MOBILE AUGMENTED REALITY APPLICATION (ARFABICS) OF HIJAIYAH LETTER INTRODUCTION AS LEARNING MEDIA FOR CHILDREN

Wildan Z Rayhan[1], Sri Wulandari[2]

[1, 2]Fakultas Sains dan Teknologi, Informatika, Universitas Teknologi Yogyakarta, Sleman, Indonesia
Email: [1]wildanzainryhn@gmail.com, [2]sri.wulandari@staff.uty.ac.id

Abstract

In Al-Qur'an, which is the holy book for Muslims, hijaiyah letters function as a letter to form a word, just like in Indonesia, where alphabet letters are used to form a word. Therefore, many Muslims from adults to children learn how to read hijaiyah letters properly and correctly so that they can properly perform their prayers. The progress in current technology has paved the way for numerous innovations in the field of education, including the implementation of augmented reality technology in learning methods. This technology allows the presentation of interactive three-dimensional objects, enhancing the effectiveness of the educational process, especially for children. This can help children understand learning materials more easily and be fun. In this study, the design of the Arfabics application, which introduces hijaiyah letters using augmented reality technology, will provide a fun new experience for children in their learning process of recognizing hijaiyah letters. This application is designed using the main software Unity 3D, Vuforia SDK, and using the Marker Based Tracking method. This research aims to enhance children's visual understanding of hijaiyah letters by utilizing three-dimensional augmented reality technology, aiming to increase children's interest and joy in learning hijaiyah letters. The results of this study demonstrate that the ArFabics application received positive responses from students and teachers who participated as respondents. This suggests that the application effectively facilitates the learning process of hijaiyah letters.

Keywords: *Hijaiyah letters, Augmented Reality, Marker Based Tracking, Unity, Vuforia SDK*

Corresponding Author: Wildan Z Rayhan

1. INTRODUCTION

The Hijaiyah letters are letters that come from the Arabic language. There are 30 hijaiyah letters, starting from the letter ١ (alif) to the letter ي (ya) [1]. In reading the holy book of the Qur'an, the ability to read hijaiyah letters is needed [2], such as the thickness, the place where it comes out of the mouth, the properties of hijaiyah letters, how to read them after being given a harakat, this needs to be considered to read the Qur'an in a good way [3]. The Qur'an itself is a holy book that is a guide in Islam which consists of 30 Juz, 114 Surah, and 6236 Verses [4], therefore many Muslims learn how to read hijaiyah letters correctly [5] to smoothly carry out their worship properly. Not only limited to adults, parents also hope that their children can read hijaiyah letters well at an early age. However, many children are not interested in learning to read hijaiyah letters.

Many young children have a lack of interest in learning hijaiyah letters, which directly affects their ability to read the Qur'an, especially since reading hijaiyah letters is not as easy as reading the letters of the alphabet. At that age children are very difficult to learn and concentrate, they tend to like to play and focus on what makes them interested. Play is a crucial component of childhood. If this element is removed from the learning process, children can quickly become bored and struggle to comprehend the lessons effectively [6]. Traditional learning methods, which still use books such as Iqra' and Tilawati, merely serve as tools to convey knowledge but fail to engage children in the learning process because they resemble textbooks [7]. Learning conducted by schools based on research [8] also uses conventional media such as blackboards and books, making children bored and not interested in learning hijaiyah letters, even though learning media is an important factor in determining student learning results [9].

The development of technology today makes learning no longer have to use books or other traditional methods, it can be replaced with something

more interesting such as videos, images, or even digital games to create a pleasant learning environment [10], especially the influence of current technology that makes children tend to like game applications on smartphone devices [11, 12]. Using modern technology as learning media can train students' creativity, provide new insights, and involve many senses, allowing students to have a new experience in their learning process [13]. Research examples [14], [15] show how AR applications that only bring up 3D objects of hijaiyah letters are used to teach hijaiyah letters in elementary schools and boarding schools can increase children's enthusiasm for learning hijaiyah letters. Researchers [16] made an application for learning hijaiyah letters using marker-based augmented reality technology which can also bring up the sound of how to read hijaiyah letters. In a study [17] that evaluated many papers on the use of augmented reality in improving learning effectiveness, the majority of the papers they reviewed showed positive results regarding the influence of augmented reality on education.

In this research, a fun Hijaiyah letter learning application called ArFabics is made by utilizing augmented reality technology that can be run on a smartphone device with the Marker Based Tracking method. The use of augmented reality technology that utilizes 3D objects can create a more interactive learning process and stimulate children's imagination, promoting a better understanding of spatial concepts and enhancing the recall of learning content [18, 19]. By using the marker-based method, children can scan the available markers so that 3D objects of hijaiyah letters appear according to the scanned markers, there are also sounds that show how to pronounce hijaiyah letters properly and correctly, as well as several other features. The learning process that uses 3D visualization and sound [20] aims to attract children's interest and enthusiasm and help them learn and recognize the hijaiyah letters.

2. RESEARCH METHOD

The research method used in this research is explained using a research framework that consists of problem identification, system analysis, system design, testing, and implementation. The research framework can be seen in Figure 1 below.
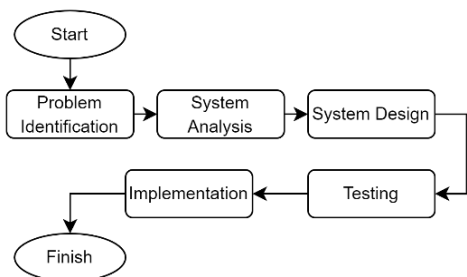

Figure 1. Research Framework

2.1. Problem Identification

At this stage, it is explained that the process of teaching and learning hijaiyah letters still uses books such as iqra', tilawati, and others so that the teaching and learning process becomes not fun and reduces children's interest in learning hijaiyah letters.

2.2. System Analysis
1. Running System Analysis

The current hijaiyah letter learning system still uses book media such as iqra', tilawati, and others in delivering hijaiyah letter material by teachers to teach children. The learning system is described in Figure 2 below.
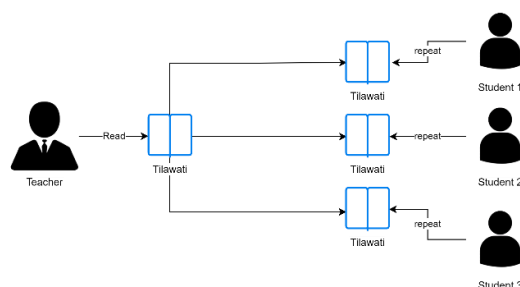

Figure 2. Current Learning System

Based on Figure 2 above shows the practice carried out by the teacher and students, each will open the tilawati book together then the teacher will read and the students will repeat based on the instructions given by the teacher.

2. New System Analysis
a. Functional Requirement Analysis

Functional requirements are explained in input type, process, and output. The input requirement involves 3D objects representing hijaiyah letters and a scannable marker. There are a total of 30 3D objects and markers used in the application, including various decorative items, music, sound effects, and more. The process requirement outlines specific procedural steps, including labeling the marker according to the chosen 3D object used as a model in developing the marker-based Augmented Reality application. The output requirement for this design involves marker detection, enabling 3D hijaiyah letters and corresponding audio to appear upon scanning. Additionally, several features are incorporated to enhance the learning experience and make it more enjoyable.

b. Non-functional Requirement Analysis

A non-functional requirement is explained in 2 points, software requirement and hardware requirement. Software requirements as a supporter of making this application include Unity 3D, Vuforia SDK, Figma, and Adobe Photoshop. The hardware requirements used by researchers in designing applications include 1 Asus Vivobook M3401QC Laptop and 1 Samsung Galaxy Note 9 (SM-N960F) smartphone.

2.3. System Design

The system design in this research consists of system architecture, flowchart, and physical design. This design aims to know the requirements and structure of the application to achieve the goal appropriately.

System Architecture

The following system architecture diagram of the ArFabics hijaiyah letter introduction application is shown in Figure 3 below.
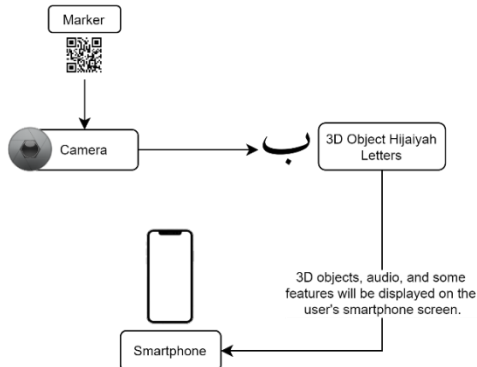
Figure 3. System Architecture

The augmented reality application ArFabics is only operated by one user. By utilizing the camera of the smartphone, the user can scan the marker that has been provided in the application which later the application will bring up a 3D object of hijaiyah letters following the scanned marker, audio of how to pronounce the letter correctly, as well as some additional features such as selecting harakat, moving, zooming, rotating hijaiyah letters so that the learning process will feel like playing a game.

Flowchart

The flowchart for the development of the ArFabics augmented reality application can be seen in Figure 4 below.
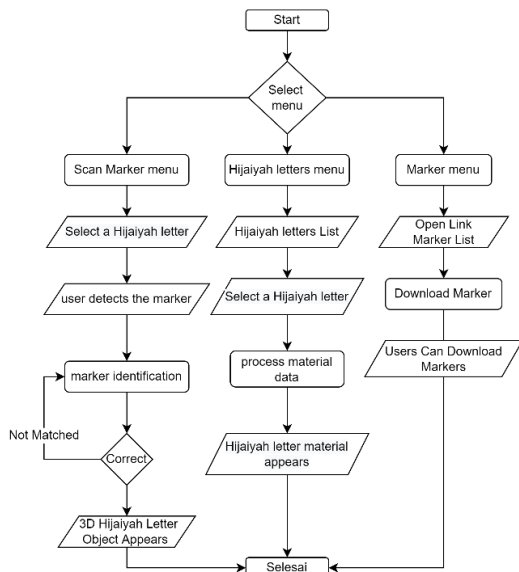
Figure 4. Flowchart

The flowchart in Figure 4 above explains that when the user starts the application, 3 main menus can be selected, the Scan Marker menu, the Hijaiyah Letter menu, Marker menu. The Scan Marker menu contains a page to start scanning markers that have been provided and bring up 3D objects of hijaiyah letters. The user will first select the hijaiyah letters that want to be scanned, after that the user can scan the marker according to the selected hijaiyah letters. In addition to the 3D object that appears after scanning, there is also an audio that explains how to pronounce hijaiyah letters along with several interaction features such as selecting harakat to add to hijaiyah letters, drag, pinch scale, and rotate features to move, resize, and rotate hijaiyah letters to make the learning process more fun. The Hijaiyah Letters menu contains a list of hijaiyah letters that can be selected by the user to open the material of each hijaiyah letter. The Marker menu can be selected by the user to enter the Google Drive page to download the marker that has been provided.

Physical Design

During this phase, a foundational structure and layout are developed using wireframes, which will be implemented in the ArFabics application. These wireframes are visual representations demonstrating how the application will be organized, ensuring a clear comprehension of the final product. The wireframe design of the application is depicted in Figure 5 below.
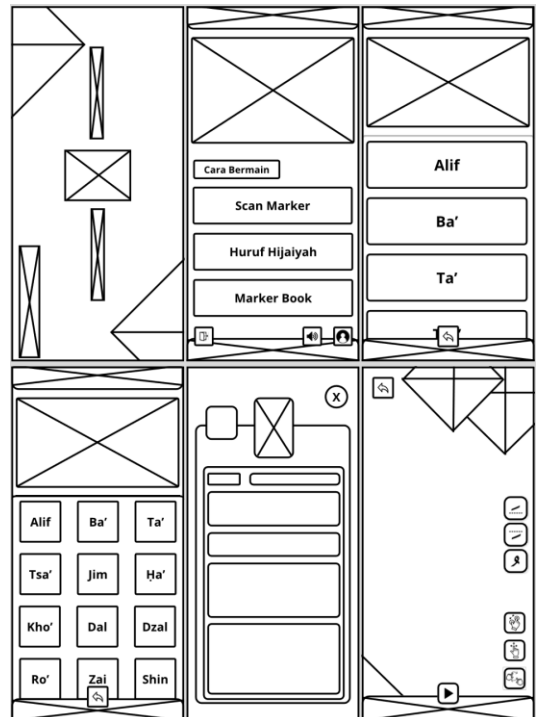
Figure 5. Wireframe Design

2.4. Testing

Black Box Testing

At this stage, the application is tested using black box testing, which focuses on the functionality of the application system and whether it has functioned following the provisions or not.

System Usability Scale

System Usability Scale (SUS) is a method of testing the usability of a system that provides an evaluation of the system's use. Using the SUS questionnaire allows for measuring the usability and functionality of the system by using 10 questions that are scored using 5 selection scales based on the description of the items used [16]. To evaluate the ArFabics application, a questionnaire will be conducted using the System Usability Scale (SUS) method. The following are the rules for calculating the score on the questionnaire:

- For each odd-numbered question, the score of each question obtained from the user's score will be deducted by 1.
- For each even-numbered question, the final score is obtained from the score of 5 minus the score of questions obtained from the user.
- The score of each question is then multiplied by 2.5 to get a score range of 1-100.
- After getting the score for each respondent, the average score will be calculated using the following formula 1.

$$\bar{x} = \frac{\sum x}{n} \tag{1}$$

$\bar{x}$ is the average score, $\sum x$ is the total number of SUS scores, and n is the number of respondents. The average score obtained will be used to determine the conclusion of the ArFabics application evaluation by adjusting the SUS assessment category in Figure 6 below.
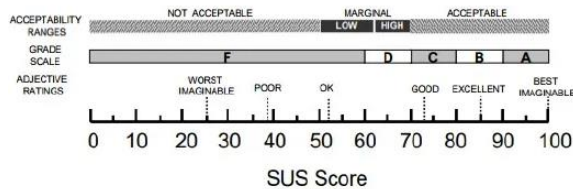

Figure 6. SUS score category

2.5. Implementation

At this implementation stage, the system refers to the analysis, design, system design, and testing stages that have been done previously in the application development process. This system will be implemented for smartphones with at least API level 25 and support with AR Core. Implementation of the system can be done in parallel, meaning that the conventional teaching and learning process will continue to run and a new system using Augmented Reality (AR) technology will also be used to add excitement to the teaching and learning process, and this ArFabics application can also be used by children themselves to learn anywhere without having to always be accompanied by a teacher like the current method.

3. RESULT AND DISCUSSION

3.1 Results

This section describes the results of designing the Arfabics application for learning Hijaiyah letters.

a. Splash Screen Page

This page is the initial page that will appear when the application is run before going to the main page similar to the loading screen. The splash screen page display can be seen in Figure 7 below.

Figure 7. Splash Screen Page

This page contains a picture that illustrates the ArFabics application and several logos that belong to the software used to develop this application such as Unity 3D, Vuforia Engine, Figma, and Adobe Photoshop.

b. Main Menu Page

This page is the main page of the ArFabics application which contains menus and buttons that can be selected by the user to operate the application. The main menu page can be seen in Figure 8 below.

Figure 8. Main Menu Page

Based on Figure 8 above, shows that the main page of the ArFabics application provides several menus and buttons, including the Scan Marker menu, Hijaiyah Letter menu, Marker Book menu, How to Play menu, about menu, sound button, and exit button to exit the application.

c.   Scan Marker Page

This page is a page to start scanning markers to display 3D objects. Later, the user will point the camera to the marker that can be downloaded on the Book Marker menu and a 3D object of hijaiyah letters will appear on the user's screen. The Scan Marker menu display can be seen in Figure 9 below.
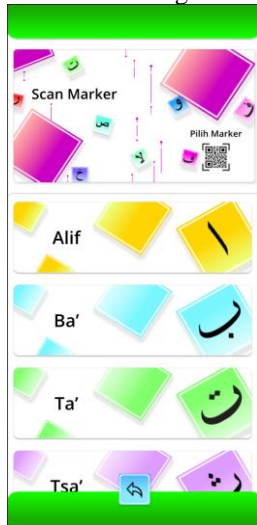
Figure 9. Scan Marker Page

Based on Figure 9 above, it can be seen that before entering the scanning page, users need to first select the hijaiyah letters to be scanned. By selecting the letter 'Tho' from the scan marker menu, users are directed to the scanning page, the visual representation of which is presented in Figure 10 below.
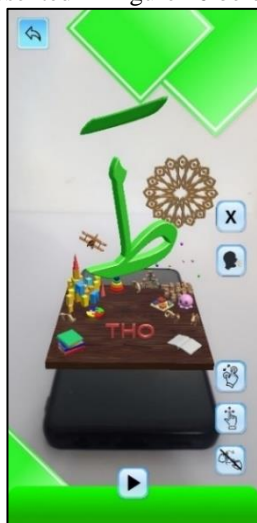
Figure 10. Scanning Page

Based on Figure 10, it is shown that the marker scan page is displaying the 3D object of the letter Tho'. On this page, the user will not be able to scan for hijaiyah letters other than the letter Tho' so the user

needs to press the back button and select other letters that want to be scanned on the list provided. There are also several buttons, including the play button to start the audio of how to read the letter Tho', the harakat button to add the harakat to the 3D object which later the user can hear the audio of how to read the letter if the desired harakat is added, the pinch zoom button to zoom in and out the 3D object, the drag button to move the 3D object, the rotate button to rotate the 3D object, and the back button to return to the hijaiyah letter selection page.

d.   Hijaiyah Letters Page

This page contains a list of hijaiyah letters and material about each hijaiyah letter. On the menu, there are a total of 30 hijaiyah letters starting from the letter alif to the letter ya'. Users can see and press one of the letters seen to bring up material about that letter. The appearance of the Hijaiyah Letters page can be seen in Figure 11 below.
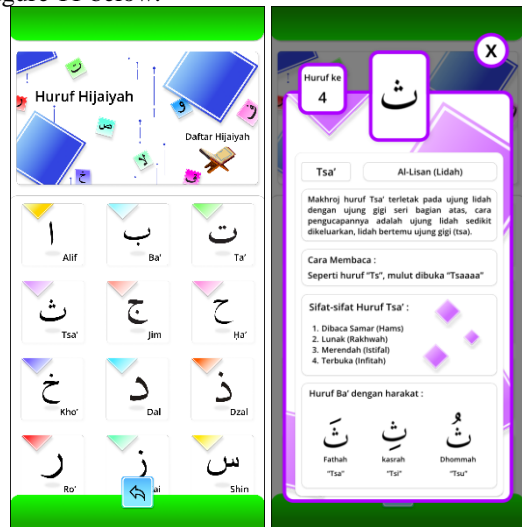
Figure 11. (a) Hijaiyah Letters Page, (b) Hijaiyah Letter Material

e.   Marker Book Page

This page is a menu for downloading markers that have been provided by the application to bring up 3D objects. The display of Google Drive pages and markers can be seen in Figure 12 below.
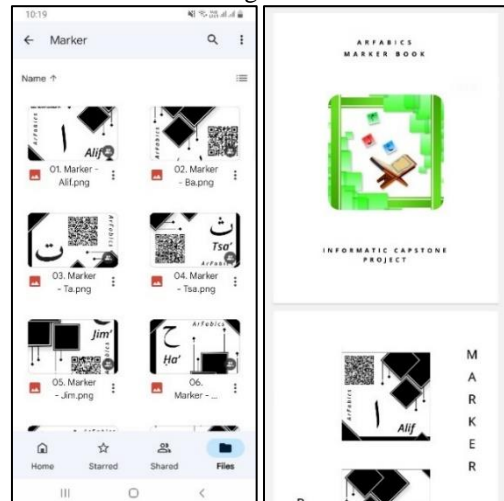
Figure 12. (a) Unit Marker, (b) Book Marker

f. About Page and How to Play

The About page contains information about the application and the people who have developed this ArFabics application, while the How to Play page contains explanatory instructions to start using the application. The display of the About and How to Play pages can be seen in Figure 13 below.

Figure 13. (a) About Page, (b) How To Play Page

3.2 Application Testing

The results of testing using the black box method, testing is conducted on the output results of all application feature functions, marker suitability with 3D objects, and the maximum distance the marker can be detected. The results of testing the application feature functions are described in Table 1 below.

Table 1. Application Feature Function Testing Results

No.	Test Scenario	Input	Expected Result	Result
1.	Scan Marker Menu	Select the Scan Marker menu	Navigate to the Scan Marker page	Valid
2.	Scanning Page	Select the hijaiyah letter tho' in the Scan Marker menu	Navigate to the Scanning page	Valid
3.	Hijaiyah Letter Menu	Select the Hijaiyah Letter menu	Navigate to the Hijaiyah Letters page	Valid
4.	Hijaiyah letter material page	Select the hijaiyah tho' letter on the Hijaiyah Letter menu	The material of the letter tho' will appear	Valid
5.	Marker Book Menu	Select the Marker Book menu	Access Google Drive to download the marker	Valid
6.	How to Play menu	Select the How to Play menu	Navigate to the How to Play page	Valid
7.	About Menu	Select the About menu	Navigate to the About page	Valid
8.	Scan Marker	Scan the hijaiyah tho' letter marker on the tho' Letter Scanning page	Bring up the 3D object of the letter tho' along with other features such as audio, select harakat, pinch zoom, and others.	Valid
9.	Sound Button	Press the sound button	Turn off and turn on the music in the application	Valid
10.	Exit Button	Press the exit button	Exit the application	Valid

Table 1 shows the results of testing the menu and features of the application. The results obtained are the menu and features of the application successfully run according to their functions. The test results of the marker to display 3D objects are shown in Table 2 below.

Table 2. Marker Match Testing Results

Marker	Scanning Result	Hasil
Alif	Display the 3D object of the letter Alif	Valid
Ba'	Display the 3D object of the letter Ba'	Valid
Ta'	Display the 3D object of the letter Ta'	Valid
Tsa'	Display the 3D object of the letter Tsa'	Valid
Jim	Display the 3D object of the letter Jim	Valid
'Ha	Display the 3D object of the letter 'Ha	Valid
Kho'	Display the 3D object of the letter Kho'	Valid
Dal	Display the 3D object of the letter Dal	Valid
Dzal	Display the 3D object of the letter Dzal	Valid
Ro'	Display the 3D object of the letter Ro'	Valid
Zai	Display the 3D object of the letter Zai	Valid
Sin	Display the 3D object of the letter Sin	Valid
Syin	Display the 3D object of the letter Syin	Valid
Shod	Display the 3D object of the letter Shod	Valid
Dhod	Display the 3D object of the letter Dhod	Valid
Tho'	Display the 3D object of the letter Tho'	Valid
Dzo'	Display the 3D object of the letter Dzo'	Valid
'Ain	Display the 3D object of the letter 'Ain	Valid
Ghoin	Display the 3D object of the letter Ghoin	Valid
Fa'	Display the 3D object of the letter Fa'	Valid
Qof'	Display the 3D object of the letter Qof	Valid
Kaf	Display the 3D object of the letter Kaf	Valid
Lam	Display the 3D object of the letter Lam	Valid
Mim	Display the 3D object of the letter Mim	Valid
Nun	Display the 3D object of the letter Nun	Valid
Wawu	Display the 3D object of the letter Wawu	Valid
Ha'	Display the 3D object of the letter Ha'	Valid
Lam Alif	Display the 3D object of the letter Lam Alif	Valid
Hamzah	Display the 3D object of the letter Hamzah	Valid
Ya'	Display the 3D object of the letter Ya'	Valid

Table 2 shows the results of the marker suitability test to display 3D objects, the results obtained are valid and each marker displays 3D objects according to their respective letters. Next, testing the detection distance of the smartphone camera on the marker, the test results of marker scanning based on distance can be seen in Table 3 below.

Table 3. Marker Scanning Distance Testing

Marker	<30 cm	<60 cm	>90 cm
Alif	Detected	Detected	Not Detected
Ba'	Detected	Detected	Not Detected
Ta'	Detected	Detected	Not Detected

Tsa'	Detected	Detected	Not Detected
Jim	Detected	Detected	Not Detected
Ha'	Detected	Detected	Not Detected
Kho'	Detected	Detected	Not Detected
Dal	Detected	Detected	Not Detected
Dzal	Detected	Detected	Not Detected
Ro'	Detected	Detected	Not Detected
Zai	Detected	Detected	Not Detected
Sin	Detected	Detected	Not Detected
Syin	Detected	Detected	Not Detected
Shod	Detected	Detected	Not Detected
Dhod	Detected	Detected	Not Detected
Tho'	Detected	Detected	Not Detected
Dzo'	Detected	Detected	Not Detected
'Ain	Detected	Detected	Not Detected
Ghoin	Detected	Detected	Not Detected
Fa'	Detected	Detected	Not Detected
Qof'	Detected	Detected	Not Detected
Kaf	Detected	Detected	Not Detected
Lam	Detected	Detected	Not Detected
Mim	Detected	Detected	Not Detected
Nun	Detected	Detected	Not Detected
Wawu	Detected	Detected	Not Detected
Ha'	Detected	Detected	Not Detected
Lam Alif	Detected	Detected	Not Detected
Hamzah	Detected	Detected	Not Detected
Ya'	Detected	Detected	Not Detected

Table 3 shows the results of marker scanning trials to display 3D objects with different distances, the results obtained are markers can be scanned properly if the distance is less than 60 cm but the marker will begin to be difficult to detect if the distance is more than 60 cm and can't be detected anymore when the distance reaches 90 cm.

3.3 Usability Testing

The purpose of usability testing is to evaluate the user's ease and satisfaction in using the ArFabics application. This evaluation is done by using a questionnaire consisting of 10 questions with answer options including 1 is strongly disagree (SD), 2 is disagree (D), 3 is neutral (N), 4 is agree (A), and 5 is strongly agree (SA). The results of usability testing obtained from respondents can be seen in Table 4 below.

Table 4. Respondent Questionnaire Results

Question	Respondent							
	1	2	3	4	5	6	7	8
Q1	5	4	5	4	5	5	5	4
Q2	1	2	1	3	2	1	2	1
Q3	4	5	5	5	4	5	4	4
Q4	3	1	1	1	2	2	1	2
Q5	5	5	4	5	5	4	3	5
Q6	1	1	3	1	1	1	2	1
Q7	4	5	4	5	4	5	4	5
Q8	1	2	2	1	2	3	2	2
Q9	5	4	5	3	5	3	4	4
Q10	3	1	2	3	2	3	2	2
Total	34	36	34	33	34	32	31	34
Score (Total x2.5)	85	90	85	82.5	85	80	77.5	85
Final Average Score				83.75				

The question form in this questionnaire is designed based on SUS (System Usability Scale) as described in the Research Method. This questionnaire was given to 8 respondents, the students and teachers

from Baitul Makmur mosque which is located in Karanganyar, Central Java. From the results of usability testing, an average score of 83.75 was obtained. This score indicates that this application is acceptable to users with an Adjective Ratings category level of 'Excellent' with a grade scale category 'B'. In addition, it can be concluded that this application is within the Acceptability Ranges which are Marginal 'High'.

4. CONCLUSION

The result of this research is the ArFabics application, a software developed to enhance the learning process of hijaiyah letters through the use of augmented reality technology. Based on the test results, the ArFabics application can run well and all of its features can be used as it is supposed to. The ArFabics application has also received a fairly good response from several respondents who have filled out questionnaires to help the teaching and learning process of hijaiyah letters. This application makes the learning process that is not interesting for children more fun with the visualization of 3-dimensional objects from the user's smartphone screen and makes students more enthusiastic to participate in the learning process. This application can still be improved, such as adding features like quizzes to evaluate students' learning results and other features that can add excitement to children's learning.

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