Development of Smart Modules Based on Augmented Reality in Vocational High Schools

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Abstract. This study aims to assess the feasibility and effectiveness of Augmented Reality-based learning media for Fiber Optic material in the 10th grade of Computer Network Engineering & Telecommunications at SMKS Jambi Medan. The research and development process follows the ADDIE model (Analysis, Design, Development, Implementation, Evaluation). Feasibility tests were conducted by two media experts and two material experts, alongside student feedback. The results from these assessments ranged between 4.17 and 5.00, falling under the "Very Decent" category. Additionally, an effectiveness test was performed using the N-Gain test in both control and experimental classes. The control class achieved a score of 0.17 or 17%, while the experimental class reached 0.77 or 77%.

Keywords: Smart Module, Augmented Reality

1. Introduction

Smartphones are tools that can facilitate all human needs and activities and are popular and the choice of various groups, including students today, such as to access information, increase insight, as a lifestyle and self-existence [1]. One of the applications that can be used on smartphones is augmented reality (AR). AR is a technology that integrates virtual objects into the real-world environment, making them appear as though they exist in real life or are projected in real-time. [2].

AR technology as a learning medium has advantages when compared to other media such as with AR technology, learning materials that seem abstract and difficult for students to understand through teaching materials, whiteboards or powerpoints can be realized into 2D and 3D visual objects by AR technology which makes it easier for students to understand them. AR also helps students to be more active because it allows them to interact with the objects produced so that it involves more senses of learning in and the process of bringing real learning experiences for students and having their own imagination in understanding the lesson [3].

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Based on observations and interviews with one of the computer and basic network subject teachers at SMKS Jambi, he stated that the teaching materials used only used media such as books and explanations from the teacher so that the learning that took place was less effective. This makes students less interested in paying attention to the material being taught, especially students whose reading level is low and sometimes reluctant to read thick textbooks full of explanations or look for online reading sources via smartphones.

SMK Swasta Jambi is one of the vocational schools that has implemented the independent curriculum. With this curriculum, teachers and students are actively using technology in the increasingly developing world of education. One of the learning technologies that is currently popular is immersive technology. Immersive technology is the use of virtual technology for interaction that can be felt directly using a computer. These immersive technologies encompass Augmented Reality (AR), Virtual Reality (VR), and Mixed Reality (MR)[4].

In developing learning media that is immersive technology, adapting the researcher also conducted a survey of subjects related to what immersive technology they know best. Where, the results obtained were that all subjects knew more about augmented reality than the other two immersive technologies. Based on several of these things, the researcher will develop a learning media in the form of a smart module based on augmented reality in the computer and telecommunications network engineering expertise program at SMK Swasta Jambi Medan.

2. Method

This study utilizes the ADDIE model (Analysis, Design, Development, Implementation, Evaluation) as its research and development framework. The ADDIE model consists of five interconnected stages that are implemented sequentially..

2.1 Analysis

The analysis stage can be considered as the goal-setting stage. The purpose of this stage is to identify or determine the possible causes of gaps that exist during learning. This analysis stage consists of: First, needs analysis where researchers conduct observations during the learning process and interviews with subject teachers. The results of observations and interviews obtained that the use of limited and less varied learning media caused students to be less interested during the learning process so that it was difficult to understand the material explained by the teacher. Second, analysis of the material that is adjusted to the Learning Objective Flow (ATP) in the subject of basic computers and networks for grade 10. Based on this analysis, fiber optic material is used as material in the learning media that is developed. Third, analysis of technology consisting of the use of smartphones with an Android system that will be used as a tool in using or running AR-based learning media.

2.2 Design

At this stage, a product design will be carried out based on the storyboard that has been developed. This storyboard helps provide an overview of the media that will be developed by considering or paying attention to several things, such as font selection, button design, and application background. The product design is also realized with the help of UML (Unified Modeling Language) such as the following use case diagram [6]:

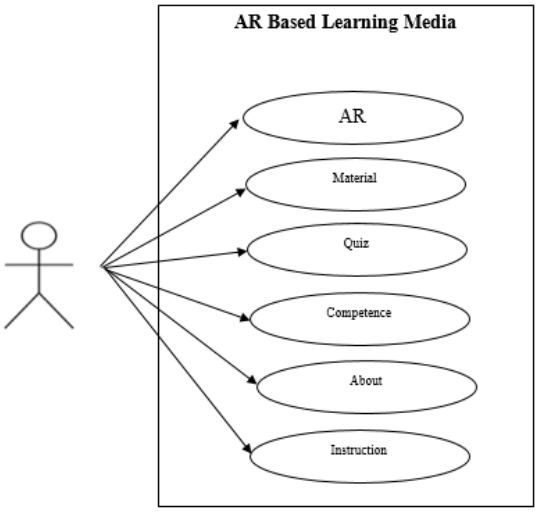

Fig. 1. Usecase Diagram

This diagram helps to depict the interactions that occur between the user and the system.

2.3 Development

Evaluation is a process to find out whether the learning product that has been developed has been effective as expected. The data analysis of the feasibility test includes media, materials, and student acceptance.

$$Xt = \frac{\sum Xi}{N} \qquad (1)$$

Description:
Xt : Total
$\sum Xi$: Total score for each indicator
N : Number of Items

The scores obtained will be transformed based on the following provisions [5]:

Table 1. Interpretation of Media Eligibility

No	Mean Score Interval	Font size and style
1	1,00 - 2,49	Not feasible
2	2,50 - 3,32	Less Worthy
3	3,33 - 4,16	Worthy
4	4.17 – 5.00	Very Worth It

Meanwhile, data analysis on the product effectiveness test is based on the N-gain test through pre-test and post-test.

$$< g >= \frac{<Sf)> - <Si>}{100 - <Si>} \text{ x } 100\% \qquad (2)$$

Description:
<g> : Normalized gain (N-gain)
<Sf> : Posttest score
<Si> : Pretest score

For the division of N gain acquisition categories in the form of percentage (%) can be seen in the following table:

Table 2. N-gain Acquisition Category

No	Mean Score Interval	Font size and style
1	< 40	Ineffective
2	40 - 55	Less Effective
3	56 - 75	Quite Effective
4	> 76	Effective

3. Result and Discussion

3.1. Result

In this study, the product produced is a learning media by adapting one of today's technologies (Immersive Technology), namely Augmented Reality. This learning media is developed using the Unity 2021.3.29f1 application and explains about Fiber Optics. The output of this learning media will be operated on Android with a file format in the form of an Android Application Package (.apk) or an application form.

The following is a display of the learning media that was developed:

1. Main Menu View

On the main menu there are several buttons, namely AR, materials, quizzes, competencies, about and instructions. There is also a bgm on/off button and an exit button from the application.

Fig. 2. Main Menu View

2. AR Camera View

In the AR menu, the smartphone will automatically open the AR camera. In the AR camera there is a guide marked with an icon with the letter "i". When the camera is directed at the marker, it will automatically display the AR object or video. There are also several buttons that will appear together with the displayed object. Such as the play, pause and restart buttons, the zoom in and zoom out buttons and the auto rotate button. Don't forget to also provide a button to return to the main menu and also a button to turn on or off the Background Music (BGM).

Fig. 3. User Guide

Fig. 4. AR 3D Object View

Fig. 5. Learning Video Display

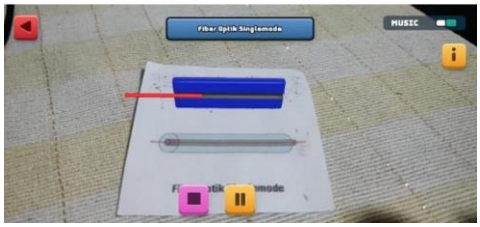

Fig. 6. Main Menu View

6. Quiz Page View

On the quiz page, instructions for completing the quiz will be presented before completing the quiz. After the questions are completed, the final score will be displayed along with the number of correct and incorrect questions. Users can also retake the quiz by selecting the restart button or return to the main page by selecting the home button.

Fig. 7. Quiz Instructions View

Fig. 8. Final Score View

3.2. Discussion

The feasibility test for the developed media was conducted by two validators, both lecturers from the Informatics and Computer Technology Education Study Program at the State

University of Medan. The media experts' evaluation resulted in a score of 4.75, placing it in the "very feasible" category. Similarly, the material feasibility test was carried out by two validators: a lecturer from the same study program and a computer and basic network subject teacher at SMKS Jambi Medan. The material experts' assessment yielded a score of 4.37, also classified as "very feasible."

In addition to the evaluations by media and material experts, students, as end-users, were involved in assessing the media's acceptability. Based on the acceptability test conducted with 27 students, the average score was 4.76, falling into the "very feasible" category.

Following the feasibility tests, the final step was to test the effectiveness of the learning media to determine its impact on learning outcomes. The effectiveness test, measured by N-Gain results from two classes, showed an N-Gain value of 0.17 (17%) for the control class and 0.77 (77%) for the experimental class.

This indicates a significant improvement in understanding after using the developed learning media in the experimental class compared to the control class. Thus, it can be concluded that the developed media is effective and can enhance student learning outcomes based on the evaluations and tests conducted.

4. Conclusion

Based on the research findings, data analysis, and discussions presented, the following conclusions can be drawn:

1. The learning media is classified as VERY FEASIBLE. This is supported by the results of the feasibility test, where media experts gave an average score of 4.75, and material experts provided an average score of 4.37, both falling into the "Very Feasible" category. Additionally, the acceptability test conducted by students resulted in a score of 4.76, also meeting the "Very Feasible" criteria.

2. The learning media is categorized as EFFECTIVE. This is evidenced by the N-Gain test results in the experimental class, which scored 0.77 or 77%, placing it in the "Effective" category, as it exceeds the 75% threshold for effective interpretation.

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