PLACE: INTERACTIVE LEARNING MEDIA AUGMENTED REALITY (AR) 3D IN "PLANT CELL" FOR 11TH GRADE STUDENTS

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Abstract

The era development, the rapid of technology, and the availability of mobile phone use for students in facilitating learning should be accompanied by familiarization of the use of media as one to support the learning. Biology is considered as a subject that requires more understanding and interpretation through its visualization. Moreover, the one focuses on "Plant Cell" material is rare. This research is further aimed at: (1) developing an interactive learning media Augmented Reality (AR) 3D in Biology material "Plant Cell" for11th grade students, (2) conducting the feasibility test of the interactive learning media, and (3) examining the effectiveness of the interactive learning media. Research and Development (R&D) was employed, and ADDIE model was adapted. The participants were 20 students. Questionnaires were utilized as the instruments. The steps in developing the media included: Needs Analysis, Design Making, Design Implementation, Alpha Testing, Revision, Beta Testing, and Media Improvement. Next, validity test and reliability test from two experts were conducted. The results of the research reveal: (1) validity test by using Aiken V was in the medium (0,5-0,75) and high category (0,875), and reliability test was in the perfect category (0,961), (2) the media effectiveness level by using Aiken V was in the medium category (0,73), and by using SUS was acceptable (71-100), and margin high (51-62). In this research, last, the suggestions in the form of some revisions to the media were provided.

Keywords: augmented reality, biology, interactive learning media, plant cell

1. Introduction

Along with the rapid development of technology, learning media are arranged according to the conditions of school infrastructure and developing technology. Agustina (2019, p. 1) states that media is categorized as proper to apply if it can help creating two-way communication between teachers and students. However, teachers tend to still apply conventional media such as Torso or other teaching aids. In terms of relevance, this type of media is considered less attractive to students in learning. Hence, there is a necessity for teachers to use technology today in the media as one of the main learning resources. (Alwi & Rahmawati (2014) in Susilo et al., 2017, p. 105). In addition, conventional learning media does not provide a good interpretation of students. Essentially, teachers must be able to create a more interactive classroom atmosphere and various kinds of tools to attract students' interest in understanding a material. One of them is through learning media, which in this case serves to assist students in interpreting the concept of the material itself. (Mustaqim & Kurniawan, 2017, p. 36)

Learning media is a tool that is created to facilitate the delivery of material concepts in learning activities. According to the research conducted by Budi (2019, p. 1), learning media will make it easier to visualize an object. Thus, Biology learning is one the right choices for applying media.

Currently, the use of AR 3D specifically in Indonesia can be considered as rare due to the lack of public recognition about this technology. As known that AR is widely used in the video games, image processing, film industry, mobile phone navigation, and medicine. In other words, it is rarely used as a facility that can help in the education field (Mustaqim & Kurniawan, 2017, p. 38). The material in the 11th Biology subject is considered as one to be difficult for students in understanding and interpreting it.

In case of Biology, it is considered as difficult to visualize the material about "Plant Cell" directly. Thus, it requires media assistance. AR 3D technology can be utilized, in which through this technology, three-dimensional objects can be displayed (Romadon et al., 2017, p. 89). "Plant Cell" learning media can be created in an AR 3D-based Mobile application. Based on what had been explained, this research is aimed at: (1). (1) developing an interactive learning media Augmented Reality (AR) 3D in Biology material "Plant Cell" for11th grade students,

(2) conducting the feasibility test of the interactive learning media, and (3) examining the effectiveness of the interactive learning media.

2. Method

This research had Research and Development (R&D) as its design, which was aimed to develop an interactive learning media AR 3D for "Plant Cell" in Biology material. 20 students were participated in this research. The development model used in this research was adapted from ADDIE one and employed seven stages, to be mentioned as: Needs Analysis, Design Making, Design Implementation, Alpha Testing, Revision, Beta Testing, and Media Improvement. The elaboration of each stage will be briefly described after the following figure.

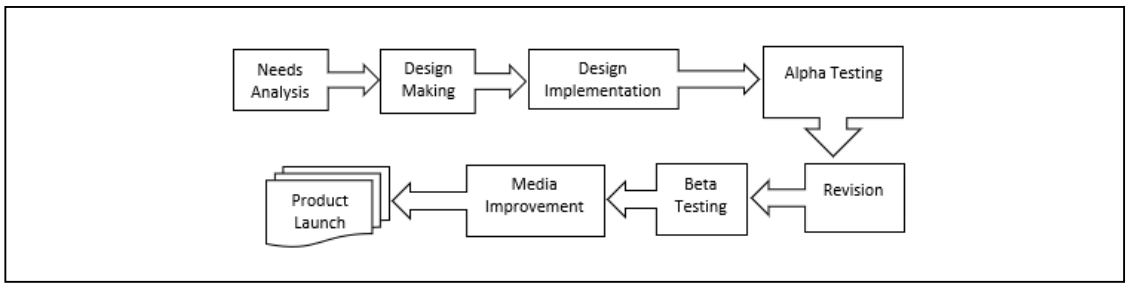

Figure 1. Research and Development (R&D) stages by Sudaryono (2011, p. 30)

Fig. 1 shows stages, the first one is namely Needs Analysis. In this stage, the concept of learning media was created by firstly collecting the information from the teachers and students. Next was the Design Making. After that, the Design Implementation was carried out, in which it was aimed to plan the program that would be created, and the tools that would be used. In this research, the tools refer to *Unity 3D*. The fourth stage was Alpha Testing, which was carried out by the experts or examiners to assess the media. The revisions from the experts/examiners were then conducted. After that, Beta Testing was carried out. In this stage, testing was carried out on the participants of this learning media and referred to the users. After making further revisions from Beta Testing was carried out, media improvements were then created based on the suggestions provided by the experts/examiners.

- Needs Analysis

At this stage, the researcher collected information about the learning materials and the problems experienced by the teachers and the students during the learning process. In addition, hardware and software requirements are needed to build AR 3D "Plant Cell".

- Design Making
  - Application Making

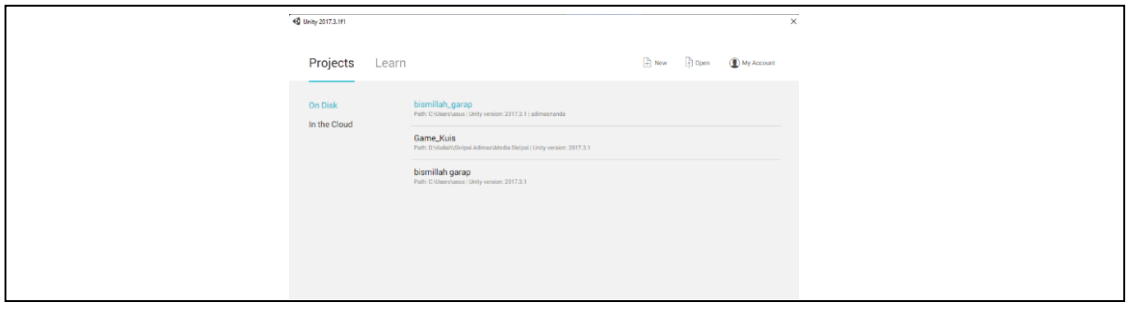

Figure 2. *New Project* Starting Menu

Fig. 2 is the starting menu to enter the *Unity* software. First, by creating a *New Project* and specifying whether a 3D or 2D application that would be created. Second, by selecting the location to save a project that would be created. Then go to the next stage, which was choosing the layout size by using the size that would be used. After that adding the required asset package, setting the function used for the media, and soon following the steps that would be carried out as needed

- Use Case Diagram

Use Case Diagram contains a brief description of what features that are available to be used by the users.

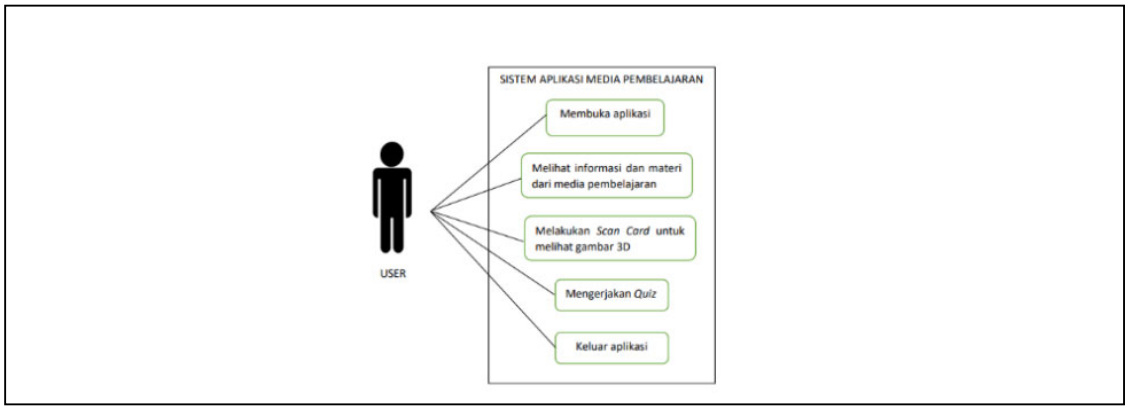

Figure 3. Use Case Diagram

- Motor Wireframes

Table 1. Product Flow (Wireframe)

No	Name	Note
1.	Home Screen and Main Menu 	In the Main Menu, there are five features, namely: Profile, Information, Material, Scan Card, and Quiz. In the right point, there is an 'Exit' button to exit this media. Then, there is 'Profile' menu that contains the Author's Profile. Below is 'Information' menu that contains a brief description of this media. Then, there is a 'Material' menu containing the 11th grade Biology e-book. Next to it is 'Scan Card' menu, which is used to display 3D "Plant Cell" images. Last, there is 'Questions' menu that contains a collection of questions for evaluating the students' learning.
2.	Profile Menu 	The Profile Menu contains the Author's Profile consisting of the author's name, date of birth, address, student number, photo, and supervisor. Then in the right point there is a button to return to the main menu
3.	Information Menu	The 'Information' menu contains a brief description of "Plant Cell" AR 3D learning media. Then in the right point there is a button to return to the main menu

		
4.	Material Menu 	The 'Material' menu contains a brief material about "Plant Cell". Then in the bottom right, there is a menu to link to the Biology e-book for 11th grade students. To return to the main menu, the users can press the arrow button on the top right.
5.	Scan Card Menu 	The 'Scan Card' menu contains a bar code that when it is scanned, a 3D "Plant Cell" image will appear.
6.	Question Section Menu 	The 'Questions' menu contains of questions related to "Plant Cell". After all of the questions are answered, the score will appear and there is a red menu in the upper right corner to exit or return to the main menu.

- Diagram Activity

The diagram activity is used to describe the workflow on the AR 3D "Plant Cell" learning media. The picture below is taken as an example, namely the activity diagram for the main display on the "Plant Cell" AR 3D learning media.

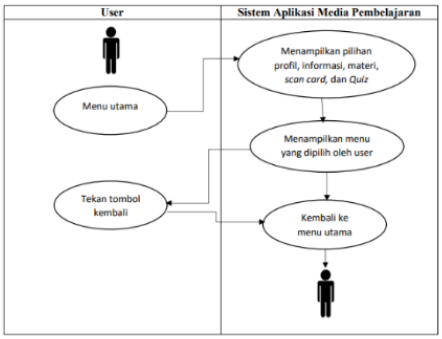

Figure 4. Activity Diagram Display

In the display of the initial menu of learning media, the user can choose 5 menus consisting of a Profile Menu, Information, Material, Scan Card, and Questions. At the beginning, the user opens the 'Information' menu to find out the purpose and how to use the learning media. Furthermore, the user is asked to get the 'Material' menu to get an understanding of the material to be delivered. If the user has understood the material, he/she is asked to press the 'Scan Card' menu and open the provided *bar code*. Then a 3D "Plant Cell" image will appear. After that, the users are asked to work on questions as the learning evaluation.

- Design Implementation

Figure 5. Media Menu Display

Fig. 5 is a display menu on "Plant Cell" AR 3D learning media, the display of the media is also suitable for 11th grade students, because it is simpler and easier to understand. The background describes the natural atmosphere; where it is expected that user can immediately understand what the media is using. This AR 3D "Plant Cell" learning media also makes it easier for them to understand the parts of "Plant Cell" in the form of 3D images.

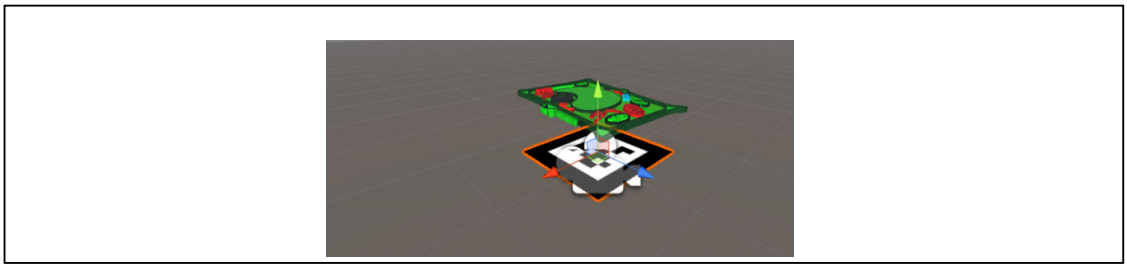

Figure 6. "Plant Cell" 3D Display

Fig. 6 is a 3D image of the "Plant Cell" that forms 3D on each part of the organelle itself.

- Alpha Testing

The test of the AR 3D "Plant Cell" learning media application was assisted by 2 lecturers, consisting of 2 expert lecturers of Information Technology Education, Universitas Muhammadiyah Surakarta. Alpha testing was conducted to get the results of the quality analysis of the software.

- Black Box Test Results

Based on the results obtained from 20 users with 11 categories 0 failed and 11 succeeded, it can be concluded that the media is 100% successful according to its functionality.

- Media Validation

$$Mean = \frac{V\ Total\ Value}{Item\ Number}$$

$$Mean = \frac{17,625}{24} = 0,73$$

Based on the media test, it was showed that there were 2 examiners whose results from Aiken V items 1-24 were 17,625 and an average of 0.73. This figure showed the medium validation value. In accordance to the interpretation, if the value of V < 0.4, the validity was low, if the value of V lies between 0.4 - 0.8, the value of validity was moderate, and if the value of V > 0.8, the value of validity was high.

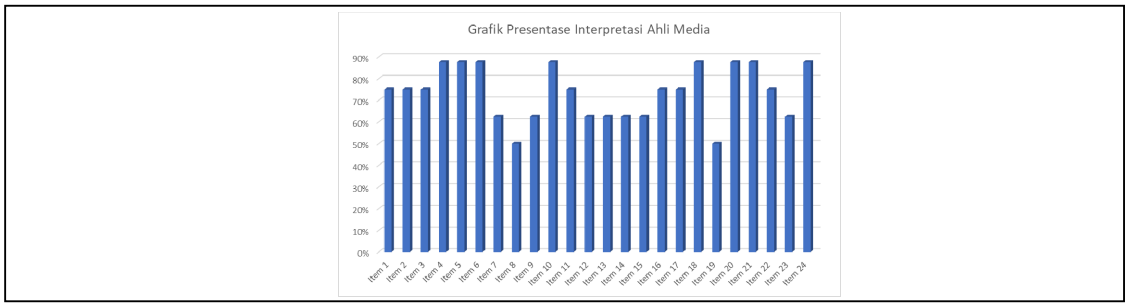

Figure 7. Media Expert Interpretation Percentage

The rating results by using interpretation within the results of items 1 to item 24 in Fig. 7 showed a graph of media expert interpretation for 24 items. The results of the analysis showed Aiken V were medium and high. Medium yields were at 0.5 – 0.75 and high yields were at 0.875.

Case Processing Summary

		N	%
Cases	Valid	2	100.0
	Excluded[a]	0	.0
	Total	2	100.0

a. Listwise deletion based on all variables in the procedure.

Figure 8. Media Expert Case Process Summary

Reliability Statistics

Cronbach's Alpha	N of Items
.961	24

Figure 9. Media Expert Reliability Statistics

The reliability test conducted by 2 media experts in Fig. 8 is a case processing summary, which contains information about the number in the SPSS program as many as 2 media experts. Since all answers were filled in, the valid number was 100%. Furthermore, Fig. 9 represented the reliability statistics. There were 24 N of items and they had a Cronbach's alpha of 0.961. Because Cronbach's alpha 0.961 was in the 0.9 category, it could be concluded that the 24 items were included in perfect reliability.

- Validation Material

$$Mean = \frac{V\ Total\ Value}{Item\ Number}$$

$$Mean = \frac{16{,}25}{23} = 0{,}706$$

The results of the media test showed that there was a user that had the results of Aiken V items 1-24 were 16.25 with an average of 0.706. This figure showed the media validation value was in the medium category. In accordance with the interpretation, if the value of V < 0.4, then the validity was low, if the value of V was between 0.4 - 0.8, the value of validity was moderate, and if the value of V > 0.8 then the value of validity was high.

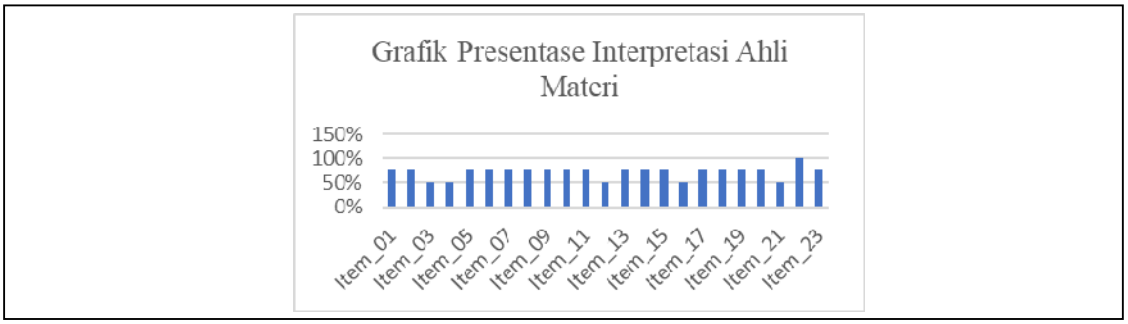

Figure 10. Material Expert Interpretation Percentage

3. Results and Discussion

- Beta Testing

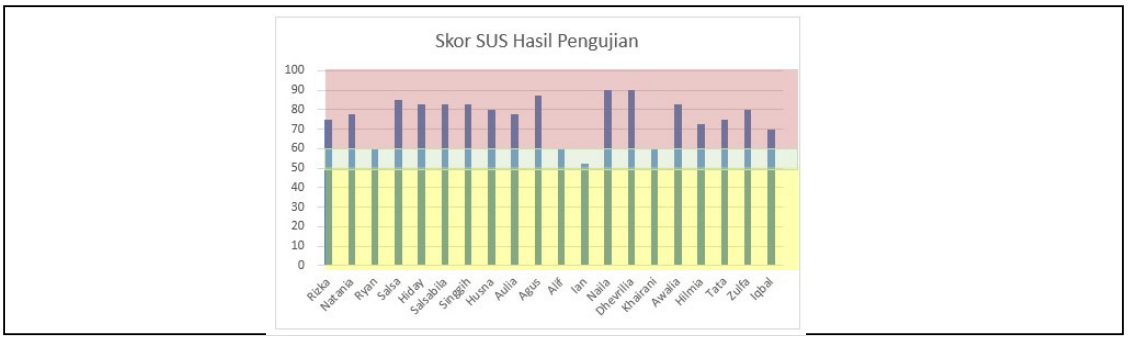

Figure 11. Usability Graph

Note:

: *Not Acceptable*

: *Margin High*

: *Acceptable*

Fig. 11 is a usability graph obtained from the calculation of SUS (System Usability Scale). From this data, none of the acceptability ranges criteria was included in the unacceptable category because the value range was above 50. However, there were 4 users who got scores in the high margin category where the range of values in the high margin was 51-62, the user named Ryan, Alif and Khairani got a score of 60 and the user named Ian got a score of 52.5. While the other 16 users were included in the acceptable category with the range of acceptable values were 71-100, then 4 users with scores above the average and were included in the acceptable category.

- Media Improvement

After testing the media to 20 users, there were several suggestions that can be used as guidelines for improving the media, such as: by adding images to the "Plant Cell", adding sound to make it more ear- catching, and changing the background for each section so that it does not look monotonous.

The effectiveness of AR 3D interactive learning media for "Plant Cell" Biology material showed by the results of this research are supported by the previous relevant researches' results which generally led to the similar conclusion on the positiveness of using 3D AR media specifically for Biology. However, it should be understood that there are at least three kinds of different factors that had been found regarding the reasons on why it can be considered as the positiveness. First, the researches carried out by Kalana, Junaini, and Fauzi (2020, p. 579-585) & Labib, Subiantoro, and Hapsari (2020, p. 899-905) both emphasized how AR as one of the forms of the transformation of the conventional way in Biology learning, is able to be accessed by mobile phone by the students specifically during Covid-19 pandemic, and can finally able to support their learning activities. Second, Weng, Otanga, Christianto, and Ju-Chun Cu (2019: p 1-24) & Damopolii, Paiki, and Nunaki (2022, p. 348-355) similarly found about the positiveness on using AR 3D that it improves the students' critical thinking, and their learning outcomes specifically in the analyzing (C4) level. Third and last, the factor is related to the ones coming from the students themselves and considered as the responses while AR 34 is implemented. Zulfarina, Syafiii, and Putri (2019, p. 417-424), Destiara (2020, p. 117-122), Liono, Amanda, Pratiwi, and Gunawan (2021, p. 144-152) & Omurtak & Zeybek (2022, p. 55-74) respectively found that AR 3D is able to create more interesting, and efficient learning activities. Besides, the students' interest improves, AR 3D thus has good readibility criteria and the teaching material is considered as pratical, AR 3D, moreover, is considered as interesting by the students in term of their visualization and it motivates them more in learning. Last, it is also stated that the fact that AR 3D looks more concrete in displaying the objects in the form of learning material makes the students think that the learning activites become fun. Finally, it can be emphasized that the results of this research are in line with the previous relevant researches that they all cover the positiveness of AR 3D in supporting the Biology learning.

4. Conclusion

The effectiveness of the media that is showed through the research results and gained through the tests conducted to the experts/examiners and the users reflect that this AR 3D interactive learning media is generally easy to understand and use. It is also in line with the results from the previous researchers where AR specifically for Biology learning is suitable that there are many different supporting factors for the reasons on why it is suitable. However, due to limitation in the research process which were conducted under Covid-19 pandemic, the adaptations or modifications were prevailed in some stages for the product making and during the research process. In the future, the similar researches are open to the others or new researchers. This kind of research is also crucial to be further developed.

5. Acknowledgement

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