Mobile Application Development as Physics Learning Resource on The Topics of Circular Motion

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Mobile Application Development as Physics Learning Resource on The Topics of Circular Motion

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Abstract **– The development of smartphones has shifted the primary function of the mobile phone as a communication device. A smartphone is like a pocket computer that enables users to access multimedia, browsing information on the internet, and install many applications to help them in doing various activities. Various functions of smartphones prompt educators to utilize smartphones in promoting teaching and learning. In this work, we develop a mobile application that can assist students in learning high-school physics. The topic focuses on circular motion. As this application is developed for the smartphone platform, it can be accessed by students anytime and anywhere. According to the experts' evaluation, the application is appropriate to support high school students in learning circular motion. A field testing has been conducted on 23 students in a private high school in Indonesia. Students' learning achievement moderately improves, with a normalized gain of 0.59. Also, the students' response to the developed mobile application is positive.**

Keywords **– mobile application, learning resource, high school physics, circular motion**

1. Introduction

The popularity of smartphones is increasing. Smartphones become devices connected to people's daily lives.

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In the past, mobile phone function was limited to communication. However, the presence of smartphones has shifted mobile phones functions beyond communication function. Smartphone features become more varied and innovative. Typically, a smartphone has a touch screen, media players, digital cameras, sensors, and navigation [1]. The advanced development of smartphones prompts educators to use them in the teaching and learning process [2], [3], [4].

Mobile devices, like smartphones, have the potential to make the learning process becomes more interactive and engaging [5], [6]. With mobile devices, teaching and learning are not restricted by place and time [7]. Learning can be continued after the class is over. It can be done at any time and place where learning is more comfortable. Mobile devices also allow more student interaction with the teacher, other students, and contents [8]. Moreover, some studies find that mobile learning can improve students' motivation in the learning process [9], [10], [11]. Mobile devices also allow students to get more information and reinforcement of a learning course [8].

Educators have tried to integrate smartphones in the physics classroom in various ways. Sensors in smartphones can be used as a real-time measurement tool to support physics experiments in the classroom [12], [13], [14], [15]. Camera features are also often used to support physics experiments [16]. The inclusion of smartphones in physics experiments may improve students' engagement and interest during the learning process.

One benefit of using smartphones is that users can install various applications on their smartphones. Educators take this benefit by developing smartphone applications for learning purposes [17], [18]. Smartphone applications are potential for supporting physics learning as it can become multimedia which provide more visualization of physics phenomena. Moreover, application developers are also able to include physics simulation in smartphone application [19], [20]. Physics simulation in smartphones has benefits such as to provide indirect data collection and analysis experience to students. It stimulates critical thinking through the inquiry process that can be conducted at unrestricted time and place. Smartphone applications also have been developed as educational games that aim to improve students' motivation and engagement in learning physics [21], [22].

Smartphones offer flexibility and personalization in learning. They match the typical young learner's preferences. Sometimes, teachers at school cannot discuss all physics material intensely due to the time limitation. Hence, students have to study the material outside the school hour. They need guidance and learning resources to do an individual study. Building smartphone applications as learning resources may help students in doing their individual study effectively. In this study, we develop a mobile application as a learning resource for assisting students in learning circular motion topics. The smartphone application includes material, simulation, problem-example, and quiz. The application aims to guide students in doing their study outside the classroom.

2. Method

At the beginning of this study, we analyze the learners' characteristics, learners' needs, and the high school physics curriculum. The targeted user of the mobile application is 10th-grade student. Most high school students are familiar with smartphone technology. In the school where we conducted the pilot study, all the students have a smartphone.

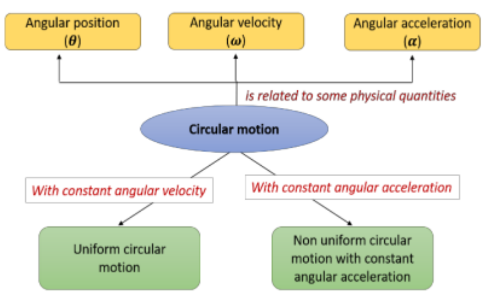

Figure 1. The concept map of the material

The analysis of learners' characteristics, learners' needs, and curriculum becomes consideration and basis for the mobile application design. The material is constructed based on the Indonesian National Curriculum. The concept map in Figure 1. briefly illustrates the material in the mobile application. After the material has been designed, we design the prototype of the mobile Application on Adobe Animate CC. Adobe Animate is a software that can be used to create interactive mobile content with illustration and animation [23].

At the next step, the prototype of the mobile application is evaluated by experts and tested to potential users (10th- grade students). Each step of evaluation and field testing is followed by revisions. Two experts evaluate the mobile application; they are experts in physics education. Before field testing, the mobile application is also assessed by pre-service teachers.

We conducted field testing at a private high school in Indonesia. The objective of the field testing is to know the effectiveness of the mobile application and the users' responses to the mobile application. Twenty-three- 10th-grade students participate in the pilot study. At the beginning of the field testing, we gave a pre-test to the participants. After participants learn Circular Motion topics using the developed mobile application, they are asked to do a post- test. By comparing the students' scores on pre- and post-test, we can identify the learning improvement. The learning improvement is represented by a parameter called normalized gain score <g>, which can be calculated with formula in Eq. 1 [24].

$$\langle g \rangle = \frac{\%\langle S_f \rangle - \%\langle S_i \rangle}{100 - \%\langle S_i \rangle} \qquad (1)$$

where $\langle S_f \rangle$ and $\langle S_i \rangle$ denote class average score on post- and pre-test, respectively. According to Hake (1998), normalized gain scores can be classified onto three categories, i.e., low if $\langle g \rangle < 0.3$, medium if $0.7 > \langle g \rangle \geq 0.3$, and high if $\langle g \rangle \geq 0.7$.

At last, the participants give their response by filling a questionnaire. They also write suggestions to improve the quality of the application.

We use a 4-scaled questionnaire to collect data about experts' evaluation, pre-service teachers' evaluations, and students' responses. The score is averaged for each aspect in the questionnaire. The average score is then classified into five categories, such as shown in Table 1. The classification is adapted from Ref. [25].

Table 1. Classification of questionnaire score

Score Interval	Criteria
$3.4 < \bar{X}$	Very Good
$3.4 \geq \bar{X} > 2.8$	Good
$2.8 \geq \bar{X} > 2.2$	Fair
$2.2 \geq \bar{X} > 1.6$	Poor
$1.6 \geq \bar{X}$	Very Poor

$\bar{X}$: average score of each aspect

3. Results and Discussions

The Features of the Mobile Application

The mobile application is designed for learning resources that can be used by students when they are learning circular motion topics. The mobile application has four main menus, i.e., material, simulation, problem examples, and quiz. The main menus are presented on the homepage (see Figure 2.).

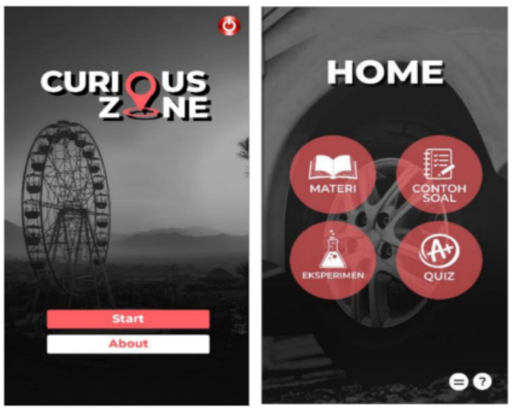

Figure 2. The screenshot of the opening and homepage of the application

The material covers circular motion topics in high school physics. It discusses the physical quantities, uniform circular motion, and non-uniform circular motion with constant angular acceleration. The material is equipped with illustration and animation to help students understand the concepts. Examples of circular motion in daily life are also presented. Figure 3. shows a screenshot of the material menu. The mobile application also provides simulation about uniform circular motion and non-uniform circular motion with constant angular acceleration. In a simulation, students can manipulate some variables and observe the change in other variables. Students are encouraged to make a graph based on the simulation data to understand the relationship among physical quantities in circular motion.

Figure 3. The screenshot of material (left) and simulation menu (right)

For individual learning activity, the problem-solving exercise is essential. The mobile application includes a problem example menu (see Figure 4.). This menu contains some problem examples related to circular motion; the solutions to the problem examples are also provided. With this menu, students can try to solve problems related to the concepts that they have learned.

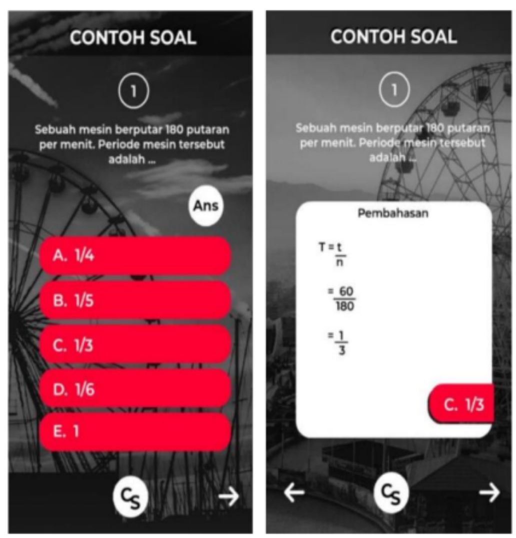

Figure 4. The screenshot of problem examples

At the end of the learning process, students can do self-evaluation of their study on the quiz menu. Figure 5. shows a screenshot of the quiz menu. When students open the quiz menu, students will be asked to do some multiple-choice questions. After they complete their answers, they can get the feedback directly.

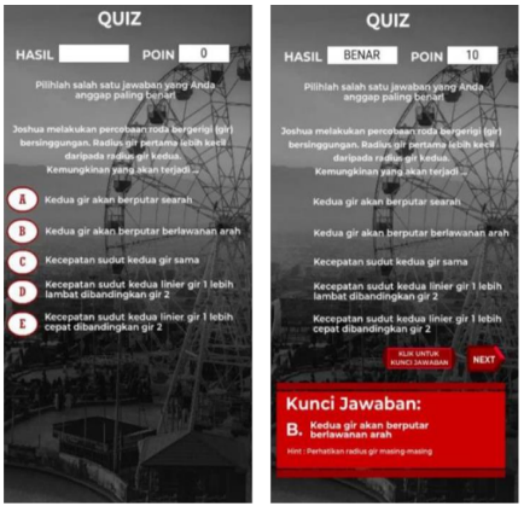

Figure 5. The screenshot of quiz menu

Developmental Testing

The mobile application is evaluated by two experts in the field of physics education. The experts assess the feasibility of the mobile application before it is being tested to students. They also give some recommendations to enhance the quality of the mobile application. The experts' recommendations become the primary consideration for the revision process. After several revisions, experts rate the mobile application as very good in terms of the content, instructional, layout, accessibility, and language aspects (see Table 2.).

Table 2. Expert evaluation to the quality of the learning resource

Aspects	Average Score*	Criteria
Material/Content	3.50	Very Good
Instructional	3.61	Very Good
Layout quality	3.79	Very Good
Accessibility	3.43	Very Good
Language	3.50	Very Good

* max score: 4.0

Besides, we also ask 20 pre-service teachers to review the mobile application. Overall, according to them, the developed application is appropriate to be used by students as a learning resource on circular motion topics. The evaluation from pre-service teachers is presented in Table 3. The mobile application has very good quality in terms of material, instructional, layout quality, and accessibility aspects.

Table 3. Pre-service teacher Evaluation to the quality of the learning resource

Aspects	Average Score*	Criteria
Material/Content	3.52	Very Good
Instructional	3.61	Very Good
Layout quality	3.65	Very Good
Accessibility	3.56	Very Good

* max score: 4.0

A field testing is conducted in a private high school in Surabaya, Indonesia. There are 23 students who participated in this pilot study. All of them have Android smartphones. In the beginning, participants are asked to do a pre-test. We ask them to install the developed mobile application on their phone and then use it to learn circular motion topics. After learning circular motion using the mobile application, each participant must do a post-test.

The average scores of pre- and post-test are presented in Table 4. As illustrated in Figure 6., students get a higher score on the post-test. Using the formula in Eq. 1, we calculate the normalized-gain score to determine how the students' learning improvement is. The normalized-gain score is 0.59. According to Hake (1998), this score can be classified as a medium improvement.

In this study, we do not compare this applied learning method with others. However, this study indicates that learning with the mobile application has affected students' learning achievement positively. This result is in accordance with the previous studies which showed the benefit of using mobile learning application in physics learning [26], [27]. The mobile application allows students to learn physics with multiple representations and visualization.

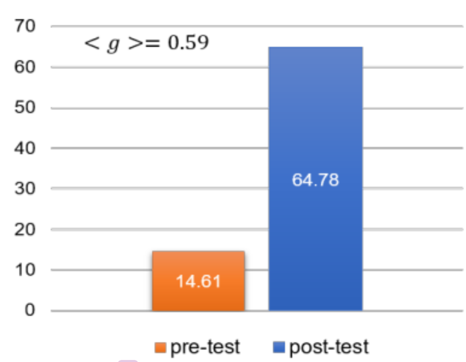

Figure 6. The average score of pre- and post-test

Table 4. The comparison between average score of pre-test and post-test

Average Score of Pre-Test	Average Score of Post-Test	Normalized Gain, <g>	Criteria
14.61	64.78	0.59	medium

Table 5. Students response to the quality of the learning resource

Aspects	Average Score*	Criteria
Material	3.41	Very Good
Instructional	3.46	Very Good
Layout quality	3.54	Very Good
Accessibility	3.49	Very Good

* max score: 4.0

At the end of the learning process, each participant gives their opinion to the mobile application that they use by filling a questionnaire. Students' responses are summarized in Table 5. Students' responses to the clarity of the material are very good. Students also give a very good rating on the instructional aspect. The layout quality is also very good. The font-size, button, background, and illustration are well designed so that students can read the material. Moreover, the accessibility aspects are very good.

4. Conclusion

In this project, we have developed a mobile application as a learning resource with topics of circular motion. According to the evaluation from the experts, the application is appropriate as circular motion learning resources. Based on the pre- and post-test results, there is students' learning improvement after using the developed mobile application. Also, students give a positive response to the mobile application. This study still has some limitations. We did not compare the developed application with other learning media or methods in field testing. In a further study, it can be improved by employing a quasi-experimental research design so that the effectiveness of mobile learning can be compared with other methods. Moreover, in this study, the learning improvement indicator is only limited to the cognitive domain. It will be better to consider other domains such as the affective and psychomotor one.

Acknowledgments

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References

[1]. Haug, S., Castro, R. P., Kwon, M., Filler, A., Kowatsch, T., & Schaub, M. P. (2015). Smartphone use and smartphone addiction among young people in Switzerland. *Journal of behavioral addictions*, *4*(4), 299-307. https://doi.org/10.1556/2006.4.2015.037

[2]. Zydney, J. M., & Warner, Z. (2016). Mobile apps for science learning: Review of research. *Computers & Education*, *94*, 1-17. https://doi.org/10.1016/j.compedu.2015.11.001

[3]. Chee, K. N., Yahaya, N., Ibrahim, N. H., & Hasan, M. N. (2017). Review of mobile learning trends 2010-2015: A meta-analysis. *Journal of Educational Technology & Society*, *20*(2), 113-126.

[4]. Hwang, G. J., & Wu, P. H. (2014). Applications, impacts and trends of mobile technology-enhanced learning: a review of 2008–2012 publications in selected SSCI journals. *International Journal of Mobile Learning and Organisation*, *8*(2), 83-95. https://doi.org/10.1504/IJMLO.2014.062346

[5]. Shen, R., Wang, M., & Pan, X. (2008). Increasing interactivity in blended classrooms through a cutting-edge mobile learning system. *British Journal of Educational Technology*, *39*(6), 1073-1086. https://doi.org/10.1111/j.1467-8535.2007.00778.x

[6]. Razzaq, A., Samiha, Y. T., & Anshari, M. (2018). Smartphone habits and behaviors in supporting students self-efficacy. *International Journal of Emerging Technologies in Learning (iJET)*, *13*(02), 94-109.

[7]. Huang, Y. M., Lin, Y. T., & Cheng, S. C. (2010). Effectiveness of a mobile plant learning system in a science curriculum in Taiwanese elementary education. *Computers & Education*, *54*(1), 47-58. https://doi.org/10.1016/j.compedu.2009.07.006

[8]. 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. https://doi.org/10.1016/j.iheduc.2013.06.002

[9]. Schmitz, B., Klemke, R., & Specht, M. (2012). Effects of mobile gaming patterns on learning outcomes: a literature review. *International Journal of Technology Enhanced Learning*, *4*(5-6), 345-358. https://doi.org/10.1504/IJTEL.2012.051817

[10]. Hsu, Y. C., & Ching, Y. H. (2013). Mobile computer-supported collaborative learning: A review of experimental research. *British Journal of Educational Technology*, *5*(44), E111-E114. https://doi.org/10.1111/bjet.12002

[11]. Yamamoto, N. (2014, November). An Interactive Learning System Using Smartphone: Improving Students' Learning Motivation and Self-Learning. In *2014 Ninth International Conference on Broadband and Wireless Computing, Communication and Applications* (pp. 428-431). IEEE. https://doi.org/10.1109/BWCCA.2014.125

[12]. Vogt, P., & Kuhn, J. (2012). Analyzing simple pendulum phenomena with a smartphone acceleration sensor. *The Physics Teacher*, *50*(7), 439-440. https://doi.org/10.1119/1.4752056

[13]. Kubsch, M., Nordine, J., & Hadinek, D. (2017). Using smartphone thermal cameras to engage students' misconceptions about energy. *The Physics Teacher*, *55*(8), 504-505. https://doi.org/10.1119/1.5008354

[14]. Arribas, E., Escobar, I., Suarez, C. P., Najera, A., & Beléndez, A. (2015). Measurement of the magnetic field of small magnets with a smartphone: a very economical laboratory practice for introductory physics courses. *European Journal of Physics*, *36*(6), 065002. https://doi.org/10.1088/0143-0807/36/6/065002

[15]. Hochberg, K., Kuhn, J., & Müller, A. (2018). Using smartphones as experimental tools—effects on interest, curiosity, and learning in physics education. *Journal of Science Education and Technology*, *27*(5), 385-403. https://doi.org/10.1007/s10956-018-9731-7

[16]. Amoroso, A., & Rinaudo, M. (2018). Study of oscillatory motion using smartphones and tracker software. In *GIREP SEMINAR 2016* (Vol. 1076, pp. 012013-012018). IOP Publishing.

[17]. Bano, M., Zowghi, D., Kearney, M., Schuck, S., & Aubusson, P. (2018). Mobile learning for science and mathematics school education: A systematic review of empirical evidence. *Computers & Education*, *121*, 30-58. https://doi.org/10.1016/j.compedu.2018.02.006

[18]. Wang, J. Y., Wu, H. K., & Hsu, Y. S. (2017). Using mobile applications for learning: Effects of simulation design, visual-motor integration, and spatial ability on high school students' conceptual understanding. *Computers in Human Behavior*, *66*, 103-113. https://doi.org/10.1016/j.chb.2016.09.032

[19]. 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 and Technology Education*, *11*(5), 1081-1088. https://doi.org/10.12973/eurasia.2015.1376a

[20]. Yuana, F., Rianto, S., & Hidayat, A. (2019, June). Development of Balmer Series Experiment Simulator in Mobile and Android Applications. In *IOP Conference Series: Materials Science and Engineering* (Vol. 546, No. 5, p. 052087). IOP Publishing. https://doi.org/10.1088/1757-899X/546/5/052087

[21]. Nada, N. Q., Saadah, U. K., Anam, A. K., Wibowo, S., & Novita, M. (2019, July). Design on 'FunPhy: Fun Physics' Educational Game Apps using Agile EXtreme Programming. In *Journal of Physics: Conference Series* (Vol. 1179, No. 1, p. 012071). IOP Publishing. https://doi.org/10.1088/1742-6596/1179/1/012071

[22]. Smith, M. K., Shull, J., Heaney, P. S., Shen, Y., Dean, A. W., & Michaeli, J. G. (2017). Overview of Game and Content Design for a Mobile Game that will Prepare Students in Calculus and Physics Prerequisites to the Engineering Curricu-lum. In *Proceedings of the American Society for Engineering Education Annual Conference and Exposition, Columbus, OH*.

[23]. Adobe. (2020). A new age for animation. Retrieved from: https://www.adobe.com/sea/products/animate.html#scroll [Retrieved from: 10. January 2020].

[24]. 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. https://doi.org/10.1119/1.18809

[25]. Widiyoko, E. P. (2013). Evaluasi program pembelajaran: Panduan praktis bagi pendidik dan calon pendidik. Yogyakarta: Pustaka Pelajar.

[26]. Liliarti, N., & Kuswanto, H. (2018). Improving the Competence of Diagrammatic and Argumentative Representation in Physics through Android-Based Mobile Learning Application. *International Journal of Instruction*, *11*(3), 107-122. https://doi.org/10.12973/iji.2018.1138a

[27]. 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. https://doi.org/10.12973/iji.2018.1111a

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