

DEVELOPMENT OF INTERACTIVE LEARNING MEDIA FOR THE BASICS OF ELECTRICAL ENGINEERING BASED ON AUGMENTED REALITY

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ABSTRACT

The purpose of this study is to clarify the development process of interactive learning media for the fundamentals of electrical engineering based on Augmented Reality (AR) and to assess the feasibility of AR-based interactive learning media to help students of Class X to understand the content related for the basics of electrical engineering at vocational high schools. This study use methodology Research and Development, specifically Waterfall model (2010). The research subjects consisted of five lecturers and one teacher. Data collection methods included both tests and non-tests. The interactive learning media trials yielded positive results for the development of AR-based electricity engineering as a teaching material. The average overall score given by media experts was 48 in range of $x \geq 42$ it is the 'Very Appropriate' category. The material experts gave an overall aspect score of 21,333 on average, with a range of $x \geq 18$ it is 'Very Appropriate' category. The average overall score of student respond to AR-based learning media was 40,655 on average, with a range of $x \geq 36$ in the 'Very Appropriate' category.

Keywords : *development; learning media; interactive; augmented reality; basics of electrical engineering*

INTRODUCTION

A quality education is an education that can meet the challenges of the present and the future. To create a superior vocational education institution of international quality, it must utilise science and technology to provide more realistic and interactive learning. This will enable students to solve problems, particularly in the industrial world. To achieve this, teachers need learning media that can facilitate such learning (Hidayat et al., 2019). The implementation of an merdeka curriculum is crucial in Vocational High School (VHS) education units. This is because it involves external parties in formulating the curriculum, ensuring that the results of graduates are accepted in the world of work. The implementation of an

merdeka curriculum in vocational school education aims to prepare students to be skilled, flexible, and tenacious, not only from an academic perspective but also in the development and use of technology (Wijaya et al., 2016).

On Wednesday 11 January 2023, observations were made at Serang City Agricultural Vocational School. The Merdeka Curriculum is being used thoroughly in every department and class level, as confirmed by an interview with the basic electrical engineering subject teacher in the school's Electrical Power Installation Engineering Department. The electricity software component in the Installation Engineering Electrical Power Skills Competency at Agricultural Vocational

School Serang City currently lacks interesting and interactive learning media. As a result, students may have difficulty understanding material presented by the teacher. The current teaching method involves students listening to the lesson material presented by the teacher and taking notes on what is written on the blackboard. Additionally, the teacher primarily uses the lecture method by reading from the subject book. According to interviews with teachers, only 30% of students have mastered the material presented in class, which contains illustrations and requires explanation of its real-world applications. The remaining students have not yet achieved mastery.

To minimize learning gaps caused by the problems previously explained, it is necessary to provide interactive learning media that aligns with technological developments and creates a more realistic learning experience. One such media is Augmented Reality (AR) learning, which merges the real and virtual worlds in two or three dimensions and can be projected into a real environment simultaneously (Afifah et al., 2019). AR learning media can be studied by students individually or in groups to enhance their understanding of the material and improve the quality of the process of teaching and the learning process. In addition, the existence of AR learning media can enhance student learning outcomes and facilitate teachers in delivering material in an engaging and diverse manner. This prevents students from becoming disinterested or bored during the teaching and learning process and reinforces their fundamental understanding throughout their three years of vocational school.

METHODS

The model development procedure (Pressman, 2010) used in the study was carried out in five stages, which can be seen in Figure 1 below:

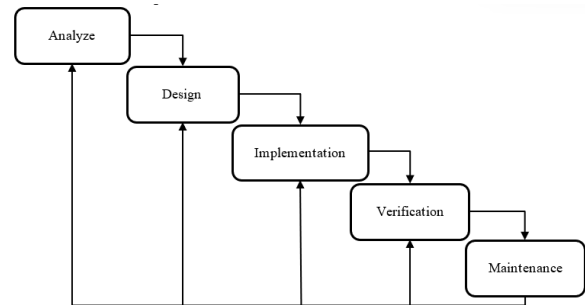


Figure 1. Waterfall Development Procedure (Pressman, 2010)

The steps are the following: (1) The analysis of the stages is divided into problem analysis and needs analysis; (2) Design of AR-based learning media will be in progress in three stages: designing a sitemap, flowchart, and storyboard; (3) The implementation process is carried out by researchers to create Augmented Reality-based learning media product is the result of the design and implementation of the application software; (4) Verification is necessary to ensure that the application, which has already been developed, is worthy of use and to minimise errors in the program. It is also important to ensure that the product generated is in accordance with expectations and the implementation for class X students in Installation Engineering Electrical Power at Agricultural Vocational School Serang City; (5) Maintenance involves changing the AR-based learning media application based on the results of testing and previous product revisions. This will ensure that the AR-based learning media application is able to and product are suitable based on verification or testing, and meet expectations.

Developing a learning media application based on Augmented Reality

for Basics of Electrical Engineering is tailored to the problems and needs of students, as determined by their learning styles and objectives. The materials used in this application adhere to the Merdeka Curriculum, CP, and teaching modules. The study involved three media expert validators who were full-time faculty members, two materials experts who were also faculty members, and one teacher. Additionally, 29 students from class X Installation Engineering Electrical Power at Agricultural Vocational School Serang City participated as users. Non-test data was collected through observation, interviews, and questionnaires.

Research data collection is divided into two types: non-testing data collection and testing data collection. In this research, non-test data was collected through observation, interviews, and questionnaires. The observation technique was used to determine the media used in the learning process in the classroom. An observation sheet was used as the instrument. A closed questionnaire was used to collect non-test data through an interview technique with the informant, who is a teacher at the Serang City Agricultural Vocational School teaching the Basics of Electrical Engineering subject. The research questionnaire used a Likert scale to verify the product developed by the researcher.

The study uses descriptive analysis to assess the potential of creating AR-based interactive learning materials for electrical engineering fundamentals. Questionnaires were completed by experts in media, materials, design, and users. The results were analysed to enhance the development of learning materials based on AR. The following are the steps for analyzing data to determine the suitability of this media:

1. Use the Likert scale rating criteria in the table below to determine the feasibility score for AR-based interactive learning media.
2. Using the following equation, calculate the average value for each data point.
3. The average is converted to a score based on specific criteria. Then, the quantitative data is interpreted as qualitative data to determine the media's level of appropriateness using a rating scale. The scale is based on the table below.

After processing and analyzing the collected data, the Augmented Reality Based Interactive Learning Media developed will determine its suitability as a teaching material or learning media.

RESULTS AND DISCUSSION

Results

The research has resulted in an Augmented Reality based Interactive Learning Media product. The resulting learning material is intended to enhance students' interest, comprehension, and learning outcomes in the fundamentals of electrical engineering. This study is a Research and Development (R&D) project that follows a development model (Pressman, 2010) consisting of five stages: (1) analysis, which includes problem and needs analysis; (2) design; (3) implementation; (4) verification; and (5) maintenance. This section presents an overview of the data on media development for each stage:

1. Analysis that includes problem analysis and needs analysis.

During the analysis stage, the researcher observed the teaching and learning activities in the course of Fundamentals of Electrical Engineering in class X and conducted interviews

with the teacher of the subject. The purpose of these observations and interviews was to identify problem areas and conduct a needs analysis.

a. Problem analysis

At this analysis stage the researcher identified problems by coming to the school with the aim of finding out the basic problems that occurred in the Basics of Electrical Engineering subject at the Agricultural Vocational School Serang City. Identify the problems encountered to get an overview of the facts, teaching materials, media and learning systems used. This identification will make it easier to determine the learning media that will later be developed. Based on the analysis of the interview results, it was found that there was no interesting and interactive learning media because it was only lectures. So in this development, researchers will try to create an AR-based interactive learning media that includes images, audio, animation and feedback (in the form of evaluation).

b. Needs Analysis

Stage analysis needs own objective in determine results from product to be developed form media learning the Basics of Electrical Engineering based on *Augmented Reality*. Activity Which done at this stage, namely through observations, interviews, and distribution of questionnaires to teachers and students in Serang City Agricultural Vocational School. Researchers do Observation And interview to identify instructional Media Which in accordance with students, learning

objectives, learning outcomes, and materials For media learning which will be later developed.

In needs analysis, first it starts with material needs and second is user needs. According to the needs analysis from interviews, it is evident that there is a lack of interesting interactive learning media for the basics of electrical engineering, as it is only delivered through lectures. Therefore, there is a need for interactive learning media based on Augmented Reality that is both interesting and engaging for these subjects. Based on the results of a student questionnaire, it was found that 70% of students were interested in visual learning styles, 21% in kinesthetic learning styles, and the remaining 9% preferred auditory learning styles.

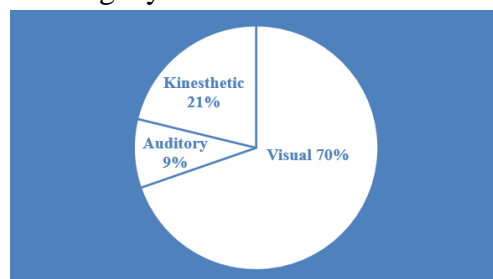


Figure 2. Diagram of Student Learning Style Interest in the Basics of Electrical Engineering

2. Design

Next stage is design, researchers create a design to produce AR-based learning media. This stage involves three stages of designing AR-based learning media: designing a sitemap, flowchart, and storyboard.

3. Implementation

In the third stage of this development model, an implementation process was carried out by researchers to create AR-based learning media

products. The design that has been created is then implemented into an application program developed as an educational medium for the Basics of Electrical Engineering with Augmented Reality technology. In this research, the software used is Unity 3D with the C# programming language. This interactive learning media based on augmented reality has gone through the validation process stages of experts, especially media experts, design experts and material experts who come from academic lecturers in Electrical Engineering at Sultan Ageng Tirtayasa University along with user expert tests (target students) for Basics of Electrical Engineering in class Installation Engineering Electrical Power at Agricultural Vocational School Serang City. The augmented reality media that was created underwent revision suggestions from experts, namely including a sitemap that did not previously exist. This is used to make it easier for users to see the entire media content so that it is not confusing.

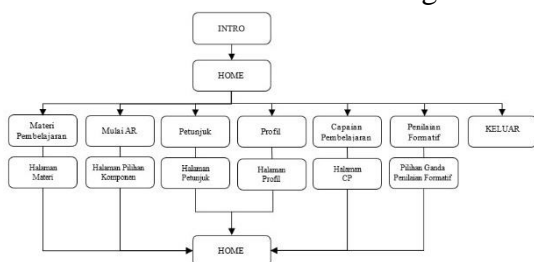


Figure 3. Results of Augmented Reality Based Interactive Learning Media Design before revision (no sitemap)



Figure 4. Results of Augmented Reality Based Interactive Learning Media Design after revision (added sitemap)

4. Verification

In the fourth stage of this development model, a verification process is carried out, which is a test of the AR based learning and educational media system. At this stage it is important to ensure whether the application being developed is suitable for use or not and in order to reduce the frequency of errors in the program, also ensure whether the product that will be produced is as expected. This stage consists of Black Box Testing and testing on media and material aspects by validators using a questionnaire which will be filled out later by experts in media and materials. In the initial stage, Black Box Testing is used to test the performance or functionality of AR-based learning media applications.

In the next stage, testing and verification is the assessment of the feasibility of the learning media being developed is conducted by experts in media and materials. Testing and verification by media experts to see to what extent the media being developed is feasible and appropriate or not. Further testing and verification by

material expert validators of the learning media to see whether the application developed has appropriate and appropriate material. After the learning media has been tested by media and material expert validators, it is then improved if there are suggestions and input from the test and verification results. After that, the students tested the learning media developed.

a) Media Expert Validation

Media expert validation includes aspects of suitability and quality of graphic and visual use, suitability and quality of audio and narration use, suitability and quality of video use, suitability and quality of animation and simulation use, accuracy of use of communication language, level of interactivity and ease of navigation, and attractiveness of media packaging. Overall.

The selection of media expert validators used 3 lecturers, namely 2 lecturers in Electrical Engineering and 1 lecturer in mechanical engineering from Sultan Ageng Tirtayasa University because these three lecturers are experts in creating interactive learning media, especially in augmented reality and in accordance with their educational background, namely Electrical Engineering and mechanical engineering. so that they understand how the media should be presented in the basics of electricity. Likewise with research that has been carried out regarding learning media, especially on augmented reality, so that they are chosen to become experts in research on the development of interactive learning media based on augmented reality on

the basics of electrical engineering.

According to the calculation results, the average score is known to be 48 with a maximum ideal score of 56, and a minimum ideal score of 14. The overall average score is 35 with a standard deviation score of 7.

Based on the data, it is known that the average assessment of the three evaluators is 48 with a range of $x \geq 42$, which indicates that the media is in the "Very Appropriate" category.

b) Material Expert Validation

Validation by materials experts involves several aspects of the truth of material content, up-to-dateness And to *Up To Date* Material, and Coverage and Sufficiency of Material.

The selection of material expert validators used two Electrical Engineering lecturers from Sultan Ageng Tirtayasa University because this lecturer has an educational background in Electrical Engineering, he teaches several courses related to Electrical Engineering and research trips regarding Electrical Engineering which are related to the material presented on interactive learning media. based on the basics of Electrical Engineering.

According to the calculation results, the average score is known to be 21,333 with a maximum ideal score of 24, and a minimum ideal score of 6. The overall average score is 15 with a standard deviation score of 3.

According to the data, the average assessment by the three evaluators is 21,333 with a range of

$x \geq 18$, which indicates that the media is in the "Very Appropriate" category.

c) Assessment of Student Responses

In the user validation test data, the researcher taught in class X TITL 2 of the Serang City Agricultural Vocational School with 29 students. After the teaching and learning process with AR-based learning media, the researcher distributed questionnaires to the students.

According to the calculation, the average score is known to be 40,655 with a maximum ideal score of 48, and a minimum ideal score of 12. The overall average score is 30 with a standard deviation score of 6.

The average rating from 29 users is 40,655 with a range of $x \geq 36$, which indicates that the media is in the "Very Appropriate" category. In other words, this AR learning media is very suitable to be used.

5. Maintenance

According to the results, this is a system for learning media based on Augmented Reality of testing and product revisions carried out previously so that it becomes an AR-based learning media application and product that is feasible based on verification or testing and so that it meets expectations.

Discussion

The end product of this research and development is an Interactive Learning Media for the Basics of Electrical Engineering Based on Augmented Reality Using the Merdeka Curriculum in Vocational High Schools. The AR-based learning media was developed using the Research and Development (R&D) method,

adapting the waterfall development model. There are five stages to this development: analysis, design, implementation, verification, and maintenance.

The analysis stage is the initial phase to identify any issues present in the school. The design stage involves creating a sitemap, flowchart, and storyboard. The implementation stage is where AR-based learning media is produced by integrating the necessary components. It involves black box testing and validation by media and material experts. The verification stage is a crucial step in the media testing process. The maintenance stage is used to revise any deficiencies identified in the learning media during the previous stage.

Media and materials experts and students evaluated the feasibility of AR-based learning media. Three media experts evaluated the media and gave scores of 42, 53, and 49. The final average score, obtained by the media experts, determined the feasibility level of augmented reality-based learning media is 48.

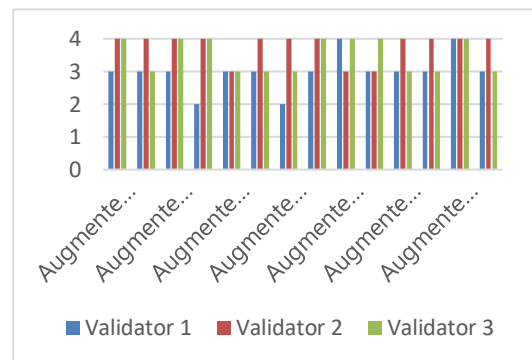


Figure 3. Results of Media Expert Assessment Analysis

Based on the data results, the media expert received an appropriate level score of 48 on average. These results fall within the value interval of $x \geq 42$, indicating that the media is classified as 'Very Eligible'. Therefore, in the teaching and learning process, AR learning media can be used.

Based on the assessment by three material experts, the material was evaluated on three aspects: content correctness, contemporary relevance, and coverage and quality. Material expert validator 1 gave a score of 22, material expert validator 2 gave a score of 20, and material expert validator 3 gave a score of 22. The scores of the material experts were averaged to determine the feasibility of Augmented Reality-based learning media. The average score was 21,333.

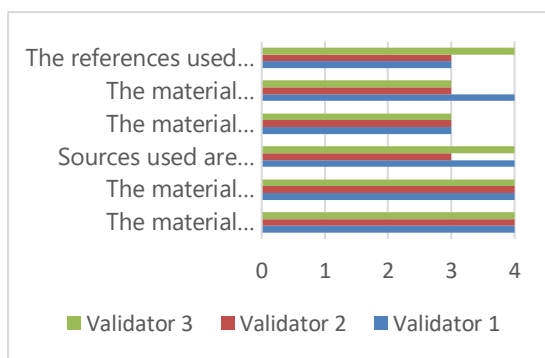


Figure 4. Results of Material Expert Assessment Analysis

Based on the score data, the average assessment of the three evaluators for the feasibility level of AR-based media is 21,333 with a range of $x \geq 18$, indicating that it falls under the 'Very Feasible' category. This means that AR learning media is highly feasible and can be used in an effective way in the teaching and learning process.

Then, from the results of the assessment by users (students), there were 29 people who assessed 6 aspects, namely: 1) Ease of use; 2) The possible level of interest and motivation of students when used in learning both individually and in the classroom; 3) Possibility of being used for individual learning by students and/or teaching aids for teachers; 4) The encouragement of possibility levels enhances students' critical thinking and

problem-solving abilities; 5) Application contextuality level or application in real life that is appropriate to the characteristics of the relevant students; 6) The level of possibility provides ease and speed of mastering material, concepts and skills according to the related topic. The average final score of 40,655 was obtained from 29 students to assess the feasibility of AR-based learning media.

From the data results, the assessment score for the feasibility level of the user test for a total of 29 users was 40,655 with a range of $x \geq 36$, which shows that the media is in the "Very Appropriate" category. In other words, this AR learning media is very suitable to be used.

From the data that has been obtained regarding the development of Augmented Reality-based learning media, users, especially students, feel interested in the new media and are motivated in learning the Basics of Electrical Engineering. This is in line with research (Irwanto, 2021), that the multimedia used in learning power electronics courses has a positive impact, so students feel happy and motivated in learning. This is also in line with research (Cahyono, et al, 2019), namely that Delphi-based learning media is interesting and interactive so that it stimulates students to learn. The position of media in learning is very important. Therefore, teachers need to play a role in using it in learning.

CONCLUSION

Based on the research results, it can be concluded that the development of augmented reality-based learning media on the basics of electrical engineering is said to be very suitable for use, seen from the validation results from media experts who

obtained an average score of 48 which is included in the "Very Appropriate" category with a score range of $x \geq 42$, the material expert validation results obtained an average of 21.333 which shows the "Very Appropriate Category" with a score range of $x \geq 18$ and the results of user respondents' (student) assessments of this AR-based learning media are in the "Very Appropriate" category with a score range of $x \geq 36$ with an average score of 40.655.

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