Development of Android App to Assist High School Students in Learning Physics Quantities and Measurement Principles

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Abstract **– Most of the time, students need to do self-study in order to understand the physics material completely. Knowledge about physical quantities and measurement is a pre-requisite for experiment-based physics class. Thus, students need to master it well. In this project, we develop supporting multimedia in the form of android app to assist students in doing self-study on topics regarding the physical quantities and measurement. Android app platform is chosen because it can provide interactive text, illustration and video. It is also popular among students, and it can be used easily by students everywhere and every time. The android app contains explanations, discussions, video demonstrations, exercises and quizzes. Field testing has been conducted to evaluate the effectivity of the android app to improve the students' conceptual understanding. According to field testing, the use of the android app in self-study is potential to enhance students' conceptual understanding of physical quantities and measurement principles.**

Keywords **– android app, learning media, self-study, high school physics, physical quantities, measurement.**

1. Introduction

Physics class is not always about theoretical lecturing, but it includes experiment or project work. Before students get into experiment-based physics class activity, they need to be prepared with basic knowledge about physical quantities and measurement principles. In Indonesian high school physics curricula it is given at the beginning of grade X.

Due to the time-constraint in the physics class, teacher may miss explaining some physical concepts in detail. Sometimes, some students cannot follow the material in tight time allocation. Thus, some students need to either get prepared for the class by pre-studying the material or re-reviewing the material after the class in order to thoroughly understand the material given by the teacher. Both pre-study and re-review are usually done through self-study. For self-study, students need a reliable learning resource that can guide them to study. A traditional textbook which is generally used by students is one of a reliable learning resource for most of the subject[1]. However, it has some limitations, such as the lack of physics visualization, it is less interactive and less flexible.

The topic of physical quantities and measurement contains several concepts and technical descriptions. Studying them only through traditional books will be a difficult task. As an example, sub-topic about how to measure length using a micrometer screw will be hard to describe through text and two-dimensional figures. In this case, multimedia probably is better choice in order to give more precise explanation.

Multimedia is a combination of text, graphic, animation, audio and video. The uses of multimedia in learning activity enable students to get information in various formats. Educational multimedia applications can be more focused on specific objectives or in more comprehensive ways [2].

Nowadays, mobile phones have developed impressively. Current mobile phones, which are known as smartphones, allow various features, including multimedia. This feature is potential to be used for educational purposes. Smartphones are also possible to engage students' participation in learning

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activity [3]. Moreover, nowadays, most of students have and bring smartphone everywhere.

Some studies about developing physics educational mobile app in smartphones have been conducted. Learning media on the topics of optics [4], electricity [5], mechanics [6], [7], [8], and thermodynamics [9], [10] have been developed. Those studies indicate that there is positive impact of embedding mobile app as learning media in physics learning activity.

The topic of physical quantities and measurement principles is necessary for starting study of other subjects in physics and getting ready for experimental activity. Thus, students need to master it well. Supporting multimedia is essential to assist students to do self-study. The multimedia can be developed as mobile app platform so that it can be opened easily anywhere and anytime by the students. So far, an application about physical quantities and measurement which is designed for high school students to do self-study is not found in digital distribution service. In this study, we develop a learning media in the form of Android app to assist high school students in physical quantities and measurement. Android app is chosen as learning media platform due to its popularity among students.

2. Methods

This study is a developmental study within 4D models [11] that consist of four phases i.e. defines, design, develop, and disseminate. The define phase includes students, task, and concept analysis. Based on the results of those analyses, we design the prototype of the android app. The android app is built using Adobe Animate CC. The develop phase involves expert appraisal and field testing. Field testing is done on a group of high school students, that consists of 42 students from a private school in Surabaya, Indonesia. We gather students' responds on using the media through a checklist. The checklist contains some statements; students are asked to choose whether they "strongly agree", "agree", "disagree", or "strongly disagree" with the statements. Students' responds are converted into numerical data such as given in Table 1. After converted to numerical data, we find the average score of each statement and interpret it to qualitative description. The conversion is given in Table 2.

Table 1: Conversion of questionnaire responds to numerical data

Response	Score
Strongly agree	4
Agree	3
Disagree	2
Strongly disagree	1

Table 2: Conversion of score to qualitative description

Interval	Description
$\bar{X} > \bar{X}i + 1.8\ SBi$	Very Good
$\bar{X}i + 0.6\ SBi < \bar{X} \leq \bar{X}i + 1.8\ SBi$	Good
$\bar{X}i\ \ -0.6\ SBi < \bar{X} \leq \bar{X}i + 1.8\ SBi$	Fair
$\bar{X}i\ \ -0.6\ SBi < \bar{X} \leq \bar{X}i\ \ -1.8\ SBi$	Poor
$\bar{X} \leq \bar{X}i\ \ -1.8\ SBi$	Very Poor

$\bar{X}$: Actual Score
$\bar{X}i$: ½ (ideal maximum score + ideal minimum score)
SBi: ⅙ (ideal maximum score – ideal minimum score)

We use one group of pre-test and post-test design to investigate the impact of the use of the android app on students' conceptual understanding. The improvement of physics performance is analyzed by finding the normalized gain score using the following formula [12]

$$< g > = \frac{\%\text{posttest score} - \%\text{pretest score}}{100 - \%\text{pretest score}} \quad (1)$$

3. Result and Discussions

Design of Android App

The application includes some main menu, i.e introduction, material, video, problem example and quiz. Since the mobile app application is designed to support students in self-study, students need to know the learning objective and the concept map of the material that will be studied. We present both of them in the introduction menu.

The content is about physical quantities and measurement principles. In the Indonesian high school physics curricula, this topic is given as the first chapter in grade X. Discussion about physical quantities, dimensions, introduction to measurement principles, how to use measurement instruments, significant figures and how to analyze physical data from experiments are given in the material section. The material is accompanied by illustrations (see Figure 1) and videos to provide more concrete examples to students. Figure 2 shows a video about how to measure Vernier caliper. The application is linked to youtube to provide the video feature.

Figure 1. Screenshots of Material Menu

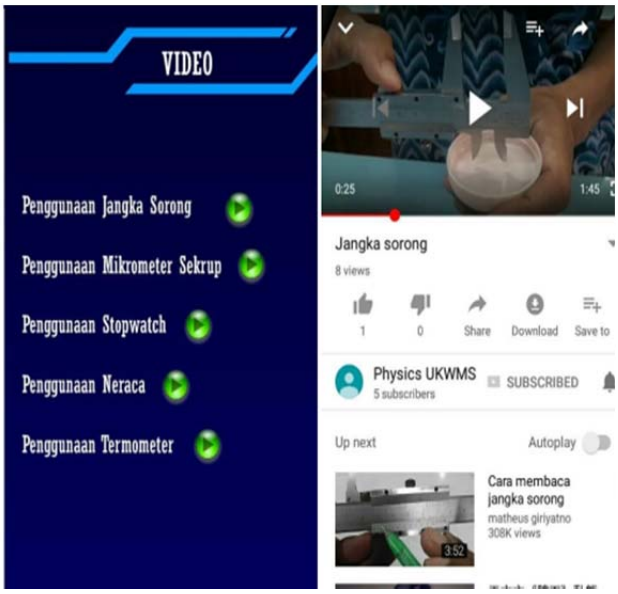

Figure 2. Screenshot of Video about how to use measurement instrument

For helping students in doing the exercise individually, the application also includes a problem example. The problem example consists of several problems. Students are directed to read the question and answer it by themselves; however they can open the solutions after they finish answering the question.

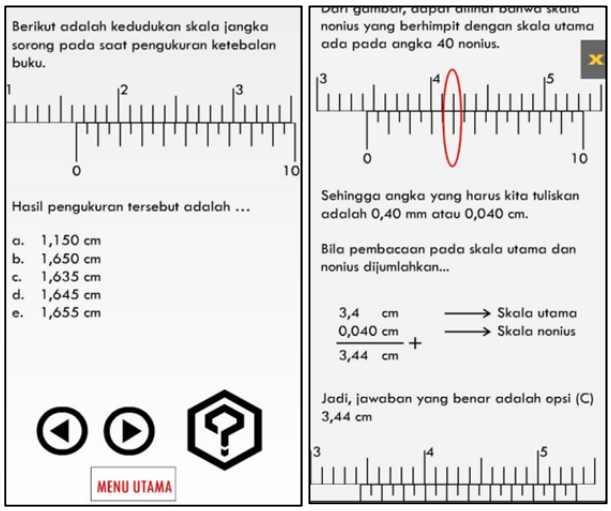

Figure 3. Problem example menu. The left side is a screenshot of the given problem. The right side is a screenshot of the solution

For self-evaluation, students are suggested to do the Quiz. The Quiz is constructed from 10 random problems. After answering each question, the feedback will appear. Students will gain ten scores if they can answer a question correctly. Students also can view the answer key after they input their answers. At the end of the quiz, students will get their total score.

Figure 4. Screenshots of Quiz

Developmental Testing

The android app is reviewed by an expert in physics education. We yield several feedbacks to improve the quality of the android app. The android app is revised to accommodate the reviewer's feedback.

After being revised, the android app is tested to high school students. Forty-two students from grade X participate in this field testing. Students are given a pre- and post-test before and after they use the app for self-study. The score of pre- and post-test are compared by calculating the normalized gain score, <g>, to assess the effectivity of the use of the android app on improving students' conceptual understanding. Table 3 shows the average pre- and post-test. The average <g> from the field testing is 0.65, which can be categorized as medium gain [12].

Table 3. Comparison between average pre- and post-test

Average pre-test score (out of 100)	Average post-test score (out of 100)	Average gain score (g_{av}) *	Criteria
53.8	83.9	0.65	Medium

*Average gain score is calculated by averaging each individual gain scores

At the end of the field testing, students are asked to fill checklists, which gather their opinion about the quality of the android app. The summary of the students' responses is given in Table 4. Overall, most students think that the android app is very good in the instructional aspect. It means students agree that the android app helps them in self-study about physical quantity and measurement. Students also

think that the layout and usability aspect of the android app is good.

Table 4. Students' responses about the quality of the android app

Aspect	Average Score	Quality
Instructional	3.44	Very good
Layout and Design	3.34	Good
Usability	3.28	Good

In this study, we find that there are significant improvements in students' cognitive achievement after they do self-study using the developed android app. It seems that features such as explanations using video, problem example and quiz are helpful to support self-study. However, this study is limited to cognitive domain only. We believe that more comprehensive investigation on the other domain such as affective and psycho-motoric domains is also required mainly because the topics about physical quantity and measurement are directly related to physics experiments.

4. Conclusions

A study has been conducted to develop an Android App to Support High School Students in Learning Physics Quantity and Measurement Principle. Based on the field testing, the application is potential to improve students' cognitive understanding of physical quantity and measurement, as indicated by the medium normalized gain. Students also give positive response to the quality of the self-learning android app. This study is still limited because cognitive domain is only evaluated. Further research on the other domain is highly recommended as the material is directly related to practical activity.

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