBL) and 43% teachers agree that the use of e-module will help students applying the materials in their daily life.

Ministry of Education stated that one of the learning models emphasized in the curriculum of 2013 is the use of PBL model [9]. PBL learning is a learning model that 'problem-based' should be the first thing to appear during the learning process [10]. This learning model also challenges students' ability to discover new knowledge, provide opportunities for students to apply their knowledge in the real world, and allow students to master the learning concepts as the way to solve real-world problems [11]. PBL develops the basic and high order thinking skills. As a result of engaging in PBL, students should be able to understand multiple perspectives and select the best ones that can improve high-level thinking [12].

One of the physics learning materials is the fluid. It is a concept that is considered difficult to study because it is difficult to describe in life and not visible directly. Based on those reasons, fluid needs a contextual teaching material. The concept of fluid is still difficult to understand by students. It can be seen from the students' daily reinforcement values. It was dominated by students' low mark. Based on the students' needs analysis, 78% of students have difficulty with the fluid material. Therefore, this study aims to develop e-module of fluid materials based on problem-based learning for students’ class XI.

2. Research Method

The method in this research is research and development method. The model used is the ADDIE model. The ADDIE development model is a model of instructional design based on an effective and efficient system approach and interactive process ie the evaluation of each phase can bring learning development to the next phase. This model consists of 5 stages namely Analyze, Design, Develop, Implement, and Evaluate [13].

2.1 Analyze

The initial data collection was undertaken to identify problems and needs in Physics lessons, to find out what materials are appropriate in the developed media, and to know educators' opinions about e-module development. This stage consists of needs analysis in several senior high schools in Jakarta and Bengkulu and observation in 17 schools in Jakarta, Depok, Tangerang, and Bekasi. This stage also determines the standard of competence that should be achieved and determines the media to be used.

2.2 Design

The data from the analysis of needs and initial information is used as a reference in developing the e-module. At this stage, the software in e-modules will be determined. Then, designing the concept of e-modules and writing the product design in detail.

2.3 Develop

Developing the design of e-modules using unity. The components in this step include:

a. Text and images stored in unity by using png form
b. The cover is created using photoshop in png form
c. Animation using *unity* with .anim format

d. Questions using *unity* software

### 2.4 Implement

#### 2.4.1 Product Validation Test

After making the e-module, the product validation test is done to the media expert, the material expert, and the learning expert. The purpose of validation is to evaluate the product which is based on the stages of problem-based learning and to obtain input and improvement for the developed product. The average score validation from physic experts, media experts, and students were analyzed. The result will be interpreted into Likert-scale criteria in order to know the quality of e-module. The following formula will be used to know the percentage of success:

\[
P_s = \frac{n}{N} \times 100\%
\]

where:

- \(P_s\) = The percentage of success (%)  
- \(n\) = The total score  
- \(N\) = The maximum score

The data will be categorized based on the following table.

| Percentage     | Interpretation     |
|----------------|-------------------|
| 0% - 20%       | Very Poor         |
| 21% - 40%      | Poor              |
| 41% - 60%      | Enough            |
| 61% - 80%      | Good              |
| 81% - 100%     | Excellent         |

#### 2.4.2 Revision

The validated e-module will be revised based on experts inputs and suggestions.

#### 2.4.3 Small Group Tryout

The revised e-module will be tested to the students. The result of the tryout will give information about the students' acceptance toward the e-module. The small tryout will be done to 5 students based on a random system.

#### 2.4.4 Revisions

The deficiencies during small group tryout will be used as the basis in the next revision.

### 2.5 Evaluation

At this stage, the product is evaluated as a revision of students' the test results. The deficiency during the limited trial will produce a re-evaluation phase. The researcher will improve the developed e-module.

### 3. Results and Discussion

#### 3.1. Validation Test Results

The results obtained from the validation test show that the e-module based problem learning is very good and feasible to use, as shown by the results of the validation of experts as follows:
The validation result from the physics material experts is 86.3% with excellent interpretation on all measured aspects; materials content and language components.

**Table 3. The Validation Result of Media Experts**

| No. | Aspects                | Average Score | Description |
|-----|------------------------|---------------|-------------|
| 1.  | The Feasibility        | 87.5%         | Very Good   |
| 2.  | The language design    | 82.5%         | Very Good   |
| 3.  | Presentation           | 80%           | Good        |
|     | The Total of Average   | 83.3%         | Very Good   |

The result of validation by the expert of instructional media is 83.3% with very good interpretation on all measured aspect i.e. introduction of e-module, e-module component, e-module characteristics, the language, graphics, and presentation.

**Table 4. The Validation Result of Learning Experts**

| No. | Aspects                          | Average Score | Description |
|-----|----------------------------------|---------------|-------------|
| 1.  | The Feasibility                  | 83.3%         | Very Good   |
| 2.  | Problem-Based Learning           | 81.2%         | Very Good   |
| 3.  | Usage                            | 87.5%         | Very Good   |
| 4.  | Presentation                     | 87.5%         | Very Good   |
|     | The Total of Average             | 84.8%         | Very Good   |

The validation result from the learning expert is 84.8% with very good interpretation on the component of feasibility, presentation, and the language design.

### 3.2. Legibility Test

After being revised according to expert advice and input, the e-module was trialed to 15 students of Senior High School Number 2 North Bengkulu to find out the acceptance of the final product and to determine whether or not the e-module was feasible to be used. Here are the results of small group tryout:

**Table 5. The Results of Legibility Test**

| No. | Aspects                  | Average Score | Interpretation |
|-----|--------------------------|---------------|----------------|
| 1.  | Introduction             | 83.3%         | Very Good      |
| 2.  | Components               | 81.2%         | Very Good      |
| 3.  | Characteristics          | 83.3%         | Very Good      |
| 4.  | The Language Used        | 87.5%         | Very Good      |
| 5.  | Graphics                 | 80.0%         | Good           |
|     | The Total of Average     | 83.0%         | Very Good      |
3.3 The Layout of Problem-Based E-module

![Figure 1. The Cover of E-module](image1)

![Figure 2. Students’ orientation towards the problems](image2)

![Figure 3. The Organization of Learning Process](image3)

![Figure 4. Inquiry Form](image4)
4. Conclusion
Based on validation results from material experts, media experts, learning experts, and field test results by students, it can be concluded that the module developed namely e-module based on problem-based learning has met the criteria very good and deserve to be used as independent study materials.

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