Android-based physics learning-media apps on circular motion

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Abstract. In recent years, the use of Android smartphones in the Indonesia community has increased very fast. Along the way, its use in the Educational aspect rises accordingly. The increase improved significantly during the period of the COVID-19 pandemic burst. While this fact has brought pain and sorrow for many, we looked at it differently. It was a kind of a blessing in disguise. Besides many inconveniences, it also opens plenty of opportunities. Instead of giving up, we prefer to develop android-based physics learning-media apps which is now needed more than before. The increase of the online portion on the learning processes during the COVID-19 pushed our spirit to complete the development of learning media apps. This apps has been tried out by high school students and has gained positive response from its users.

1. Introduction

In the past five years, concern about emerging of the fourth industrial revolution upheave stronger and stronger. One of the most articulated concerns was reported by the World Economic Forum (WEF), introducing sixteen skills needed in the 21st century [1]. The advancement of technology has brought many disruptions and disputes among the society members, whether or not robots will replace several roles. Among others, will the role of teachers in the future be taken over by machines?

The COVID-19 epidemic [2] identified in Wuhan, China, by the end of 2019 has spread globally until recently. In many countries, including in Indonesia, many schools were closed mostly from March until recently. Since then, the learning processes were dominated by online learning more than ever. While this fact brought pains and miseries for many in terms of health and economic aspects, it opened some opportunities to those who did not want to give up on this condition, especially in educational sector which was forced to operate online in response to minimize the spread of the pandemic. This research took place in the midst of this situation.

Amid profound and rapid changes in Information and Communication Technology (ICT), the Android operating system gained a significant increase in users in the last five years, especially in Indonesia [3]. Statista Research Department reported that the market share of mobile operating systems in Indonesia showed that the percentage of Android users was increased from 74.23 % in Jan 2016 to 92.14% in Aug 2020. This has become the main reason why we chose Android as the framework of our learning media development. In contrast with a web-based learning media that mostly requires the users to connect to the website to access the media’s content, an Android-based learning media apps can be downloaded from the play store to a gadget (smartphone), then can be operated offline from the gadget.
The circular motion was the last topic of serial learning media apps development. Our observations showed that there are quite a few available learning media apps of this topic presented in the Indonesian language. The available ones are mostly in the web-based media or foreign languages. The research’s main objective was to produce attractive and useful physics learning media apps on the topic of circular motion presented in the Indonesian language. The attractiveness of the media was measured by the response provided by its users [4-5]. On the other hand, the media’s usefulness was measured by the gain of the users’ learning achievement on the circular motion test.

2. Methods
The research and development method was chosen as the main framework of the research. More specifically, the 4D model [6]: define, design, develop, and disseminate were applied sequentially in the development of the learning media. In the define stage, we did needs and concept analyses and determined the scope of the topic presented in the learning media. In the design stage, we determined the main features of the learning media that supported the objectives. Each main feature represented a modular component. At the develop stage, each modular component was broken down into several sub-components. Starting from each sub-component, we built a modular component, until all modular components needed to make up the learning media completed. At the end of this stage, the constructed learning media would be verified by media and content (physics education) experts and then university students tried out. The last stage, disseminate, was meant to run a final test on the developed learning media and presented it to a number of high school students as the intended users.

As stated previously, the learning media apps was developed as an Android-based one. For the sake of familiarity and practicality, Adobe Flash Professional CS6 was chosen to develop the learning-media. This software brought some flexibility that can accommodate various needs in the learning media [7]. As a tool of the research instruments we developed evaluation sheets equipped with sets of questionnaires, corresponding rubrics, and pretest-posttest on the circular motion topics.

Considering the characteristic of the data collected, we will analyze them using descriptive statistics. The learning media evaluation would focus on four aspects: appearance, topic (physics) content, learning instruction, and practicality. Similarly, the questionnaires for the users could be clustered into four aspects. The average of the scores on the expert evaluation as well as for the users’ response were stored. We set the questionnaires and the evaluation by experts and peers, as well as users, in 4-scales (strongly not agree, not agree, agree, and strongly agree). Table 1 would be used to interpret the average score [8].

| Average score | Category | Attribute   |
|---------------|----------|-------------|
| \(\bar{x} > 3.4\) | A        | Very good   |
| \(2.8 < \bar{x} \leq 3.4\) | B        | Good        |
| \(2.2 < \bar{x} \leq 2.8\) | C        | Sufficient  |
| \(1.6 < \bar{x} \leq 2.2\) | D        | Bad         |
| \(\bar{x} \leq 1.6\) | E        | Very bad    |

To measure the usefulness of the learning media, we applied gain test on the collected scores of posttest and pretest. First, we calculated gain for each participant which is defined as the difference between the posttest and pretest scores. Then we calculated the normalized gain score, \(g\) [9], which is defined as the ratio of the average gains and the difference between the maximum score and the average of the pretest scores, as shown in equation (1). Then, the conversion Table 2 would be used to interpret the normalized gain score [10].

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g = \frac{\text{average of posttest scores} - \text{average of pretest scores}}{\text{maximum score} - \text{average of pretest scores}}
\]
3. Results

Following the methods described above, the stages of the 4D model can be summarized as follows.

3.1. Define stage
Based on our needs analysis, the circular motion topics was still needed. We decided to cover the circular motion topics: uniformly circular motion, uniformly accelerated circular motion, and irregular circular motion. These topics were presented as generalized linear motion that can be grouped into uniformly linear motion, uniformly accelerated linear motion, and irregular linear motion. The circular motion will discuss its kinematics such as frequency, period, elapsed distance, elapsed angle, angular velocity, linear velocity, angular acceleration, and linear acceleration; and its dynamics such as centripetal force, the circular motion inside a vertical circle, and the circular motion outside of a vertical circle.

3.2. Design stage
As stated earlier, Adobe Flash Professional CS6 was chosen as the main software to develop the learning media. The main features of the learning media consisted of opening, and the main page. Each of these main features could be broken down into sub-components.

The opening page consisted of the background picture, the title of the learning media, Start, About, and Exit buttons. In an effort to engage the users’ curiosity, the learning media was entitled Curious Zone as shown in Figure 1 below. Start button will lead the users to the main page, while the About button will introduce the media developers. In addition, the stop or exit button when clicked will lead the users leave the learning media.

![Figure 1](image)

**Figure 1.** The appearance of the opening page entitled Curious Zone.

The main page consisted of four sub-components: sub-topic discussions (“materi”), miscellaneous problem-solving examples (“contoh soal”), experimental simulation (“eksperimen”), and quizzes
(“quiz”). The main page was equipped with instructional manual (“?”) button that gave brief description on how to operate the learning media and where to find specific information of interests. The sub-topic discussions referred to the coverage scope of the topics stated in the define stage. The miscellaneous problem-solving examples consisted of various examples given as solved problems covering the topics. Experimental simulations were focused on two main circular motions: uniformly circular motion and uniformly accelerated circular motion. The quizzes presented in several modules, each module consisted of 10 questions with certain compositions of easy, medium, and difficult questions. This part was meant to drill the users’ abilities to solve problems. The snapshots of the main page and the instruction manual are shown in Figure 2.

![Figure 2. The appearance of the main page and the instruction manual](image)

3.3. Develop stage

At this stage, the main components on each page were broken down into sub-components. The main sub-components constituted the main page are materi, contoh soal, eksperimen, and quiz. Each of these sub-components was broken down into several sub-sub-components. The snapshots of several sub-components of the main page are shown in Figure 3. After completing all the constituents of the learning media, we proceeded to expert judgments. The learning media evaluation by media experts was based on its appearance, practicality, and language clarity; while the review by the physics education experts was based on the suitability of the topics discussed with the targeted users, the suitability of the chosen experimental simulation to support the learning, as well as the correctness of the information presented in the learning media. After passing through the expert judgments, the learning media was tried out by the fifth semester of the Physics Education students. Upon completing the operation of the learning media, they were required to fill out a set of 4-scaled questionnaires to measure the appearance, the content, the learning instruction, and the practicality of the learning media. After making some adjustments and improvements to respond the expert judgments and the Physics Education students’ evaluation, the learning media was about ready to be used by the intended users. Table 2 and 3 summarize the experts and the Physics Education students’ evaluations on the learning media.
Figure 3. Snapshots of several subcomponents of the learning media
Table 3. Experts evaluation on the learning media

| Evaluation aspect     | Average score | Attribute   |
|-----------------------|---------------|-------------|
| Appearance            | 3.61          | Very good   |
| Topic content         | 3.56          | Very good   |
| Learning instruction  | 3.5           | Very good   |
| Practicality          | 3.5           | Very good   |

Table 4. Physics Education students’ evaluation on the learning media

| Evaluation aspect     | Average score | Attribute   |
|-----------------------|---------------|-------------|
| Appearance            | 3.65          | Very good   |
| Topic content         | 3.52          | Very good   |
| Learning instruction  | 3.61          | Very good   |
| Practicality          | 3.56          | Very good   |

3.4. Disseminate stage
We collaborate with a private high school in Surabaya. 23 high school students participated in the try-out of the learning media. We applied one-group pretest-posttest design to measure the gain scores of the participants. Our data showed an increase in the average posttest score compared to that of the average pretest score as reflected in the average normalized gain of 0.59, which was in the range of moderate gain category.

By the end of the posttest we required the participating students to fill-out 4-scaled questionnaires. The summary of the high school students’ response is shown in Table 4.

Table 5. High school students’ evaluation on the learning media

| Evaluation aspect     | Average score | Attribute   |
|-----------------------|---------------|-------------|
| Appearance            | 3.54          | Very good   |
| Topic content         | 3.41          | Very good   |
| Learning instruction  | 3.46          | Very good   |
| Practicality          | 3.49          | Very good   |

4. Discussions
We have completed the development of Android-based circular motion learning-media apps for high school students. It consists of four main features: sub-topic discussions, various problem-solving examples, experimental simulations, and quizzes using the Indonesian language as the communication media. It has passed the media and physics education experts’ judgments, as can be seen from the average evaluation score on each evaluation aspect shown in Table 3. It has also passed the Physics Education students’ evaluation, as shown in Table 4. Moreover, it also has gone through try-out by the intended users and produced response, as shown in Table 5. The most remarkable fact was that all groups of evaluators gave similar responses. They all agree that the learning media has very good attribute in each evaluation aspect.

One of the research’s main goal was to produce an attractive learning media. One of the most important parts of attractiveness is appearance, which is one of the evaluation aspects addressed to the learning media users. Indirectly, the other evaluation aspects also add to complete the attractiveness of the learning media. The fact that the average score of the users’ response in each aspect can be
categorized as very good is very encouraging. Although the number of students participating in the try-out was considerably small, it was promising and a sign of a good start.

Attractiveness of a learning media is insufficient unless it is also useful. The usefulness of the learning media was measured by its use in improving students’ learning achievement. This was done by providing pretest-posttest to the students participating in the try-out of this learning media. It was found out that the learning media could improve the average of students’ learning achievement from 14.6 to 64.8. If the improvement was converted into gain of the posttest score with respect to its pretest score, the average of normalized gain was 0.59, which was in a moderate gain category. Once again, apart from the fact that the number of participating students was considerably low, this result was quite promising.

5. Conclusion
Comparing the results and the research’s main goals, we can optimistically state that the developed Android-based physics learning-media apps on circular motion have been accomplished the research goals. Further work is needed to increase the number of users to check if the preliminary results will remain unchanged.

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