

Development and User Evaluation of Virtual Hajj (V-Hajj) Courseware for Hajj Learning Procedures

Mohd Fitri Yusoff, Abdul Nasir Zulkifli and Nur Fadziana Faisal Mohamed

Abstract—Hajj is one of five pillars of Islam. Every capable and able-bodied Muslim is obliged to make the pilgrimage to Mecca at least once in their lifetime. Even though comprehension courses were provided before the pilgrimage particularly in Malaysia, additional learning material is still needed. This is due to the complexity of Hajj procedures comprehension including the practical parts. Thus, this paper proposed a model of persuasive Hajj learning environment, and then has been applied in the V-Hajj courseware. User evaluation also has been deployed and discussed in detail, as well as the development process and stages in the V-Hajj implementation. This paper is hoped to bring ideas and help designers and developers in the future.

Index Terms—virtual environment, multimedia, persuasive, Hajj learning procedure, user evaluation, TAM

1 INTRODUCTION

According to [1], many pilgrims face many difficulties and problems to perform the Hajj as a result of lack of knowledge and weaknesses towards the practical steps of Hajj. This view is also supported by [2] based on their own experience, when they were bewildered by the amount of information, rules, tasks, practical steps and the Al-Quran verses that must be understood and memorized after the Hajj courses. Author [2] concluded that supplementary materials are the alternative solution to increase their retention and understanding towards the learning. However, according to [3], the existing supplementary learning materials for Hajj are lacking in terms of constructing learners' own experience. Practical steps in Hajj require pilgrims to involve actively in performing the steps for Tawaf, Sa'ie and throwing of the Jamarat.

Hence a prototype of virtual environment (VE) and multimedia adaptation has been developed as an alternative to users for learning Hajj procedures interactively and attractive. The prototype has been developed by using the proposed model as shown in Figure 1. The key-steps for the prototype development were derived by [4]. Human factor perspectives were considered as guidelines to creating an interactive VE for learning purposes. Importantly, a Hajj expert was involved in this phase to provide proper guidance and advice in developing the V-Hajj prototype. Figure 2 shows the steps in developing the prototype.

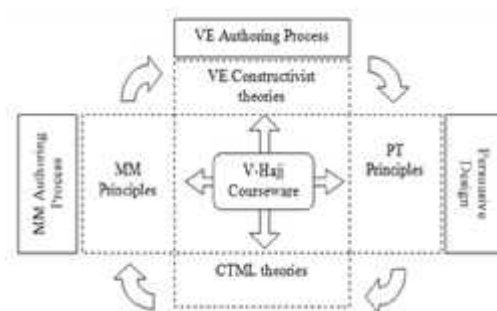


Fig. 1. The Model of V-Hajj Courseware for Hajj Learning Procedures



Fig. 2. The Development Processes for V-Hajj Courseware

2 THE DEVELOPMENT PROCESSES (VE)

2.1 Scene Definition

The purpose of scene definition is to ensure that the prototype specifications are properly set. In this phase, all contents related to Hajj, Umrah and Ziarah were gathered. The scenes basically introduced some of the Holy places for performing the practical rituals such as for Tawaf, Sa'ie and throwing of the Jamarat. The selection of the Tawaf, Sa'ie and throwing of the Jamarat

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to be presented in VE is based on the critical issues in presenting these rituals to the learners. These rituals are the most critical practical problems in the Hajj procedures. It was agreed by the Hajj content expert from LTH that it is hard for most pilgrims to imagine the real situation of the rituals. Although the Hajj courses provide practical trainings for Tawaf, Sa'ie and throwing of the Jamarat, they are still inadequate. The pilgrims cannot imagine the real situation of the rituals since they are not able to see the real or actual environment themselves. Thus, VE was used to facilitate the learners. Learners not only can self-manuever in the environment but also see the environments realistically as if they are of the actual environments that exist in Mecca.

Ideas were proposed for the structures of the Holy places before they are being modeled in the second phase. The contents, related pictures, audios and videos, which were gathered from various sources, were checked in detail by the experts from LTH to ensure that they are correct, accurate and valid. Figure 3 shows the scene definition example.



Fig. 3. Example of Scene Definition (Scenes for Sa'ie)

2.2 Object Modeling

The object-modeling phase is the most fundamental process in developing the VE. The process of developing Hajj environment consists of two important tasks namely; geometric modeling and behavior modeling. Geometric modeling is where the shape of the object is represented. Combination of polygons creates a model and the polygons were shaped to suit the needs of the environment. Besides, texturing is also an important task for creating a more realistic model in geometric modeling.

Behavior modeling represents the motion and the reaction of the object in the VE. All these tasks were developed by using Autodesk 3Ds Max and Quest3D. In this part, 3D environments such as the area of Kaabah (Tawaf), Hills of Safa and Marwah (Sa'ie) and also the area for throwing the Jamarat were developed. For making the environments more realistic, human characters were created with different movement, for example walking (man and woman), praying action, kissing the Hajarul Aswad and throwing. Figure 4 shows the example of object modeling.

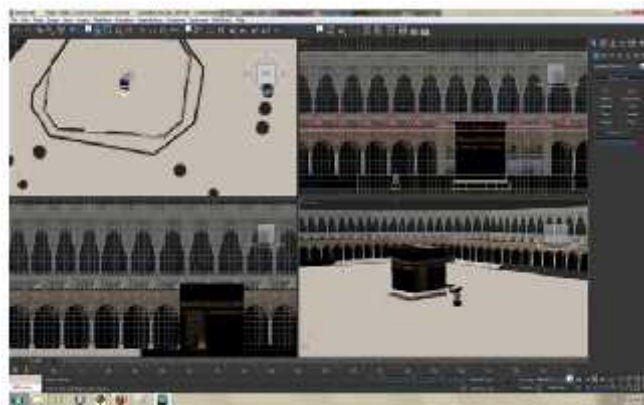


Fig. 4. Example of Object Modeling

2.3 Optional Database Conversion

This is an optional phase for the modeling system in producing 3D geometric model files, which is related in increasing the models' consistency in the authoring system. Although the authoring system is capable of supporting any 3D models, the random access memory (RAM) and graphic capability of computer systems need also to be considered. This determines the application speed when users are running the VE application.

Since V-Hajj is based on the integration of MM and VE technologies, thus, more storage space is needed. In order to minimize the storage space, every 3D model such as the Kaabah and all the holy places and the human characters were developed with minimum polygon count. This was done using Polygon Cruncher, a plug-in for 3Ds Max software. This plug-in enables the reduction of the number of faces and vertices of 3D models, which eventually reduces the polygon count without distorting the shape of the model.

The finished 3D characters were duplicated and then animated appropriately based on the practical rituals required. The duplication process was done to create the crowd simulation. Since VE is based on real-time rendering and visualization, the number of characters for the crowd simulation has to be minimized so as to avoid lag in the visualization of the VE.

Polygon Cruncher is a plug-in for 3Ds Max in reducing the number of polygon count of 3D models without distorting their appearance and shape. It can also be used to optimize and taking care of the symmetry of objects and also keep the details even at high optimization ratio and texture. Polygon Cruncher has an OpenGL view, which allows controlling optimization results. Figure 5 shows the example of optional database conversion for Masjidil Haram. Before exporting the models in Quest3D, the models need to be converted to the Microsoft DirectX '.x' file format.

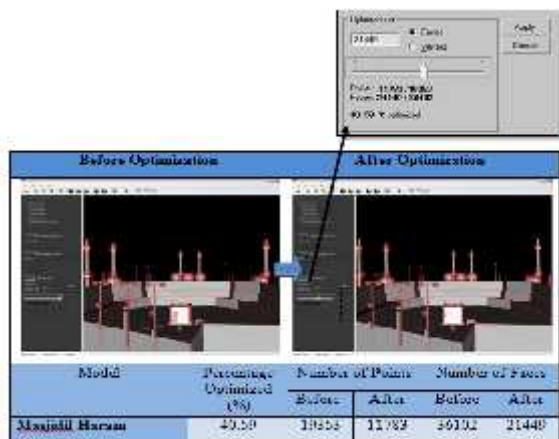


Fig. 5. Example of Optional Database Conversion

2.4 VE Authoring

For this phase, Quest3D software was used for VE authoring. Quest3D requires all interactions to be created using channels. A channel is a container consisting of functionality and/or data. A channel needs some input before it can function. The channels that are linked to the bottom of a channel are called children. A channel can have loads of children. If a vector is linked to another channel, then the vector is a child of whatever channel it is linked to (its parent). Figure 6 shows the example of channels in Quest3D for the authoring processes in VE.

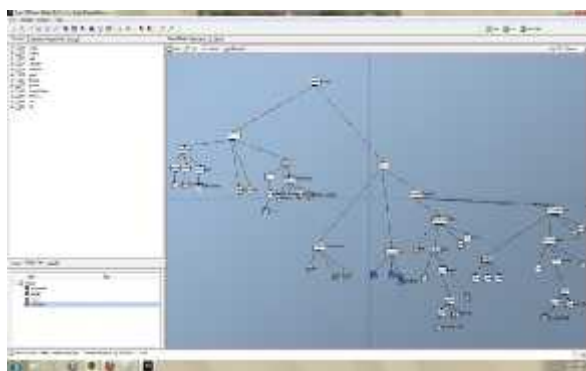


Fig. 6. Example of VE Authoring in Quest 3D for VE Platform

3 THE DEVELOPMENT PROCESS (MULTIMEDIA)

The MM development process consists of the following tasks namely; planning, design, production and validation. The tasks are listed sequentially in the order they would often be tackled in the actual development process. The MM development process is explained as follows.

3.1 Acquire Media

In this process, the media was divided into contents and raw materials, which include text, picture, sound and video. The contents include all information related to Hajj, Umrah and Ziarah, which were mainly sourced from Hajj Trainers and experts, Lembaga Tabung Haji and other supplementary sources. For the graphics, photos of Mecca, Madinah and other related places were

gathered from the Lembaga Tabung Haji personnel and also the Internet. After all the media were acquired, they were ready to be digitized.

3.2 Digitize Media

In this process, all the materials were digitized including the texts, graphics and videos. Digitizing is the primary way of storing images in a form suitable for transmission and the process of converting information into a digital format. Text and images can be digitized similarly; a scanner captures an image and converts it to an image file, such as a bitmap.

3.3 Edit Media

Image editing encompasses the process of altering the image, whether it is a digital photograph, traditional analogue photograph, or illustration. Traditional analogue image editing is known as photo retouching, using tools such as an airbrush to modify photographs, or editing illustrations with any traditional art medium. Graphic software programs, which can be broadly grouped into vector graphics editors, raster graphics editors, and 3D modellers, are the primary tools with which user may manipulate, enhance, and transform images. In this study Adobe Photoshop was used to edit the graphics related to the Hajj procedures.

A digital audio editor is a computer application for audio editing and manipulating the digital audio. In this study, the audios were edited by using Sound Forge.

Video editing is the process of re-arranging or modifying segments of video to form another piece of video. The goals of video editing are the same as in film editing, which is to remove the unwanted footage, the isolation of desired footage, and the arrangement of footage in time to synthesize a new piece of footage. The video editing in this study was created by using Adobe Premier software. Figure 7 illustrates an example of the process.



Fig. 7. Example of Editing Processes

3.4 Import Media

Once the media elements have been digitized and stored in the PC, they can then be edited or modified in software packages. In these packages, the media elements are modified to include special effects and filters to enhance its look and perspective. In the process, 1176 items were generated in the platform software including bitmaps, symbols, movie clips, videos and buttons. These items were used for MM authoring.

This step is a prominent step. The existence of this function permits users to interact with the prototype. Adding interactivity is the core function of the authoring process and is the crux of the success of the MM application. The ability to incorporate interactive features into the final application is of utmost importance in an authoring tool.

This phase also integrates VE and MM into the platform software, Adobe Flash to produce the V-Hajj prototype. The following script in Adobe Flash was used to link the VE for Tawaf, which is an executable file (.exe) with the V-Hajj prototype.

```
on(press)
{
    gotoAndPlay("press");
    //stopAllSounds();
    _root.vhaj.muzik.gotoAndPlay("demoVR_Tawaf");
}
```

4 USER EVALUATION

User evaluation was conducted by using TAM questionnaires. The evaluation was based on the modified and improved prototype after heuristic evaluation [5]. User evaluation for V-Hajj was intended to determine users' acceptance and perception towards the integration of VE and MM in the supplementary Hajj learning material.

4.1 Sample and Procedures

Convenient sampling technique was applied in the selection of the samples. The sample consisted of 60 users. They were divided into two groups as Youngster (19 to 39 years old) and Elder (40 and above 40 years old), and the division were based on Erikson's stages of psychosocial development. The purpose of grouping was to differentiate the subjects who will be learning the Hajj procedures based on age. Each group contains of thirty subjects, as suggested by [6], whereby 30 is an ideal number of subjects in order to avoid any shortage of information.

The evaluations have been conducted in two places, the Information Technology Building (ITB) and the other one in the Islamic Centre, Universiti Utara Malaysia. Two laboratories were set up for that purpose. The ITB was selected as the place for evaluation as it provides the computer facilities. While the Islamic Centre was selected because the participants of a Hajj Seminar conducted at that centre became the respondents for the evaluation. The

subjects were 57.5% male and 42.5% female, whereby the majority (92.5%) have College/University education. In addition 95% of the subjects have computers experience and only 26.7% have Virtual Reality experience.

4.2 Reliability of the Questionnaires Used

In assessing the degree of error presents in the user evaluation questionnaires, reliability and validity testing were conducted. The reliability of a questionnaire is the ability of the questionnaire to give the same results when filled out by like-minded people in similar circumstances. While, the validity of a questionnaire is the degree to which the questionnaire is actually measuring or collecting data about what the researcher thinks it should be measuring or collecting data about [7]. To establish the data inter-item reliability, which assesses the degree of internal consistency between multiple measurements of a dimension, the Cronbach alpha score was calculated using SPSS 15.0 software. Table 1 presents the Cronbach alpha value for each dimension measurement and value of each measurement from reliability evaluation test among 30 respondents.

TABLE 1. CRONBACH ALPHA FOR EACH MEASUREMENT

Measurement	Number Of Items	Alpha
Perceived Ease of Use (PEOU)	4	0.879
Perceived Usefulness (PU)	3	0.834
Attitude Towards Using (ATTITUDE)	1	0.824
Intention to Use (ITU)	2	0.792

From Table 1, the PEOU had a Cronbach Alpha of 0.879, the PU 0.834 had a score of 0.834, the ATTITUDE score had a Cronbach Alpha of 0.824 and the ITU had a Cronbach Alpha of 0.792. Since all the measurements have Cronbach Alpha values of greater than 0.7, then all the four dimension measurement items are highly interrelated as suggested by [8]. According to [7], any number which greater than 0.7 is reliable. The greater the number, the better the reliability will be.

4.3 Comparison Results of Youngster and Elder Group

Results of comparison between the two groups of Elder and Youngster were made for every item of the measurements. The results depicted the difference in perceptions among subjects between the two groups after using the V-Hajj prototype as a supplementary Hajj learning material. Discussions on the results for each measurement are presented in the following sub sections.

For PEOU measurement, the mean value for the Elder group was 4.27 while for the Youngster group was 4.28. PU measurement shows the mean value for the Elder group was 4.41 while for the Youngster group was 4.49. Meanwhile, ATTITUDE measurement, the mean value for the Elder group was 4.47 while for the Youngster group was 4.52. Last but not least, ITU measurement shows the mean value for the Elder group was 4.22 while for the Youngster group was 4.25. Table 2 shows the results in detail.

TABLE 2. MEAN VALUE FOR EACH DIVISION

Perceived Ease of Use (PEOU)		MEAN	
		Elder	Youngster
1.	I found V-Hajj easy to use.	4.23	4.30
2.	Learning to use V-Hajj would be easy for me.	4.37	4.20
3.	My interaction with V-Hajj was clear and understandable.	4.37	4.23
4.	It would be easy for me to find information at V-Hajj.	4.20	4.37
TOTAL		4.27	4.28
Perceived Usefulness (PU)		MEAN	
		Elder	Youngster
1.	Using V-Hajj would enhance my effectiveness in learning.	4.47	4.40
2.	Using V-Hajj would improve my course performance.	4.40	4.43
3.	I found V-Hajj useful.	4.37	4.63
TOTAL		4.41	4.49
Attitude Towards Using (ATTITUDE)		MEAN	
		Elder	Youngster
1.	I like the idea of using V-Hajj.	4.67	4.57
2.	I have a generally favorable attitude toward using V-Hajj.	4.23	4.43
3.	Using V-Hajj is a good idea.	4.50	4.57
TOTAL		4.47	4.52
Intention to Use (ITU)		MEAN	
Attributes and Questions		Elder	Youngster
1.	I intend to use V-Hajj for learn Hajj.	4.27	4.53
2.	I will return to V-Hajj often.	4.17	3.97
TOTAL		4.22	4.25

4.3 Persuasive Results in Learning V-Hajj

This section discusses on the results related to the persuasive effect of using V-Hajj as a supplementary Hajj learning material among users. As mentioned in previous paper [5], the results of the preliminary study indicated that the respondents from the elder group were more interested in talk, seminar and VCD/DVD as their preferred Hajj learning approach. The results of the study also revealed that even though computer applications have been widely used nowadays, the elder were not likely to use it as one of their preferred supplementary Hajj learning approach. So the discussion will focus on this group in order to determine the persuasive effect of V-Hajj on them. Figure 8 shows the early perception of the two groups of users regarding the use of computer application as supplementary Hajj learning material. 66% of the elder users did not agree while for the youngster users, only 34% to using computer application as their supplementary Hajj learning material.

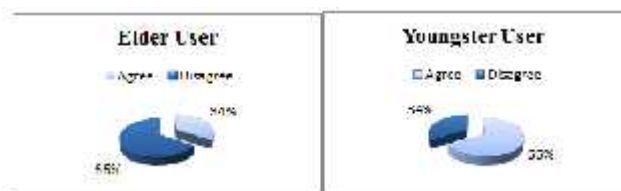


Fig. 8. Preliminary Study on the use of Computer Application as Supplementary Hajj Learning Material (Based On Group) [5]

An evaluation to investigate users' acceptance toward the use of V-Hajj prototype as a supplementary Hajj learning material was conducted. It involved two groups of users, youngster and elder and the measurements involved were PEOU, PU, ATTITUDE and ITU. Surprisingly, the results of the evaluation were contrary to the results of the earlier preliminary study. Figure 9 shows the results where most of the elder group

users agreed on the use of the V-Hajj prototype as a supplementary Hajj learning material. From the figure, in term of PEOU, 80.1% of the elder group users agreed on the use of the V-Hajj prototype, for ITU, 93.3% of the elder group users agreed on the use of the V-Hajj prototype, for PU, 93.4% of the elder group users agreed on the use of the V-Hajj prototype and finally for ATTITUDE, 96.7% of the elder group users agreed on the use of the V-Hajj prototype as a supplementary Hajj learning material. Generally, the percentages of V-Hajj acceptance among the elder users for all the measurements were higher than in that from the preliminary study. Thus, it can be concluded that the V-Hajj prototype has the persuasive effect on the elder users toward using computer-based learning as their supplementary Hajj learning material.

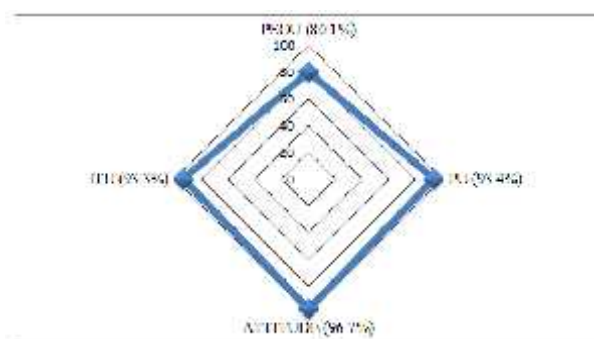


Fig. 9. Percentages of the Elder Users Who Agreed on the Use of the V-Hajj Prototype Based on PEOU, PU, ATTITUDE and ITU

5 CONCLUSION

As suggested by the model, V-Hajj employs several technologies namely; MM, VE and PT. The development or authoring processes of V-Hajj was guided by certain particular theories, principles and guidelines. By applying the theory, the prototype was developed by referring to the actual environments and procedures of performing Hajj in Mecca. The learners also experienced maneuvering the environment on their own. In the development phase, two technology design processes were adopted and combined, namely; [9] for VE authoring, and [10] for MM authoring. In order to investigate users' acceptance toward the V-Hajj prototype as a supplementary Hajj learning material between two groups of users, youngster and elder and among the elder in terms of the persuasive effect, user were deployed. From the above results, it can be concluded that both groups of subjects agreed that V-Hajj is easy to use, easy to be learnt, the interaction between the subjects and prototype was clear and understandable and it is easy for them to search information in the V-Hajj prototype.

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REFERENCES

- [1] Jamaan, A.R. (2010). *Panduan Lengkap Haji & Umrah*. Johor: Universiti Teknologi MARA.
- [2] Jabar, M. F., Daud, S. K., Abdullah, C. Z., & Ahmad, A. H. (2008). *Virtual Haj, Game via Experiential Design*. Retrieved September 13, 2009 from <http://www.cms.livjm.ac.uk/library/AAA-GAMES-Conferences/GDTW/2008/Papers/PDF/SP9.pdf>
- [3] Yahia, M. (2007). *IOL Virtual Hajj in Second Life*. Retrieved March 23, 2010, from <http://www.islamonline.net/servlet/Satellite>.
- [4] Kalawsky, R. (1993). *The Science of Virtual Reality and Virtual Environments: A Technical, Scientific and Engineering Reference on Virtual Environments*. England: Addison Wesley Publishing Company.
- [5] Yusoff, M. F., Zulkifli, A. N. & Faisal Mohamed, N. F. (2015). *The Model of Persuasive Hajj Learning Environment*. Paper presented at Creative Industry International Conference 2015, Sintok, Kedah.
- [6] Coakes, S. j., & Steed, L. G. (2003). *SPSS Analysis without Anguish Version 11.0 for Windows*. Australia: John Wiley & Sons.
- [7] Ng, K., & Komiya, R. (2000). *Introduction of Intelligent Interface to Virtual Learning Environment*. Paper Presented at the Multimedia University International Symposium on Information and Communication Technologies 2000 (M2USIC'2000), Selangor, Malaysia. Retrieved August 13, 2009 from <http://www.jsor.org/stable/10.2307/3250989>.
- [8] Kalawsky, R. (2000). *Human Factors Aspects of Virtual Design Environments in Education*. Retrieved December 28, 2009 from, http://www.jisc.ac.uk/uploaded_documents/jtap-048.pdf on, 7.
- [9] Neo, T. K., Neo, M., & Teoh, B. S. P. (2007). *Designing a CD Based Learning Environment for a Multimedia Animation Course: A Malaysian Experience*. Paper Presented at the Australasian Society for Computers in Learning in Tertiary Education, Singapore. Retrieved April 15, 2009 from, <http://www.questia.com/googleScholar.qst?docId=5002483795>.



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