Available online at www.jlls.org

JOURNAL OF LANGUAGE AND LINGUISTIC STUDIES

ISSN: 1305-578X

Journal of Language and Linguistic Studies, 17(4), 1760-1772; 2021

ARabic-Kafa: Design and development of educational material for Arabic vocabulary with augmented reality technology

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APA Citation:

Daud, W. A. A. W., Ghani, M. T. A., Rahman, A. A., Yusof, M. A. B. M., Amiruddin, A. Z. (2021). ARabic-Kafa: Design and development of educational material for Arabic vocabulary with augmented reality technology. *Journal of Language and Linguistic Studies, 17*(4), 1760-1772. Doi: 10.52462/jlls.128

Submission Date:01/05/2021

Acceptance Date:31/07/2021

Abstract

This research focuses on the production and creation of educational materials for Arabic vocabulary learning using Augmented Reality Technology, namely ARabic-Kafa, which can support both teachers and students. The Marker Based Tracking tool is used in this Augmented Reality application. This method was employed because it can read objects and then display 3-dimensional (3D) virtual objects. The first step in resolving this issue is to create animations through the blender application, choose the image to be utilised as a Marker, and finally, export it to Vuforia to form an Augmented Reality app. The mobile app of Augmented Reality-based educational media is the product of this research. A series of testing were employed and a minimum distance for displaying a 3D object is 10 cm, and the minimum angle 30° to 90° to view 3D objects. The rotation marker's output effectively shows every aspect of the 3D object. Furthermore, the audio pronunciations can be played effortlessly.

Keywords: Augmented Reality; Educational material; Arabic language; Arabic vocabulary; Teaching and learning; Design and development

1. Introduction

The philosophy behind implementing Quranic and Fardhu Ain Classes (KAFA) is an ongoing effort to educate and shape Muslim students towards developing individual facets in line with the requirements of the Quran and as-Sunnah. This effort aims to produce educated people with the influence of Quranic and as-Sunnah teachings in their faith and worship of Allah, as well as to appreciate the morals and way of life of Islam.

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According to previous studies, Arabic language proficiency among students is still poorly achieved (Hussin, 2002; Zawawi et al., 2004; Hasnurol Hashim, 2010; Noor et al., 2016). The issue of Arabic language vocabulary management has been a significant focus of modern researchers. Researchers have listed several problems in vocabulary acquisition, including lack of a more exciting approach and teaching and learning materials. Their studies have therefore found that the usage of technology in education, especially primary school learning, could increase vocabulary acquisition and motivate students to learn Arabic and thus provide a more attractive environment.

The utilisation of Augmented Reality (AR) application is growing in educational field. The use and disclosure of AR application technology are still in its infancy, and requires in-depth research (Billinghurst, 2002). The integration of AR into the education system will enhance the effectiveness of learning for students in their real lives (Kesim & Ozarslan, 2012). One of the crucial functions of AR in education is to convey intricate ideas by revealing information on educational materials in reality (Nazatul Aini et al., 2015), as well as creating a better learning environment, which is both active and interactive to students (Nischelwitzer et al., 2007). AR technology in KAFA education will enhance students' understanding of the concept of Arabic language learning, create a more interactive teaching and learning environment, and facilitate the function of educators in the preparation of student educational materials. The practise of AR technology in KAFA teaching will have a significant impact on students' knowledge through educational materials and will enhance their motivation and desire to learn beyond the existing traditional teaching methods.

Quran and Fardhu Ain (KAFA) classes are curricula under the supervision of the Department of Islamic Development Malaysia (JAKIM). The question is what is the best approach for the Arabic language curriculum in KAFA to overcome the problem of vocabulary shortages? This study will therefore attempt to design and develop learning material for learning Arabic vocabulary with AR technology.

2. Literature Review

Augmented Reality Technology is among the latest technologies that were increasingly implemented in numerous arenas before being applied in education. In the field of education, this technology has also gone through several phases of its own development which are used in the learning and facilitation of various subjects, including Arabic language subjects.

The use of Augmented Reality (AR) technology is growing in educational landscape. The use and exposure of Augmented Reality application technology requires in-depth study (Billinghurst, 2002) to increase the effectiveness of its use in education. It is also possible to improve the efficacy of the PdPc process by using the AR technology into the education system (Kesim & Ozarslan, 2012). One of the major tasks in the application of augmented reality in education is to explain complicated ideas through the review of information in reality regarding learning materials (Nazatul Aini et al, 2015); as well as creating an active and exciting educational atmosphere for the learners (Nischelwitzer et al., 2007).

To add, Nazatul Aini et al., (2015) claimed in their study that Augmented Reality is able to attract many students in a class to teaching materials compared to classes that only use slide presentations or traditional methods. Augmented Reality can deliver a positive impact on students in the aspects of enthusiasm, usability, involvement, and excitement in their education as well as potential in increasing students' interest in a subject learned in school (Gopalan et al., 2015).

In the scope of language education, the need for current advances in the field of Augmentation Reality technology among others has been translated by Scrivner and Madewell (2016) in their study by explaining the potential of Augmentation Reality in teaching and learning languages, particularly in

the case of foreign languages, in honing language abilities and boosting student performance in language learning. Various objects, such as language textbooks and classroom objects as markers, can be given the impact of Augmented Reality. This quantitative study using test instruments and questionnaires applied Spanish language learning materials assisted by 2D and 3D Augmentation Reality through the Aurasma mobile Augmentation Reality app. Findings of the study show that Augmentation of Reality has high potential in helping language learners to imitate or follow the pronunciation of learned language words better, in addition to providing useful and meaningful new experiences to students.

Furthermore, a study by Chen Li et al. (2016) used Augmented Reality to incorporate virtual objects into a reality setting for English-language learning. The prototype developed in this study was evaluated through a semi-structured interview method with the study sample involved, namely the experts. This study also applied the theory of flow (Flow), which highlights a more focused learning situation with a combination of activities such as art activities, games and work. The findings of this study obtained expert feedback stating that the prototype built is suitable for digital language learning methods in addition to covering the cognitive aspects of students. Experts also suggest that the design of the prototype takes into account aspects of the curriculum that are appropriate for language learning.

A study by Huisinga (2017) used Augmentation Reality technology to help weaker students by giving them motivation to master reading skills through the Augmentation Reality platform. This mixed methodology study, which used questionnaire instruments and focus group interviews, found that students who are weak as well as students who are moderate in reading skills can be helped by the implementation of Augmented Reality as a support material for reading proficiency. This Augmented Reality technology uses scaffolding theory with visual aids as one of the multimedia elements as well as vocabulary and text comprehension as the main learning material for the platform.

From the perspective of teachers, especially primary school teachers as implementers of Augmented Reality assisted activities for teaching and learning process, Alkhattabi (2017) highlighted in his study the challenges faced by these teachers in using digital platforms. The study used examples such as Augmentation Reality technology in teaching and learning process in schools, especially in providing students with a learning process which is more active and effective. The findings show that among the main challenges faced by teachers in primary schools to implement this Augmented Reality technology is the absence of IT equipment, lack of IT expertise itself, as well as difficulty in changing to the use of modern technology. In view of this issue, these primary school educators must confront the obstacles of achieving the aims of the current teaching and learning curriculum, which more closely focuses on the usage of the latest technologies, including the platform for Augmented Reality.

For the learning materials or curriculum required for Augmented Reality technology in the classroom or classroom, Bonner & Reinders (2018) suggested some of the appropriate aspects for inclusion in Augmented Reality technology. Among those given emphasis were:

1. Learning vocabulary, which consists of nouns, verbs, and also adjectives.

2. Grammar through the description of a sentence or a situation that allows students to understand the context of a given sentence.

As for the aspect of the Augmented Reality platform, a study by Sahin and Ozcan (2019) which focused on teaching old Turkish language to over 50 college students in Turkey used the Aurasma 3D app on smartphone mobile devices. This study is a quantitative study that uses quasi-experimental with pre- and post-tests to the research sample involved. The findings of the analysis proved that there was an increase in student achievement as a result of their use of the Augmented Reality application,

thus creating a positive and motivating atmosphere and environment for students involved in following the teaching materials provided.

3. Methodology

This study has three main phases, which are the analysis, design and development, and testing phase. The details for each phase are as follows:

3.1. Analysis Phase

A study of issues, procedures, operating methods and solutions in the *ARabic-Kafa* is carried out at this point. This research required an analysis of the need for hardware, software, and materials. This study's hardware requirements are a computer and a smartphone. The preceding are the device prerequisites for running the test. The following are the requirements:

1. Smartphone

The smartphone used to run the *ARabic-Kafa* application was developed using Samsung Galaxy Note 10.

1.1 Operating system: Android 9.0 (Pie)

1.2 Chipset: Qualcomm SM8150 Snapdragon 855

1.3 RAM: 8GB

1.4 Main Camera: 12MP

1.5 Audio Quality: Noise -92.8dB

2. Computer

The computer was used to develop the *ARabic-Kafa* application with specific specifications.

2.1 RAM: 8GB DDR3

2.2 Processor: Intel® Core i5 8th Gen

2.3 Storage: 1TB

In addition, multiple pieces of software were used to create the *ARabic-Kafa* application. Each software used is described in detail below.

Software	Description	Purpose
Unity	Unity Software is a creator of the Unity Engine, which enables game production to "democratise" and accessible to 2D and 3D content. It is utilised to produce VR programs and AR applications as well as popular video games for PCs, consoles and mobile devices.	The engine delivers a main C# scripting API, for the Unity editor as plugin and game, and for the drag and drop capabilities, to develop both 2D and 3D games and experiences.
Vuforia	Vuforia is an AR software development kit (SDK) for mobile platforms which permits the development of apps in augmented reality. Computer vision technology is used to detect and track in real time planar pictures and 3D items.	Applies to leading phones, tablets and eyewear as a platform for AR creation. To create AR experiences that interact realistically with objects and the environment, developers may quickly integrate powerful computer viewing capabilities to Android, iOS, and UWP apps.
	Blender is a free 3D creative suite which is	To develop 3D characters of

Blender	an open-source application. The 3D pipeline modelling, animation, rendering, rigging, motion and composite tracking, video editing, simulation and 2D animation pipeline are fully supported.	learning media.
Adobe Photoshop	Adobe Photoshop has been created by Adobe Inc. for Windows and MacOS and has been distributed by Adobe Inc.	To edit the graphic, design logos and background.
Adobe Audition	Audition is a complete tool kit that encompasses the creation, mixing, editing and restoring of audio content in multitrack, waveform and spectral presentation. This sophisticated audio workstation is meant to speed up processes and audio creation and provide a professional mix with an unprecedented quality.	To record and edit the audio content.

In addition, this study also conducted a thorough analysis of learning materials. The main source for designing the learning materials is the textbook. There are several types of textbooks available in the market store; hence, this study tries to analyse and extract the similar content and follow the standard learning document provided by the government to ensure the learning materials achieved all the learning objectives and were used by all levels.

3.2. Design and Development Phase

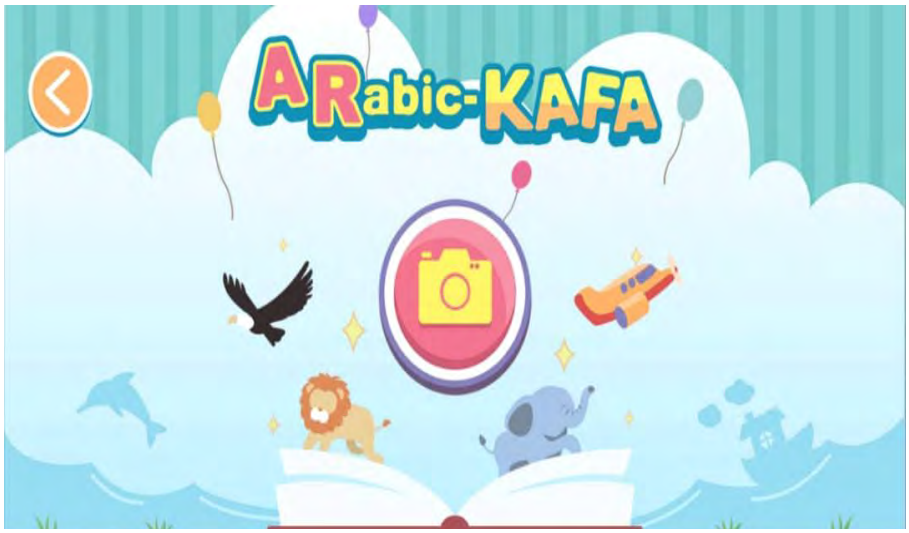

Figure 1. Main Menu Screen

The figure above illustrates the main menu screen of the *ARabic-Kafa* application for learning Arabic vocabulary. After the splash screen, the primary menu screen appears. The primary menu screen display is the *ARabic-Kafa* application. The main menu screen contains the name of the application, a camera button and back button. This page is accompanied by background music to develop the element of fantasy and stimulate the user's stimuli. In addition, it also provides a space for players to be in ready mode and develop motivation to use it.

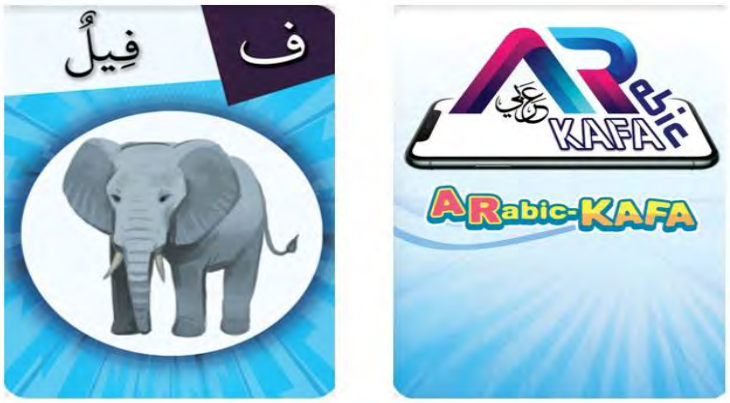

Figure 2. Display Image of Marker

The figure above shows the display image of marker. There are 28 flash cards which consist of 28 markers. Each marker is a representative of each Arabic alphabet. The flash cards use consistent icons in the same location except the marker image to create visible and invisible interaction between the application and user. The Arabic alphabet is located on the upper right-hand corner and corresponds to the vocabulary. According to Mayer (2021), the contiguity principle suggests placing the text near corresponding graphics, which results in better learning for students when the image is near its correspondence text.

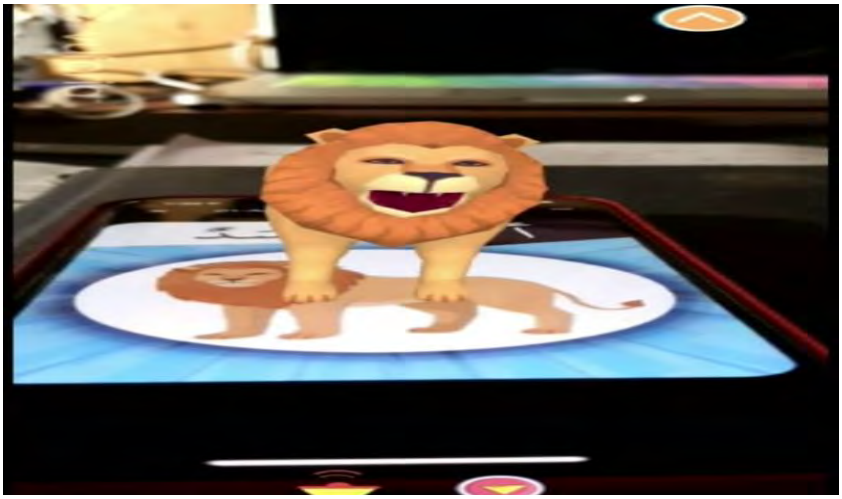

Figure 3. 3D Image

The figure above illustrates the 3D image from the marker. There are 3D images located at the centre and three main buttons. First, the back button is located at the top of the screen. The screen will go to the main menu screen if the back button is clicked. Second is the play button. The play button provides a sound of the 3D image and several movements of the 3D image. This is to stimulate students' stimuli and enhance interactivity as well as sustain students' engagement with the application. The last button is the play button. This screen also provides a play button to assist students with pronunciation of the vocabulary. All these buttons only function after clicking them. This is to avoid redundancy of information to the students. Since humans have limited capacity to process information, the researchers created a rule where the audio can only play when the student clicks on

the respective button. Therefore, students can choose either to use visual channels or visual and auditory channels for the learning process.

3.3. Testing Phase

The *ARabic-Kafa* application was functionally evaluated through a series of tests in this study. This test is an internal assessment that determines if all software functions are operating in accordance with the functional requirements that have been specified. The outcomes are explained in findings section.

4. Findings and Discussions

The Samsung Galaxy Note10 with Android 9.0 (Pie) smartphone was used to perform internal assessment of the *ARabic-Kafa* application. The internal assessments are including main menu screen testing, camera angle for scanning the marker testing, camera distance to the marker testing, lighting level testing, 3D object rotation testing, and audio testing. The outcomes are as follows.

Table 1. Main Menu Screen Testing

Input	Expectation	Observation	Decision
Background music	The music played right after opening the app	The music played	Approved
Click the camera button	The screen moves to the AR screen camera	The camera button works	Approved
Click back button	The app closes	The back button works	Approved

Based on the findings above, the *ARabic-Kafa* application's main menu went off without a hitch. The background music started playing as soon as the student opened the application. This background music aims to increase the students' attention to the application. Furthermore, this serves as a cue for students to be prepared before the learning process begins. Furthermore, the camera press works properly, where the screen switches to the AR screen monitor, which is now ready to scan the marker. Finally, the back button on the right of the screen also works properly. After pressing the back button, the *ARabic-Kafa* application is closed. The following is a test table for camera angle to scan the marker. The outcomes are as follows:

Table 2. Camera Angle for Scanning the Marker

Camera Angle (Degrees)	3D Object
0	not detected
10	not detected
20	not detected
30	detected
40	detected
50	detected
60	detected
70	detected
80	detected
90	detected

The following is a test table for camera distance to the marker. The outcomes are as follows:

Table 3. The Test Results of Camera Distance to the Marker

Camera Distance(cm)	3D Object
0	not detected
10	detected
20	detected
30	detected
40	detected
50	detected
60	detected
70	detected
80	detected
90	detected
100	detected

The table below shows the test results for the *ARabic-Kafa* application at various lighting levels. Lighting degree checking, according to Grandjean (1986), can be split into four conditions:

1. Normal lighting is described as direct lighting, with 90-100% of the light aimed straight at the item.

2. Low-level lighting is a semi-direct lighting scheme in which 60-90% of the light is focused to the ceiling, while upper walls and the remaining light is pointed to the floor.

3. A very low angle of lighting is an indirect lighting scheme in which 90-100% of the light is focused on the ceiling. It is then projected off the upper wall to lighten the entire room.

4. With no lighting level, it is a state in which there is no light during the night (dark).

Table 4. Test Result of Lighting Level

Lighting Level	3D Object
Normal	Appears
Minimal	Appears
A very low lighting level	Appears
Without a lighting level	Does not appear

Based on the results above, the 3D objects in the *ARabic-Kafa* application can appear in three states: normal, minimal, and very low lighting levels. Therefore, this factor will improve the apparent practicality and ease of use of the *ARabic-Kafa* application among students.

The table below shows the results of the 3D model rotation testing either clockwise or anti-clockwise. This test ensures that the students can see all sides of the object. The outcomes are as follows.

Table 5. Test Result of 3D Object Rotation

Marker No.	3D Object Rotation
1	Successful and no distraction

2	Successful and no distraction
3	Successful and no distraction
4	Successful and no distraction
5	Successful and no distraction
6	Successful and no distraction
7	Successful and no distraction
8	Successful and no distraction
9	Successful and no distraction
10	Successful and no distraction
11	Successful and no distraction
12	Successful and no distraction
13	Successful and no distraction
14	Successful and no distraction
15	Successful and no distraction
16	Successful and no distraction
17	Successful and no distraction
18	Successful and no distraction
19	Successful and no distraction
20	Successful and no distraction
21	Successful and no distraction
22	Successful and no distraction
23	Successful and no distraction
24	Successful and no distraction
25	Successful and no distraction
26	Successful and no distraction
27	Successful and no distraction
28	Successful and no distraction

The audio test results are seen in the table below. This test ensures that the character's audio pronunciation is correct and avoids errors.

Table 6. Test of Result Audio

No. of Marker	Audio Played
1	Successful and clear
2	Successful and clear
3	Successful and clear
4	Successful and clear
5	Successful and clear
6	Successful and clear
7	Successful and clear

8	Successful and clear
9	Successful and clear
10	Successful and clear
11	Successful and clear
12	Successful and clear
13	Successful and clear
14	Successful and clear
15	Successful and clear
16	Successful and clear
17	Successful and clear
18	Successful and clear
19	Successful and clear
20	Successful and clear
21	Successful and clear
22	Successful and clear
23	Successful and clear
24	Successful and clear
25	Successful and clear
26	Successful and clear
27	Successful and clear
28	Successful and clear

5. Conclusion

A successful learning media must be well-structured and configured to ensure that mistakes do not occur during the teaching and learning process. *ARabic-Kafa*, an augmented reality-based educational media, has been developed successfully in the Android operating system. The augmented reality technology for studying Arabic vocabulary in primary schools is the product of this research. Students of the *ARabic-Kafa* application will learn to recognise the Arabic alphabet and vocabulary. Furthermore, students can see 3D images of words and develop new learning experiences, learning settings and constructive learning. The camera distance to the marker test resulted in a distance of 10cm as the minimum distance for displaying a 3D model. However, the minimum angle for the outcome of measuring the camera angle to the marker obtained was 30° to 90°. Except for the absence of light, all 3D objects can be seen under all lighting conditions. The rotation marker's outcome successfully showed either side of the 3D object even when the rotation of the 3D object is not disturbed while reviewing the 3D object from different sides. Furthermore, all of the audio for each character can be played seamlessly. As a result, this study indicates that upcoming researches may want to emphasise on the usability of the *ARabic-Kafa* application using fuzzy Delphi analysis and directly implement it among students through quasi-experiment to measure its effectiveness.

Acknowledgement

Fundamental Research Grant Scheme (FRGS) funded this research under the Ministry of Higher Education Malaysia (MoHE) and Universiti Malaysia Kelantan (UMK) R/FRGS/A0400/0064 7 A/002/2018/00561.

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