The Development of an Augmented Reality-based Learning Media on the Subject of Radio and Television System

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ABSTRACT
Many types of instructional media can be used to attract students' interest in learning such as graphics, audio, video and visual media. This research aims at developing and applying innovative learning media based on augmented reality, which is the combination of graphics, audio, and visual media in an android application. We measure the students' comfort level when using augmented reality on the subject of Radio and Television System through usability testing. The usability criteria are learnability, efficiency, memorability, error, and satisfaction. The experiments were conducted at public Vocational High School 4 Bandung, Indonesia with the students from the program of Audio Video Technique as the research subjects. The results showed that our design may improve learning outcomes and meet usability aspects with highly valuable rating category.

Keywords: *Innovative Learning Media, Augmented Reality, Usability Test, Vocational High School.*

1. INTRODUCTION

Learning media is an instructional component that includes messages, people, and tools. There are several types of media commonly used in teaching and learning activities especially in Indonesia. Among them are graphics media, audio media, and silent projection media. Graphics media has a variety of types including: drawings, sketches, charts, graphics, cartoons, posters, panel boards, bulletin boards. And the type of silent projection media includes framed films, composite films, transparent media, translucent projectors, microphones, movies, television, games and simulations [1],[2].

Based on the observation at Public Vocational High School 4 Bandung, there are some problems regarding the use of power point learning media, that is, packaging of media is less interactive and involving students. The authors interviewed students about study on engineering of radio and television system. Based on the case, it needs an interactive learning media that makes the students interest to learn so that the material can be delivered well to the students.

Augmented Reality (AR) is a technology that can combine two dimensional and three-dimensional visual objects and project it into a real environment in real-time, so that we can see objects projected as if they were in real environments [3]. AR technology has started to develop such as the field of architecture, medicine, entertainment, and including education. The development of this technology is potentially good when used in education, because with this technology the material delivered during the learning process will be presented with more interactive and real. Even researchers believe that AR-based learning media is one of the new ways to gain knowledge holistic [4],[5].

Based on the aforementioned issues, it is importance of designing an innovative learning media relevant to the subjects engineering of radio and television system, so that learning can attract students to learn. We intend to design AR-based learning media to give students' understanding on radio and television system subjects. Besides, we also measure the usability level of design to determine the level of interest and comfort of students when using our design.

2. MATERIALS AND METHODS

This research uses Research & Development approach to develop and validate the learning products [6],[7]. In this research, the product is AR-based learning media on engineering of radio and television system subjects for vocational high school majoring in Audio

Video Engineering. This development is focused on digital television topic in the form of applications running on android operating system.

The research and development procedure in this research follow the steps as illustrated in Figure 1.
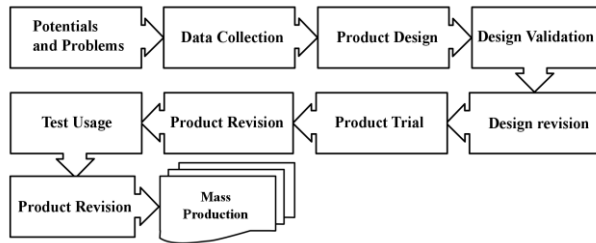

Figure 1. Research flow [6].

There are 10 steps referring Figure 1 as follows.

Potentials and Problems: The potential analysis of the problem is done by preliminary studies and interviews both to teachers and students.

Data Collection: Once the potential problems can be demonstrated, then the next it needs to collect information that can be used as material for planning the development of learning media that is expected to solve the problem. Data collection is done by preliminary study and discussion with related parties.

Product Design: Product design is made by considering the needs of students of vocational high school in learning Radio and Television System Engineering. Product design consists of product design in the form of android application and module product design.

Design Validation: Design validation is an activity process to assess product design, in which case of the new work system will rationally be more effective than the old one or not [6]. Validation of products can be done by presenting experts or experts to assess the resulting new products and design validation can be done in the discussion forum.

Design Revision: Once the product design is validated through experts and experts it will be known that the product weakness is further improved to reduce the weakness of the product.

Product Trial: After the product has been validated and improved, the product is ready for trial. Testing the product here is a feasibility test of a product.

Product Revision: The second product revision is made after a limited test of the expert, it is known if there is a shortage if the product will be applied to large population numbers. It is then revised to improve the portion of the product suggested less by respondents to further improve the eligibility and quality of instructional media.

Test Usage: After going through the product revision process, it is assumed the product is ready for trial usage. Trials will be conducted by students. Once tested, the students will provide opinions on learning media reviewed from the level of comfort and usability.

Product Revision: This product revision is done, if in trial use still found deficiencies that can interfere with the function of the media of learning.

Mass Production: The mass production process is carried out if the learning media has been declared feasible and ready to be implemented on a wider scale.

In addition, we tested the application of media by performing a series of tests in the form of pre-test, treatment, and post-test. Testers also assess the affective and psychomotor of the students. The question items used 25 valid questions from the total of 40 questions that have been tested the validity, with the 4 item difficult questions, 16 medium questions, and 5 easy questions. And all validated questions are declared reliable.

3. RESULTS AND DISCUSSION

3.1 Product Results

Product design consists of AR-based application design that is installed on smartphone device with Android platform and supporting module. The software used are Unity3D, Blender, Inkscape, other supporting software. Figs 2 to 5 show the result of the module design, meanwhile the design result of PSRTV (Perekayasaan Sistem Radio dan Televisi) AR application are shown in Figs 6 to 15.
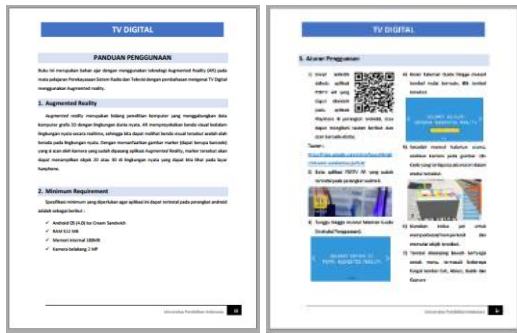

Figure 2. Design Cover.

Figure 3. Design Guide Module.

Figure 4. Design Marker.

Marker is a QR Code image that can display 2D and 3D objects. The numbers of markers on the module are 8 markers with the information regarding the topics.
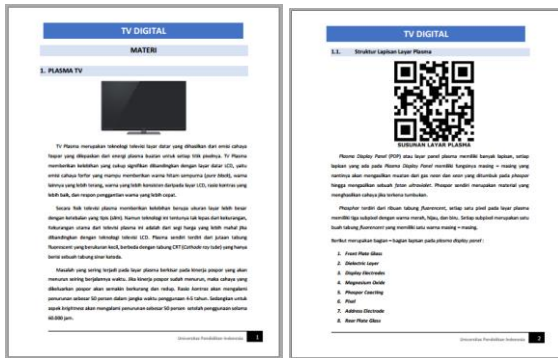

Figure 5. Modul Content.

Figure 6. Design Icon Application.

Logo is a symbol that will appear when the application has been installed on the device. Start page (Splash Screen) is the initial image that appears when the application is opened, this image contains the title of the application being opened.

Figure 7. Design Splash Screen.

Figure 8. Instruction Page Welcome Screen.

Figure 9. Instruction Page Guide Screen.

Figure 10. Instruction Page Play Button Screen.

The instruction page is a page that provides information on how to use the app until the user is fully ready to use it. To view information, simply press the forward and back buttons on the side of the screen. The start play button is used to move to the main page and start enabling augmented reality.

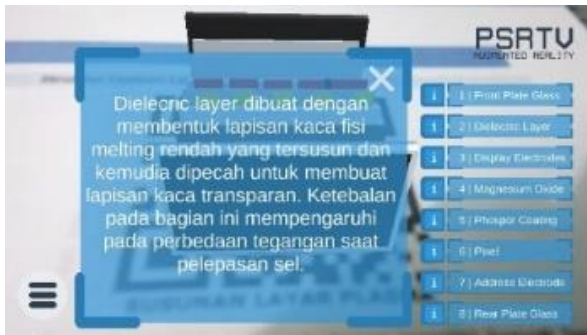

Figure 11. Main Page AR.

Figure 12. Main Page and AR Information.

The main page is a page with augmented reality system. When the camera is directed to the marker it will show 3D objects and information buttons. When the title button is pressed then the 3D object will run the animation and show the requested object. When the "i" button is pressed it will display 3D object information. If the menu button beside is pressed it will display another menu on the screen.

Figure 13. Menu Button.

The menu button functions to move pages like about and guide. To exit the app can use the exit button.

Figure 14. Animated 3D Object.

When the camera is directed to an animated 3D object, a mute button and a play button next to it will appear. The developer information page is a page that serves to provide developer information.

Figure 15. Developer Information.

3.2 Design Validation and Product Trials

Testing media usage is done through validation test (content) obtained by material experts and construct validation obtained from media experts. An expert is considered to have knowledge in the field of subjects of Radio and Television System Engineering, while the media expert is someone who has an expert in the field of learning media. Our product undergoes several revisions which include the addition of animation to 3D objects displayed in the application. After revision then the media is ready for testing.

At this stage, the application is tested into several devices to determine the application portability level. The tools for testing vary for comparable purposes. Table 1 presents the device information used in the application test and Table 2 presents the results of the trials seen from several aspects.

Table 1. Smartphone Specs Trial.

No	Chipset	OS	RAM	Camera	LCD
1	Mediatek MT6795 Helio X10	Android 5.0.2	2 GB	13 MP	5.5 inch
2	Qualdcomm MSM8917 Snapdragon 425	Android 5.0.2	3 GB	13 MP	5.0 inch
3	Intel Atom Z2520	Android 4.4.4	1 GB	5 MP	4.7 inch
4	Mediatek MT6753	Android 5.0.2	2 GB	13 MP	5.5 inch
5	Mediatek MT6580	Android 5.1.1	2 GB	8 MP	5.0 inch

Table 2. Trial Result.

No	Chipset	Launch	Button	Animation	Sound	Distance
1	Mediatek MT6795 Helio X10	√ (10 sec.)	√	√	√	13 cm
2	Qualdcomm MSM8917 Snapdragon 425	√ (8 sec.)	√	√	√	13 cm
3	Intel Atom Z2520	√ (24 sec.)	√	√	√	6 cm
4	Mediatek MT6753	√ (12 sec.)	√	√	√	12 cm
5	Mediatek MT6580	√ (10 sec.)	√	√	√	8 cm

3.3 Usage Test Result

Table 3 describes the percentage of results from the usage test. The usability testing comes from 32 student responses in the form of questionnaires. This test is done to see the level of comfort and interest of students when using the media learning.

Table 3. Media Usage Test Result.

No	Rated Aspect	Total Score of respondents	Maximum Score	Result (%)
1	System Aspects	470	512	91.79
2	User Aspect	1483	1664	89.12
3	Interaction Aspects	914	1024	49.90
Percentage overall (%)				76.94

The usability assessment refers to the indicators, that is, learnability, efficiency, memorability, errors, and satisfactions [8]-[10]. The learnability aspects of AR media are in the category very easy to learn with the percentage of 75.42% and 24.57% stated that AR learning media is easy to learn. Therefore, it can be concluded that AR learning media has fulfilled one aspect of usability, that is, learnability.

The efficiency of learning media AR is in the category of highly efficient studied with the percentage of 73.84%, efficient category as much as 27.25% and as much as 2.19% stated less efficient AR learning media. Overall from the results of these measurements can be concluded that the learning media AR is relatively efficient and has met the aspect of efficiency.

The memorability aspects of AR learning media are in very easy to remember category with 79.15% percentage, easy category to remember as much as 18.65% and as much as 2.18% stated AR learning media can be remembered. Therefore, it can be concluded that augmented reality learning media is easy to remember and has fulfilled one aspect of usability that is memorability. 75.88% stated the application of AR based media level (error) is so low that almost never happened and as much as 24.11% said our media has a low error rate. Therefore, it can be concluded that our media has a low error level and almost never happened and has fulfilled one of the usability aspects of errors.

The satisfaction aspects of our media are in very satisfying category once with the percentage 82.57%, satisfying category as much as 15.42% and as much as 2% stated AR lesson media less satisfactory. Overall from the results of these measurements can be concluded that AR learning media assessed relatively give satisfaction to the user and has met one aspect of usability is the satisfaction. The usability test that we run shows that the application system for human-computer interaction runs well. This is significant point so that

users can comfortably operate this AR system. And this result was parallel with statements of [12],[13] regarding the usability test beneficiary.

Furthermore, the AR system guides the user to be more entertained by the display and functions the system offers. So that the learning message for the user becomes something fun and does not burden the cognitive process [14]-[16]. The user's reaction or response in terms of addressing fun learning makes the knowledge transfer function easier and more efficient. Therefore, it is a fact that AR-based learning is currently one of the pillars in the 21st century learning context [17],[18].

3.4 Media Application Implementation Results

Validated questions are tested to students with the pre-test stage. It has been found that no student has attended the minimum standard quality in the trial. But after the treatment, the result of post-test which the result increase from pre-test result, there are 32 students that exceeded the minimum standard quality with the result of data analysis of pre-test and post-test score with pre-test score of 32.88 and post-test 84.50. From the results of the average score of pre-test and post-test indicate an increase in students' ability after being given treatment with good criteria. And there is also an increase in student learning outcomes which can be seen from the analysis of N-gain data obtained by 0.77, indicating the N-gain value in the high category. The average affective rating is 82.81 with the A-predicate, in accordance with predetermined assessment criteria in the affective domain in the curriculum 2013 [11], the average value predicate in the affective domain is a good criterion. Psychomotor assessment is 85.98 with A-predicate, in accordance with predetermined criterion criteria in the psychomotor domain in the curriculum of 2013, then the average value predicate in the psychomotor domain is a good criterion. Assessment of the affective and psychomotor aspects of the application of instructional media also meets the standard value of the minimum standard quality established by the school that is 82 with good criteria.

4. CONCLUSSION

Based on observations, data processing, and analysis, we conclude that the results of the implementation of AR-based learning media to students showed an increase in their capabilities. For the affective and psychomotor domains, results are h good category achievement.

The usability result stated that the media meets usability aspect. Each category of usability has a relatively good value, such as the result of learning ability which shows that the media is very easy to use, the efficiency result shows the media is relatively efficient, the result of memorability shows the media is relatively

easy to remember, errors show the error rate that occurs in the media is very minimal and almost did not happen error at all, and for satisfaction show relative learning media to give satisfaction to the user.

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