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Development of Android Based E-Module on Biotechnology Topic

Dewi Jumiarni[1], Rendi Zulni Eka Putri[2], Rambat Nur Sasongko[3], Endang Widi Winarni[4], Eko Risdianto[5]

Universitas Bengkulu, Indonesia
[1]dewij@unib.ac.id, [2]rzekaputri@unib.ac.id, [3]rambatnur@unib.ac.id, [4]endangwidi@unib.ac.id, [5]eko_risdianto@unib.ac.id

ABSTRACT

This study purpose to develop an android-based electronic module on Biotechnology topic to suppot mobile learning. This study is an Research and Development research according steps to the ADDIE model (Analyze, Design, Develop, Implement and Evaluation). Data were collected by using questionnaires and interviews. Developed electronic module was validated by teaching materials experts and content experts. Students' responses analysis was carried out to 30 students. Result data were analyzed by using qualitative and quantitative descriptive analysis. The results of this study revealed that the Android-based E-module on Biotechnology topic that has been developed is in the highly valid category according to the validator's assessment of content experts and media experts, with validation score value are 87,5% and 94,28 respectively. While the student's response assessment revealed that the media was very good with a percentage of 87,5%. Thus the electronic module developed is feasible to be implemented in class for mobile learning.

Keywords: **Android, Biotechnology, Electronic Module, Mobile Learning**

A. INTRODUCTION

Recently the world has entered the time of industrial revolution generation 4.0 that is marked by exaggerated connectivity, interaction and development of digital systems, computing, and virtual. With the increasingly merging boundaries between humans, machines and alternative resources, info and communication technology definitely has an impression on numerous sectors of life, together with the education system in Indonesia. To deal with the time of industrial revolution 4.0, education is required to generate an creative, innovative, and competitive generation. One of the ways to attain this is by optimizing the utilization of technology as a tool education (Kariyanti & Handayani, 2021). In addition, Covid-19 pandemic has changed many aspects of life, including education. Various learning implementation strategies are carried out to ensure the continuity of learning, such online learning, study from home, and mobile learning by utilizing technological advances.

Biotechnology is one of topic in Fundamental Biology course. This topic discusses both a basic and an applied science. It is applied in agriculture, health care, forensics, industrial processing, and environmental management in many useful ways. Biotechnology is fascinating for students because it often gives recent contextual information and always evolving according to the development of science and technology. However, this topic requires a more complex understanding and insight because students have to learned theories and concepts from several different topics in one biotechnology subject, thus resulting in low mastery of student concepts in biotechnology topic.

Each student's learning ability is different, thus to realize the achievements of mastery concepts in this course, lecturers require right strategies and methods to conduct learning process more interesting and perceive. According to Lase (2016), there are nine trends associated with education 4.0, including learning anytime and anywhere, individual learning, students selecting their study method, project-based learning, field experiences, data interpretation, diverse assessments, student engagement, and mentoring. In connection with learning media, learning media are needed that can be used independently, online or mobile. Electronic module (E-module) is one of the media that can be used in accordance with this trend.

E-module is an independent teaching material that are systematically arranged into certain learning units, which are presented in an electronic format, where each learning activity in it is linked with a link as a navigation that makes participants students become more interactive with the program, equipped with the presentation of video tutorials, animations and audio to enrich the learning experience. According to Prasetya (2021), e-module is an ICT-based module that is

interactive, easier to navigate, displays pictures, audio, video, and animation, and is equipped with formative tests/quizzes that enable automatic feedback.

In order to accelerate student's accessibility, e-module is able to be equipped with an access system using Android, since it is the most widely used operating system in Indonesia. Based on data in December 2017, smartphone users with the Android operating system in Indonesia was 88.37%, which suggest the most widely applied operating systems than others (Sukir, 2018). Android-based e-modules are appropriate for students as they can be accessed using smartphones. This is evidenced by the results of need analysis through the distribution of questionnaires to students participating in Fundamental Biology course at Biology Education Department Bengkulu University which revealed that during online learning in covid-19 pandemic time, students mainly use smartphones as learning tools (83%). The smartphones were used when learning to access Zoom conference meeting or when getting assignments to search references on internet. Most of the students' smartphones use Android operating system (96,2%).

According to Masruroh & Agustina (2021), using an android in the teaching and learning process believed to be able to bring many benefits, including students can learn from multiple sources (with an internet network connection), learning activities can be carried out anywhere and whenever and it is not only limited in the classroom, it provides opportunities for teachers to develop digital-based learning techniques in order to they can gain maximum student learning outcomes. Previous study by Ahmar & Rahman (2017) concluded that the teaching materials based on Android is effectively used for learning activities and students understand the learning material faster and students are better prepared to face the subject matter. Therefore this study was conducted to develop an android-based e-module for Fundamental Biology course in Biotechnology topic to support mobile learning.

B. LITERATURE REVIEW

Mobile Learning

Mobile learning is a technology that is supported by flexibility in use. The emergence of mobile learning is motivated by several things, including the penetration of mobile devices is very fast, more than a PC, easier to operate than a PC, and mobile devices can be used as learning media (Susilo et al., 2019). The application of Mobile learning is based on the availability of networks and digital devices that are portable (easy to carry anywhere), including laptop computers, tablet PCs, PDAs (Personal Digital Assistants), game consoles, MP3s (for listening to audio recordings of lectures), camera phones and smart phone (smartphone), and

flexible in determining the place to carry out the learning process. Learning can be done using mobile phones so as to provide opportunities to connect informal learning experiences with formal learning experiences, such as learning in virtual classrooms, games or online learning (Agustina et al., 2016).

Implementation of mobile device in teaching-learning process have many advantages as following : 1) New ways of learning (applications, simulations, games, etc., 2) Facilitates access to information, 3) Facilitates the exchange of information, 4) Omnipresence of users, anywhere, anytime, 5) Self-regulated learning, 6) Leads to informal learning, 7) Learning Improvement, 8) A more natural approach to learning for generation "digital natives", 9) Better access to education in remote areas and developing countries (Agustina et al., 2016). Meanwhile the disadvantages of mobile learning are limitations and barriers can be divided into three specific areas: (1) Technological limitations of mobile devices and related technologies. For example insufficient cellular network coverage or link failure in wireless, small screens and keyboards, little coverage of cellular networks and short battery life, high costs associated with deploying and deploying mobile infrastructure for learning, content heterogeneity and content delivery to the user. (2) The use of learning by individuals and organizations. For example that not all learning applications have used usability tests, nor do we find guides or frameworks to evaluate them. This can generate problems with some groups of users are not very familiar with mobile technology and therefore have limitations on their interaction and understanding of learning applications, and (3) Cultural Aspects. For example, mobile devices can be perceived as sources of distraction, both by teachers and students, which may affect academic achievement. Some educational institutions report that the collaborative pedagogical use of mobile technology occurs to a limited extent and learning and face-to-face interaction with experts rarely occurs, this could be a threat that could degrade their educational quality. The acquisition of m-learning awakens students to a negative expectation, because students feel that they need to make additional efforts to master m-learning skills (Criollo et al., 2018).

Android Operating System

Android is an operating system for mobile phones based on Linux. Android provides an open platform for developers to create their own applications for use by various mobile devices (Ardiansyah & Nana, 2020). The developer is given the flexibility to develop Android applications in accordance with the needs of Android applications with no exception in the field of education, especially as learning media. Hence, smartphone completed with Andoid

operating system is possible to be used as a medium of online learning or currently more popular known as M-Learning (Mobile Learning) (Musahrein, 2016).

There are various versions of the Android OS such as: version 1.1, Android version 1.5 (cupcake), the Android version 1.6 (Donut), the Android version 2.0/2.1 (Aclair), the android version 2.2 (Froyo: Frozen yogurt), Android 2.3 (Gingerbread), Android version 3.0/3.1 (Honeycomb), Android version 4.0 (Ice Cream Sandwich) Android version 4.1 (Jellly Beans), the android version 4.4 (Kitkat), Android version 5.0 (Lollipop), Android version 6.0 (Marshmallows), and android version 7.0 (Nougat) (Musahrein, 2016).

The android system have several advantages and disadvantages. The advantages of Android including complete (complete platform), open (open source), free (free platform), and able be accessed at an affordable price. These advantages can be used by teachers to apply android-based teaching materials in a class that focuses more on theory than practice therefore create a more interesting class. Nevertheless, the android system also has some disadvantages such as almost all applications connected to internet, the presence of advertisements, and faster draining of smartphone battery power (Istiawan dan Kusdianto, 2018).

Electronic module

Modules are different teaching materials from textbooks. Modules provide opportunities for students to practice and accommodate student learning difficulties. The density of the material in the module has been adjusted to the needs of students unlike usual textbooks and the module also has a mechanism to collect feedback from students. Modules are structured and designed for students, this is what distinguishes them from textbooks. Through the application of the learning module, it is expected that students will become more active and responsible for the learning process and results they do, because students are more trusted to be more active in learning (Marzuqi & Sihkabuden, 2016).

Electronic modules as digital teaching materials must meet eligibility qualifications in terms of validity, applicability, practicality, presentation, and legibility as teaching materials. The use of electronic module can make the students learn independently and can access materials wherever they are, it also will change the views of students to read and consume interactively and make them comfortable, where the printed modules have images, narratives, and graphics but emodules can contain various features such as audio, music, animation, and video (Prasetya, 2021).

E-module is a form of independent teaching material that is arranged systematically with language that is easily understood into the smallest learning unit, presented in an electronic

format in which there are animations, audio, videos that make users more interactive with the program. Characteristics of modules electronics as above need to be owned by students because electronic modules have the potential to increase student motivation (Komikesari et al., 2020).

C. METHOD

This study was a research and development approach based on the ADDIE model, which consists of five phases, including analyze, design, development, implementation, and evaluation (Fig.1).

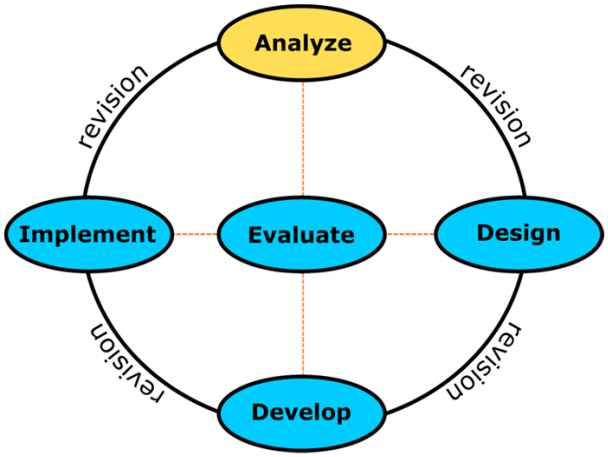

Figure 1. Research and development phase by ADDIE model

The research was carried out at each stage are as follows :

a. Analysis

The phase of analysis included needs analysis, semester lesson plan analysis, students characteristics analysis, content analysis, and technical analysis. Analysis phase was conducted to developed e-module that was appropriate and suitable to the students characteristics. The analysis phase was conducted by questionnaire distribution and observation in class.

b. Design

Design phase is a process which includes responding to the analysis phase. At this phase, an android-based e-module was designed based on the need analysis. Activities in this stage were : 1) Preparing content of biotechnology topic in the e-module, 2) Designing the e-module layout, 3) Collecting references related to Biotechnology topic.

c. Develop

At this stage, an android-based e-module were created by using Smart App Creator version 3.0. The writing of the module content is adapted to the e-module framework with the specifications in the form of android-based electronic media with biotechnology topic, displayed with the e-module display design. E-module feasibility was measured by validation by teaching materials expert and content expert. Result data from each expert was then analyzed to determine the level of module validity. E-module was revised based on suggestions from these experts.

d. Implementation

After the e-module was declared valid and feasible, this e-module was implemented to 30 students participating in the Fundamental Biology course, followed by filling out a questionnaire to determine student response readibility to the e-module that had been developed.

e. Evaluate

The evaluation was obtained from the results of student and teacher questionnaires, teacher interviews, and field notes. At the evaluation phase, the final revision of the product developed was carried out based on student suggestions at the implementation phase.

Data were analyzed descriptively and quantitatively. Descriptive analysis was carried out based on suggestions from the validator and suggestions from the results of the students response. The descriptive analysis technique is carried out by collecting information from the suggestions and criticisms given. Quantitative analysis is carried out based on the score validation results by content expert, teaching materials expert and lecturer. Quantitative analysis data were obtained from the assessment score using a questionnaire. When the calculation of the percentage of validity obtained, then a decision is made regarding the validity of the module which refers to Table 1.

Table 1

Criteria for Validity of Data and Decision Making on Revision of Module

Validity scale (%)	**Criteria**	**Decision**
86-100	Highly valid	Feasible and no revision
71-85	Valid	Feasible with minor revision
56-70	Sufficiently valid	Quite feasible with mayor revision
41-55	Less valid	Less feasible with mayor revision
25-20	Invalid	Not feasible and mayor revision

(Akbar, 2013)

For the score of student assessment results on teaching materials from the readability test, the assessment criteria refer to Table 2.

Table 2. Student response criteria

Score (%)	Criteria
76-100	Very good
51-75	Good
26-50	Sufficiently
≤ 25	Not good

D. RESULTS AND DISCUSSION

The Feasibility of E-Module Product

Android-based Biotechnology e-module was designed using Smart Apps Creator version 3.0. Smart Apps Creator 3 is an application for creating android and iOS mobile applications without programming code, and able to generate HTML5 and .exe formats. It could be used to create learning multimedia mobile applications and able to operated offline mode on an Android smartphone or on a laptop. The appearance of the e-module is as follows (Figure 1).

1. The first page is the title of the topic, namely “Bioteknologi”. At the bottom corner there is a button to turn off or turn on the accompaniment music.
2. The second page contains menu, namely "Materi", "Video" and "Latihan", each button when clicked will move to the content of the material according to the menu title.
3. The “Materi” page contains learning materials on the topic of Biotechnology with the sub-topics “Pendahuluan”, “Sejarah”, “Jenis Bioteknologi” and “Dampak Bioteknologi”. Each page has a "Home" button to return to the first page and a "Back" button to return to the previous page.
4. The “Video” page contains two examples videos of modern biotechnology
5. The “Latihan” page contains questions to evaluate students' level of mastery concept.

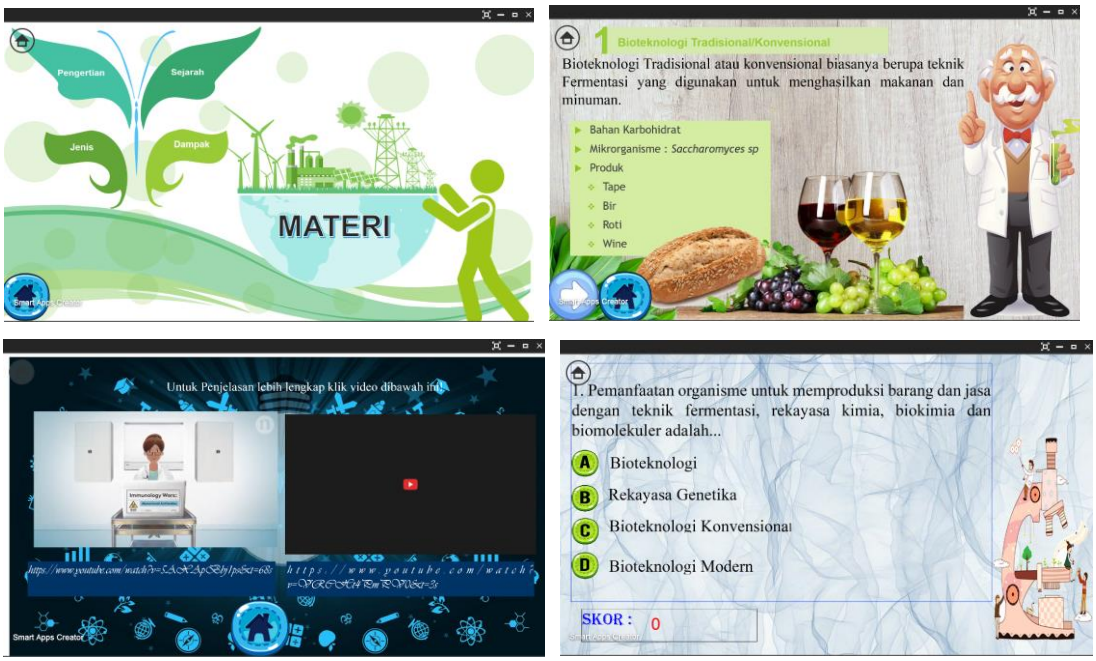

Figure 1. Android-based e-module product

To assess the feasibility of the e-module that has been designed, a feasibility test was carried out through a questionnaire assessment by validators of content expert and media expert. The validation results are shown in the Table 3.

Table 1. Result of E-module Validation

Validator	Score (%)	Criteria
Content expert	87,5	Highly valid
Media expert	94,28	Highly valid

The results of the validator's assessment show that the e-module Biotechnology was on the criteria highly valid. This result revealed that e-module product was feasible dan applicable as teaching material for Fundamental Biology course. However there are some suggestions for improvement from the validator are summarized in below :

1. At the beginning of the content, add a pointer button to scroll to the next view. The pointer button already exists, but only appears on the fourth page.
2. Activities are still limited to reading skills, watching videos, and doing questions. Add some activities that can give students the skills to create something, such as a simple biotechnology application project, for example making *nata* de coco, *tempe*, yogurt etc.

3. For modern biotechnology topic which targeting to higher students, add some examples of new knowledge such as leaf fragmentation techniques, gene guns, antisense technology, forensic biotechnology, bioremediation, Bioassays, Crown Gall, edible vaccines, etc.
4. In the video, examples of conventional biotechnology derived from local culture can be added, such as making tempeh, soy sauce, tape, and others.

The validator suggested to enhance the e-module with some project activities to encourage students skills in creating a biotechnology product, such as a conventional biotechnology application project, for example making *nata* de coco, *tempe*, *tapai*, etc. The addition of activities in the form of projects in learning process will increase students' mastery concept of biotechnology topic. This is in line with the statement of Fajrina et al. (2018), that the process of creating or implementing projects which are authentic, constructive in learning causes students learn new basic skills and experience increased knowledge. By using project learning, the learning process become more meaningful since not only memorize information, but more interesting. In this case, the e-module was revised by addition some project activities for students in groups, that is practice implementation of conventional biotechnology products.

Through project activities, the mastery concept of biotechnology topic become more meaningful toward conducting real experiments, rather than reading theory. Addition a project in learning provides opportunities for students to work independently to develop their own learning. Teachers are not sole source information, but students themselves are trying to get information. Students build their own knowledge by being actively involved in complex learning processes. Therefore, the knowledge will be stored properly because of the impression they get in the process to achieve more meaningful knowledge.

Biological learning should be contextual and based on student's environment therefore students are able to understand learning material (Sulistyawati et al., 2019). Furthermore, Ma'wa et al. (2022) stated that project learning encourages students and teachers to direct in-depth investigations of problem solving, collaboration, and critical thinking skills that reflect real-world problems that focus on a particular end product.

Material expert validators also suggest adding recent topics in modern biotechnology such as leaf fragmentation techniques, gene guns, antisense technology, forensic biotechnology, bioremediation, bioassays, etc. The addition of material in the form of recent topics will attract students' interest to read the developed e-module and will enhance the content of the module therefore the learning becomes attractive and comprehensive. In accordance with the objectives of the module's characteristics, the use of the module is frequently associated with self-instruction

activities, so the consequences that the module have to comprehensive; this means that the content or presentation material in a module should be completely discussed through presentations that students understand enough each topic in this module.

Students Response to The E-module

The results of students response readability test revealed very good category with a percentage of 87.5%. This is due to the e-module is interesting, practical and easy to use, therefore students understand the material and the learning media assist lecturers in delivering material to achieve learning objectives. In line with Djamarah (2016) state that the presence of learning media has quite an important meaning, because in these activities the ambiguity of the teaching materials delivered can be helped by presenting the media as an intermediary and with this media the teacher can be avoided flatness and student fatigue in learning. Module can be developed into two modes, both online learning and face-to-face learning (Wimbi et al., 2021). Moreover, the use of android-based as learning media is very feasible, can improve student learning outcomes (Handayani et al., 2021), very suitable for students and is effectively used for distance education activities, especially during the current COVID-19 pandemic (Nurhasanah et al., 2021). Implementation of e-module allows students to learn independently and gain access to materials from anywhere. It also transforms students' reading experiences with interactive and comfortable media. Whereas printed modules contain images, narratives, and graphics, e-modules contain a variety of features such as audio, music, animation, and video (Prasetya, 2021).

CONCLUSIONS

It can be concluded that developed android-based e-module is highly valid category according to validator's assessment of content expert and media expert with validation score value is 87,5% and 94,28 respectively. While the results of the student's response assessment were very good with a percentage of 87,5%. Therefore, the e-module is feasible to be implemented in class for online learning.

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