Validity and Reliability of the Problem-Based High School Teaching Materials of Physics using Android

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Abstract. The very rapid development of information and communication technology has such a broad influence including education. Educators as the main actors in formal education are required to be able to utilize the development of information and communication technology to support the learning process undertaken. The learning model with classical media applied by the teacher so far has not broadly developed a high level of thinking. This classical model results in the ability of students to evaluate whose capability to develop is unsatisfactory. Starting from this consideration, this research was conducted with the aim of knowing the validity and reliability of problem-based high school teaching materials of physics using Android and of improving the ability of students to evaluate such teaching materials. This development research was carried out by adopting the ADDIE (Analysis, Design, Development, Implementation, and Evaluation) model. Data collection was done using validation sheets, observation sheets, questionnaires, and tests. The results showed that problem-based high school teaching materials of physics using Android were valid with a total average score of 3.44 and with the percentage agreement (PA) level of 89.52%. The teaching materials are also able to improve the ability of students in evaluating in the improvement category medium with an N-gain value of 0.359.

1. Introduction

Education has a very important role for human life because education is a human way to transmit various knowledge in order to develop one's potential. Education trains a person to be able to think critically, to process a variety of intelligences, to be disciplined, to have responsibility, to be active, to be creative, and to be innovative in various situations and conditions in the surrounding environment.

In the formal learning process, a teacher is the main character in running the education cycles. Through a series of learning activities, both theoretically and practically the teacher hopes that the learning objectives that have been planned are able to be achieved. To achieve these learning objectives, the teacher needs a learning strategy. Learning strategy is a pattern of learning activities that are chosen and used by teachers contextually, in accordance with the characteristics of students, condition of the school, surrounding environment, and the learning objectives specified [1].

In science learning, the learning carried out must prioritize the process, understanding, scientific attitudes, and skills. This is inseparable from the characteristics of science, which is itself a process, principle, and scientific attitude. To realize such learning is certainly not easy. Teachers are required to
innovate in selecting and using learning strategies so that the interaction between the learner and his environment can be maximized.

One of several learning models that can be applied to meet the characteristics of science is problem-based learning. Problem-based learning is a learning strategy involving real-world problems as a context for students to be able to train them to possess high-level thinking skills, critical thinking, and problem solving [2]. Through problem-based learning, students learn not only the concepts and principles, but also the process of science, and at the same time they solve the problem. In so doing the students’ ability to think creatively can be improved [3].

Problem-based learning would successfully be applied if it is supported by instructional media. Learning media can be created and designed in accordance with the development of information and communication technology (ICT) today. By providing learning with assisted ICT, learning becomes interesting and has a positive impact on academic performance in the form of students’ learning motivation and learning outcomes [4].

Unfortunately, the use of classical learning media still dominates the learning carried out by teachers both in the elementary and secondary levels. Teaching materials that present the concepts and principles of simple teaching with examples of questions and exercises are still an option. The problems raised are still dominated by simple theoretical problems at the level of memory. The application starts from the example of the problem and ends with a similar exercise. In classical learning media, problems that deal with women with high-level thinking are rarely found. This condition results the unsatisfactory students’ ability to make evaluations.

One of several ways that can be done to improve the students’ ability in evaluating is by developing teaching materials assisted by ICT that involves higher-order thinking skills. Teaching materials are materials or learning activities that are systematically arranged and that are used by students and teachers in the learning process. The development of teaching materials assisted with ICT can be done through smartphone devices with the Android operating system. The existing of Android system on smartphones can be alternative in learning because it is easy for teachers to master, understand, and use it. Meanwhile, students will also be more motivated and encouraged to study physics [5].

The use of Android-based learning media is one of the applications of 21st century learning styles [6]. The use of this type of learning media has the potential to help improving students’ academic performance in the form of learning outcomes in the cognitive domain [7] [8], and to increase students’ learning motivation [9][6]. Smartphones and tablets that use this Android system have the power to transform learning experiences and allow learners overcoming the limited time and place with interesting applications [10][11][12].

2. Method Research

Research on the validity and reliability of teaching materials is part of the development of physics teaching materials by adopting the analysis, design, development, implementation, and evaluation (ADDIE) model. Steps taken in the teaching materials development include: (1) Analysis, recognizing and determining problems and finding appropriate solutions to develop right teaching materials; (2) Designing, carrying out to determine specific competencies, methods, teaching materials, and learning strategies that are used so that a prototype of teaching materials is formed; (3) Development, validating prototype of teaching materials that will be used in learning programs; (4) Implementation, carrying out learning by using instructional materials that have been developed; and (5) Evaluation, utilizing the stage of evaluation of the teaching materials which has been developed.

The instruments used in this study are the sheets of product validation and ability to evaluate observation. Validation sheets are used to generate data on the validity and consistency of problem-based teaching materials developed. This product validation sheet is then given to three assessors which include content and media experts and linguists. The data collected through this validation was then analyzed using various percentage techniques presented in Equation 1.
Based on the values obtained from the percentage analysis, to be able to find out the validity of the instructional material developed, the criteria used are presented in Table 1.

### Table 1. Categories of Validity of High School Teaching Material of Physics

| Average $\chi$          | Category of Validity     |
|-------------------------|--------------------------|
| $3.00 < \chi \leq 4.00$ | Valid                    |
| $2.00 < \chi \leq 3.00$ | Fairly Valid             |
| $1.00 < \chi \leq 2.00$ | Enough Valid             |
| $0.00 < \chi \leq 1.00$ | Invalid                  |

After testing the validity of the instructional material developed, the analysis is continued to see the consistency of the teaching material. Because the assessment of teaching materials is carried out by Rater, the consistency analysis of teaching materials is carried out using the percentage agreement index. The percentage of agreement index is calculated using Equation 2.

$$PA = \left(1 - \frac{A - B}{A + B}\right) \times 100\%$$

where $PA = \text{Percentage Agreement}$, $A = \text{higher score than the observer’s}$, and $B = \text{lower score than the observer’s}$.

Based on the values obtained from the percentage agreement analysis, to be able to determine the consistency of the developed teaching material, the categories of Percentage Agreement (PA) of High School Physics Teaching Material are presented in Table 2.

### Table 2. Categories of Percentage Agreement (PA) of High School Physics Teaching Material

| PA Value Range (%) | Categories of PA                      |
|--------------------|---------------------------------------|
| 76-100             | Reliable                              |
| 51-75              | Pretty Reliable                       |
| 26-50              | Less Reliable (revision)              |
| 00-25              | Not Reliable (revision)               |

Observation sheets can be used to collect data on students’ ability to evaluate. Observations are carried out in two stages. In each stage of observation, assessors classify students in two groups, namely groups that have low and high evaluation abilities. The results of this data collection process are then analyzed using Equation 3.

$$N_g = \frac{S_f - S_l}{100 - S_l}$$

where $N_g = \text{normalized gain}$, $S_f = \text{number of test participants who have high evaluation skills after using instructional materials}$, and $S_l = \text{number of test participants who have high evaluation skills before using teaching materials}$.

Based on the results of the N-gain obtained, to be able to find out whether or not after using teaching materials developed the ability of students to evaluate increases, the criteria used is presented in the Table 3.
3. Results and Discussion

To produce problem-based high school teaching materials of physics using Android, the ADDIE development model is used. Furthermore, the instructional material developed is designed using the eXe-Learning application that is applied in the form of applications on Android. The competency test presented in the teaching material contains a low cognitive domain to the evaluation domain. This teaching material is a new media for teachers and students because it has never been used in the previous learning process.

The study begins by analyzing the problems and needs in by conducting interviews to teachers and learners related to the learning process, methods, and media which are appropriate to apply in the physics class. After obtaining the sufficient information needed to develop physics teaching materials through needs analysis, then the process, i.e. the physics teaching materials design, is carried out. This process produces prototypes of physics teaching materials.

The prototype generated from the design step is then validated by content and media experts, linguists, and teachers as users. The validation results: aspects of content with a score of 3.15 with a valid category, aspects of language with a score of 3.5 with a valid category, aspects of the media with a score of 3.75 with valid categories, aspects of design and appearance with a score of 3.12 with a valid categories, and aspects of operation ease of the program with a score of 3.0 with a fairly valid category. Thus, the average of all aspects with a mean score of 3.30 with the category is valid.

| Table 3. Normalized Gain Criteria |
|-----------------------------------|
| Criteria | Conclusion |
| \( N_r \geq 0.7 \) | High |
| 0.30 \(< N_r \leq 0.70 \) | Medium |
| \( N_r < 0.3 \) | Low |

| Table 4. Validation Results of High School Teaching Material of Physics |
|---------------------------------|
| No. | Rated aspect | Score | Category |
|-----|--------------|-------|----------|
| 1.  | Feasibility of Content | 3.15 | 3.46 | Very valid |
| 2.  | Linguistic | 3.50 | 3.67 | Very valid |
| 3.  | Media | 3.75 | 4.00 | Very valid |
| 4.  | Design and Display | 3.12 | 3.75 | Very valid |
| 5.  | Program Operations | 3.00 | 3.00 | Valid |
| Actual Scores | | 3.30 | 3.58 | Vary valid |

The results of the validation by teachers to the teaching materials of physics using Android-based on problems of feasibility aspects of the contents with a score of 3.46 with a valid category, aspects of language with a score of 3.67 with a valid categories, aspects of the media with a score of 4.00 in valid categories, aspects design and display with a score of 3.75 with valid category, and aspects of ease of operation of the program with a score of 3.00 with a fairly valid category. As a result, the average of all aspects with a score of 3.58 is in the valid category. Total average scores obtained from experts and teachers of physics is 3.44 which a categorized valid enough to be eligible for use in learning. Reliability test shows PA = 89.52%, so the data obtained is reliable.

After validity and reliability of problem-based high school teaching materials of physics using Android have been tested, then the teaching materials are able to be used as learning media. The results of this implementation process show that in general the ability of students has increased. On the ability to evaluate, the increase of ability is measured by N-gain analysis by using pre-test and post-test score data. The results of N-gain analysis showed that students in evaluating the student’ ability increased moderately with N-gain value 0.359.
Table 5. Results of Observation of Students’ Ability in Evaluating

| Observation | Low Ability | High Ability |
|-------------|-------------|--------------|
| Early       | 30          | 6            |
| End         | 14          | 22           |

4. Conclusion
The results showed that problem-based high school teaching materials of physics using Android were valid with a total average score of 3.44 and with the percentage agreement (PA) level of 89.52%. The teaching material is also able to improve the ability of students in evaluating within the medium improvement category with an N-gain value of 0.359.

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