Bukti Korespondensi untuk Artikel dengan judul: Development of Android App to Assist High School Students in Learning Physics Quantities and Measurement Principles. (TEM Journal, Vol. 9, Issue 1, Februari 2020, Publisher: UIKTEN).

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1. Artikel submitted: November 18, 2019

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Article re-submission

Elisabeth Founda <elisa.founda@gmail.com> Mon, Nov 18, 2019 at 6:30 AM
To: office@temjournal.com

Dear TEM Journal Editorial Team,

We wish to submit our manuscript, entitled “Development of Android App to Assist High School Students in Learning Physics Quantities and Measurement Principles” by Herwinarso, B. Untung, J.V.D Wirjawan, E. Pratidhina for your consideration of publication in TEM-Journal

Topics of physical quantities and measurements become basic knowledge in doing physics experimental activities, thus students need to master it well. In this project we develop a learning media to assist students in doing self-study on the topics of physical quantities and measurements. Android platform is chosen due to its popularity, flexibility, and its potential to provide various formats including text, figures, animations, and videos.

As our project is combining technology and education, we think that our manuscript will be suitable for publication in TEM Journal. Finally, please send all correspondences regarding the manuscript to E. Pratidhina.

Sincerely yours,

Elisabeth Pratidhina
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Jalan Kalijudan 37 Surabaya 60114
Tel: +62-31-3891265
E-mail: elisa.founda@ukwms.ac.id ; elisa.founda@gmail.com

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With sincere regards,

Elisabeth Pratidhina Founda Noviani

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1. Artikel submitted: November 18, 2019

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

Herwinarso, Budijanto Untung, Johannes V.D. Wirjawan, Elisabeth Pratidhina

Department of Physics Education, Widya Mandala Catholic University Surabaya, Indonesia

***Abstract* – Most of the time, students need to do self-study 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 the topics of 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 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 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 generally is used by students is one of a reliable learning resource for most of subject[1]. However, it has some limitations, such as has lack of physics visualization, less interactive and less flexible.

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

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Learning media on the topics of optics [4], electricity [5], mechanics [6]–[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 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.

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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 to a group of high school students consist of 42 students from a private school in Surabaya, Indonesia. We gather students' responds on the using of 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.

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Strongly agree	4
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Interval	Description
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$\bar{X}i\ -0.6\ SBi < \bar{X} \leq \bar{X}i\ -1.8\ SBi$	Poor
$\bar{X} \leq \bar{X}i\ -1.8\ SBi$	Very Poor

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

We use one group 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.

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Figure 1. Screenshots of Material Menu

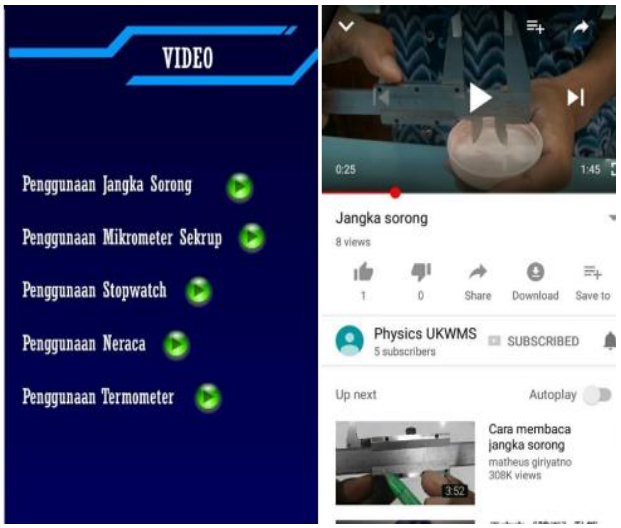

Figure 2. Screenshot of Video about how to use measurement instrument

For helping students in doing the exercise individually, the application also includes 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.

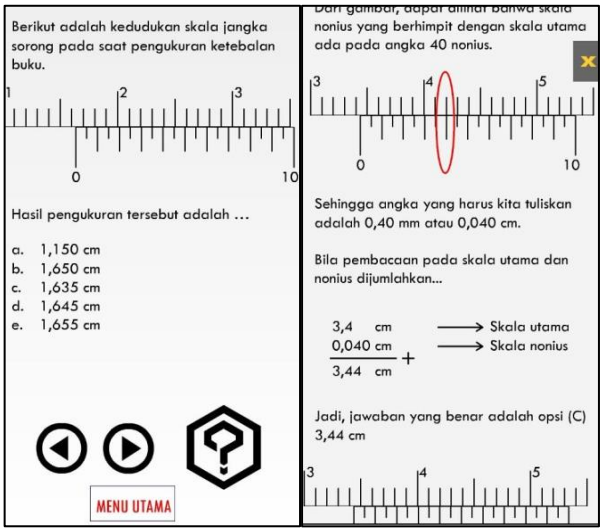

Figure 3. Problem example menu. The left side is a screenshot of the given problem. The right side is a screenshot of the solution

For self-evaluation, students are suggested to do the Quiz. The Quiz is constructed from 10 random problems. After answering each question, 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.

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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 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 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 only cognitive domain is evaluated. Further research on the other domain is highly recommended as the material is directly related to practical activity.

Acknowledgements

This work is supported by Grant from the Ministry of Research and Higher Education with contract number 115AI/WM01.5/N/2018

References

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[5] A. I. Yasin, E. C. Prima, and H. Sholihin, "Learning Electricity using Arduino-Android based Game to Improve STEM Learning Electricity using Arduino-Android based Game to Improve STEM Literacy," *J. Sci. Learn.*, vol. 1, no. 3, pp. 77–94, 2018.

[6] F. S. Arista and H. Kuswanto, "Virtual Physics Laboratory Application Based on the Android Smartphone to Improve Learning Independence and Conceptual Understanding," *Int. J. Instr.*, vol. 11, no. 1, pp. 1–16, 2018.

[7] B. R. Simanjuntak and E. Budi, "The Development of Web-based Instructional Media for Teaching Wave Physics on Android Mobile," *J. Penelit. dan Pengemb. Pendidik. Fis.*, vol. 4, no. 1, pp. 1–10, 2018.

[8] H. D. Kurniawan and H. Kuswanto, "CAKA as Physics Learning Media Based on Android Apps on CAKA as Physics Learning Media Based on Android Apps on Smartphones," *J. Phys. Conf. Ser.*, vol. 1227, p. 012032, 2019.

[9] L. Ratnaningtyas, I. Wilujeng, and H. Kuswanto, "Android-based Physics Comic Media Development on Thermodynamic Experiment for Mapping Cooperate Attitude for Senior High School Android-based Physics Comic Media Development on Thermodynamic Experiment for Mapping Cooperate Attitude for Senior High School," *J. Phys. Conf. Ser.*, vol. 1233, p. 012054, 2019.

[10] I. M. Astra, H. Nasbey, and A. Nugraha, "Development of an Android Application in the Form of a Simulation Lab as Learning Media for Senior

High School Students," 2015.
[11] S. Thiagarajan, D. S. Sammel, and S. I. Melvyn, *Instructional development for training teachers of exceptional children*. Bloomington: Indiana University, 1974.
[12] R. R. Hake, "Interactive-engagement versus traditional methods: A six-thousand-student survey of mechanics test data for introductory physics courses," *Am. J. Phys.*, vol. 66, no. 1, pp. 64–74, Jan. 1998.

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Article re-submission

TEM Journal <office@temjournal.com> Mon, Nov 18, 2019 at 5:39 PM
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Dear Elisabeth Pratidhina,

We have received your manuscript and forwarded it to reviewers.
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Elisabeth Founda <elisa.founda@gmail.com>

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4. Review result: February 5, 2020

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To: Elisabeth Founda <elisa.founda@gmail.com>

Dear Elisabeth Pratidhina,

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The authors must have a first name and a forename (at least two words, there can not be one single word—Herwinarso).

2
Adjust your paper according to the instructions for the authors.

First Author [1], Second Author [2], Third Author [3]

[1] *First affiliation, Address, City, Country (e-mail)*
[2] *Second affiliation, Address, City, Country (e-mail)*
[3] *Third affiliation, Address, City, Country (e-mail)*

3
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Article re-submission

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Dear TEM Journal Editor,

Thank you for your feedback.

We have revised our manuscript according to the comments. Enclosed is our revised manuscript.

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

Herwinarso Herwinarso[1], Budijanto Untung[1], Johannes V.D. Wirjawan[1], Elisabeth Pratidhina[1]

[1]*Department of Physics Education, Widya Mandala Catholic University Surabaya, Jalan Kalijudan 37 Surabaya, Indonesia*

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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.

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Received: -----.
Accepted: -----.
Published: -----.

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$\bar{X} \leq \bar{X}i\ \ -1.8\ SBi$	Very Poor

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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.

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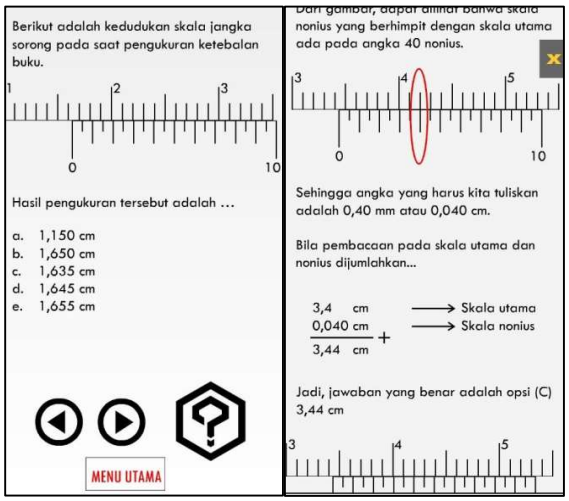

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Average pre-test score (out of 100)	Average post-test score (out of 100)	Average gain score (g_{av}) *	Criteria
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*Average gain score is calculated by averaging each individual gain scores

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.

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Aspect	Average Score	Quality
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Acknowledgements

This work was supported by Indonesian Ministry of Research, Technology and Higher Education under Research Grant No. 200AE/WM01.5/N/2019.

References

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[7] B. R. Simanjuntak and E. Budi, "The Development of Web-based Instructional Media for Teaching Wave Physics on Android Mobile," *J. Penelit. dan Pengemb. Pendidik. Fis.*, vol. 4, no. 1, pp. 1–10, 2018.

[8] H. D. Kurniawan and H. Kuswanto, "CAKA as Physics Learning Media Based on Android Apps on CAKA as Physics Learning Media Based on Android Apps on Smartphones," *J. Phys. Conf. Ser.*, vol. 1227, p. 012032, 2019.

[9] L. Ratnaningtyas, I. Wilujeng, and H. Kuswanto, "Android-based Physics Comic Media Development on Thermodynamic Experiment for Mapping Cooperate Attitude for Senior High School Android-based Physics Comic Media Development on Thermodynamic Experiment for Mapping Cooperate Attitude for Senior High School," *J. Phys. Conf. Ser.*, vol. 1233, p. 012054, 2019.

[10] I. M. Astra, H. Nasbey, and A. Nugraha, "Development of an Android Application in the Form of a Simulation Lab as Learning Media for Senior

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[11] S. Thiagarajan, D. S. Sammel, and S. I. Melvyn, *Instructional development for training teachers of exceptional children*. Bloomington: Indiana University, 1974.
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Development of Android App to Assist High School Students in Learning Physics Quantities and Measurement Principles

Herwinarso Herwinarso[1], Budijanto Untung[1], Johannes V.D. Wirjawan[1], Elisabeth Pratidhina[1]

[1]*Department of Physics Education, Widya Mandala Catholic University Surabaya, Jalan Kalijudan 37 Surabaya, Indonesia*

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 ~~the~~ topics ~~of~~ 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.

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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 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.

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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 ~~to~~ on a group of high school students, that consists of 42 students from a private school in Surabaya, Indonesia. We gather students' responds on ~~the~~ using ~~of~~ 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.

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$\bar{X}i\ \ -0.6\ SBi < \bar{X} \leq \bar{X}i\ \ -1.8\ SBi$	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.

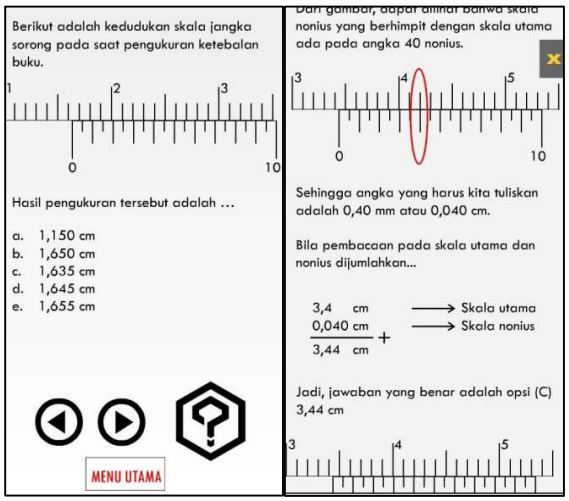

Figure 3. Problem example menu. The left side is a screenshot of the given problem. The right side is a screenshot of the solution

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 ~~only~~ cognitive domain is only evaluated. Further research on the other domain is highly recommended as the material is directly related to practical activity.

Acknowledgements

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References

[1] G. L. Bradshaw, "Multimedia Textbooks and Student Learning," vol. 1, no. 2, 2005.

[2] N. A. Mukti and S. P. Hwa, "Malaysian Perspective : Designing Interactive Multimedia Learning Environment for Moral Values Education," *Int. Fourum Educ. Technol. Soc.*, vol. 7, no. 4, pp. 142–152, 2004.

[3] J. Gikas and M. M. Grant, "Internet and Higher Education Mobile computing devices in higher education : Student perspectives on learning with cellphones , smartphones & social media," *Internet High. Educ.*, vol. 19, pp. 18–26, 2013.

[4] A. Billah and A. Widiyatmoko, "The Development of Virtual Laboratory Learnig Media for The Physcal Optics Subject," *J. Ilm. Pendidik. Fis. Al-BiRuNi*, vol. 07, no. 2, pp. 153–160, 2018.

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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

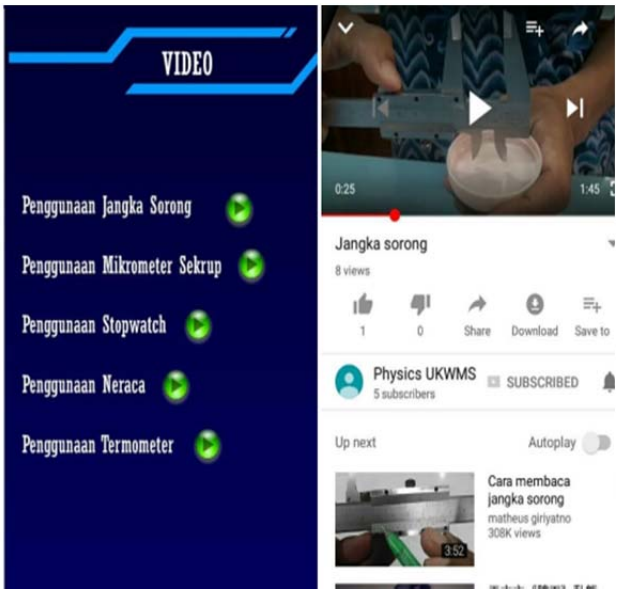

Figure 2. Screenshot of Video about how to use measurement instrument

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.

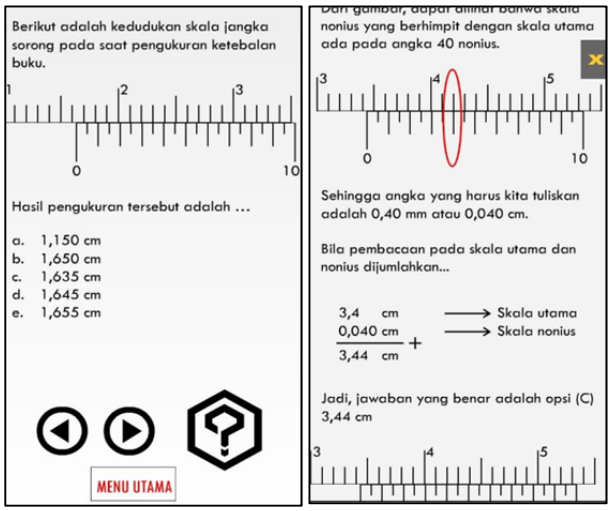

Figure 3. Problem example menu. The left side is a screenshot of the given problem. The right side is a screenshot of the solution

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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References

[1] Bradshaw, G. L. (2005). Multimedia textbooks and student learning. *MERLOT Journal of Online Learning and Teaching*, *1*(2), 31-46.

[2] Mukti, N. A., & Hwa, S. P. (2004). Malaysian perspective: Designing interactive multimedia learning environment for moral values education. *Journal of Educational Technology & Society*, *7*(4), 143-152.

[3] Gikas, J., & Grant, M. M. (2013). Mobile computing devices in higher education: Student perspectives on learning with cellphones, smartphones & social media. *The Internet and Higher Education*, *19*, 18-26.

[4] A. Billah and A. Widiyatmoko, "The Development of Virtual Laboratory Learnig Media for The Physcal Optics Subject," *J. Ilm. Pendidik. Fis. Al-BiRuNi*, 7 (2), 153-160.

[5] Yasin, A. I., Prima, E. C., & Sholihin, H. (2018). Learning Electricity using Arduino-Android based Game to Improve STEM Literacy. *Journal of Science Learning*, *1*(3), 77-94.

[6] Arista, F. S., & Kuswanto, H. (2018). Virtual Physics Laboratory Application Based on the Android Smartphone to Improve Learning Independence and Conceptual Understanding. *International Journal of Instruction*, *11*(1), 1-16.

[7] Simanjuntak, B. R., Desnita, D., & Budi, E. (2018). The Development of Web-based Instructional Media for Teaching Wave Physics on Android Mobile. *Jurnal Penelitian & Pengembangan Pendidikan Fisika*, *4*(1), 1-10.

[8] Kurniawan, H. D., & Kuswanto, H. (2019, June). CAKA as Physics Learning Media Based on Android Apps on Smartphones. In *Journal of Physics: Conference Series* (Vol. 1227, No. 1, p. 012032). IOP Publishing.

[9] Ratnaningtyas, L., Wilujeng, I., & Kuswanto, H. (2019, June). Android-based Physics Comic Media Development on Thermodynamic Experiment for Mapping Cooperate Attitude for Senior High School. In *Journal of Physics: Conference Series* (Vol. 1233, No. 1, p. 012054). IOP Publishing.

[10] Astra, I. M., Nasbey, H., & Nugraha, A. (2015). Development of an android application in the form of a simulation lab as learning media for senior high school students. *Eurasia Journal of Mathematics, Science & Technology Education*, *11*(5), 1081-1088.

[11] Thiagarajan, S., Semmel, D. S., & Semmel, M. I. (1974). Instructional development for training teachers of exceptional children.

[12] Hake, R. R. (1998). Interactive-engagement versus traditional methods: A six-thousand-student survey of mechanics test data for introductory physics courses. *American journal of Physics*, *66*(1), 64-74.