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AUGMENTED REALITY BASED-LEARNING MEDIA OF COMPUTERS*

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Abstract

Augmented reality is the latest technology that combines 3D objects (virtual world) into a real environment using webcam media or cellphone cameras. This study aims to create a learning media application of computers utilizing the development of Android-based smartphone technology using augmented reality technology. The use of augmented reality technology can be employed for fun learning media and increase the curiosity of students. This study applied Research and Development (R&D) method and the SDLC (Software Development Life Cycle) development method. The media was tested individually to obtain responses from users. The first test was conducted on three lecturers at the Universitas Muhammadiyah Surakarta. The results showed that the average coefficient V of media experts was 0.88, which was declared valid. The result of the reliability test of media experts obtained a value of 0.813 and was declared highly reliable. When the test was administered on three accompanying teachers at SDIT Al Firdaus Purwodadi, it was obtained an average coefficient V of material experts of 0.83 which was declared valid. The results of the material expert reliability test obtained a value of 0.725 and declared high reliability. The results of the interpretation test of the test percentage carried on 4 students yielded a percentage value of 66%, which was included in the "Agree" category. Based on field trials, after applying introduction to computer application using augmented reality technology, students appeared to be enthusiastic and excited to see the application. At first, the children were preoccupied to talk each others, but after the application was run, they immediately paid attention to the application and drove to see the application more clearly.

Keywords: augmented reality, computer introduction, learning media.

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1. Introduction

Augmented reality is a technology that combines 3D objects (virtual world) into a real environment using webcam media or cellphone cameras (Kusniyati et al., 2017). Learning media is currently widely used in the education milieu, in the use of learning media may improve interest in learning, add knowledge and insight by overcoming space and time, and optimize the learning process in delivering material to students (Salam et al., 2018; Oktaviati et al., 2018; Adam and Syastra, 2015). For this reason, learning media is required because, in addition to its sufficient use, it is also deemed better than the lecture method and conventional methods. Students are more engrossed in using learning media with varied forms, unique displays, and good animations. The development is required to apply the concept of interactive and fun learning media.

One of the developing digital technologies is augmented reality. Augmented reality has features that can visualize abstract configurations to be real. Augmented reality systems work assisted by markers that are used as image detection so that 3D objects appear when scanning markers have been provided (Gunasinghe et al., 2019, 2020; Karisman et al., 2019). Given the development of this technology usage, it brings positive impacts if used wisely (Al-Shuaili et al., 2019; Herlandy et al., 2019). Research on augmented reality learning media has emerged to facilitate interactive learning processes. The use of learning media will encourage students to understand the material provided by the teacher and increase high curiosity (Nurseto, 2012). The learning process that applying the rote method is insufficient as students can only understand the material, but cannot apply it in everyday life (Ekayani, 2017). The use of augmented reality learning media fosters students' interest in learning and is very practical in its application (Endra and Agustina, 2019).

Introduction to computers should be given early to students, yet currently, many students are not familiar with computers because the learning process is using conventional methods (Saputra et al., 2018). The learning process employing conventional methods leads students to be less interested in learning computers (Fahrurozie, 2019).

Based on the prevailing drawbacks, it is necessary to take action to help stimulate the enthusiasm for introduction to learning computer to students. In addition, it is expected to increase students' understanding and knowledge. Learning media is created to facilitate the student learning process. Departing from the description above, the researchers designed an android-based computer recognition learning media using augmented reality technology.

2. Method

This research was conducted at SDIT (Islamic Elementary School) Al Firdaus Purwodadi with the Research and Development (R&D) method. The research development model was designed using SDLC (Software Development Life Cycle). Based on the concept of the SDLC (Software Development Life Cycle) development model, it consists of 5 stages of development. The first stage, Needs Analysis (Analyze), is an activity to analyze what is needed by the users, starting from functional and non-functional needs. The second stage, namely Design, is an act of designing the user interface of the product to be made. The third stage, which is Coding/Program, is the implementation of the product user interface design that has been made at the design stage. The fourth stage, Testing, is an activity to try out the product, the application system encounters either errors or no errors, either follows or does not follow user needs. The last stage, namely Implementation, is implementing the product that has been made to the targets predetermined by the researcher.

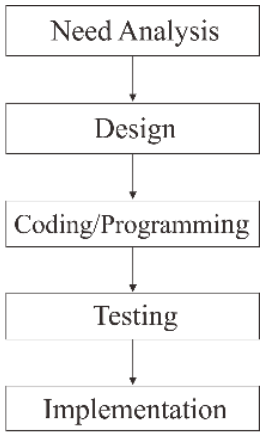

Fig. 1. SDLC Development Model

2.1. Analysis

At this stage, the interview was done with an ICT teacher of SDIT Al Firdaus Purwodadi to obtain information about the needs of ICT subject learning media, as well as finding several learning curricula to collect data.

2.2. System design

2.2.1. Use case diagram

Use case diagram is a diagram to describe the functionality of the interaction relationship of the application system and the user. The description of the use case diagram function in this research is presented in Fig. 2.

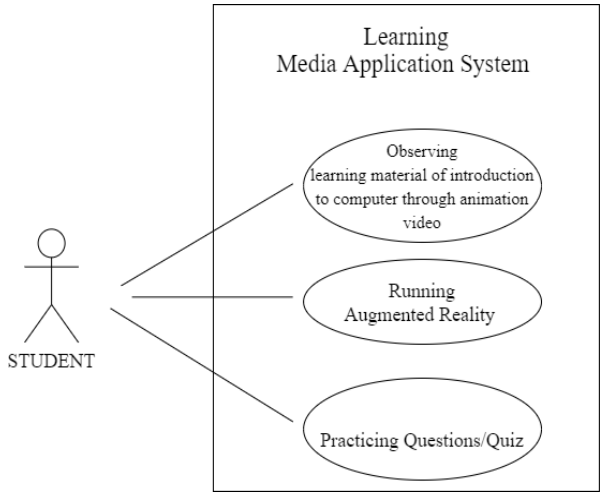

Fig. 2. Use case diagram

The learning media application comprises 3 main menus; *materi* (material), *pindai* (scan), and quiz. If the user selects the material menu, the application system will display

computer introduction material in the form of an animated video. If the user chooses *pindai* menu, the application system will open the camera to scan the marker image that has been provided, then after the marker system, the application will display the name of the computer hardware as well as 3D-shaped objects and their functions. If the user opts for the quiz menu, the application system will show quiz questions. After finishing the quiz, the system will display the user's score. The user may repeat the quiz or return to the menu page.

2.2.2. Activity diagram

Activity diagram describes workflow in a system or application. Activity diagram on learning media made by researchers explains the workflow for introduction to computer at SDIT Al Firdaus Purwodadi. The following is the activity diagram for computer learning media. Figure 3 shows that the activity diagram displays a menu initiated when the user clicks the "Next" button and the system will display the menu page. Next, the user may select one of the menus and the system will display the selected menu (Fig. 4).

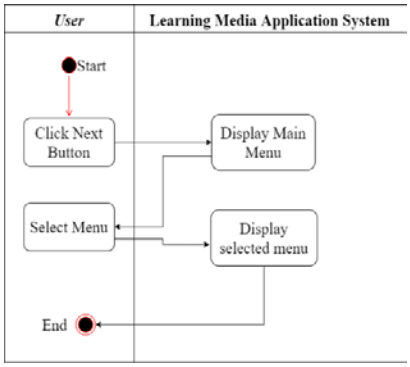

Fig. 3. Activity diagram of selecting menu

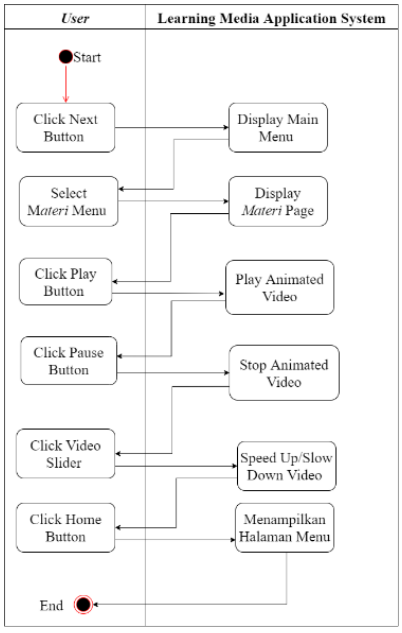

Fig. 4. Activity diagram of *Materi* (material) menu

The Activity Diagram (Fig. 5) displays the *materi* menu when the user clicks the next button, the menu page will appear. The user may select the *materi* menu, then the system will show *materi* menu. Following that, the user may click the play button and the system will load the animated video material. Furthermore, the user may click the pause button, then the animated video will stop by the system automatically. The user may click the slider to slow down or speed up the video, then the system will slow down or speed up the video. When the user clicks the home button, it will direct to the menu page.

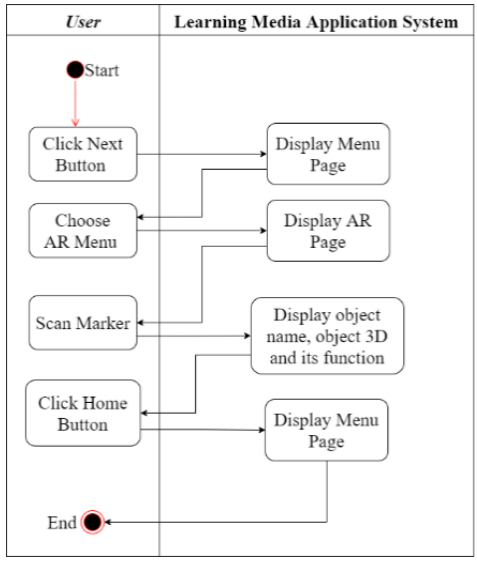

Fig. 5. Activity Diagram of Scan Menu

The Activity Diagram displays a *pindai* (scan) menu when the user clicks the next button, then the menu page will be shown. The user may select *Pindai* menu, then the system will display *Pindai* page and automatically activate the camera. The user is allowed to scan the marker, the system will display the name of the object, the 3D object, and the function of the 3D object. Next, the user may click the home button and the system will return to the menu page (Fig. 6). The activity diagram exhibits the quiz menu when the user clicks the next button, the menu page will appear (Fig. 6). The user may select the quiz menu and the system will display the quiz page. Next, the user may answer the questions and when the answers are completed, the system will display the scores earned. The user may click the *ulang* (repeat) button if the score is below the maximum, the system will display questions again. If the score is good, the user may click the home button and the system will direct to the menu page.

Activity diagram out of the application can be done by clicking the next button, then the menu page will show up. The user may choose the exit button on the menu page and the system will display an exit popup (Fig. 7). The user may click YES button to exit the application and the system will process and exit the application. Otherwise, the user may click NO button to not exit the application and the system will remove the pop-up and return to the menu page display.

a. Code Writing Program

The Coding/Programming stage is the stage for implementing the product user interface design that has been created at the design stage. The design operates the Unity 3D application

to build applications and create 3D objects, Corel Draw X7 to design the user interface, Visual Studio 2019 to process program code, and other essential applications.

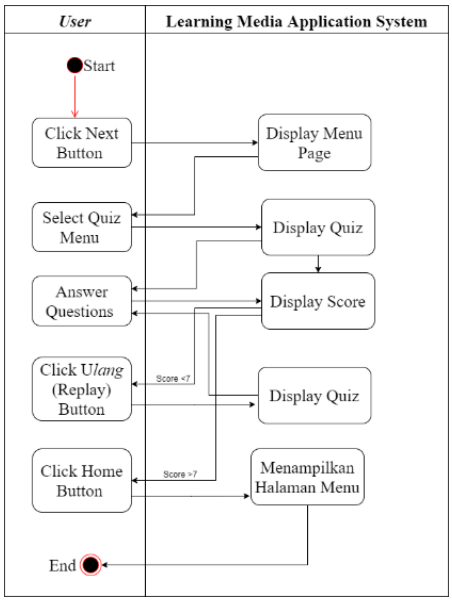

Fig. 6. Activity Diagram of Quiz Menu

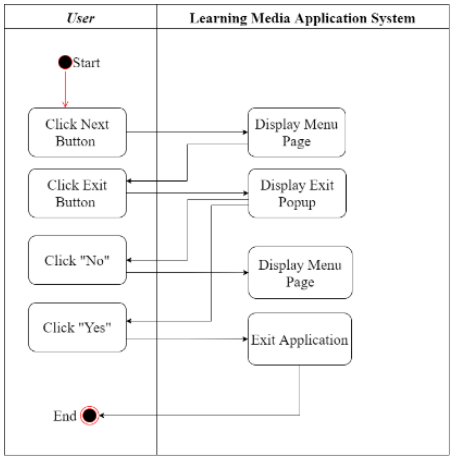

Fig. 7. Activity Diagram of Exit Menu

b. Testing Program

The testing stage is for testing the product, whether an error may or may not occur, and whether it is according or not following user needs. Testing is done through the black-box test, material test, media test, usability test, and interpretation test.

c. Implementation and Maintenance

This implementation phase was performed on four fourth-grade students of SDIT Al Firdaus Purwodadi to determine student responses and the feasibility of the learning media

application. Students learned introduction to computer material, especially hardware and its functions, conducted AR experiments on the learning media application, and practiced quizzes.

3. Results and discussion

In this study, a product has been developed, namely an Android-based introduction to computer learning media using augmented reality technology. Augmented reality is a technology that can be used to visualize abstract shapes into something real. Therefore, the introduction to computer using augmented reality brings benefits to visualize computer hardware.This learning media aims to increase student understanding and knowledge, for that the material displayed is related to computers, which is computer hardware. The material is displayed in the form of animation and utilizes augmented reality technology to display computer hardware objects in 3D. To run the learning media application, an android phone is required.

This computer recognition learning media application using augmented reality technology was developed using Unity 2017.3.1 with the support of Corel Draw X7, Notepad++, and Vuforia. The learning media comprises material in the form of animation, display of 3D objects by employing augmented reality technology, and questions or quizzes to train students' understanding. The learning media application is established based on the wireframe that has been created.

Wireframes

Figure 8 is the initial interface once *pengenalan komputer* (introduction to computer) application opens. The learning media shows introduction to computers which will discuss computers. Display design presents brightly colored garden atmosphere that may attract attention. The background choice is for students to becoming more enthusiastic in learning and having an enjoyable mood.

Fig. 8. Initial Interface of Learning Media of Introduction to Computer

Figure 9 is a pop-up display of information for the learning media creator, showing the full name of the creator. While at the top right, an exit button is attached which is used to close the information pop-up and will return to the home page. Figure 10 is the main menu display on the learning media of introduction to computer. The user may select the materi button, pindai button, and quiz button. While at the top right, there is a home button to return to the menu page. Figure 11 is a display of the materi menu presented in an animated video. There are 3 buttons that can be selected by the user. The play button is for playing the animated video, the pause button is used to pause the animated video, and the button at the top right of the home button is used to return to the menu page. There is also a slider to slow down/speed up the animated video.

Fig. 9. Creator Profile Display

Fig. 10. Display of the Main Menu of Learning Media

Fig. 11. *Materi* Menu Display

Figure 12 is *pindai* menu display. When enter *pindai* menu, the system will automatically activate the camera which can be used by the user to scan the provided markers. After the marker is scanned, the name of the object, the shape of the 3D object, and its function will appear. While the button at the top right can be selected to return to the menu page. Figure 13 is a quiz menu display in which there are random questions the user may complete. Each question has a timer of 15 seconds, if the timer runs out, the question will disappear and move on to the next question. While the button at the top right may be clicked to return to the menu page.

Fig. 12. Pindai (scan) Menu Display

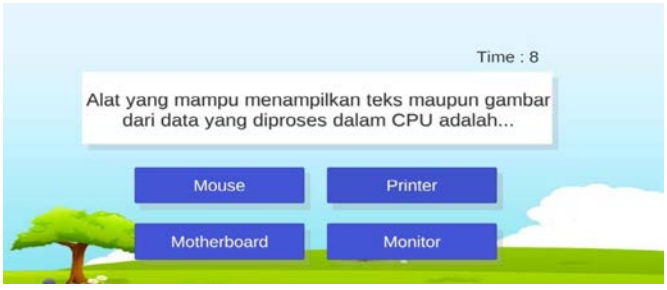

Fig. 13. Quiz Menu Display

Figure 14 is the score display obtained after finishing answering all the questions. There are 2 buttons embedded, including the ulang (repeat) button which directs to repeat the quiz, while the home button will direct to the menu page.

Fig. 14. Score Display

Figure 15 is an exit pop-up display that appears after clicking the exit button at the top right on the home page of the learning media. There are 2 buttons provided on the exit pop-up, "NO" button if the user wishes to exit which will redirect to the start page, while "YES" button if the user wishes to exit the learning media. Figure 16 is an augmented reality game display. The camera will automatically activate and several computer hardware components will appear. The mission of this game is to shoot all the hardware components of the computer. Each hardware shot will earn a score of “1”. The red button serves to shoot the computer hardware, while the home button will direct the user to the menu page.

Fig. 15. Exit Display

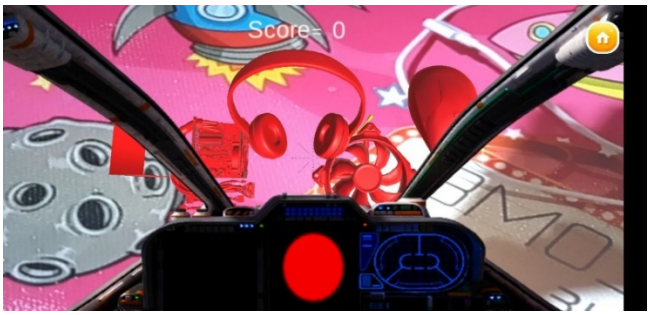

Figure 16. AR Game Display

Media Expert Testing

The media expert assessment was carried out by three lecturers from the Universitas Muhammadiyah Surakarta, participated by Mr. Arif Setiawan, S.Kom., M.Eng, Mr. Hardika Dwi Hermawan, S.Pd., M.Sc(ITE), and Mr. Agung Wiratmo. The results from media experts are given by Eqs. (1, 2).

$$\text{Mean} = \frac{Total\ V\ score}{Total\ Item} \quad (1)$$

$$\text{Mean} = \frac{22.03}{25} = 0.88 \quad (2)$$

The data above are the results of research from the media test which explains that there are 3 validators who assessed learning media, the results of the coefficient per item, and the mean of the three validators. Assessment on each item obtained the results of the coefficients almost equivalent. The limit table of Aiken V of 25 items entails conditions from a lower limit of 0.69 to an upper limit of 0.96. The results above show that 25 items earned V value of 0.88. Then, the content validation that has been obtained may be declared valid because it is following the limit table of Aiken. Furthermore, the reliability test was carried out by the same three lecturers. The results of the reliability test are shown in Figs. 17 and 18.

Figure 17 provides information about the number of samples or validators (N) analyzed by the SPSS program, showing N as many as three lecturers from the Informatics Engineering Education Study Program, Universitas Muhammadiyah Surakarta. Due to the absence of blank data, in other words, the validator's answers were completely filled, the valid number was 100%.

Case Processing Summary

		N	%
Cases	Valid	3	100.0
	Excluded[a]	0	.0
	Total	3	100.0

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

Fig. 17. Case processing summary Table of media

Figure 18 is reliability statistics, which N of Items (number of items or questions) contains 25 items with Cronbach's alpha value of 0.813. As the value of Cronbach's alpha 0.813 is within a range of 0.7≤a≤0.9, then as the ground for decision making in the reliability test, it can be determined that the 25 or all items in the questionnaire had strong reliability.

Reliability Statistics

Cronbach's Alpha	N of Items
.813	25

Fig. 18. Reliability Statistics Table of Media

Rating results used interpretation presentation. The percentage results of items 1 to 25 can be seen in Fig. 19. This Figure shows a graph of the interpretation percentage of media experts, totaling 25 items. Of 25 items, all had interpretations above 60. Thus, all items are eligible to be reused as instruments.

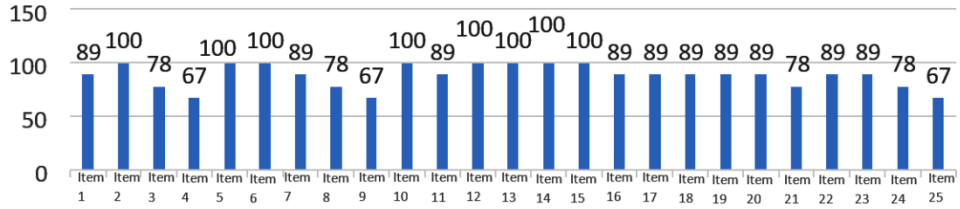

Fig. 19. Graph of Media Expert Interpretation Percentage

Material Expert Testing

The material expert assessment was performed by three teachers from SDIT Al Firdaus Purwodadi. The results of the material expert test are displayed by Eqs. (3, 4):

$$\text{Mean} = \frac{Total\ V\ score}{Total\ Item} \quad (3)$$

$$\text{Mean} = \frac{18.93}{3} = 0.83 \quad (4)$$

The data above are the results of an assessment of the material test which explains that there are 3 validators, the results of the per-item coefficient, and the average of the three validators. Assessment on each item shows the results of the coefficient V which is almost the same. Limit table Aiken V 23 items with a lower limit of 0.64 to an upper limit of 0.93. The results above show that 23 items have a V value of 0.83. Then the content validation that has been obtained can be declared valid because it is in accordance with the Aiken limit table.

The reliability test was also carried out by the same three teachers. The results of the reliability test are shown in Figs. 20 and 21. Figure 20 is a case processing summary, regarding the information on the number of samples or respondents (N) analyzed in the SPSS program. N covers three teachers of SDIT Al Firdaus Purwodadi. Due to the absence of blank data (the respondents' answers were completely filled out), then the valid number was 100%.

Figure 21 represents reliability statistics, it is known that there were 23 N of Items (number of items or questionnaire questions) with a Cronbach's alpha value of 0.725, which is a range from $0.7 \leq a \leq 0.9$. Therefore, as the basis for decision making in the reliability test above, it can be concluded that the 23 or all items in the questionnaire had strong reliability.

Case Processing Summary

		N	%
Cases	Valid	3	100.0
	Excluded[a]	0	.0
	Total	3	100.0

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

Fig. 20. Case Processing Summary Table of Material Expert

Reliability Statistics

Cronbach's Alpha	N of Items
.725	23

Fig. 21. Reliability Statistics Table of Material Experts

Rating results used the interpretation percentage. The percentage results of items 1 to item 23 are shown in Fig. 22.

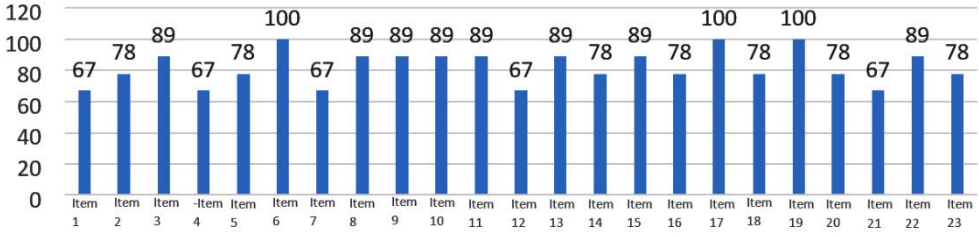

Fig. 22. Graph of Interpretation Percentage of Material Expert

Figure 22 shows a graph of the interpretation percentage of media experts, totaling 23 items. Of 23 items, all had interpretations above 60, thus all items are eligible to be reused as instruments.

User Testing

User testing was administered on students of SDIT Al Firdaus Purwodadi with a total of 4 students. Calculation of the mean employed Eqs. (5, 6):

$$Nilai\ rata - rata \sum_{i=1}^{n} \frac{Xi}{N} \qquad \text{(Mean….)} \qquad (5)$$

where:

Xi = respondent's score

N = number of respondents

Then:

$$Nilai\ rata - rata \frac{325}{4} = 81{,}25 \qquad \text{(Mean…)} \qquad (6)$$

1.

The data above is the mean of the student questionnaire filled out by 4 students of SDIT Al Firdaus Purwodadi. A mean of 81.25 is included in the acceptable category obtained using the SUS (System Usability Scale) calculation covering 10 questions that must be answered by users of learning media, comprising students of SDIT Al Firdaus Purwodadi. Figure 23 is a graph of student data obtained applying the SUS (System Usability Scale) calculation. From the data, it can be determined that there were 4 students whose scores range from 71-100, which are included into acceptable.

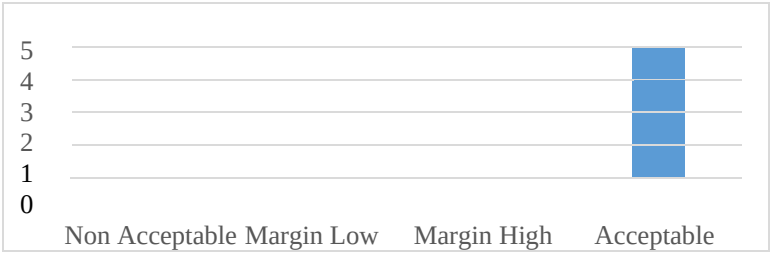

Fig. 23. Graph of Student Data Using SUS (System Usability Scale)

Functionality Test

The functionality test is intended to test the feasibility of the learning media developed by the researcher focusing on the functionality of the learning media using Black Box Testing (Table 1).

Table 2 is a summary of the black box testing, which tested the functional features and buttons on the learning media. Of 20 tests, all showed a 100% success rate, implying that all the features and buttons in the learning media functioned properly.

Table 1. Black Box Test Results

No	***Item***	***Case and testing result***		***Information***
		Scenario	***Expected output***	
Main Menu Display				
1.	Enter menu	Tap enter button	Direct to main menu	Well-functioned
2.	Creator profile menu	Tap the creator profile button	Display personal data of the learning media creator	Well-functioned
3.	Audio	Tap audio button	Turn on or turn off audio	Well-functioned
4.	Email	Tap email button	Direct to email page	Well-functioned
5.	Exit	Tap exit button	Exit learning media	Well-functioned
Main Menu				
6.	*Materi* menu	Tap *materi* button	Direct to *materi* menu page	Well-functioned
7.	*Pindai* menu	Tap *pindai* button	Direct to *pindai* menu page	Well-functioned
8.	Quiz menu	Tap quiz *b*utton	Direct to quiz menu page	Well-functioned
9.	Home	Tap home button	Direct to main menu	Well-functioned
***Materi* Menu**				
10.	Play	Tap play button	Play animated video	Well-functioned
11.	Pause	Tap pause button	Pause animated video	Well-functioned
12.	Slider	Tap slider button	Speed up or slow down animated video	Well-functioned
13.	Home	Tap home button	Direct to main menu	Well-functioned
***Pindai* Menu**				
14.	Home	Tap home button	Direct to main menu page	Well-functioned
Menu *Quiz*				
15.	Answer A	Tap A button	Direct to next question	Well-functioned
16.	Answer B	Tap B button	Direct to next question	Well-functioned
17.	Answer C	Tap C button	Direct to next question	Well-functioned
18.	Answer D	Tap D button	Direct to next question	Well-functioned
19.	Reply arrow	Tap reply arrow	Direct to the first question of quiz	Well-functioned
20.	Home	Tap home button	Direct to main menu	Well-functioned
21.	Game	Tap game button	Direct to game page	Well-functioned
22.	Shoot	Tap shoot button	Release bullet	Well-functioned

Tabel 2. Black Box Testing Summary

Number of testing	Succeed	Fail
20	20	0
Percentage	100%	0%

User Rating

User ratings conducted the following questionnaires:

The user assessment was carried out by 4 students of SDIT Al Firdaus Purwodadi. The results of student questionnaires can be seen in Table 3.

Table 3. Results of students' questionnaire/ John Brooke's Test

No	***Question***	***Scoring***				
		1	**2**	**3**	**4**	**5**
1.	I think I like this learning media so I will use it many times					
2.	I think this learning media is too complicated to use					
3.	I think this learning media is easy to use					
4.	I need other's help to use this learning media (I can't operate learning media on my own without assistance)					
5.	I think these parts of the learning media can be used well					
6.	I think how to operate this learning media is confusing					
7.	I think other people will learn to use this learning media easily (very quickly)					
8.	I consider this learning media impractical (difficult) to use					
9.	I think I can use this learning media					
10.	I need to learn first to be able to use this learning application					

Calculation of the mean used Eqs. (7, 8).

$$Mean \sum_{i=1}^{n} \frac{Xi}{N} \tag{7}$$

where:

Xi = respondent's score
N = number of respondents

Then:

$$Mean \frac{325}{4} = 81.25 \tag{8}$$

The data above is the mean of the student questionnaire filled out by 4 students of SDIT Al Firdaus Purwodadi. A mean of 81.25 is included in the acceptable category obtained using the SUS (System Usability Scale) calculation consisting of 10 questions that must be answered by users of learning media, comprising students of SDIT Al Firdaus Purwodadi. The SUS calculation had been validated and used for a small number of respondents.

4. Conclusions

Based on the results of research and discussion, all things considered, learning media of introduction to computer based on Android using augmented reality technology may act as an alternative learning media to improve student understanding and knowledge and be used to increase student enthusiasm for learning.

The learning media is classified as feasible based on research of the questionnaire calculation given to media experts, material experts, and students as users obtained the following results: 1) the mean of the coefficient V of media experts was 0.88, which is declared valid. The result of the media expert reliability testing obtained a value of 0.813 and was declared to have strong reliability, 2) the mean of the coefficient V of material expert was 0.83, which is declared valid. The results of the material expert reliability testing obtained a value of 0.725 and declared strong reliability, 3) the mean of student or user questionnaires was 81.25, which according to the SUS criteria 4 of them were in the acceptable category, 4) the results of the interpretation percentage of tests carried out on 4 respondents or users yielded a percentage value of 66% or in the "Agree" category. Based on field trials, Based on field trials, after applying introduction to computer application using augmented reality technology, students appeared to be enthusiastic and excited to see the application. At first, the children were preoccupied to talk with others, but after the application was run, they immediately paid attention to the application and fought for the front place to see the application more clearly.

This research still entails drawbacks, which is the introduction to computer consisting of deeper object recognition, the location of the 3d object is not adequate, and the conclusion of the quiz score is still simple.

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