Developing smartphone-based laboratory manual as a learning media

A Suryanda*, N Sartono and H Sa’diyah
Biology Education Department, Universitas Negeri Jakarta, Jalan Rawamangun Muka, Jakarta Timur 13220, Indonesia

*adesuryanda@yahoo.com

Abstract. The purpose of this study was to develop a smartphone based laboratory manual as learning media for biology learning. This research was conducted using the ADDIE model (Analysis, design, development, implementation, and evaluation). The media feasibility test obtained an assessment of 90.28%, material experts 87.75%, biology teachers 91.37% and 88.46% students with very good interpretations. The increase in psychomotor ability test obtained a gain value of 0.49, which means there is an increase in psychomotor abilities of students with a moderate category. The conclusion obtained is that the smartphone-based laboratory manual has been successfully developed and is suitable for use in learning.

1. Introduction

The personal use of smartphones and related technologies in education has increased since 2000s. Smartphone technology is being deployed around the world at a rapid rate [1]. In the current industrial era 4.0 the use of mobile technology in learning has become a necessity as well as its own challenges for the world of education. Smartphones are a one of mobile learning technologies that are mostly owned by students compared to other mobile devices [2]. Based on the survey data from the Indonesian Internet Service Provider Alliance (APJII) that 50% of the Indonesian Population Owns Smartphones, which only reaches 25.72%. In accordance with observation data that 100% of students have smartphones and not all students have laptops and computers [3].

The use of smartphones as a learning media can generate many benefits for students, including smartphone is small and familiar for students, and deliver more interesting content than print-based conventional learning media [4]. In the industrial era 4.0, the use of smartphones in learning will make it easier for students to learn the material they want compared to if students have to buy one by one learning media separately. Technology can bring together the content that students want in just one device so that it becomes a new challenge in the development of learning media.

One of the learning media that requires a lot of content is lab work manual. In laboratory activity, students are usually given a module or instruction sheet before conducting lab work. But the common media provided is still in the form of conventional media with text and image elements only. This makes students still abstractly imagine the lab work procedure that they will do. However, the limited content of the module
which is only text has not been able to make students understand the procedure correctly. The images are also still limited because when they contain more images, the cost of producing modules will increase, so students must buy modules at a more expensive price. Even with the technological potential of the present era, learning media can be packaged in a more practical, interesting, complete manner, and contain all the elements needed by students without having to be separated.

Using smartphone technology, laboratory manual can be added to the elements even in addition to just images. These elements can be in the form of moving images / animations, sounds, simulation videos, and laboratory questions. Technology also allows students to learn laboratory activity with a learning media that are more complete, easy to obtain, fun, and can be learned anywhere. The use of smartphones in learning can also increase student learning motivation [5], improve student learning outcomes [6], and be able to improve student laboratory skills [7].

So the purpose of this study was to develop a laboratory manual based on smartphone application for students 11th grade senior high school. This media is expected to be an alternative media for learning lab manual that can more motivated students and improve their psychomotor learning outcomes.

2. Method
This research is a development research, a method that aims to produce a product then test the effectiveness. The stages in this research refer to the ADDIE model which consists of analysis phase, design, development, implementation, and evaluation. The feasibility test using feasibility instrument of material expert, media expert, biology teacher and students eleventh grade with small-scale test (12 students) and large-scale test (30 students) [8,9]. The subjects of the implementation step was students eleventh grade of SMAN 77 Jakarta as many as 30 students. The effectiveness test was to see gains score of psychomotor learning outcome between before and after using the media (pretest and post test).

3. Result and discussion
The steps of this research stages, there are analysis, design, development, implementation, and evaluation. At the analysis stage the researcher uses the instrument of needs analysis, teacher interview guidelines, and literature study data. The results obtained are learning media that can be developed are practical learning media with the needs of all practical material. Most practicum material is found in the eleventh grade of senior high school with a total of 9 practical material. The most widely owned devices by students are smartphone.

The stages of design are preparing flowcharts, then preparing designs for materials, images, and icons to be used with Microsoft Office. The next step is making practicum videos. Videos that have been recorded are then edited with adobe premiere and movavi video editing software. Figure 1 shows the stages of making lab work simulation video.
All videos that have been finished are then uploaded on a Youtube channel to be connected to the smartphone application. It aims to ease the storage so that the application does not require large storage space and disrupts performance when the smartphone is used. Youtube video link is then entered into the application so that the display will appear as shown in Figure 2. If students want to learn videos, the video will appear as a youtube display so it requires an internet connection to run it. Figure 2 also shows the process of combining the previously created youtube link with the menu that is in the application.

Figure 1. Editing lab work simulation video step.

Figure 2. Process of combining youtube link in the application.
After the process of submit was over, the web gave a link to download application so material expert, media expert, teacher and students can use the media for feasibility test. The material expert was biology lecture in biology department State University of Jakarta, and the media expert was media and ICT lecture in information and technology lecture from IT department State University of Jakarta. The result of feasibility was many suggestion to revised the display and some materials text in application. Then the product was given to teacher and students to see the response of the applications that have been developed. The results of the media feasibility test can be seen in Table 1. From the data we can know that the media get very good interpretations so that the media can use in biology learning.

Table 1. Result of feasibility test.

| Validator       | Percentage | Interpretation |
|-----------------|------------|----------------|
| Material Expert | 90.28      | Very good      |
| Media Expert    | 87.75      | Very good      |
| Biology Teacher | 91.37      | Very good      |
| Students        | 88.46      | Very good      |

According to students, the media can be used well and is very suitable for the needs of students in the current era. The lack of media according to the students is the internet network and the large number of quota that they have will affect the course of the application, thereby reducing the speed of access during learning. According to media experts and teachers, the use of the internet is actually not an obstacle in a media, especially if it is used in a big city like Jakarta. That is a challenge for students to increasingly interact with technological devices that become the learning qualification standards of generation 4.0 era [10].

The product effectiveness stage aims to determine the level of achievement of biology laboratory manual in learning, in this case biology laboratory activity. The effectiveness testing process is carried out by the design of the pre-test and post-test on three aspects of psychomotor learning outcome, there are assessment of laboratory knowledge, assessment of laboratory skills, and assessment of lab reports which are representative of the basic competencies themselves. The instrument and percentage assessment were adopted based on the psychomotor assessment instrument developed [11].

To see whether there is an increase in the average value of students before using the media with the use of the media, a gain test is performed on the overall psychomotor value which is divided into three assessment aspects, namely the assessment of practical skills, practical knowledge in the form of pre-test and post-test, and laboratory report. The results obtained based on the average increase in student grades are as in Table 2 below:

Table 2. Gain score of student’s psychomotoric outcome.

| No  | Aspect              | Gain Test Value | Interpretation       |
|-----|---------------------|-----------------|----------------------|
| 1   | Laboratory skills   | 0.51            | Moderate increase    |
| 2   | Laboratory Knowledge| 0.46            | Moderate increase    |
| 3   | Laboratory Report   | 0.16            | Low increase         |

The gain score of students’ psychomotor learning outcome was 0.49 with the medium category. From the results obtained, it can be seen that the increase occur after students use the application of laboratory manual in smartphone. It based on the observation sheet of lab work ability, it was seen that on average students experienced an increase in terms of preparation of tools and materials, laboratory skills according to the procedure, and the ability to provide observational results. At the time of laboratory activity, students have also experienced an increase in terms of independence of observation, in contrast to before giving the media,
students still gave many questions to their teacher about the correct procedures during the implementation of the lab.

It can happened because when students learn lab manual using media, there are video which is contain the stages they are doing through animated images or simulations therein. The video facilitates the construction of students' understanding so that indirectly guided students to carry out the procedure correctly. This is in accordance with the statement that the use of video has several learning goals, one of which is the goal into the psychomotor domain [11].

Unlike the previous guidelines that have existed, these guidelines are usually only in the form of text and images so that they experience limitations in terms of explanation of important points during the implementation of the lab. In this way, students have the possibility of greater procedural errors than when students learn through the smartphone application laboratory manual. Another reason is ability of the media to motivate students. Students who have simultaneous characters in the millennial era now also prefer learning that varies and tends not to be monotonous, which in this case can be overcome by the presence of learning videos. Videos integrated in Youtube can also stimulate active learning and provide additional knowledge beyond the expected capabilities [12].

4. Conclusion

Based on the results of the study, it can be concluded that the application of biology lab manual has been successfully developed with very good categories so that it is suitable for use by teachers and students in schools. The use of products by students has an average gain value in the medium category, which means that the use of media can improve students learning outcome.

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