CAKA as Physics Learning Media Based on Android Apps on Smartphones

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Abstract. In this research, we aimed to design physics learning media based on Android apps on smartphones. The media were tested to ensure their validity, practicality and efficiency for learning activities. We used the Analysis, Design, Development, Implementation and Evaluation (ADDIE) model as the model of development. The media were tested through three steps: peer, expert and small group test. Data were collected via questionnaires, interviews and observations. This research produced physics learning media based on an application named CAKA (Becak Fisika). CAKA contains some senior high school physics topics such as work and energy, Newton’s laws and circular motion. The results showed that the CAKA learning media had good compatibility and there were no significant problems when they were used. The CAKA application was tested, and the result was found to be valid, practical and efficient for learning activities.

1. Introduction

The role of education in the digital era has become a new challenge in preparing innovative learning processes. It is true that technological advancements demand classroom learning processes that should be able to benefit from technology [1]. Learning processes that benefit from technology result in significant influences on students [2]. Students attain the impact of stimulation using technology-based media within their learning processes. Using technology-based media can create more interesting and joyful learning processes, consequently improving students’ achievements [3]. If technological advancements are maximally incorporated within learning processes, then students’ achievements will be maximum.

Nowadays, the rapid development of technology influences human life. Many novel tools have been born from this rapid development. One of such tools is smartphones. Smartphones are considered to be mini-computers owing to their multiple functions. The invention of smartphones gave birth to the adoption of innovations in numerous life aspects, one of which is the term ‘mobile learning’ within education. The term ‘mobile learning’ (m-learning) refers to the use of information and technology devices such as smartphones, laptops and PC tablets within learning processes. As an innovation in learning processes, m-learning enables learning processes to be more flexible and more non-teacher-centered. In addition, m-learning can assist students in performing their independent (student learning) learning processes [4]. Indirectly, m-learning will turn students into independent and critical individuals.

The term ‘m-learning’ refers to learning media that help student access materials, directions and applications in relation to learning processes in any location and at any time. Such assistance will
improve the focus on the learning materials, because the learning processes to be more persuasive and motivate students to be involved in lifelong learning. In addition, compared to conventional learning processes, m-learning provides more opportunities for interactions informally among students [5].

Using m-learning, students have the freedom to decide when and where they should perform the learning process. At the same time, m-learning also provides freedom to access information and learning materials that can improve the quality of life of an individual without paying attention to the residence, the social status or even the culture of that individual [6].

Media play a role important for learning processes. Before being used in the learning process, the media must fulfill several conditions. The conditions that must be owned by the media are educative, practical, efficient and feasible. Learning media is said to be educative if it contains information about knowledge that is unknown to students. Learning media must also be practical. Practically what is meant is that it is easy to use by teachers and students. The media must also be able to improve student learning outcomes when used. The most important learning media must be declared for use [7, 8].

Implementing m-learning in Indonesian education is not easy. Many problems are faced, especially the ability of teachers to use the media. Many teachers lack confidence in using m-learning in the learning process. The teacher is afraid of being wrong in conveying the subject matter because of a lack of understanding of the media used [9]. The complicated learning media used also become problems. Teachers have difficulty in operating the media in the learning process [10]. Then it takes a good learning media, easy to use and easy to access by teachers and students.

The ability of teachers Indonesia to prepare learning tools and media is still lacking. although it can make media, the media that is made is still far from expectations. media just only to meet the demands of the government administration and not to facilitate the learning process and increase students' knowledge. teachers lack awareness to use learning media. Teachers are less interested in adding supporting items such as computers, laptops, and notebooks. they are more focused on using the lecture method than using interactive learning media [11].

There are several reasons why mobile learning must be implemented in schools. First, is time flexibility. Many students spend time in school for training in several fields other than lessons, so students often miss lessons. Using m learning students can learn lessons outside school hours. Second, giving students the opportunity to repeat the material indefinitely. With the existence of m learning will help students to learn outside of school without the need to be tied to the teacher. The government emphasized the use of m-learning in schools, but the government only provides policies without providing examples of good media. The result teachers make the media poorly because they do not have the knowledge to make good learning media that can improve students' abilities. Consequently, the use of m-learning does not provide many benefits and instead wastes the teacher's time during the learning process [12].

Educational processes in schools may not leave the local wisdom [13]. Combination between local wisdom and science is very important in the learning process. Inserting local wisdom into the learning process can improve the quality of the learning process. Consequently, the process of learning physics will be more meaningful for the students. Local-wisdom-based learning processes can also improve the students’ learning results [14, 15]. With regard to the local wisdom, becak (pedicab) is a traditional vehicle that still exists in Yogyakarta. Becak is considered the local wisdom of the people of Yogyakarta because it represents modesty. Owing to that peculiarity, students will easily understand the learning materials if becak is part of the learning media, since they know a lot about becak.

Smartphones are considered the technology of the 21st century. They were first introduced by Apple Inc. (Cupertino, CA, USA) through their product named iPhone. Smartphones enable their users to talk, compose messages, browse the Internet and take pictures, all in one gadget [16]. They are handheld gadgets that have the capacity to provide wireless voice communication along with other supportive applications. Data applications usually include messages (text and multimedia messages), e-mail, audio recorders/players and Internet browsers. Another important feature of smartphones is their ability to connect to personal computers via a USB or wireless connection. This feature is used for uploading or downloading the user’s data, which usually consist of pictures, music, videos and other files.
Most smartphones operate on a system named Android, which is a Linux-based operating system (OS) that has been modified for mobile device use. This system consists of the OS itself, middleware and main applications. This system has been receiving updates since its first launch on 9 February 2009 under the name ‘Android Version 1.1’. Its first version was equipped with application updates, an alarm clock, voice search, e-mail delivery via Gmail and e-mail notifications. Several months later, Android Version 1.5, known as ‘Cupcake’, was launched. This version was certainly different from the previous one. Ever since the launch of these two versions, Android has been receiving updates for the features it has. At the time of writing this paper, the Android version that has been released to the market is Android Version 8.0 (Oreo) [17, 18].

The Android OS is developed for smartphones and tablets. It consists of four layers: application, application framework, library and Linux kernel. Most Android users interact with these layers. All applications are designed using the Java programming language. The application that has been designed belongs to the highest level in the structure of Android. This includes Android’s default applications, such as telephone, e-mail readers, programs, contacts and the calendar. Recently, Android operating system has been considered the best system of cellular operating system [19, 20].

2. Method
This research was conducted at Universitas Negeri Yogyakarta and SMAN 3 Yogyakarta. The objective of this research was the application CAKA, and the subjects of this research were physics lecturers, senior high school physics teachers, graduate students and Grade X students. The method that was implemented in this research was Analysis, Design, Development, Implementation and Evaluation (ADDIE) [21]. This method was selected as it is general and can be evaluated continuously until the desired results are attained.

The research began by analysing the problems and the needs of the students of SMAN 3 Yogyakarta. Then, the research was continued by designing the relevant product, and the product design consisted of the structure, content and layout. After the design was finished, the product was tested in order to identify whether there will be any problems during execution on smartphones. Afterwards, the product was validated by media and material experts together with senior high school physics teachers and graduate students. After the product validity was confirmed, the product was tested in a limited group that comprised 30 Grade X students from SMAN 3 Yogyakarta.

3. Result and Discussion
CAKA (Becak Fisika, or literally ‘physics pedicab’) is a learning media application that contains the learning materials of force and energy, Newton’s laws and circular movement. The CAKA application benefits from the element of local wisdom, becak or pedicab. Becak is helpful in pursuing the understanding of physics learning materials. From this becak, students can learn several learning materials, such as force and energy, Newton’s laws and circular movement.

3.1. Application Testing
All learning materials in the CAKA application are related to becak. Videos were inserted in order to facilitate the students’ understanding of the learning materials that are described in becak. One of these materials was kinetic energy, which could be seen from the pedal’s movement in becak as displayed in Fig. 1. Then, the learning materials of potential energy were described by an illustration that depicted a becak that went down the street, as displayed in Fig. 2. This illustration was inserted in order to facilitate the students’ understanding of the related learning materials. In addition to the materials and the videos, there were test items for the exercises that students might work on. The test items also contained the element of becak as displayed in Fig. 3.
When pedaled, pedicab drivers also give force to pedicab so that the pedicab moves and has kinetic energy.

**Figure 1:** Video display.

Translation: Potential Energy

*Figure 3.* Pedicab descends a road which has height, \( h \), from a flat road.

**Figure 2:** Material display.

Translation: Question 1

A pedicab with masses, \( m \), is pushed towards the uphill road with initial velocity \( v_0 \). At height, \( h \), the pedicab has kinetic energy of ....

**Figure 3:** Test item display.
The CAKA application was displayed using the black-box method. The test focused on the functionality of all menus and buttons in the application. This test was performed on a smartphone running Android by installing CAKA. The application was run and its performance was observed during the test. The results of the test on the overall menu and application buttons are shown in Table 1.

| Menu               | Testing                  | Result of Testing |
|--------------------|--------------------------|-------------------|
| Introduction       | Operating all of the existing functions | All functions ran well |
| Competence         | Operating all of the existing functions | All functions ran well |
| Material           | Operating all of the existing functions | All functions ran well |
| Becak Video        | Operating all of the existing functions | All functions ran well |
| Experiment Simulation | Operating all of the existing functions | All functions ran well |
| Exercise           | Operating all of the existing functions | All functions ran well |
| Library and Glossary | Operating all of the existing functions | All functions ran well |

From the results displayed in Table 1, it was apparent that all menus and application buttons ran well according to their functionality. The menus in the application that were tested were Introduction, Competence, Material, Becak Video, Experiment Simulation, Exercise and Library and Glossary. In the Introduction, there was information about CAKA and a brief explanation about becak. Then, in the Competence, there were basic competencies for each material and competencies that should be measured for each student. Next, in the Material, there were learning materials that were related to becak, such as force and energy, Newton’s laws and circular movement. Furthermore, in the Becak Video, there were videos that explained the parts of becak and the physics learning materials that were contained in becak. The Experiment Simulation contained the simulation that was performed in order to help the students implement the learning materials that they studied. The Exercise contained the test items and all the learning materials that have been delivered. The Library and Glossary contained information sources that were contained in the application and the definitions of several terms.

The experiment was continued by installing the CAKA application on several smartphones. The brands of these smartphones were Asus, Xiaomi, Lenovo, Samsung and Sony, which were all running Android OS. The results of the test that involved multiple brands of smartphones and multiple versions of Android are shown in Table 2.
Table 2. CAKA test on multiple smartphone brand and the operating android system.

| Smartphones         | Operating system | RAM    | Result                                           |
|---------------------|------------------|--------|--------------------------------------------------|
| Asus Zenfone 4 Max  | Nougat           | 3 GB   | Application ran well                             |
| Xiaomi 5A           | Marshmallow      | 2 GB   | Application ran well                             |
| Lenovo A6000        | Lollipop         | 1 GB   | Application ran well                             |
| Lenovo A6000        | Jelly Bean       | 1 GB   | Application ran well                             |
| Lenovo A369i        | KitKat           | 512 MB | Lagging                                          |
| Samsung Galaxy J2  | Marshmallow      | 1.5 GB | Application ran well                             |
| Prime               |                  |        | Application ran well but was very slow to respond|
| Sony Xperia E       | Ice Cream Sandwich | 512 MB |                                                |

Table 2 displays the results of the application test on multiple brands of smartphones and Android versions. The brands of smartphones that were involved in the experiment were Lenovo, Asus, Xiaomi, Samsung and Sony. On the other hand, the Android versions that were tested in the experiment were versions 4.0 (Ice Cream Sandwich), 4.1 (Jelly Bean), 4.4 (KitKat), 5.0 (Lollipop), 6.0 (Marshmallow) and 7.1 (Nougat). The results of the experiment showed that the CAKA application was able to run on all smartphones and Android versions. However, on the Lenovo A369i and Sony Xperia E, the performance of the CAKA application was not as good as that on the other brands. On the Lenovo A369i, the video menu suffered from lagging. The time taken to play the video was longer than on the other brands. This lag was found to be caused by the RAM that this brand had: 512 MB. The size of the RAM influences the performance of the smartphone while operating an application. Besides the Lenovo A369i, the CAKA application was installed on the Sony Xperia E, but the application took a long time to respond. This occurred whenever the application was running.

In order to evaluate the CAKA application, it was disseminated by uploading it to Google’s Play Store. By uploading the application to Google’s Play Store, many users will be able to try the application, and thus they can provide feedback for further development so that the application becomes better.

The results of the CAKA experiment on Android versions 4.0 (Ice Cream Sandwich), 4.1 (Jelly Bean), 4.4 (KitKat), 5.0 (Lollipop), 6.0 (Marshmallow) and 7.1 (Nougat) showed that the application was able to run on these versions. However, there were problems when the application was run on a smartphone with a RAM of less than 1 GB. This finding showed that the application can attain its maximum performance when run on a smartphone with at least 1 GB of RAM. Overall, the application will run well on all brands of smartphones and all Android versions.

A compatibility test was performed by installing and running the application on many devices. The devices that were available were 22 units. The results of the compatibility test are shown in Table 3.
Table 3. Result of compatibility test.

| Test                  | Operating | Failed | Score |
|-----------------------|-----------|--------|-------|
| Device installation   | 20        | 0      | 10    |
| Application running   | 20        | 0      | 10    |
| Total                 | 20        | 0      | 20    |
| Percentage            |           |        | 100%  |

Based on the results displayed in Table 3, it was apparent that the application can be installed on all devices in the experiment, and it can also run with 100% performance. These findings showed that the CAKA application meets the standards of compatibility.

3.2. CAKA Evaluation
The CAKA application has already been validated and evaluated by material experts, media experts, senior high school physics teachers and peer reviewers. An evaluation was also provided by senior high school students within a limited experiment. The Android-based learning media product that was developed in the research was very good in terms of the materials, media, quality and compatibility according to the results of the evaluation by the material experts, the media experts, the senior high school physics teachers, the peer reviewers and the students. The results of media quality evaluation based on the aspects of software engineering and visual communication according to the media experts, peer reviewers and senior high school physics teachers are shown in Table 4.

Table 4. Results of the evaluation of the aspects of audio, visual and software technology by media experts, peer reviewers and physics teachers.

| Aspects          | Media expert | Mean score by peer reviewers | Mean score by physics teachers | Maximum score |
|------------------|--------------|------------------------------|-------------------------------|---------------|
| Software engineering | 12           | 11                           | 11                            | 12            |
| Visual communication | 6            | 8                             | 9                             | 9             |
| Total            | 18           | 19                            | 20                            | 21            |
| Mean score       |              | 19                            |                               |               |
| Category         |              |                               | Very good                     |               |

Through the conversion of data from the evaluation by the media experts, peer reviewers and senior high school physics teachers with the two aspects (software engineering and visual communication) as the basis of the conversion, it was found that the learning media belonged to the ‘good’ category. The overall mean score that was attained for both aspects was 19 (with a maximum score of 21). The mean score belonged to Range A, which is referred to as the ‘very good’ category. The material experts together with the peer reviewers and the senior high school physics teachers evaluated the aspects of the learning process and content completeness within the media, and the results are displayed in Table 5.
Table 5. Results of the evaluation of the aspects of learning process and material/content completeness by media experts, peer reviewers and physics teachers.

| Aspects                        | Media expert Mean score | Mean score by peer reviewers | Mean score by physics teachers | Maximum score |
|--------------------------------|-------------------------|------------------------------|--------------------------------|---------------|
| Learning process               | 12                      | 11                           | 11                             | 12            |
| Material / content completeness| 6                       | 8                            | 9                              | 9             |
| Total                          | 18                      | 19                           | 20                             | 21            |
| Mean score                     |                          |                              | 19                             |               |
| Category                       |                          |                              | Very good                      |               |

From the results of the evaluations carried out by the material experts, peer reviewers and senior high school physics teachers, it was found that the mean score was 14.33 (with a maximum score of 15). The mean score that was attained in this regard belonged to Range A, which implied the ‘very good’ category. Then, the media evaluation that involved senior high school students comprised 30 Grade X respondents. The aspects that were evaluated were the learning process and materials as well as the media layout and operationalisation. The results of the evaluation are shown in Table 6.

Table 6. Result of media evaluation from the experiment.

| Aspect                        | Limited test | Maximum score |
|-------------------------------|--------------|---------------|
| Learning process / materials  | 14           | 16            |
| Operationalisation and navigation | 25         | 28            |
| Program’s attractiveness      | 15           | 16            |
| Program’s benefits            | 7            | 8             |
| Total                         | 61           | 68            |
| Category                      | Good         |               |

3.3. Discussion
The development of learning media conducted in this study resulted in media application products that can be run on Android smartphones. In addition, the learning media also meets the conditions that must be owned by the media, namely valid and practical. The application is named CAKA (Physics pedicab). After CAKA is finished, it is tested first using the black box method. From the results of the trial, all the menus in CAKA can run well. There were no problems when CAKA operated.

Next, CAKA is installed on various smartphone brands and Android operating systems. The results show CAKA can be installed and operated on various smartphone brands such as Samsung, Lenovo, Asus, Xiaomi and Sony. On various Android operating systems ranging from version 4.0 (Ice Cream Sandwich) to version 7.1 (Nouget), CAKA can operate properly. But there are problems when CAKA is operated using a smartphone with RAM below 1GB. When using a smartphone with Ram below 1 GB, the smartphone has slowed down.

CAKA was then evaluated by several media experts, material experts, physics teachers, and peer reviewers. The aspects assessed by CAKA are media and content. In the media, the aspect is divided
into 2 sub-aspects namely software engineering and visual communication. The assessment of these two sub-aspects can be seen in table 4. The score obtained by CAKA is 19 and is categorized very well.

In the Contents aspect, it is further divided into 2 sub-aspects namely Learning and Completeness of contents. The assessment of these 2 sub-aspects can be seen in table 5. CAKA scored 14.33 from a maximum score of 15 and was in the very good category.

In addition to assessments by media experts, material experts, physics teachers, and peer reviewers, also conducted limited trials on high school students. Limited trials were carried out on 30 10th grade students of SMA N 3 Yogyakarta. Students try CAKA on their respective smartphones and provide value. There are several aspects assessed by students namely Learning/material, operations and Navigation, program attractiveness and program benefits. Students give a high enough score for this application. Although there were some suggestions from students about the writing and music of CAKA.

CAKA itself is a very practical application because it can be installed on an android smart phone. Where almost all students and teachers have Android-based smartphones. Because being installed on Android, students can study wherever and whenever.

4. Conclusion
Based on the results of this study, it can be concluded that the results of validation by media experts, material experts, senior high school physics teachers and peer reviewers are very good according to the mean score that has been attained. The results of the observations showed that the CAKA application has good compatibility and does not encounter significant problems during operationalisation. As a result, this application can be considered to be valid, practical and efficient to be implemented in learning processes.

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