Development of E-Modules Assisted by PjBL-Based AR on Angiosperms Topic

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Abstract. Learning is inseparable from strategies, teaching materials and learning media so that there is maximum two-way interaction between students and lecturers. Teaching materials owned by students on the topic of angiosperms are still very general and simple without using the latest learning media. Furthermore, students' understanding of the topic of angiosperms is still low and teaching materials are less motivating. The research carried out was research and development using the Lee and Owens development model (2004) with a total of 72 biology students batch 2021 subjects. The development was carried out in May-September 2022. The types of data obtained were qualitative data and quantitative data. The assessment instrument uses a media expert questionnaire sheet and product practicality from students and field practitioners. Based on the development carried out, it was obtained 96% with very valid criteria.

Keywords: E-Modules, PjBL, AR.

1 Introduction

Flower structure is one of the important topics in lectures at the UM biology department. This topic is part of the lecture on plant structure and development which must be mastered by all UM biology department students. Even though this topic is very important, not all students can understand and master it due to a lack of motivation in studying the topic of flower structures, lecturers who still dominate lectures and supporting materials such as teaching materials that have not kept up with the times. Teaching materials owned by UM biology department students on the topic of flower structures are still very simple, supporting pictures are still simple and not very clear, there is no latest technology and do not have clear learning activities. These teaching materials are still not able to support lectures on the topic of flower structure because the main characteristics in this topic are the clarity of supporting images and the material contained must be complex. Not a few students still have difficulty clearly observing the structure of flowers in practicum activities so that the teaching materials they have must be able to overcome these main problems. [1] revealed that today's students are modern Gen Z students, which is why many students require digital visual aids to receive educational materials.

Each learning process requires a stage or learning strategy so that the learning process can run smoothly. In studying the structure of flowers, students are required to

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study the parts of the flower structure to produce an innovation related to the structure of flowers in everyday life. To achieve this goal, a learning strategy is needed in the form of a PjBL learning model. Positive impact of PjBL in increasing pre-service teacher learning outcomes and understanding and specific knowledge. For the skills aspect, the analysis results reveal that pre-service teachers develop academic skills, teaching-related skills such as cognitive and skill aspects of instructional design and pedagogical skills, scientific research skills and digital skills. Besides, through the use of competency assessment scales, many studies have shown the effectiveness of PjBL in the development of cognitive skills of teachers-students such as higher-order thinking skills, problem-solving skills, creative thinking skills, and analogical/metaphorical thinking skills [2]. The PjBL model will encourage students to associate concepts or topics in daily life, increase activity in the learning process, increase motivation and develop team spirit so that their cognitive learning results also increase [3].

One of the technological developments that is currently spreading is augmented reality (AR). The development of AR technology has mostly been included in the world of education but is still rare in the world of education, especially plants (botany). Augmented reality is a technology that combines computer-generated virtual objects with the real world in real-time. It is about integrating two-dimensional or three-dimensional virtual elements into the physical environment. In doing so, augmented reality augments the real world by adding virtual elements that seem to coexist with reality. This technology allows users to experience virtual objects as if they were actually present in the real world, resulting in engaging and immersive interactions [4]. Learning ability encompasses multiple aspects, including approaches to learning, existing knowledge, areas of lack of understanding, and assessment of future learning goals. Basically, the initial ability is the cognitive ability that a person acquires through learning before the new learning process [5]. Unlike virtual reality technology, augmented reality does not create a completely virtual environment, but combines virtual elements with the real world virtual objects are added to the user's real environment, which changes according to his actions [1].

The use of augmented reality (AR) technology in education proves beneficial in imparting knowledge, skills and attitudes while capturing students' attention and stimulating their interest and effectively. The use of technology in teaching and learning activities is very beneficial. Today, technological advancements can be seen in many aspects of everyday life. Without modifying the content of the material, educators should create engaging learning materials [6]. Augmented reality technologies are creating unique opportunities in education. By applying these AR technologies in an educational setting, and supplementing them with relevant visual information, you can create a visual template for teaching materials. As a result, students' spatial imagination develops, helping them to understand more deeply about processes, properties, proving theorems [1]. Since augmented reality creates a three-dimensional visualization of real objects, it encourages students to better understand the lessons being taught and increases their curiosity to think critically. Thanks to great curiosity, there is also great enthusiasm for learning [7]. [8] revealed some of the weaknesses of Augmented Reality, among others (1) Lack of infrastructure, (2) Requires training, (3) Limited device battery life, (4) Risk of distraction and non-concentration, (5) Lack of control.

Based on the explanation above, it is necessary to develop E-Modules Assisted by PjBL-Based AR on Angiosperms Topic in helping students understand the topic of flower structure and in the future there will be teaching materials that can help students understand material, especially in the field of botany using the latest technology.

2. Methods

The research conducted is research and development using the development model of Lee and Owens (2004). In the Lee and Owens model there are several stages including (1) assessment or analysis, (2) design, (3) development, (4) implementation and (5) evaluation but in the research conducted it was only limited to the development step. The type of data obtained is descriptive quantitative. The instrument used was a media validation sheet with a Likert scale of 1-5. The schematic model of [9]Lee and Owens (2004) can be seen in Figure 1. The steps in the Lee and Owens Model will be described as follows.

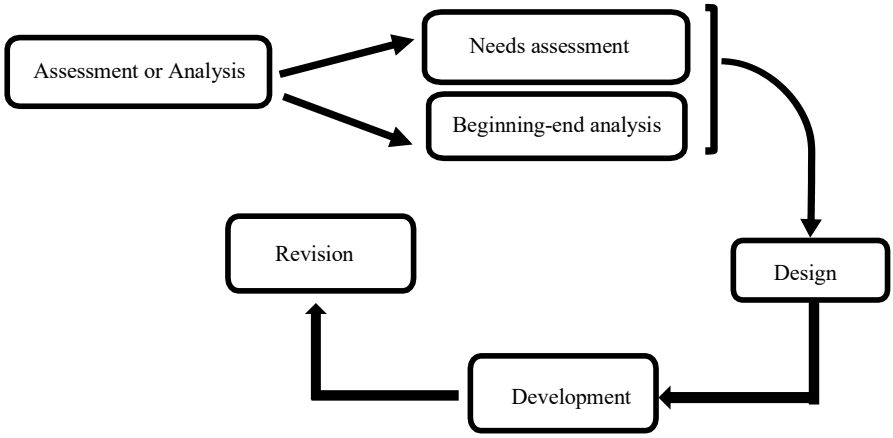

Fig. 1. Lee and Owens (2004) Step Model Schematic

2.1 Assessment or Analysis

In the first step there are stages, namely needs assessment and initial-end analysis. At the needs assessment stage, it is carried out based on a preliminary study using the interview method with the course lecturers with the aim of knowing the gap between the real condition and the desired condition. The next stage is the initial and final analysis with nine stages, namely student analysis, technology analysis, learning situation analysis, task analysis, critical incident analysis, objective incidents, media analysis,

available data analysis and cost-benefit analysis. The stages in the initial and final analysis were carried out using the observation method on students and supporting lecturers to find out the real conditions and problems that exist in the learning process.

2.2 Design

The next step is design. The design step is a multimedia design that will be developed based on the problems that arise. Multimedia development will be carried out in May-September 2022. Then a validation process will be carried out by media experts which will be carried out in October 2022. In the design step there are several media specifications, namely software, hardware, interface design, themes, text, images and videos adapted to the material which will be brought.

2.3 Development

The development step is carried out by making workflows into storyboards, developing material elements into electronic modules and compiling instructions for using electronic modules as well as conducting reviews or improvements with the consideration of media experts so that electronic modules are feasible for further development.

3. Results and Discussions

3.1 Findings in the Analysis, Design and Development Stage

In the development of E-Modules Assisted by PjBL-Based AR on Angiosperms Topic, observations and interviews were carried out with lecturers in the plant structure and development course. Furthermore, these results will be used as a basis for developing electronic module products. Following are the findings that have been made at each step of Lee and Owens

Assessment or analysis. The findings at this step are that the teaching materials used do not have the latest technology, the teaching materials are only in the form of pdf, the images in the teaching materials are less attractive. Furthermore, the teaching materials that are owned do not have stages of the learning process so that the student learning process is not structured. Biology department students have heterogeneous backgrounds and have the ability to use technological devices such as laptops and smartphones. The material that is very difficult for biology department students to understand is the flower structure contained in the CPMK flower morphological structure so that the material contained in the electronic module focuses on that material.

Design. In accordance with the findings in the assessment or analysis step, an electronic module was developed that can assist students in understanding flower structure material. In the design there are several specifications that must exist, among others:

a) Software: software used is Unity and Google Drive

b) Hardware: PC dan Mouse
c) Interface design: electronic module cover, preface, table of contents, floral structure material, material relating floral structures to stem and leaf structures, concept maps for each material, learning activities with PjBL syntax, reference lists, QR-Code Augmented Reality images and electronic module developer biodata page
d) Theme: the theme used is in accordance with the main topic, namely the structure of flowers
e) Text: the text used is adjusted to the needs in development

After preparing the design to be developed, the next step is to make the learning process flow in E-Modules Assisted by PjBL-Based AR on Angiosperms Topic. The following is the flow of the learning process.

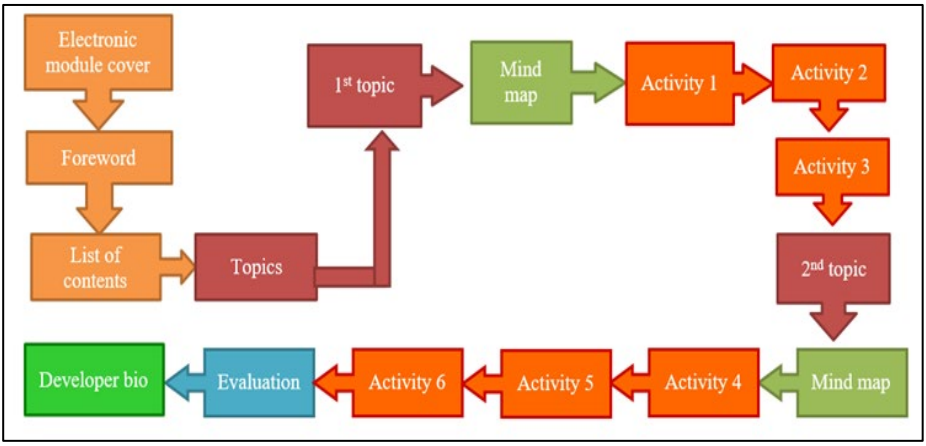

Fig. 2. Learning Flow E-Modules Assisted by PjBL-Based AR on Angiosperms Topic

Development. The development step is carried out after making the learning process flow. The following is a description of the product specifications developed

a) Cover
The developed cover contains the title "Modul Elektronik berbasis PjBL berbantuan Augmented Reality", electronic module maker, UM logo and visualization image of one of the materials in the electronic module.
b) Preface
Contains the author's words in compiling E-Modules Assisted by PjBL-Based AR on Angiosperms Topic as well as the expectations of the compiler of the product being developed.
c) Table of Contents
Contains several material lists to the developer page. The table of contents contains pages making it easier for readers to find the material they need
d) List of Images
Contains a collection of images used in the Electronic Module

e) Sub-CPMK and Course Objectives
Contains several skills that must be mastered by students in topic
f) Concept Map
Contains some of the main points that will be discussed in several materials
g) Topic 1 Morphological Structure of Flowers
h) Topic 2 regarding the morphological structure of flowers with the structure of stems and leaves
i) Learning Activities with PjBL Syntax
Learning activities contain activities that must be carried out by students in each meeting. This activity must be done before entering into the next activity.
j) Reference List
Contains several references used in creating material content and image content
k) Developer bio page
Contains some developer biodata from E-Modules Assisted by PjBL-Based AR on Angiosperms Topic which consists of authors and supervisors

Fig. 3. Cover E-Modules Assisted by PjBL-Based AR on Angiosperms Topic

Topic 1 contains several sub-materials which are equipped with various visuals that support the material as well as several Augmented Reality QR Codes that will appear using applications that have been made previously. Topic 2 contains several sub-materials that are equipped with various visuals that support the material as well as several Augmented Reality QR Codes that will appear using applications that have been made previously. Furthermore, the product that has been made will be validated by media experts to produce a valid product. The media validation results are contained in table 1.

Table 1. Percentage of Learning Media Validation Results

No	Media	Persentage	Criteria
1.	Media Topic 1	96%	Very Valid

2.	Media Topic 2	96%	Very Valid

3.2 Development E-Modules Assisted by PjBL-Based AR on Angiosperms Topic

The findings at the analysis stage form the basis for making learning media. These findings include teaching materials owned by students in lectures on plant structure and development that are not attractive, images are not visualized properly, there are no clear learning steps, the technology used is still very simple and there is a gap in understanding between the supervising lecturer and course students. Based on this review, an Augmented Reality-assisted PjBL-based electronic module was developed which has 9 QR Code Augmented Reality and an electronic module in the form of a flipbook. In the teaching process, the teacher does not only provide knowledge but also integrates all the skills he has [9].

The main directions for modernizing biology teaching are: visibility, accessibility, the relationship between theory and practice, and knowledge solidity of students. Recently, students' interest in biology has decreased. And this is unfortunate, because biology, as a natural science, provides knowledge about the world around us, forming a correct perception of the world around us. around us and this determines an individual's behavior and activities in society [10]. Good learning materials can be a crucial motivate of collaborative learning and have a real impact on enhancing student outcomes. Study material is really an important control to achieve learning outcomes. One of the new learning styles adopted by teachers is media or tool development [11].

Augmented Reality technology is the concept of merging the virtual world with the real world by generating information from data taken from the system on the desired real object so that the boundary between the two becomes thinner [12]. Although Augmented Reality technology is very promising, its use in education, especially biology, is still rare. The topic of biology has many very abstract topics that require clear visualization so that the planned learning objectives can be achieved. The development of AR media in the electronic module on the topic Angiosperms aims to make it easier for students to observe observable materials that are difficult to observe directly or with the help of a stereo microscope.

The percentage of media validation results in the electronic module on Flower Morphological Structure Topic and Topic Related to Flower Morphological Structures and Stem and Leaf Structures is 96%. This percentage is in the very valid category based on Akbar's criteria (2013). Good learning is student-centered learning so that lecturers must behave actively, creatively, innovatively and effectively in choosing learning methods so that student learning motivation increases, especially in Angiospermae topic which is considered difficult and memorizes a lot [13].

With the development of AR media in the Angiosperm electronic module, it can help students understand Angiosperm material because it has several advantages, including: (1) Augmented Reality contains digital content (audio, video, 2D and 3D objects) that looks integrated with the real world through devices (device), (2) AR allows content learning in three dimensions (3D) so that it can visualize things that are difficult to observe, (3) AR's ability to present virtual objects into the real world in real time can increase student learning motivation [14].

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