

Development of Interactive Digital Modules Based on Augmented Reality

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ABSTRACT

Interactive digital modules have now become a new commodity in the world of learning that must be a major concern in order to facilitate an efficient and flexible learning process. The purpose of this development is to create *augmented reality* to be used as a learning resource by all academics. This study uses the Lee & Owens development model which consists of 4 stages, namely *assessment/analysis, design, development and implementation, and evaluation*. This development activity involved a learning media expert, a material expert, and 8 small group pilots to assess the feasibility of the digital module being developed. Based on the presentation of the validator's assessment of *the augmented reality*, it can be concluded that *augmented reality* is very valid criteria which means it is very good for use in learning with a percentage of 90.25% of media experts, 88.75% from material experts, and 86.5% from small group trials. Researchers recommend using this material as a learning resource for Information Technology courses that can be accessed on the Halu Oleo University website. Researchers also suggest making *augmented reality* as part of the learning materials developed.

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1. INTRODUCTION

The development of technology that has reached the era of the industrial revolution 4.0 and *society* 5.0 has brought fundamental changes to human life, including a paradigm shift in learning. The government through the Ministry of Education and Culture responds to the times by issuing the Independent Learning-Independent Campus policy with the ultimate goal of increasing the competence of graduates, both *soft skills* and *hard skills*, to be better prepared to face challenges at the global level. Halu Oleo University welcomed this policy by carrying out various curriculum

reconstructions that were adapted to the Independent Learning-Independent Campus policy and changing the learning process by using a mixed method of face-to-face learning and online learning (*hybrid learning*).

Online learning is an educational innovation that involves elements of information technology in learning (Fitriyani, Fauzi, & Sari, 2020). Online learning is basically learning that is done virtually through available virtual applications while still paying attention to the competencies to be taught (Syarifudin, 2020). Online learning at Halu Oleo University is facilitated by the availability of *Learning Management System (LMS) Moodle* which can be accessed on the website <http://e-green.uho.ac.id/>. Data as of March 29, 2021, Halu Oleo University LMS has been used by 283 lecturers in 144 courses, with 7864 users from 106 study programs. The LMS of Halu Oleo University has been registered with the SPADA Indonesia aggregator. Various online learning support devices provided by Halu Oleo University are an effort to support the implementation of online learning. However, based on the results of the internal evaluation, a fundamental and most urgent problem was found, namely the lack of availability of quality content and support for the achievement of maximum learning. The material presented in online learning is still in the form of PowerPoint material that is not supported by video and animation, so learning multimedia is not formed. The material is monotonous and uninteresting, thus making students not interested in reading the material provided.

Similar problems occur in the Information Technology Course studied by FKIP students at Halu Oleo University. This course is a general course programmed by first-semester students (one) with the aim of introducing early on the importance of IT integration in education. *The outcome* of this course is that students are expected to be able to determine, design, and implement applications/platforms/software that supports the education sector so that educational goals can be achieved as expected. This course is the main foundation for FKIP students in general and especially Mathematics Education students to be able to have IT skills to support online learning. The reality in the field shows that early semester students experience a number of difficulties in understanding in detail the shape of computer components such as *motherboards*, CPUs, VGA, RAM, *processors*, and *sound cards*. This is because most of these students come from rural, coastal, and island areas and still lack knowledge of computer technology and its use in learning at school.

Another problem in the Information Technology course is that there are no adequate digital modules that students can use for independent study. In fact, students need concrete examples and interactive content to make it easier for students to understand the material. Interactive digital modules have now become a new commodity in the world of learning that must be a major concern in order to facilitate an efficient and flexible learning process. Various kinds of research have been carried out such as (Irwandani et al. 2017) developing an interactive digital module based on *articulate studio'13*. Another research was carried out (Mawarni & Muhtadi, 2017) by developing a *digital book* interactive *compact* disk and a manual. Meanwhile (Winatha, Suharsono, & Agustini, 2018) in their research shows that the results of designing interactive e-modules that have been developed in digital simulation subjects using innovative project-based learning models are successfully applied and feasible to be implemented in the learning process. The description above creates a new space for this research to combine interactive digital modules with *augmented reality* because based on existing data, there has not been found an interactive digital module based on *augmented reality*.

Augmented reality is a technique that combines two-dimensional and three-dimensional virtual objects into a three-dimensional real sphere and then projects these virtual objects in real-time (Hanan, Fajar, and Pramuditya 2018; Soepriyanto, Sulthoni., and Ulfa 2017; Wardani 2015). (Pellas et al., 2019) explained *augmented reality* can allow students to add learning experiences based on ideas and concepts that are being given and visualized through objects. *Augmented reality* has the ability to combine virtual objects and the real world together so as to create quality learning and good learning activities (Saputra et al. 2020). *media Augmented reality* in learning has several advantages, namely: (1) more interactive, (2) effective in its use, (3) can be widely implemented in various media, (4) object modeling simply because

it only displays some objects, (5) the creation of which does not cost too much, and (6) easy to operated (Ilmawan & Kurniawan, 2017).

Based on the problems described above, it is necessary to develop a quality interactive digital module and become one of the sources of student learning. The digital module developed is devoted to the Information Technology course as a pilot project at the Halu Oleo University FKIP, especially the Mathematics Education Study Program. In addition to internal purposes, this digital module will also be used as an open source material that can be accessed by the entire community through the SPADA Indonesia website. The interactive digital module developed is an interactive digital module based on *augmented reality* that is quality and efficient to be used as a learning resource by all academics. The development of this digital module is a learning innovation to be able to increase the fulfillment of access, relevance, and quality of learning in higher education to improve student competencies which will make them more active people in learning and get a more meaningful learning experience.

2. METHODS

This study uses the development model developed by (Lee and Owens 2004). This model consists of 4 stages, namely assessment/analysis, design, development and implementation, and evaluation. The first stage, namely assessment/analysis, is carried out by identifying the appropriate competencies between the learning objectives and the profiles of graduates of the Mathematics Education study program, the need for materials and teaching media related to these courses, and supporting infrastructure. The second stage, namely design carried out by designing interactive digital modules that are in accordance with the characteristics of the course, student conditions, and student needs in general.

The third stage is development and implementation. This stage consists of marker development activities, 3D products, videos, and applications. The development of markers is carried out to obtain markers with an augmentable level so that they have a fast readability level by the application. The marker design used is a QR Code with images to make it easier for users to recognize 3D objects and videos that will appear. Modeling 3D objects and giving skins to 3D objects is the next activity by utilizing 3D model development software. Video functions as a medium that can complement the shortcomings of other media such as 3D, text, and images. The final stage in this process is application development. The output of this application is in the form of a file in the application package file (.apk) extension that can be installed on a smartphone. The application developed in this interactive digital module consists of 3 applications, namely AR Component, Computer-Application, and Computer_Learning.

The fourth stage is an evaluation that aims to determine the feasibility of augmented reality. This evaluation activity involved a learning media expert, a material expert, and 8 people for small group trials. The instrument used to collect data using an instrument in the form of a Likert scale. The results of this test are used as a benchmark for the feasibility of developing interactive digital modules and improvements based on suggestions from experts. The media eligibility criteria in this development can be seen in Table 1 below.

Table 1. Eligibility Criteria for Learning Media

| Percentage (%) | Information Validity | Conclusion |
|----------------|----------------------|----------------------------------|
| 25.00-40.00 | Invalid | not be used |
| 41.00-55.00 | Less valid | not be used |
| 56.00-70.00 | Sufficiently valid | May be used after major revision |

| | | |
|-------------|------------|----------------------------------|
| 71.00-85.00 | Valid | May be used after minor revision |
| 86.00-100 | Very valid | Very good to use |

(Adaptation Akbar, 2016)

3. FINDINGS AND DISCUSSION

Analysis

This development begins with the *assessment/analysis* which is carried out using a brainstorming discussion method between the development team and the head of the study program to produce a formulation of learning outcomes and innovative products that are in accordance with the characteristics of students of the Mathematics Education study program. The results of the discussion provide information related to material that is in accordance with the characteristics of *augmented reality*, namely Computer-Based Information and Communication Technology in Information Technology Courses. The formulation of learning outcomes has also been adapted to the needs of the material and has been organized in interactive digital modules that have been developed.

At this stage, the implementation team also analyzes the available technology, where in developing *augmented reality* software, AR application developers and 3D models are needed. There is 2 software used to develop augmented reality media, namely *software* application developer *augmented reality* and supporting application developer software *Augmented reality* is used to set the layout of 3D images and insert *scripts*. Support software is used to upload *markers* so they can be scanned. The technology available to implement *augmented reality* is *smartphones* owned by students and lecturers.

Design

The second stage in this development is *design*. Design activities are carried out by preparing a schedule plan for developing interactive digital modules, dividing the tasks of teams involved in developing interactive digital modules, specifications for *augmented reality*, and structuring the contents of interactive digital modules based on *augmented reality* which include: (1) course descriptions; (2) learning outcomes; (3) learning map; (4) module usage instructions; (5) references; (6) content presentation consisting of application installation, concept exploration, and guided reflection; and (7) evaluation. The arrangement of the contents of the interactive digital module also includes the arrangement of text, images, markers, 3D objects and videos. The outputs of this activity are lesson plans, program maps, and *flowcharts* for the preparation of interactive digital modules.

Development and Implementation

The third stage is *development and implementation*. This stage is an activity to compose an interactive digital module based on *augmented reality* in accordance with the design that has been prepared. Details of the development of interactive digital modules can be seen in the following pictures:





Figure 2. Augmented Reality Video Marker Material Use of Computers in Learning



Figure 3. Display of Interactive Digital Module Learning Map

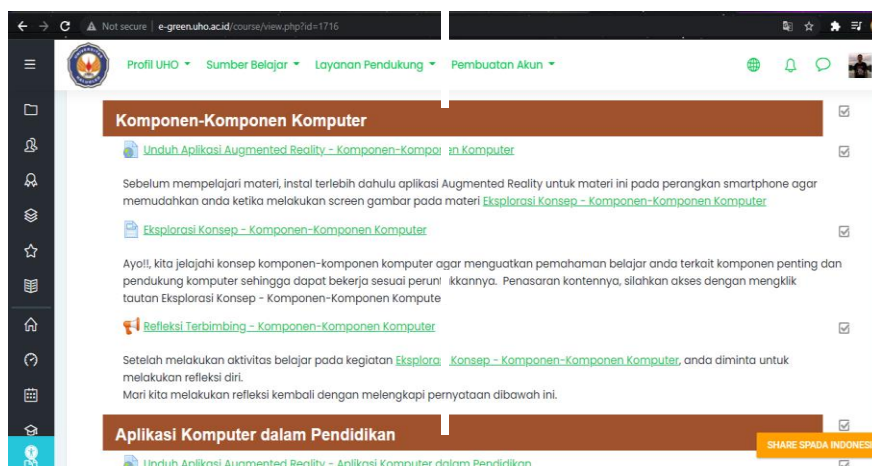


Figure 4. Display of Material Presentation

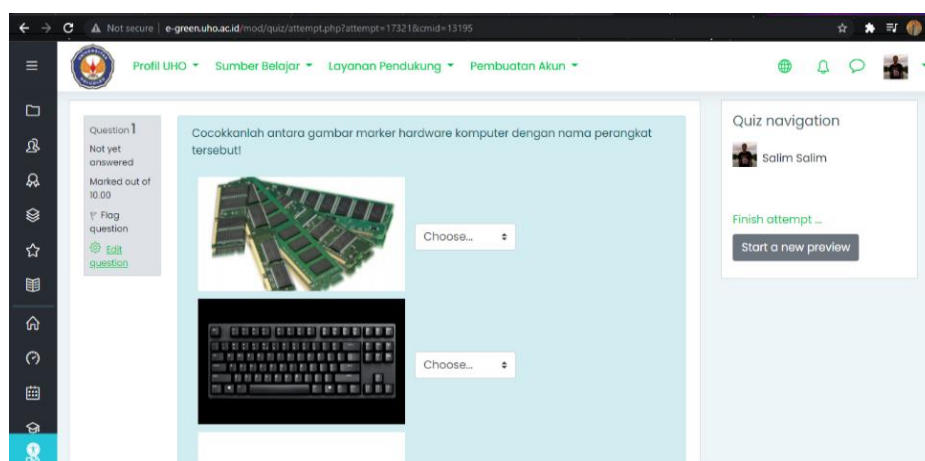


Figure 5. Evaluation Display

Interactive digital module *augmented reality* that was developed consists of 4 sub-topics including (1) computer development, (2) computer components, (3) computer applications in education, and (4) computer use in education. Materials on computer development and the use of computers in education are organized with the help of *augmented reality videos*. This is done to provide convenience and attract students to understand the material independently. This meaning is in accordance with the opinion (Saputra and Fajriani 2021b) which explains that the visualization provided in the form of video-assisted by *augmented reality* makes it easy for users of digital devices to understand the information. Another opinion was expressed (Yip et. al., 2019) that the complexity of information will be easily understood with *augmented reality videos*.

Materials on computer components and computer applications in education are organized with the help of *augmented reality* equipped with narration. The computer components provided by the marker are a *mouse*, *monitor*, *motherboard*, *RAM*, *graphics card*, *speakers*, and *processor*. While computer applications in education provided with markers are data processing applications (Excel and PowerPoint), graphic processing applications (adobe illustrator, Corel draw, and photoshop), audio processing applications (audacity and adobe audition), video processing applications (adobe premiere and slide video studio), and animation processing applications (adobe flash and 3DS Max). the marker used in this development is a marker in the form of a *QR-Code*. (Prasetyo et. al., 2017) revealed that *the QR-Code* has contrasting colors and a high level of *augmenting ability*. *QR-Code* will make it easier for *users* to recognize 3D objects that will appear (Saputra & Fajriani, 2021a). Meanwhile, (Atmaja, 2018) explained that the existence of *augmented reality* would make it easier for academics to understand the material presented.

The last organizer in presenting an interactive digital module based on *augmented reality* is self-evaluation. In this module, self-evaluation is presented in the form of multiple choice and matchmaking. These two techniques were chosen so that students can directly see the value obtained when they have completed the self-evaluation questions provided. The advantage of multiple-choice tests is that they contain several different answers that are related to each other, but the differences are made almost subtly between the answer choices (Suseno, 2017). Meanwhile, matchmaking tests can evaluate knowledge about facts that have specific meanings (Putri, 2020).

Evaluation

The fourth stage in this development is *evaluation*. -based interactive digital module *augmented reality* developed will be validated by media experts, material experts, and 8 students for small group trials. The presentation of the assessment results can be seen in Figure 6 below.

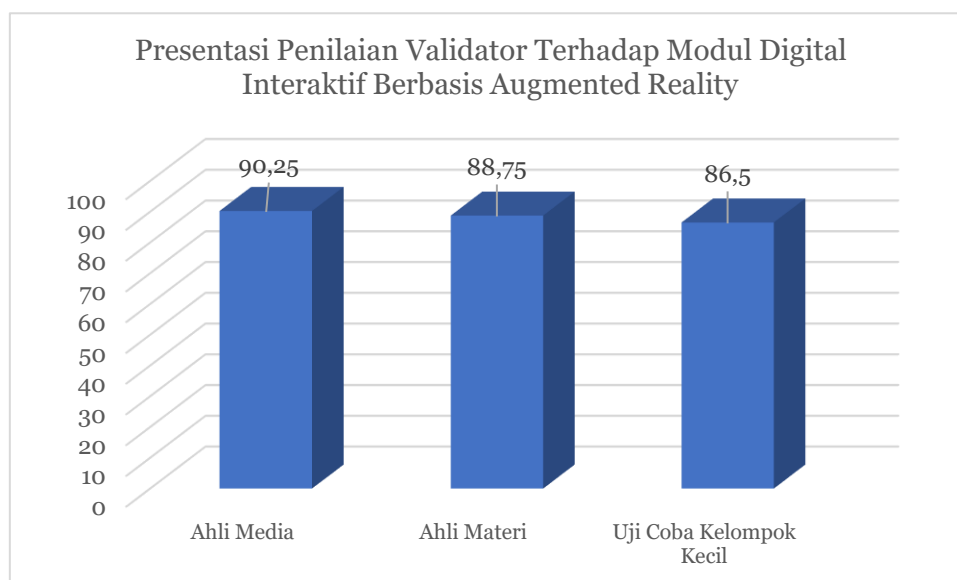


Figure 6. Presentation of Validator Assessment of Augmented Reality-Based Interactive Digital Module

Based on the presentation of the validator's assessment of the interactive digital module based on *augmented reality* with reference to the eligibility criteria in Table 1, it can be concluded that the interactive digital module based on *augmented reality* is in very valid criteria which means it is very good for use in learning-based digital textbooks are *augmented reality* very suitable to be used as teaching materials and can facilitate students' scientific literacy skills. (Djafar & Novian, 2021) conveyed his research findings that the implementation of *augmented reality* in the development of learning media can produce interactive digital media and display computer hardware in *real time* in three-dimensional format with marker cards as intermediaries so that it can be used by students on a *mobile* through *mobile*. Another finding revealed (Yuliono, Sarwanto, & Rintayati, 2018) that *augmented reality* effective for increasing students' conceptual knowledge.

4. CONCLUSION

Based on the presentation of the validator's assessment of the interactive digital module based on *augmented reality*, it can be concluded that the interactive digital module based on *augmented reality* is very valid criteria which means it is very good for use in learning with a percentage of 90.25% of media experts, 88.75 % from material experts, and 86.5% from small group trials. Researchers recommend using this material as a learning resource for Information Technology courses that can be accessed on the Halu Oleo University website. Researchers also suggest making *augmented reality* part of the learning materials developed. The use of augmented reality in online learning requires efforts to design learning appropriately so that it can make it easier for students to understand the content presented. The weakness in this study is that there are 4 applications that must be installed to be able to scan augmented reality markers. In addition, the number of evaluation questions is still very small to measure students' independent learning abilities. Therefore, the researcher suggests furthering research that the *augmented reality* developed is sufficient for all existing materials installed on the *Play Store* and it is necessary to increase the number of self-learning experience evaluation questions.

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