

AR Mobile Application in Learning Hajj for Children in Malaysia

A Preliminary Study

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Abstract—Education is experiencing rapid revolution from the chalk to the computer. Since then, education and technology are moving forward with advanced technology. Furthermore, with the positive impact derived from previous research, Augmented Reality (AR) started to play a role in education either in learning or teaching. Thus, the aim of this paper is to explore the elements will be implemented in the development of Hajj AR mobile application for learning Hajj among the children in Malaysia. In the preliminary study, a survey using an open-ended and closed-ended questionnaire was conducted among experienced teachers. The findings from the survey revealed that the elements of AR could be implemented in the Hajj AR mobile application as an interactive learning tool. Thus, a Hajj AR mobile application will be developed by implementing the findings obtained in the preliminary study to evaluate the user-experience among the children who are using the AR mobile application when learning Hajj. In conclusion, this mobile application could attract and provide creative information to children in learning about Hajj through AR.

Keywords—Augmented Reality (AR), Mobile Learning Application, Hajj, Children, Early Childhood Education.

1 Introduction

This era of all-round technological advancement has motivated society to move forward to achieve success in life by adopting innovative technology. Like in the field of technology, education has experienced a revolution which emanated from the chalk to the computer. Since then, education and technology have been moving forward with advanced technology. Furthermore, education is not only limited to the classroom or to the school [1]. Therefore, education should be a priority, not only in higher education but also in Early Childhood Education (ECE). In recent years, AR started to have a role in education which is in the process of learning and teaching. Thus, with the positive impact derived from previous research, AR now is used in education. Besides, AR also provides excellent opportunities in the field of education which has more excitingly redefined eLearning [2]. Furthermore, some of the educational institutions such as

schools and universities used AR in their process of learning and also in some other field of study [3], [4] & [5]. Besides, AR is now being used as a cognitive tool for education and training purpose across subject areas both in formal and informal learning environments [6].

The objective of this study is to explore the elements that will be implemented in the Hajj AR mobile application. Therefore, the significance of this study is to attract children to have fun and be creative in learning AR technology. In addition, using AR as a medium to hone the skills of children in order that they will immerse their experience in Hajj learning.

2 Literature Review

The evaluation of Augmented Reality (AR) is synonymous with the concept of Virtual Reality (VR) [7]. AR is one of the technologies that is continually growing from time to time. Besides, AR has augmented the present reality with technology, unlike virtual reality which submerged the user into the virtual environment [8]. In addition, the rapid growth in AR technology and the variety of AR implementation tools could be seen globally today [7]. Furthermore, in 1977, the first survey conducted by Ronald Azuma, identified that AR is a combination of the real and virtual environment which is widely acknowledged until today [9]. AR is also known as a computer-generated object that appears in the same space and environment to present the existence of the real world for the user [10], [11]. Thus, in simple words, AR combines the real and computer-based scenes and images to deliver a unified but enhanced world of the user [12]. The goal of the AR is to give and enhance the perception of the person by looking at the surrounding world through technology [7].

2.1 Augmented Reality in early children education

The use of AR systems has opened up new opportunities in the research field [13]. Nowadays, AR comes with m-learning features to visual the learning content that appears in the real environment. It has been acknowledged as a medium of enhancement to engage children's attention and motivation in learning [14]. AR has been used in some subjects such as the storybook, reading [15], [16], science [17], literacy [18], [19], [18], Islamic [21], [22] and others in Early Childhood Education. Thus, AR is starting to embrace and instill a kind of human-computer interaction with children's perception and the development of this technology in terms of 'virtual' manipulative which has since risen [23]. Therefore, AR has the potential to place education in a relevant social and environmental context; and giving opportunities for learning experiences among students [23]. Furthermore, a variety of physical manipulative are now used in the contemporary classroom among children in kindergarten who find AR more fun and enjoyable. Hence, the positive views among users have acclaimed, AR as the potential in learning especially among children in Early Childhood Education. Table 1 shows an earlier study applying AR in children learning.

Table 1. Subject of Learning using AR in Early Childhood Education.

Title	Authors & Years	Subject of Learning with AR
Augmented Reality: Daily Prayer for Preschooler Children	H. Pradibta, 2018 [22]	Prayer
Augmented Reality in Early Childhood Literacy	M. Kumar and K. Mac-Callum, 2017 [19]	Literacy
ABC3D- using an Augmented Reality Mobile Game to enhance literacy in Early Childhood Education	A. Bhadra et al., 2016 [18]	Literacy
Educational Magic Toys (EMT) developed with Augmented Reality technology for Early Childhood Education	R.M. Yilmaz, 2016 [20]	Literacy
Using Augmented Reality tools to enhance children’s library services	T. R. Meredith, 2015 [16]	Literacy and Reading

According to Table 1, most of AR was used in Early Childhood Education through the game, educational platform, module and others in learning Literacy [16], [18]–[20]. Although it is widely used in learning but it is lacking in Islamic learning [22]. To date, only a few subjects were chosen for children learning whether online or offline through AR.

2.2 Augmented Reality in Hajj

Performing Hajj is one of the five pillars of Islam. The ritual in doing Hajj involves many rules and procedures among pilgrims, thus, it is a problem for pilgrims to remember all the rules and procedures[24]. Thus, nowadays, with the advancement in technology, it could provide services in various fields including in the development of mobile application, especially for Islamic application. The application can be used in smartphone devices to assist pilgrims to comfortably perform the Hajj. Technology has gained increasing momentum among users, thus, the idea of combining AR with a mobile application is an alternative which could be used either in learning or in performing the Hajj. A few significant features of the application is as an interactive guide for pilgrims, providing solutions to common problems faced by pilgrims and as a model for simulating the pilgrims’ movement. Thus, the technology of AR could be applied in learning Hajj in Early Childhood Education and as a tool of learning. Table 2 shows the earlier study on the existing application in learning Hajj.

Table 2. The Existing Application in Learning Hajj.

Title	Authors & Years	Result/ Existing Application
Augmented pilgrim experience and safety geo-location way finding and mobile Augmented Reality	N. N. Albaqami, K. H. Allehaibi, and A. H. Basori, 2018 [25]	Combined the AR technology with global positioning system (GPS) to give proper direction towards pilgrim
Development and user evaluation of Virtual Hajj (V-Hajj) courseware for hajj learning procedures	M. F. Yusoff, A. N. Zulkifli, and N. F. Faisal Mohamed, 2016 [26]	V-Hajj was authored by certain particular theories, principles and guidelines.
AL HAJJ-Hajj App For IOS	A. Shaout And S. Khan, 2016 [27]	AlHajj app
HAIJRAH: An innovative application for pilgrims of Hajj and Umrah	Abdul Majid, A. A.Samah, L. Mi Yusuf, D. Nasien, and N. S. S. Nor Hisham, 2016 [28]	HAIJRAH
Hajj crowd management via a Mobile Augmented Reality application: A Case of the Hajj Event, Saudi Arabia.	O.Almoaid A, 2015 [29]	This application assists and manages the pilgrims' movements between the ritual places and provides directions to the pilgrims who have lost their way.

According to Table 2, an earlier study revealed that the application was focused on the elderly who were performing Hajj. Besides, the application of AR when combined with Global Positioning System (GPS) can serve as a guide for the pilgrims to complete their Hajj [25], [28], [29]. Furthermore, some of the current mobile applications only focus on elderly pilgrims but are not user-friendly for children to learn Hajj [27].

2.3 Constructivism learning theory

Constructivism learning theory is a paradigm that depicts learning as an active, developing process of understanding, knowledge, and experience with the learners themselves based on their prior knowledge [30]. Besides, with collaboration AR and constructivism, it allows students to explore the world in an interactive way [31]. Constructivism learning theory also leads to an active participant and learning by doing in the lesson [30]. Thus, the effectiveness of AR technology could be gain by using constructivism learning which is self-directed, creative and innovative where the children could gain confidence and motivation by experiencing the task [32].

2.4 Problems background

This study which was conducted based on earlier studies identified some of the background problems:

Lack of existing AR mobile applications in learning Hajj for children: In Malaysia, there are limited studies in the field of education using AR [33]&[34] as it is still at its infancy in the field education [35]. Although the use of AR technology is gaining

impetus rapidly in many fields, there is still a dearth and is uncommon to find children learning especially in Islamic study [35]. Furthermore, many applications are found in applications store regarding education who used AR as a medium of learning such as literacy, numeric, science and others. In addition, most of the applications on learning Islamic studies that exist in mobile application only cover fasting, performing prayers [21] but lack of learning Hajj.

Besides, some of the Islamic applications were developed by organizations and individuals to assist pilgrims perform their Islamic rituals, hence, it is not suitable for children to learn [36],[37]. Overall, the earlier study shows the application only focus on the elderly for the purpose of learning and performing the Hajj. Thus, it is limited for children to learn Hajj.

Existing mobile application unsuitable: Presently, one problem facing mobile application is that it is unsuitable for children in the learning process. Some of the existing mobile applications regarding the obligations of Hajj on apps store are not interactive, not informative and not organized as well for the user especially for children, as the text is hard to read due to the small font size and the amount of static text on the screen [27]. In addition, some of the applications are too mundane and some are purely based on linear scrolling through all the steps of Hajj [27]. Besides, poor user interface with bad color combination will take some effort to read the information being presented to the user [27]. Thus, the application is not suitable for children to learn but probably more suitable for the elderly.

Learning approach: The learning approach in the Malaysia school environment still based on learning-centred class and geared towards examinations [38]. Present day, educators are encouraged to use a variety of materials in a multimedia approach to vary the learning experiences [39]. Besides, the contents presented in the textbooks (syllabuses) are considered far too detailed and outdated by the students. Thus, learning cannot be absorbed efficiently unless it is presented in a specific way especially in Islamic subject as the children need to learn through the traditional method. In addition, the educator has to explain to the children using the traditional method failing which. The children will encounter problem in engagement and focus during the learning sessions. Although there is a wide variety of learning media available such as newspapers, television, and the internet but nevertheless learning through mobile application has not been used effectively as an additional tool in the learning process due to the non-availability in some subjects [38]. Other than that, students also have difficulties in visualizing the abstract concept as it will lead to misconceptions arising from a misunderstanding of the concept [34]. In addition to the abovementioned problems, there is also a scarcity of research conducted on how the technology especially AR could be used in teaching and learning Islamic studies [35]. Thus, learning using AR through mobile application could help simplify the learning and make learning more interesting. In the field of educational, AR application could also be dubbed as alternative instructional media [35] and as a new way to improve the learning of three-dimensional shapes instead of the traditional method [34]. Thus, the use of visualization technologies such as AR in education is becoming more advanced and more sophisticated [34].

3 Methodology

In this paper, a survey was conducted using a questionnaire which consists of 11 questions, a mixture of both open-ended and closed-ended questions. A preliminary study was also conducted to collect data on the process development of Hajj AR mobile application for children learning.

3.1 Preliminary study

In this phase will describe the learning process of what student will learn which forms the basis of all the other steps. Also, at this juncture, the researcher determines the needs, knowledge, and skill that the respondents (children) must have or they are expected to have (criteria) according to the objectives and goals of the research set. The characteristic of the intended learner, such as their prior knowledge, attitudes, culture, interests are determined and based on instructional goals to be achieved, as all, information collected will be needed for the development of the application [33], [40]. Subsequently, the subject field and the target group will be determined under the Analysis phase for further development of the Hajj AR mobile application.

The preliminary study was conducted to determine the suitable research design, target respondents' for the research, perception of respondents' in the learning using AR technology method, opinions, data collection and selection of the subject matter for research before designing the development of Hajj AR mobile application [33].

Similarly, in the Analysis phase, a preliminary study was conducted among experienced educators to analyze the elements of AR that will be implemented in the Hajj AR mobile application.

3.2 Development of questionnaire

A survey was conducted using an open-ended and a close-ended questionnaire. The questionnaire consists of 11 questions. The questionnaire was distributed to all experienced educators in Early Childhood Education to collect the opinion of respondents on the application that will be developed. All information pertaining to the respondents are kept private and confidential. All experienced educators have been teaching ritual of Hajj among 6 years old children. The estimated class time is 30 minutes within the average of every class is 12 students. In addition, the questionnaire was adapted from an online user survey on current mobile augmented reality applications [41] and <https://pt.surveymonkey.com/t/ar-ch-en>.

The questions were divided into four sections; (1) Demographic Information; section (2) and section (4), the respondents are required to tick (✓) the suitable answers and answer an open-ended question in the space given. In section (3), a closed-ended question using Likert Scale was used. The Likert Scale represents as 1= Strongly disagree; 2=Disagree; 3=Neutral; 4= Agree; 5= Strongly agree. Here, the respondents are required to circle an appropriate value based on the questions.

3.3 Data collection

The questionnaires are distributed among 13 experienced educators from three different Little Caliphs kindergarten. Each educator must have a minimum of five years' experience in teaching Early Childhood Education in addition to having experience and involvement in the Hajj simulation. The respondents from the three different Little Caliphs kindergarten participated in the survey to avoid any bias information that will be gathered. The purpose of the preliminary study is to gather information which will be implemented in the Hajj AR mobile application for children's learning. The data were analyzed using Microsoft Office Excel to obtain the results for the preliminary study phase which were documented accordingly.

4 Results

The results of the preliminary study are detailed below.

4.1 Demographic information

There are four questions under demographic information which are gender, age, experience in teaching Early Childhood Education and educational background. Table 3 shows the results of demographic information.

Table 3. The Results from the Demographic Information.

Demographic Categories		Percentage (%)
Gender	Male	7.7%
	Female	92.3%
Age (years old)	20-25	23.1%
	26-30	53.8%
	31-35	7.7%
	36-40	7.7%
	41-45	7.7%
Experience in Teaching	5-6 years	84.6%
	7-8 years	15.4%
Educational Background	Diploma	30.8%
	Bachelor's degree	53.8%
	Master's degree	15.4 %

Based on the preliminary study conducted, there were a total of 13 responses comprising 12 female respondents (92.3%) and 1 male respondent (7.7%) from the three different Little Caliphs kindergartens.

Of the 7 respondents, majority of them were between 26-30 years old (53.8%), followed by 3 other respondents who were between 20-25 years old (23.1 %). While, for age 31-35 years old, 36-40 years and 41-45 years old there was only 1 respondent (7.7%) respectively.

On teaching experience, a total of 11 respondents (84.6%) out of the 13 respondents (teacher) have experience in teaching 5-6 years old whereas the remaining 2 respondents (15.4%) have 7-8 years' experience in teaching among the children.

On the educational background of the respondents, a total of 7 respondents (53.8%) possess a bachelor degree, followed by 4 respondents (30.8%) who possess a diploma. While another 2 respondents (15.4%) have Master degree.

4.2 Experience in teaching Hajj

In this section, the questionnaire consists of two questions which are (1) Teaching Tools used in Learning Hajj for Children's and (2) Benefits from the Involvement in Little Hajj Simulation as an Educator. The respondents could choose more than one teaching tool.

Question 1: What are the teaching tools that you used in teaching Hajj? Fig.1 shows the result of teaching tools used in learning Hajj.

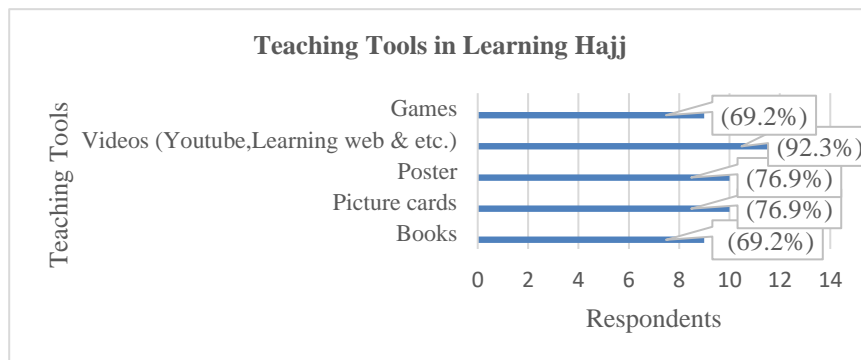


Fig. 1. Teaching Tools in Learning Hajj

Based on Fig.1, 12 respondents (92.3%) from 13 respondents chose videos such as YouTube, learning web and others as teaching tools for learning hajj. Then, followed by poster and picture cards which are the teaching tools representing 10 respondents (76.9%). A total of 9 respondents (69.2%) chose the games and books as teaching tools for children to learn Hajj.

Question 2: What are the benefits of your involvement in Little Hajj Simulation as an educator?

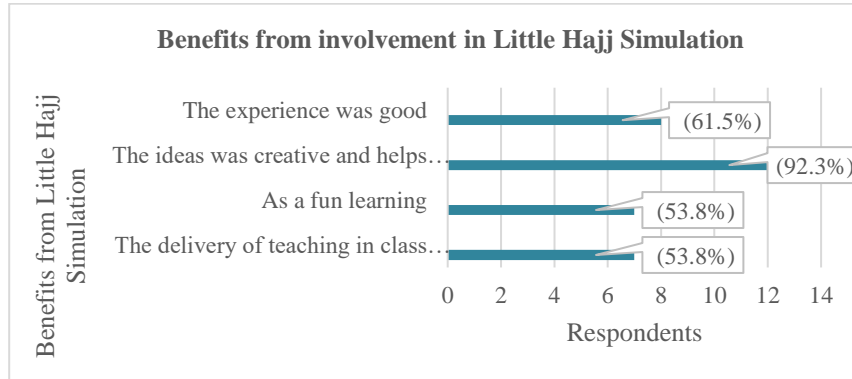


Fig. 2. Benefits from Involvement in Little Hajj Simulation

Fig.2 shows 12 respondents (92.3%) who are educators, agree with the statement that the ideas were creative and helpful for the visualization and understanding of children’s in learning. While 8 respondents (61.5%) gained good experience for their involvement in Little Hajj simulation. Another 7 respondents (53.8%), found it to be fun learning and the delivery of the teaching in class is easier. In the opinion section, only 1 respondent gave her opinion about Little Hajj on the state of the respondent, importance of learning and practical life of role-play in doing hajj before performing the Little Hajj simulation.

4.3 Learning Hajj through Augmented Reality

In learning Hajj through AR section, there are four questions, namely (1) Awareness of AR, (2) The User Perception on AR, (3) The Perspective of Applying AR in Learning Hajj and (4) The Suitable Elements to Implement in Hajj AR Mobile Application. Fig.3 shows, the respondent’s awareness of AR.

Question 1: Are you familiar with Augmented Reality technology?

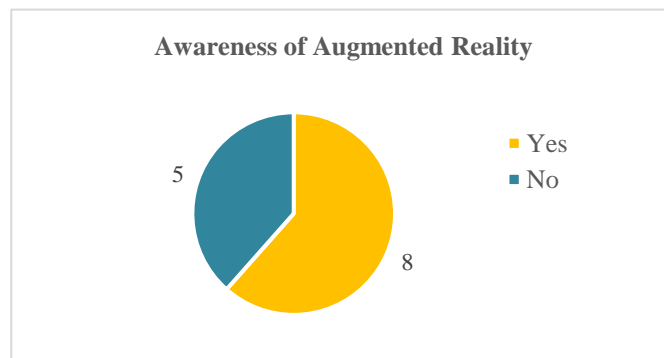


Fig. 3. Respondents’ Awareness of Augmented Reality

Based on Fig.3, 13 responses were received, out of which 8 respondents (61.5%) were familiar with AR, whereas the other 5 respondents (38.5%) were not familiar with AR.

Question 2: The User Perceptions on AR.

To answer this question, the five-point Likert scale ranging from (1) *strongly disagrees* to (5) *strongly agrees* were used to measure the user perception on AR.

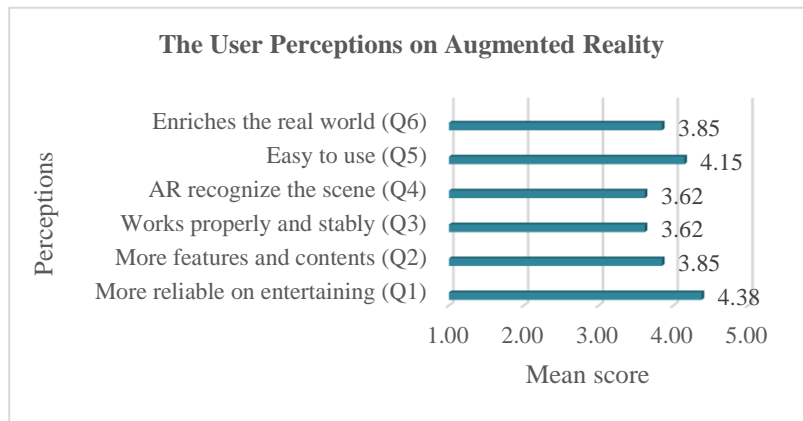


Fig. 4. Respondents' Perception on Augmented Reality

Fig.4 shows the respondents' perception on Augmented Reality. The higher mean score on the user's perception of AR is the application with AR function which is technically more reliable on entertaining with a mean score of 4.38. Next, easy to use has a mean score of 4.15. Then, the user's perception on AR is the application with AR function has more features and contents, compared with, enriches the real world by combining real and virtual information which has a mean score of 3.85 respectively. Then, the lower mean score for the application with AR function works properly and with more stability, then locate and recognize the scene precisely (i.e. objects in the real and virtual worlds are properly aligned with each other) also have a same mean score which is 3.62 respectively.

Question 3: The Perspective of Applying AR in Learning Hajj.

To answer this question, the five-point Likert scale ranging from (1) *strongly disagrees* to (5) *strongly agrees* were used to measure the perspective of Applying AR in Learning Hajj.

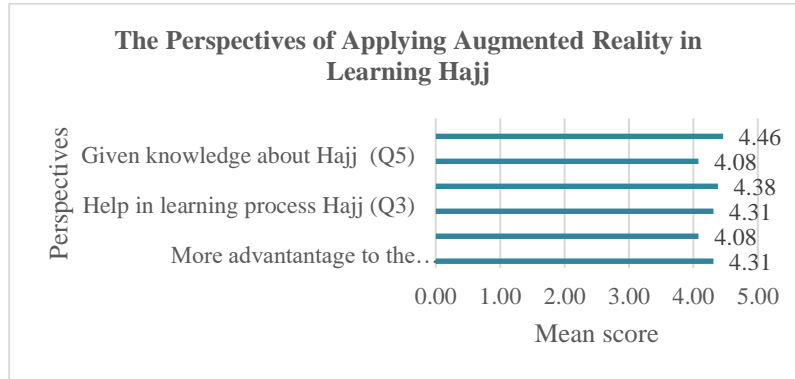


Fig. 5. Respondents’ Perspective of Applying Augmented Reality in Learning Hajj

Fig.5 shows the respondents’ perspective of applying AR in learning Hajj. The results revealed that the higher mean score perspective of applying AR is 4.46, which the respondents believe that learning Hajj through AR will motivate more students to have fun. This is followed by AR is a suitable learning tool for Hajj subject with a mean score of 4.38. Then, the mean score for learning Hajj through AR will bring more advantages to the students and AR as a learning tool to help the students in the learning process of Hajj is 4.31, respectively. Other than that, the mean score for AR helps the students to memorize a certain event more effectively is 4.08. Additionally, the mean score of learning through AR given students’ knowledge and will help students to understand more about Hajj also obtained a score of 4.08.

Question 4: Which of the suitable elements to implement in Hajj AR application? (You may choose more than one (1) answers):

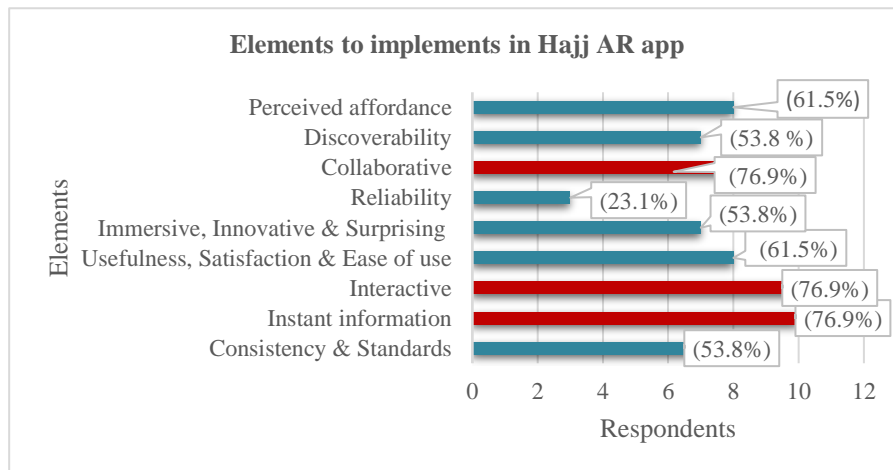


Fig. 6. Elements to Implement in Hajj AR Mobile Application

Fig.6 shows the elements that are suitable for implementation in Hajj AR mobile application. The result disclosed that the 10 respondents (76.9%) chose three suitable elements to implement in Hajj AR application is collaborative (Mobile technologies are supported communication between students and teachers), interactive and instant information. This is followed, by perceived affordance, and usefulness, satisfaction, and ease of use with 8 respondents (61.5%). A total of 7 respondents (53.8%) chose discoverability, immersive, innovation and surprising, consistency and standards. Only 3 respondents (23.1%) chose reliability elements to implement in the application. Thus, the three main highest elements will be implemented in Hajj AR mobile application.

4.4 Elements in developing Hajj AR mobile application for children

In this section, the respondents proposed some suggestions for developing Hajj AR mobile application. From the survey, the researcher concluded that there were three elements which were suggested for the development of Hajj AR mobile application for children, which are either easy to use or user- friendly, thus making it an interesting for children to understand every aspect of Hajj ritually.

5 Discussion

The idea of developing a Hajj AR mobile application is based on previous studies where many of the existing AR mobile application for children's learning is on the alphabet, animals, numbers, Islamic and others. Besides, most of the existing applications are for the elderly [28] and unsuitable for children learning. Therefore, from this preliminary study, the researcher wants to explore the suitable elements that could be implemented in the AR mobile application and to develop a suitable AR mobile application for children learning. Furthermore, the preliminary study shows a positive consensus from educators concerning the application that will be developed and acknowledge a new technology integrated with education, and teachers' positive opinion is important [20].

From the previous study, the elements that will be implemented in the AR mobile application is easy to adapt, meaningful to the user, motivational which will increase student's willingness, interactive and social interaction [42] & [43]. Besides, in research Mobile Learning Application based on Augmented Reality for Science subject: *Isains*, researcher found that interactive and user-friendly elements can be that implemented in the application [38]. Accordingly [40], the AR design for mobile application must have visual, navigation, accessibility, attention of usability, freedom of mobility and others. Thus, from the previous study, it could be concluded that the main elements to be implemented in developing AR mobile application are interactive, easy to use (user-friendly) and accessibility. Hence, from the previous and preliminary study, the researcher could conclude that the important element in AR mobile application is interactive.

Besides, the educators can improve their practices to ensure that the use of AR can enhance the learning outcome with provides a new perspective for learning by allowing

learners to visualize complex spatial relationship and abstract concepts, for example learning Hajj. The educators also can use AR to improve learning performance to a similar extent as the most used teaching materials (both picture books and physical interaction) do with creative way [44].

The significance of this study is that the researcher could identify and determine the suitable elements to be implemented in the process of developing a Hajj AR mobile application. In addition, from this preliminary study, the respondents' perception and perspective on AR were also determined. Since the respondents are aware about AR, it could be applied as a learning method for children in the future with the potential to add meaningful value in the process of fun learning. Thus, the educational benefits have made AR one of the key emerging technologies for education over the next five years [45]. In addition, through the AR application, it is an alternative medium in changing the traditional learning method that only uses storybooks as references leading towards a better form of learning environment [46]. The challenges are the lack of contents for children to learn Hajj in mobile application, the cost of developing application and finding suitable smartphones for children's learning. Thus, these challenges need to be overcome to ensure a Hajj AR mobile application can be developed.

6 Conclusion and Future Work

In conclusion, this study is focused in obtaining information and descriptive perspective of AR in the processes of developing Hajj AR mobile application. Hence, the researcher highlighted the problems in developing the prototype and achieved the first objective by doing this preliminary study in addition to obtaining information and knowledge about Hajj from experienced educators. Also, this study has highlighted the elements of AR that could be implemented in developing Hajj AR mobile application which serves as a learning tool that could be applied in the future learning activity. From that, the elements that will be implemented is collaborative which supports communication between students and teachers, interactive and instant information. Through this preliminary study, the researcher hopes that the development of the Hajj AR mobile application could attract children towards technology and create an active learning environment.

Overall, learning through AR could help increase fantasy play, besides, enhancing interaction with physical and virtual reality activity [20]. Furthermore, multimedia components may increase the user's interaction and could lead the children to have a high level of interaction with technology [20]. Through the preliminary study, the researcher starts to see the potential of AR in an education setting and foresees that further research within the field is needed [13]. Thus, for future work, the Hajj AR mobile application will be designed and developed at the next stage. Hence, the process of the development will continue in other phases, namely the design phase, development phase, implementation phase, and evaluation phase.

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