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V-Tawaf: A Virtual Reality Application for the Learning of the Tawaf Ritual

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ABSTRACT

Pendidikan Islam is one of the subjects taken by Muslim students in Malaysia with the purpose of instilling them with knowledge and values of Islam. Depending on the topics, the teachings of Islam in schools focus solely on cognitive elements but quite limited on the practical elements. Lack of practical in the teaching of Pendidikan Islam would cause students to be bored thus, impacting student's understanding and appreciation of the fundamentals of the subject. This paper presents the design of a V-Tawaf, a non-immersive virtual reality application for students to learn about Hajj in general and the tawaf ritual specifically. In V-Tawaf, students perform the tawaf virtually through an avatar. While performing the tawaf, students can interact with pre-determined objects in the application to get more information on tawaf. The content of the VR application is based on the Pendidikan Islam Form 4 syllabus. The development of the VR application prototype consists of the creating the 3D models, designing the VR applications interfaces and lastly, integrating the developed 3D models and VR application interfaces as a VR application. Based on the textbooks and other references, the 3D model Masjidil Haram interior structure, Kaabah, Maqam Ibrahim, Hajarul Aswad and Hijr Ismail were developed. Testing have been conducted to evaluate the usability and learning of the application. The results indicated the users generally feel that the application has easy to use controls, but it requires clear instructions in navigating the application. Nonetheless, the users perceived that the VR simulation module of the application has provided an interactive learning environment which makes the learning of tawaf more interesting.

Introduction

Pendidikan Islam or Islamic studies are one of those subjects that Muslim students have to take throughout their whole years in primary and secondary schools in Malaysia. On top of the Pendidikan Islam subjects taught in schools, Muslim students also attend religious schools to supplement their learning of Islam. According to the Curriculum and Assessment Standard document released by the Ministry of Education, Malaysia for Year 6 Pendidikan Islam, the Pendidikan Islam curriculum focuses on seven areas which are al-Quran, Hadith, Akidah, Ibadah, Sirah, Adab, and Jawi. The learning domain for the seven areas encompass knowledge, practical and values in which the lessons are delivered through various approaches, methods, and techniques. The teaching needs to be effective to fulfill the 21st century skills such as high-level order thinking skills, innovative and creativity. Currently, certain topics in Pendidikan Islam focus solely on knowledge delivery and lack on practical. Student's learning experience is limited through textbooks, images and videos. The use of conventional methods in delivering knowledge and understanding of Hajj and Umrah is considered as ineffective (Isa et al., 2017). According to Yusoff (2012), existing supplementary materials and learning methods were less effective in giving a clear understanding to the users, whether they are youngsters or elders. Most of the current supplementary materials are based on passive learning mode. This could impact student's understanding and appreciation of the fundamentals of the subject. To enhance student's learning experience, the use of technologies in teaching and learning seems to be an opportunity. Technologies such as mobile application (Kaur et al, 2021), Internet of Things (Sulisworo et al., 2022), virtual reality, augmented reality (Ramli & Zaman, 2020) have been adopted in teaching and learning. These technologies have the potential to enhance student's engagement by transforming the way educational content is being delivered (Maratha et al, 2021).

This study presents the design of non-immersive VR prototype called V-Tawaf that could enhance student's understanding on the tawaf ritual by allowing students to view. interact and experience the digital environment of Masjidil Haram's interior which includes Kaaba, Maqam Ibrahim, Hijr-Ismail, and the pillars around Masjidil Haram, and Hajarul Aswad. The topic Hajj and Umrah from Pendidikan Islam Form 4 syllabus is used as the main reference for the VR content.

Literature Review

Overview of Immersive Technology

Immersive technology is defined as any form of technology that allows the blurring of virtual and real worlds while providing a sense of immersion (Dieck & Han, 2022). Immersive technologies create a distinct experience by merging the physical world with a digital world. Examples of immersive technologies are augmented reality (AR), virtual reality (VR), mixed reality (MR) and extensible reality (XR). VR is widely used in education (Freina & Ott, 2015) and will continue to be one the of the important technology in education as it promotes fexibility, openness and learning collaboratively in teaching and learning (Papanastasiou et al., 2019). VR is a simulation of computer graphics that create a hyper-realistic look of the world in which users can respond to this digital world either through hand gesture or verbal command in real-time (Coiffet & Burdea, 2003). There are three types of VR immersiveness namely fully immersive, semi-immersive and non-immersive. A fully immersive VR enables users to experience the VR world using a head-mounted display (HMD). In this way, users can look and interact in all directions and the environment changes as the user moves giving that continuity of surroundings. Typically, the HMD system incorporate motion sensors to determine the direction and movement in the VR application. Using a HMD, students can be fully immersive into the VR world. Engineering, geography, and astronomy are some of the subjects that are suitable for a fully immersive VR experience. The second type of VR is the semi-immersive or projection virtual reality. In this type of VR, the virtual environment is projected on a wall, floor, or even multiple screens (Lorusso et al., 2020). A semi-immersive VR is commonly used in flight training where pilot trainee sits in a room with large concave screen, projection system and monitor. The pilot trainee does not have to wear a HMD to experience the VR environment and still aware of the real world. The third type of VR is the non-immersive VR or desktop virtual reality. This type of VR provides users with a computer-generated environment without a feeling of being immersed in the virtual world. In this type of VR, the users interact with the virtual environment using a mouse, joystick, or gloves. The user only interacts with the environment but do not experience the

sensation of being in that virtual environment. Non-immersive VR applications are common in games such as SecondLife, World of WarCraft, PUBG and many others played on a computer or other gaming devices. In education, non-immersive VR can be seen through works by Rahouti et al. (2021) on healthcare fire safety training, Rosli, Che Embi & Abdullah (2021) on autistic children social training, Samah et al. (2021) on tourism, Bastidas et al. (2022) on virtual robotics and Vergara-Rodriguez et al. (2021) on science. The use of avatars seems to be common in non-immersive VR games. An avatar is a visual representation of an imagined or real character (Kharbach, 2016). Having an avatar in educational VR applications could be beneficial as it creates a more realistic and engaging learning environment (Wasmuth, 2016).

The Adoption of VR in Education

The adoption of VR in education could revolutionize teaching and learning by enabling students to learn in an immersive environment from anywhere and any place. With VR, student can be brought to a world that they could not possibly go. Companies such as TechRow develops mobile VR applications for students to experience the digital environment of rainforest, solar systems, iconic places and many more. The benefits of using VR in teaching and learning is that it makes learning more interesting, and it increases student's learning efficiency. For primary schools and secondary schools' students, existing works have been done in the use of VR in science subjects (Zulherman et al, 2021; Anggara et al, 2021), vocational subjects (Maulana et al, 2021), art (Zhang and Lin, 2021) and architecture (Puggioni et al, 2021). Maulana et al (2021) conducted an assessment of student's performance and interest in using VR application in their learning. Their findings indicate that students learning using VR application performs better than those who use conventional approach. Student's interest on learning also shows an increase as compared to learning using conventional approach. Similar findings were report by Puggioni et al (2021). The authors tested two group. The first group use VR in their learning and the second group learns through face-to-face lecture. Their evaluation sees that first group outperformed the second one on all metrics of evaluation.

Immersive Technology in the Learning of Hajj and Umrah

There has been a considerable amount of work on the use of immersive technology for the learning of Hajj and Umrah. Madi et al (2020) explores the use of a Hajj mobile learning application using augmented reality technology among teachers. Their findings indicate that teachers accept the use of AR mobile application as an interactive learning tool. The use of AR makes the teaching more entertaining because the children can visualize the Hajj ritual and interact with the digital environment in the app. The teachers also believe that using AR could enhance children's understanding on Hajj. The teachers also believe that if such app is to be developed, the app must be interactive, provide instant information and allow collaborative learning. Nonetheless, the author stated lack of contents for children to learn Hajj in mobile application, the cost of developing application and finding suitable smartphones for children's learning as the challenges for AR mobile application. However, if educators are open, possess high inquisitiveness and able to learn and master new technologies in teaching, it could contribute to the success in instilling VR technologies in Islamic studies.

Existing work on the use of virtual reality for the learning of Hajj and Umrah varies from its target audience, purpose, and level of comprehensiveness. Kabir et al (2021) developed a VR application for that provides interactive and realistic user experience in educating the pilgrims of Bangladesh. The application consists of an Android application, a webpage, and the VR application itself. The scope of the app is the entirety of the hajj pilgrimage which also includes the Islamic ways, traditions, rules, prayers, and history. The application includes a virtual guide to educate and inform pilgrims about pilgrimage, an activity planner and map service with useful locations. Clearly, the target users for the application are the pilgrimage themselves which could really assist them in better preparing themselves for Hajj. Because of the intended user are the pilgrims therefore, the scope of the Hajj ritual in the VR application is comprehensive. Another application with complete Hajj ritual is Free Hajj. Free Hajj was developed by Sumardani et al (2020). The application consists of 6 features namely hajj series, hajj series guide, Arabic language, floor plans, frequently asked questions, and instructions for use. The application adopts a 360-degree video to get that panoramic view of Makkah. The application has a guide to three types of Hajj series with an audio narrative explaining in each of the series. The application was developed on smartphone and VR Box is used to provide that VR experience.

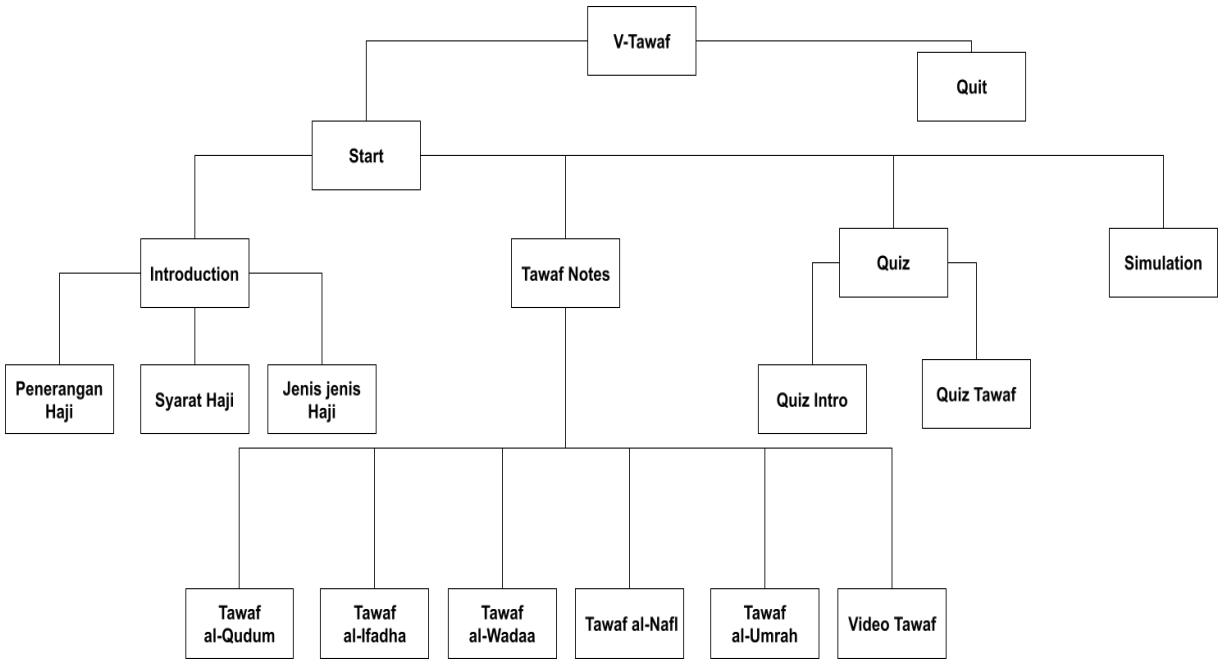
Isa et. al. (2017) studied the user satisfaction for a VR-based application called Virtual Umrah among secondary school students. The application was developed using a user centered design approach. The application was developed based on a framework that consists of five elements namely content, virtual reality technology, multimedia elements, user profile and usability evaluation. The development of the application includes a 360-degree photography technique which gives a panoramic image that surrounds the Masjidil Haram. This technique produces a simulation of real-world using image-based model with high degree of realistic user experience. Their findings indicate that the application is good in terms of satisfaction, memorability, errors, and efficiency.

Alsaif (2017) conducted a study on the teaching of Hajj using virtual simulation technology among middle school students in Saudi Arabia. She stated that the use of virtual simulation enhances student's motivation to learn, enhance their engagement level and allow the student to explore the Hajj season in a safe environment. However, it is unclear on the workings of the Hajj virtual simulation and its technical design and development. Nonetheless, it can be assumed that the features and functionalities of the virtual reality simulation is like any other VR apps. An interesting note to consider is that the author stated that there is little research that has been done on the effectiveness of virtual simulation technology in Islamic Studies instruction in Saudi Arabia as compared to other Islamic countries such as Malaysia. Thus, the adoption of virtual reality in Islamic education particularly in the topic of Hajj can be seen as an opportunity that researchers and developers can tap into (Salleh et al, 2021).

V-Tawaf Prototype Development

V-Tawaf was developed using the rapid application development (RAD) method. The justification of adopting RAD is because of its agility and iterative characteristics. Using RAD, the development of V-Tawaf is quicker as constant feedback on the prototype is obtained and the development progress can be easily quantifiable for monitoring (Silverthorne, 2019). Figure 1 shows the navigation diagram of V-Tawaf. User can access the content of the application by clicking the Start button on the main page of the app. The menu of the app consists of Introduction, Tawaf Notes, Quiz and Simulation.

Figure 1: V-Tawaf Navigation Diagram



The Introduction module consists of content regarding Hajj in general. This includes the overview of Hajj, types of Hajj and requirements of Hajj. The main reference for the learning content is the Hajj topic from Pendidikan Islam Form 4 textbook. The Tawaf Notes module consists of material on the four types of tawaf namely Tawaf al-Qudum, Tawaf al-Ifadha, Tawaf al-Nafl and Tawaf al-Umrah. The Quiz module contains the assessment for learning on Tawaf. It is suggested that the users do the assessment once they

have completed all the learning module. The content in the Introduction, Tawaf Notes and Quiz are text-based. The Simulation module contains the VR application of V-Tawaf. The user will use an avatar to move in the digital environment of the Masjidil Haram's tawaf area. The camera inside has been setup to follow the avatar and able to move around to capture the surrounding environment for the user to look at.

The development of the V-Tawaf is based on the modules. A module will be designed, developed, and tested until it meets the intended objectives of the module. Once the module is completed, the same process will be applied for the next module. This iterative process includes the design of the flowchart, wireframes, 3D objects and the user interface. During the designing phase of the 3D objects, basic geometry was set up, followed by polygons and topology adjustments to simulate the real-life objects and locations measurement for the immersion of users. Figure 2 shows the basic structure for the Kaaba that was setup in the Unity software. Materials and textures of the Kaaba were then later chosen and applied after the adjustments has been finalized as shown in Figure 3.

Figure 2: Kaaba Basic Structure

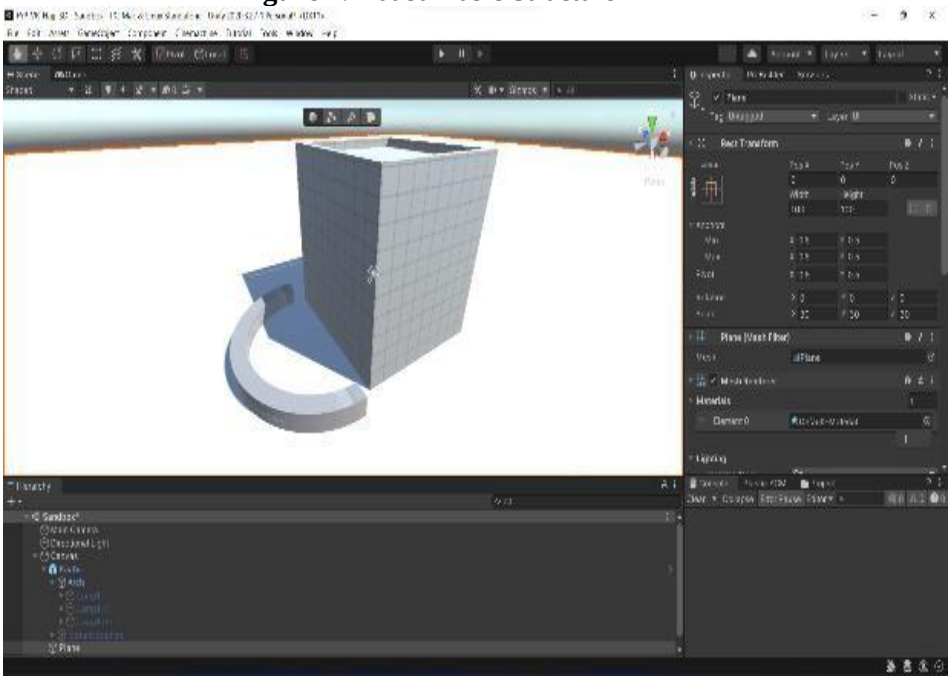
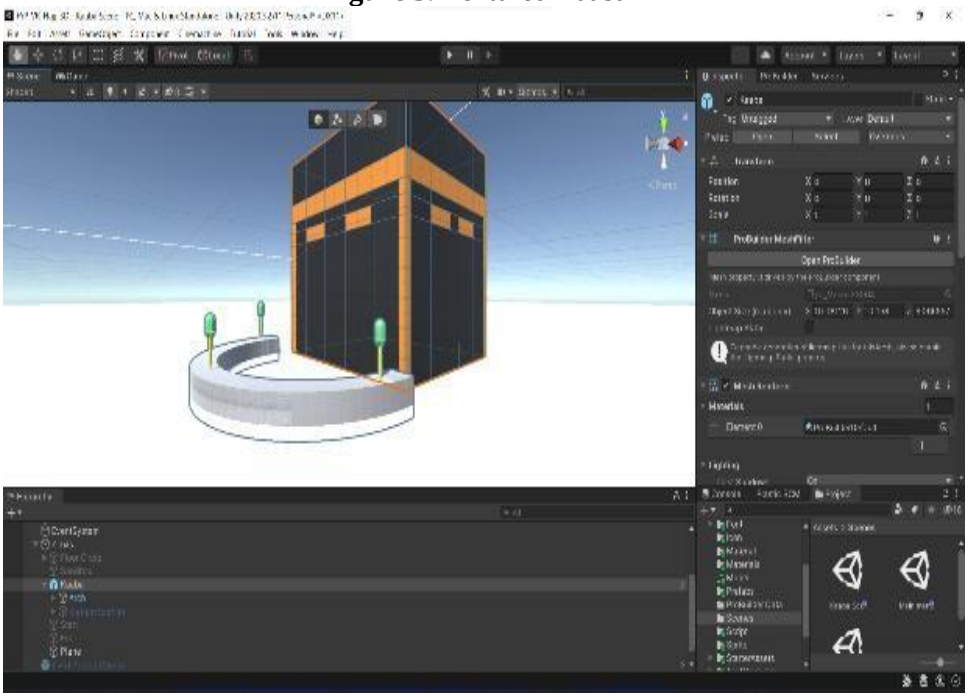


Figure 3: Textured Kaaba



V-Tawaf user interface design aim to be consistent and predictable in the choices and layout. This improves work completion, efficiency, and satisfaction. Example of the common interface elements in this UI is the input control using a clickable button to go to the next page or previous page. The use of simple and direct text on the button also gives a simple idea to user what it will display and execute.

Figure 4 shows a snapshot of the simulation of this application. It allowed the user to freely controls the avatar to explore the non-immersive virtual environment. The simulation happens in the display of the user's device which is usually either a laptop or a desk monitor. User can control of the avatar by using the keyboard or the mouse. Using a keyboard to control the avatar, the user can press the arrow keys located at the left side of the keyboard or press the letter W, A, S and D on the keyboard. The justification of this set up is to give flexibility to the user. Users who use a laptop will have difficulties in using the arrow keys, hence pressing the key W, A, S and D on the laptop keyboard to control the avatar's movement makes more sense. In Figure 5 Some objects are placed in the Masjidil Haram as an interactable info box. Users can interact with these objects to gain more insights on Tawaf in the form of text displays or videos. The info included not limited to Tawaf but also explain the purpose and objective of each building in the environment. On the walls of Masjidil Haram, there were also some texts embedded as tips for Tawaf.

Figure 4: User Point of View

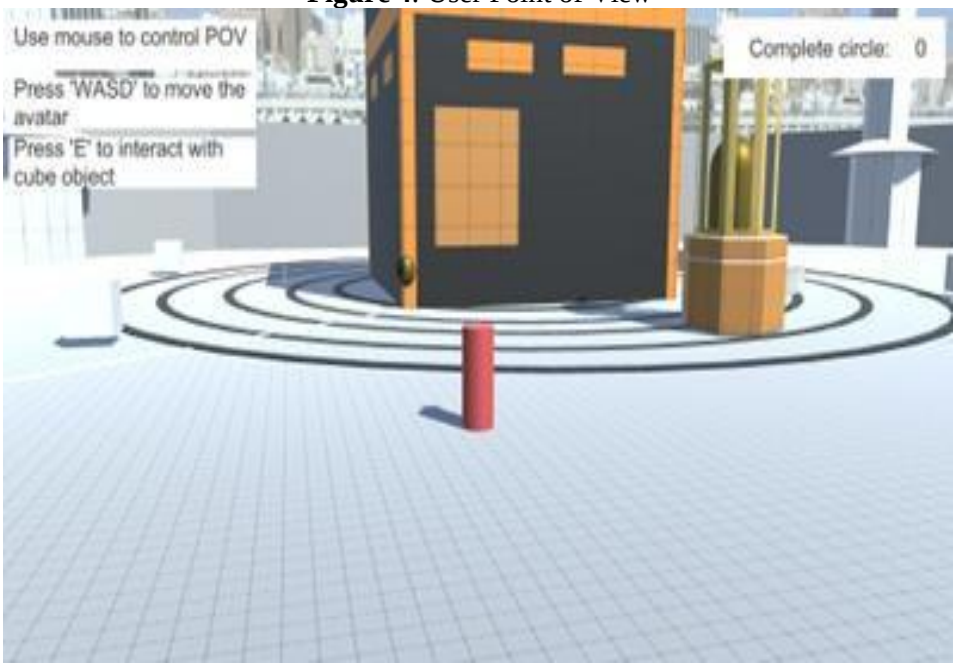
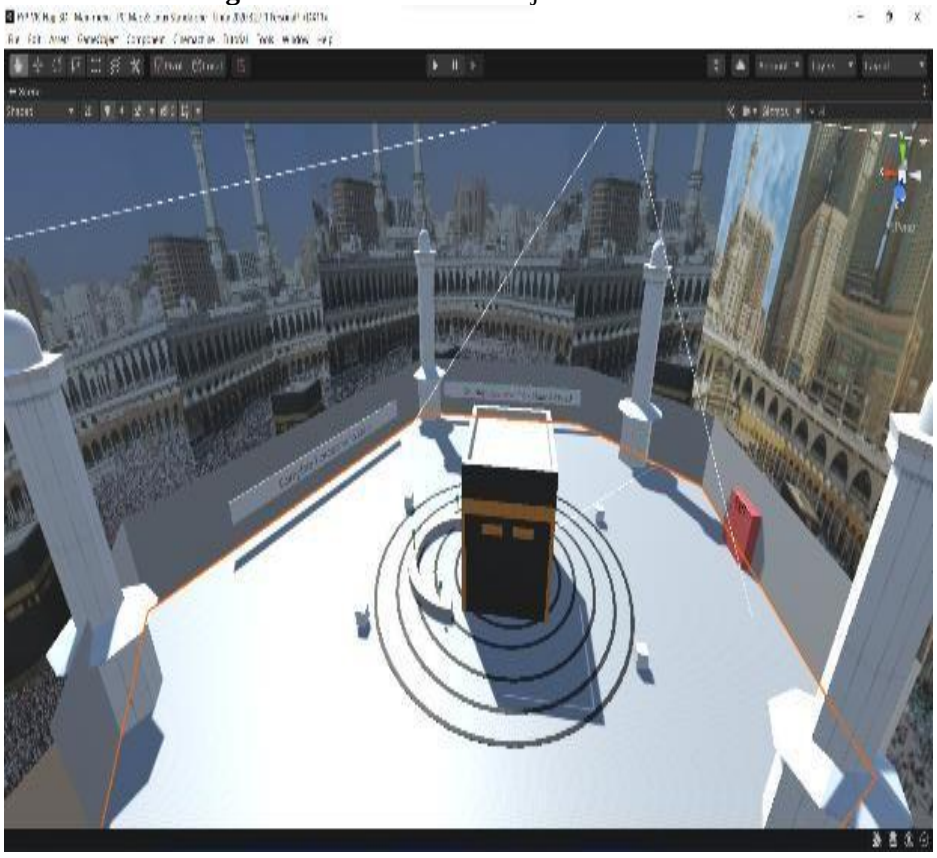


Figure 5: Side View of Masjidil Haram



V-Tawaf Prototype Evaluation

The evaluation was conducted to measure the usability, content, and perceived learning of V-Tawaf. The ISO 9241-11: 1998 definition of usability as the extent in which a product can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use (cited in Yaacob, Rushdi and Mustapha Kamal, 2020). For this study, the user satisfaction is the main area of evaluation to measure the system usability. Effectiveness and efficiency were not measured as part

of usability because it is deemed as less relevant to the overall objective of the application. In this study, simplicity which relates to the design layout of the application, comfortability which relates to user experience and ease of use are items measured under usability. The inclusion of content and perceived learning relates to the role of V-Tawaf as an educational VR application. Information structure and clarify were selected as the items under content. Perceived learning relates to the users learning experience. Secondary school students, who are actual target users of V-Tawaf, were not available to assess the application at the time of evaluation due to school holidays. Thus, university students were invited instead to evaluate V-Tawaf with the assumption that both groups come from the same generation Z group. Five students were invited to participate in the evaluation of V-Tawaf. This is in line with the minimum number of participants for measuring usability (Panchenko, 2022) During the evaluation session, the participants were briefed on the application and then to navigate through V-Tawaf and proceed to answer a survey that is based on the three major areas of evaluation. Table 1 shows the results of the V-Tawaf prototype evaluation.

Table 1: V-Tawaf Evaluation Results

Usability		
Items	Mean	Overall Mean
Simplicity	5	4.8
Comfortability	4.8	
Easy to use	4.6	
Content		
Items	Mean	Overall Mean
Information clarity	4.6	4.5
Information organization	4.4	
Perceived information accuracy	4.4	
Perceived Learning		
Items	Mean	Overall Mean
Module completeness	4.6	4.7
Enhance Interest to Learn	4.8	
Easy to learn	4.6	

In terms of usability, the participants assessed if accomplishing a task in the application is efficient, whether the design of the V-Tawaf is intuitive that it is easy to use and if they feel comfortable in navigating the application. Participants rated usability with a score of 4.8 average. This indicates the participants agreed strongly that V-Tawaf has good usability with a simple and minimal design. The navigations are not complicated and easy to understand.

Content refers to the instructions, learning content and other information in V-Tawaf application. For Content, the participants assessed the application on the clarity of the information, how the information are organized and structure and the perceived information accuracy. On average, participants rated content with a 4.5 overall mean. The information presented is perceived to be clear and well understood but it is worth to revisit on how the information is organized and to address the perception of accuracy on the information particularly on the learning content. While the learning content is based on Pendidikan Islam Form Four textbook, it could be worthwhile to get expert validation of the content from religious experts. It is also suggested a statement that indicate the source of the content to be included in the application.

For perceived learning, V-Tawaf is evaluated in terms of the completeness of the learning module, ease in learning and whether the application enhance student's interest to learn more about the tawaf ritual. The overall mean for perceived learning is 4.7. The participants agreed strongly that the application could enhance student's interest. This finding is in line with other studies on the impact of VR application

towards learning. The VR content does contribute to the ease of learning. The VR feature in the Simulation module complements its text-based learning content. The VR shows not only the practical aspect of tawaf but also the environment in which tawaf is performed. This makes the learning of tawaf more efficient. In terms of module completeness, the participants perceived that there could be more topics and content that can be added into the application.

Conclusion and Future Recommendations

The advancement of virtual reality has benefited many industries, including medicine, training, and tourism. The adoption of virtual reality in Islamic education particularly in the topic of Hajj is timely. Using VR, students can experience Makkah and Hajj rituals in a digital environment. V-Tawaf is one of those applications that contribute to the development of VR applications for the learning of tawaf. V-Tawaf is a non-immersive VR application that include the virtual environment of the interior of Masjidil Haram, Kaabah and its surroundings.

Students learn by interacting with an avatar that performs the tawaf. While performing the tawaf, the avatar can interact with certain objects to get more information on tawaf. The evaluation of the V-Tawaf prototype sees that the application makes the learning of tawaf much more interesting, and this could enhance students to learn more. However, more work needs to be done to improve V-Tawaf particularly on the aspects of learning content, 3D designs models and other technical improvements. Developing an immersive V-Tawaf can also be a future recommendation. Nonetheless, it needs to be designed with care. While an immersive VR seems to be more appealing to students, it could be less effective in terms of learning. This is because an immersive VR could be a distraction and time consuming for the teachers to set up in the classroom (Mahmoud et al., 2020; Vergara-Rodríguez et al., 2021).

Overall, the integration of VR technology in the teaching of umrah and Hajj is one of the best solution methods to provide in-depth exposure and give individuals a more precise understanding of umrah's implementation of Hajj. This VR innovation is an innovation of the future that is expected to have a practical impact on education, especially Islamic Education.

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