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Development of Contextual Physics Teaching Materials Assisted by Virtual Lab Based-Android as Alternative Learning in Covid-19 Pandemic

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Abstract: This study aims to develop effective and efficient contextual physics teaching materials for students and teachers in the Covid-19 pandemic. The teaching materials are based on virtual lab-based Android so that they can be used in any conditions, including when applying physical distancing protocols at school or study from home (SFH). The teaching materials in the form of this application makes it easy for students to access the content on their mobile phones even when they cannot connect to the internet. Also, this application is very easy for teachers to be used. The research method used is based on the 4D model, that is define, design, develop and disseminate. The teaching materials that have been developed passed the first stage test with a Very Good result. The validity test is assessed by expert validators. The subject material used in this study is limited to Reflection and Refraction of Light. The response of students using the teaching materials is Good. According to the students, the teaching materials are easy to use, motivate learning, and deem effective in its implementation.

Keywords: Android; Contextual Physics; Pandemic Covid-19; Teaching Materials; Virtual Lab; Pandemic Covid-19

Introduction

Learning is one of the processes in achieving educational goals. Learning is generally done in schools with tools that have been prepared. But in certain circumstances, learning can be done remotely without having to come to school. Espeically in this Covid-19 pandemic, distance learning has been widely applied by several countries with the help of various platforms. The implementation of distance learning certainly encounters several obstacles such as e-learning. The use of internet or e-learning media has considerable obstacles including network connections and technical errors such as server down and errors that hinder learning success (Nurmukhametov et al., 2015). Hence, the concepts and principles of the subject material tend to become difficult to be accepted by students, especially for learning physics (Abdi et al., 2017).

Physics lessons that are related to natural and human life are a common problem for high school students (Guido, 2013; Ohle et al., 2015). Physics materials that contain abstract concepts are one of the complaints from students ((Fatmaryanti et al., 2015). Students have difficulty constructing existing concepts so that they are not able to master the material (Rahmatullah & Suparno, 2020).

Materials in physics must be packaged well by teachers. Many teaching materials that contain various materials are too dense so that the reading enthusiasm of students is reduced. Attractive teaching materials increase students' literacy interest (Allchin, 2014). The material that is associated with phenomena in everyday life also adds to the impression of attracting students to physics. However, there are many teaching materials that are not contextual so that the concepts obtained by students are not complete. Teaching materials play an important role for teachers and students. Without

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teaching materials, the effectiveness of learning will be difficult to obtain (Perwitasari et al., 2018).

The use of technology-based teaching materials are very effective in learning. Teaching materials are generally in the form of physical materials such as printed books, textbooks, and so on. These types of teaching materials have limited accessibility because their size are relatively large and inefficient when brought to various places (Prabowo et al., 2019).

During a pandemic like this, effective teaching materials for students are very difficult to find. Many obstacles are experienced by students, such as lack of internet connection to support learning; mental disturbance caused by the threatening atmosphere of Covid-19; and the learning platform used by teachers is not very precise in its implementation. Moreover, the Covid-19 pandemic is a health crisis that is disrupting the world. The threat from the Covid-19 virus inhibits or even paralyzes various sectors including Education. Schools are closed to prevent the spread of the virus that has claimed many lives. Hence, learning activities are carried out from home by applying distance learning.

A solution to this pandemic problem lies in technology. Many types of technology can be developed to support learning both online and offline. The tools provided should adopt the existing environmental conditions including the social impact of the pandemic. Some studies explain that there are many technology-based learning developments such as mobile learning (m-learning). M-learning helps students and teachers to conduct daily learning by utilizing gadgets (cellphones) anytime and anywhere (Ghareb & Mohammed, 2016).

However, the challenges faced by teachers are not just about access. Teachers need to improve the cognitive, affective and psychomotor abilities of students. Cognitive ability is improved through good learning resources, while psychomotor skills can be improved through practical activities. These efforts become difficult if done at a time of pandemic at the moment. But with the help of technology, these problems can hopely be solved.

Android is one of the most popular operating system (OS) technologies in the world (El-Sofany et al., 2014). The OS developed by Google is widely used on mobile and tablet devices. This OS platform is commonly used in creating games and social media applications. Android is a mobile platform that is free, open source, and can be fully adapted to existing mobile. Android has software development so that someone can create or develop an application.

Moreover, in this digital age, the use of Android is quite dominant among students' compared to other activities. Hence, the use of Android is something that cannot be separated from the lives of students. However, these useful resources appear to be underutilized by teachers primarily due to a lack of understanding of their benefits. Resti & Jaslin (2016) stated that one of the learning media supported by information technology that can be used as a learning media is a smartphone device equipped with an Android OS. Seeing this opportunity, this study has develop effective and efficient teaching materials for learning during the pandemic. The teaching materials combine contextual material with virtual lab. The aim of this study is to provide easy access for students so that they can improve their abilities.

Method

This study is based upon a research and development. This development research adopts the 4D model consisting of i) Defining, ii) Designing, iii) Developing, and iv) Disseminating by Molenda (2015); Shabrina & Kuswanto (2018)his can be seen in Figure 1. The Define stage is done through several ways including field and literature studies. The goal is to obtain information about the product that is needed. The Design stage includes two steps, namely the assessment stage and the stage of determining the teaching materials being produced. So that the indicators of achievement are clear when measured. Moreover, the device for making the products needs to be identified so that it makes the development process easier. In the Develop stage, the products of teaching materials are being developed according to the design given in the previous stage. Finally, the Disseminate stage is done in the form of scientific publications. The aim is to educate teachers and pre-service teachers in preparing a breakthrough in technology-based learning. This is supported by Lari (2014) by stating that technology-based learning has an effect of excellence compared to traditional learning.

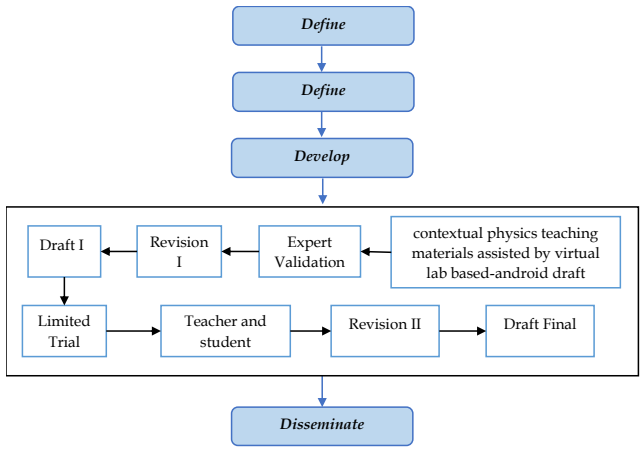

Figure 1. 4D Model stages of development

The purpose of this study is to produce a product in the form of teaching materials assisted by virtual labs as an alternative to learning physics in the Covid-19

pandemic. This study is designed with the assistance of a software to produce an Android application, which is subjected to several test stages. The test phases are carried out through expert validators in their respective fields. The focus of the validator's assessment is on the design of the application, the composition of teaching materials, and the discussion material. This study develops teaching materials on the subject material of Light Reflection and Refraction.

The results of the expert validations are then analyzed by finding the average value. Then the results of the validation are analyzed using descriptive analysis. The data in the form of Likert statements are then converted into quantitative form. The data that have been converted are then classified into an actual score group which states the validity level of the product that has been validated. Widyoko (2014) made a classification on the basis of a comparison of the average ideal score ($\bar{X}_i$) and the ideal standard deviation score (SB_i) given by the equations below:

$$\bar{X}_i = \frac{1}{2}\,(ideal\ max.score + ideal\ min.score) \quad (1)$$

and

$$SB_i = \frac{1}{6}\,(ideal\ max.score - ideal\ min.score) \quad (2)$$

where $\bar{X}_i$ is the average ideal score, SB_i is the standard deviation score, and X is the score obtained. The qualification level is divided into five categories with the following criteria given in Table 1. After the analysis using the steps above, quantitative scores are converted into qualitative categories.

After obtaining the validity results, then the field trials are conducted to get students' responses regarding the materials used during this pandemic. The results are then analyzed descriptively based on the data obtained.

Table 1. Range of Scores in Determining Validity Criteria

Average Score Range	Achievement Criteria	Category
$X \geq \bar{X}_i + 1.8\,SB_i$	$X \geq 84.0$	Very good
$\bar{X}_i + 0.6\,SB_i < X \leq \bar{X}_i + 1.8$	$68.0 < X \leq 84.0$	Good
$\bar{X}_i - 0.6\,SB_i < X \leq \bar{X}_i + 0.6\,SB_i$	$52.0 < X \leq 68.0$	Moderate
$\bar{X}_i - 1.8\,SB_i < X \leq \bar{X}_i - 0.6\,SB_i$	$36.0 < X \leq 52.0$	Bad
$\bar{X} \leq \bar{X}_i - 1.8\,SB_i$	$X \leq 36.0$	Very bad

Result and Discussion

The description of the development that has been made is given as follows. In the Define stage, based on observations in the field there is no physics learning materials using contextual physics teaching aids based on Android and assisted by virtual labs. Learning with the later teaching material is fairly new because there is an element of technology-based media incorporation. Moreover, Maturradiyah & Rusilowati (2015) revealed that there are still many teaching materials that are not integrated with technology that have an impact on learning outcomes. The materials studied in the Design stage are core competencies, basic competencies, and subject materials according to the research theme. The teaching materials are produced using PowerPoint (PPT) 2016 platform. Practical questions and learning evaluations are made using the iSpring Suit 9 platform. The physics teaching materials are produced in the Develop stage. The teaching materials are the combined with the virtual lab application. The merging is done with the assistance of Android APK builder so that the teaching materials assisted with virtual lab can be used on Android in the form of an application. An important note in the development of this application is that it uses formats that support PPT. These formats include .jpg, .png, .mp4, .html, .gif, .wmv, and .xml. Every media or device that is combined into the PPT must be supported with the aforementioned formats.

After the application is ready for use, the next step is to test its validity. The validity of the application is assessed by experts in the field of physics and learning media. The results of the validity test of contextual physical teaching materials assisted with virtual lab can be seen in Table 2. The validity scores of the application design, teaching material, and subject material aspects are 93.0, 94.2, and 92.0, respectively. These aspects are in the Very Good category. Furthermore, the average score obtained for the validity test is 93.0, which is again in the Very Good category.

Table 2. Validity Test Results for Contextual Physics Teaching Materials Assisted by Virtual Lab based on Android

Aspect	Score	Category
Application Design	93.0	Very Good
Teaching Material	94.2	Very Good
Subject Material	92.0	Very Good
Average	93.0	Very Good

The Android application is developed based on the current condition (Alanzi, 2021; Fan et al., 2022; Krishnan et al., 2021). The Covid-19 pandemic is the primary reason of making this application with an initial menu display that can be seen in Figure 2. The initial menu contains i) the introduction, ii) instructions for use, iii) about the application, iv) the author's profile, and v) the start button to start learning. Moreover, the display

start page of the contextual physics teaching materials (see Figure 3) contains i) core competencies, ii) basic competencies and indicators, iii) learning objectives, iv) prerequisite concepts, v) concept maps, vi) materials, vii) practice questions (evaluation), and viii) bibliography. The description of some of the buttons in the application is listed in Table 3.

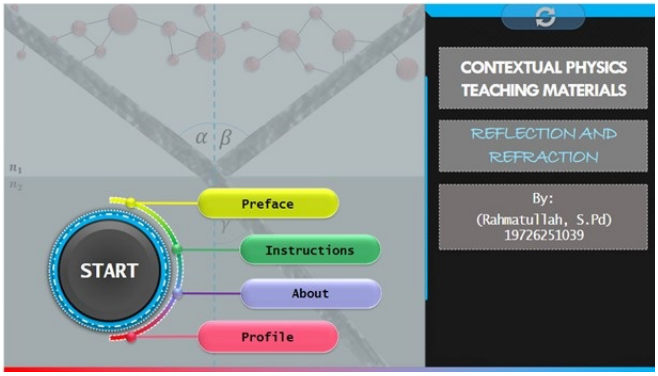

Figure 2. Display Start Page Application of the Teaching Materials

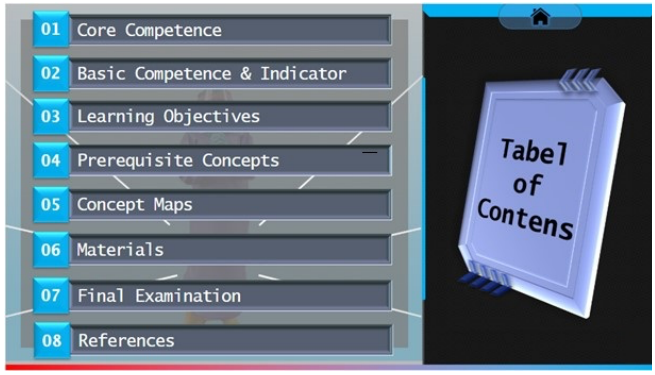

Figure 3. Table of Content Display of the Teaching Materials

The application of the teaching materials is equipped with music that may help increase students' enthusiasm for learning. Music can make learning more interesting, reduce anxiety, motivate and help effective learning (Bokiev et al., 2018). Music is a form of emotional control in order to reduce the burden of worries about the Covid-19 plague. Moreover, Android-based learning applications have also been made by Nanda & Wilujeng (2018) with more complete material, but not equipped with music audio, practicum activities, and evaluations (practice questions), as in this application.

The physics material discussed in this application is the Reflection and Refraction of Light. The design of the learning material is adjusted based on the applications that exist in life (see Figure 4). This teaching material is also equipped with several animations, simulations, and learning videos. Hence, students can observe directly and can build concepts from the reading they conducted. Özdemir & Öner (2015) stated that simulation and animation could have a positive influence on students' motivation in learning.

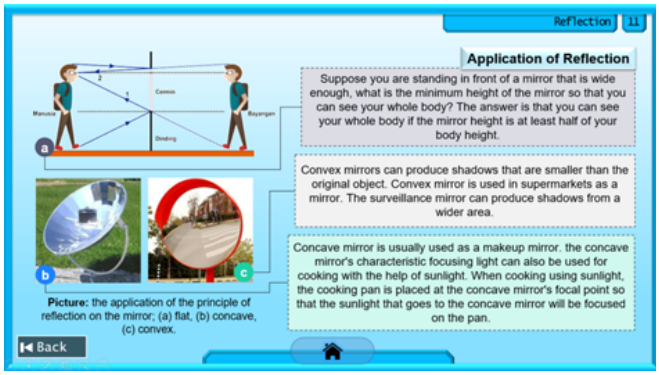

Figure 4. The Application of the Teaching Materials.

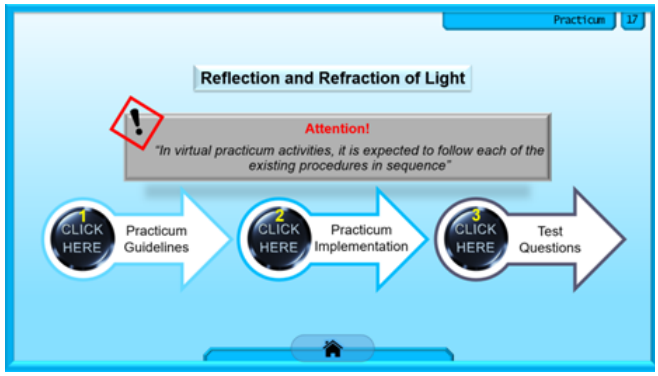

Figure 5. Virtual Lab Practicum Menu

Table 3. Description of Some Buttons of the Application

Section	Button	Description
General	Reload	to restore the opening page.
	Home	to return to the front page or table of contents.
	Next	to continue the teaching material page.
	Back	to rewind the teaching material page.
Front Page	Start	to start the learning activities.
	Preface	contains remarks about the background and the use of the application.
	Instructions	contains learning procedures and application usage.
	Profile	describes the background (profile) of the application maker.

Section	Button	Description
Table of Contents	Core Competence	the level of students' ability to achieve a competency standard at every level, class, or program.
	Basic Competence & Indicator	the ability of students to achieve the core competencies through learning. Indicators are markers of basic competence achievement through measurable behaviour changes that include attitudes, knowledge, and skills.
	Learning Objectives	contains the objectives to be achieved by students after learning the material provided.
	Prerequisite Concepts	the concept that must be possessed by students before studying the material provided.
	Concept Maps	the flow chart of the material that will be studied in detail.
	Materials	contains intensive material, Reflection, Refraction, sample questions, practicum, and summary.
	Final Examination	contains test questions about the concepts that have been learned.
	References	contains the references from the materials.

This developed application is assisted with a virtual lab feature. The virtual lab used adopts an existing application that is the Phet Simulation platform. Before doing the practicum, students are given instructions in using the Android-based virtual practicum (see Figure 5). To support the implementation of the practicum, students are given worksheets, which are directly contained in the application (see Figure 6). On the other hand, practicum questions are given in the form of a survey quiz containing questions about the practicum. The results of the practicum quiz are sent automatically to the researcher's email and then an assessment is made. So, in one Android application students can enjoy learning including evaluation activities (practice questions).

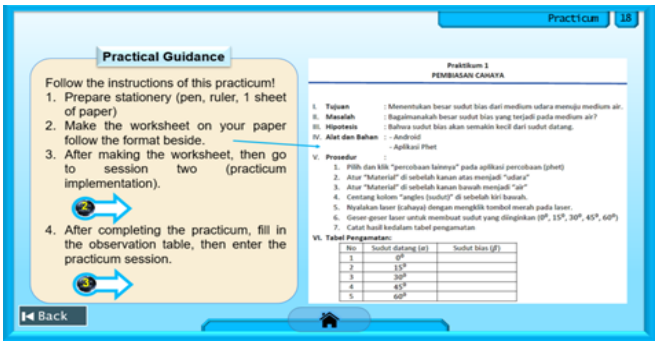

Figure 6. Guidance and Practicum worksheet.

The evaluation made in the form of quiz contains questions about concept understanding. The answers given by students can be fully controlled by the teacher via email. The total time for students to do the quiz, the report of the scores obtained, and the list of correct and wrong answers are recorded in the teacher's email. The work by the students can be reviewed again to find out where the error is and the correct answer.

Field-testing needs to be done to determine the condition of the application made. The results obtained are in the form of students' responses in the aspects of content, presentation, graphics, and language, which can be seen in Table 4. Based on the results in Table 4, it may be observed that the application is in the Very Good category based on presentation, graphic, and language with scores of 87.0; 87.6; and 85.8, respectively. The application is in the Good category based on the aspect of content with a score of 83.2. These results explain that the application that has been designed is appropriate for students as learning materials.

Table 4. Students' Response to the Application

Aspects	Score	Category
content	83.2	Good
presentation	87.0	Very Good
graphic	87.6	Very Good
language	85.8	Very Good

Students' responses are also obtained in terms of the application usage. The results of responses of the application usage can be seen in Table 5. The results show that in terms of application usage all three aspects of the assessment, i.e.: convenience, motivation, and effectiveness are in the Good category with scores 83.8; 77.0; and 74.7, respectively. The highest score is obtained in the aspect of convenience (practical), whereas the effectiveness of the application usage gets the lowest score but still in the Good category.

Students feel there is a special pleasure in learning using this application compared to previous learning methods in the Covid-19 pandemic. The instruction for its use is very clear with procedure mimicking studying at school in general. So that these teaching materials not only can be used for learning from home, but can also be used when learning activities at school are allowed (new normal life).

Table 5. Students' Responses towards the Application Usage

Aspect	Score	Category
Convenience	83.8	Good
Motivation	77.0	Good
Effectiveness	74.7	Good

Virtual lab may be the main attraction for students. The students' responses state that the virtual practicum

makes the concepts at the beginning become clearer. The virtual practicum facilitates the students in understanding the concepts they are learning. The use of virtual lab has a positive effect on understanding students' concepts (Gunawan et al., 2018). Without having to go to school and use normal practicum devices, the virtual lab makes it easy for students to learn even more in investigating concepts. Rahmatullah & Suparno (2020) explained that practicum activities combined with a media or technology would provide more effectiveness and efficiency in learning. The goal of the Android-based application is to make it easier for students to access content on their mobile phones even when they cannot connect to the internet or do not have a quota (credit) for data on their cellphones (Walker, 2011).

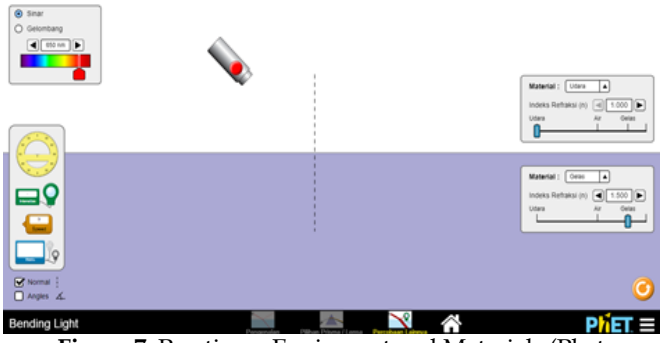

Figure 7. Practicum Equipment and Materials (Phet Simulation)

Conclusion

Contextual physics teaching materials assisted by virtual lab based on Android is feasible for use in learning. The teaching materials developed obtain positive responses from students. Students get the convenience of learning physics. Moreover, students are motivated even though they are in the midst of Covid-19 pandemic. This application is also effective to be used both when having to study from home and when implementing new normal life in the school. The Android-based application makes it easy for students to access the content on their mobile phones even when they cannot connect to the internet or do not have a quota (credit) for data on their cellphones.

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Author Contributions
Rahmatullah: student analysis, concept analysis, software, writing the original draft, data analysis, and so on; Bahtiar: conceptualization, validation and editing; Maimun: writing and review

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Conflicts of Interest
The authors declare no conflict of interest.

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