

Digital Heritage Gamification: An Augmented-Virtual Walkthrough to Learn and Explore Tangible Cultural Heritage

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Abstract— In the last decade, cultural heritage including historical sites are reconstructed into digital heritage. Based on UNESCO , digital heritage defines as “cultural, educational, scientific and administrative resources, as well as technical, legal, medical and other kinds of information created digitally, or converted into digital form from existing analogue resources”. In addition, the digital heritage is doubling in size every two years and expected will grow tenfold between 2013 and 2020. In order to attract and stir the interest of younger generations about digital heritage, gamification has been widely promoted. In this research, a virtual walkthrough combine with gamifications are proposed for learning and exploring historical places in Malaysia by using mobile device. In conjunction with Visit Perak 2017 Campaign, this virtual walkthrough is proposed for Kellie’s Castle at Perak. The objectives of this research are two folds 1) modelling and design of innovative mobile game for virtual walkthrough application, and 2) to attract tourist to explore and learn historical places by using sophisticated graphics from Augmented Reality. The efficiency and effectiveness of the mobile virtual walkthrough will be accessed by the International and local tourists. In conclusion, this research is speculated to be pervasively improve the cultural and historical knowledge of the learners.

Index Terms— Cultural heritage; Augmented; Gamification.

I. INTRODUCTION

Malaysia economy has reached a new level of improvement where it is diversified in many areas. One of the most contributing sector that caused a huge splash in the economy is the tourism sector. Almost every year, government discharged expenditure to make a huge promotion to solidify Malaysia as the No 1 Tourism Country around the world. In term of tourism, Malaysia provided a variety of hotel and accommodation, historic places and cultural heritage, restaurants and foods and so many more. One of the most promising feature with Malaysia is its historic places and heritage.

With the help of modern technology, tourism can be promoted through a variety of way such as via mobile application. With the advent of mobile technology, there is no wonder that mobile games are the fastest growing game segment almost doubling its revenue. This reason alone state it is a must for us to develop an application, mobile game in particular to promote Malaysian Tourism to the next level. Easy access on the tourism destination with a smartphone will be one of key feature in this mobile game. With the

advances in mobile technology nowadays, it enables game experiences out of the tourist’s pocket with the help of these little game apps.

The mobile game application that have been designed is focused on Historical Places in Perak called “MIGHT: Mobile Gamification HeriTage”. This mobile game application emphasized on cultural and historic place in Perak. The mobile game itself is based on the concept of exploration with the integration of Augmented Reality (AR) technology. Tourist will have to locate a pit stop or a checkpoint just like the exploration game before finishing the race. The key element is essential because it will guide tourist to explore the cultural and heritage places in Malaysia. In order to test their understanding in the exploration mode. Quizzes mode was also developed in this application in order to evaluate their understanding on the contents of the exploration mode. This mobile game application served not only in the tourism field but also served in the education field as well.

II. LITERATURE REVIEW

There are many technology and trends that have been carried out in the mobile games. Several technologies and trends such as 1) pervasive mobile, 2) location based game, 3) Game based learning, 4) Augmented Reality and Virtual Reality appeared in the current mobile development as shown in Table 1.

Table 1. Several Technologies and Trends in the Current Mobile Development

| AREAS | DESCRIPTION | ADVANTAGES/ DISADVANTAGES |
|--|---|--|
| Pervasive Game A pervasive game is a video game where the gaming experience is extended out in the real world where the fictive world in which the game takes place blends with the physical world. [1, 5] | Described a case study of MuseUs (a pervasive game) which running in the smartphone. The pervasive game is able to provide a learning effect during a visit to a museum exhibition. [1] | Advantages [1]: 1) MuseUs allows players to match statement to art works while at the museum and this help to combine the entertainment aspects of games with learning effects. 2) A relatively strong correlation was found between learning and immersion. Disadvantages [1]: |

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|--|---|---|--|---|---|
| | | <p>1) Lack of support for social learning.</p> <p>2) Shortage of personal narratives in the application of MuseUs.</p> | and apply said subject matter to the real world. [3] | theory. [3] | <p>effective learning in an entertainment context.</p> <p>2) Shortage of user adaptivity.</p> |
| | Presented a pervasive game on Android platform where the players can play a knowledge competition tour in groups in the city of Trondheim, and gain better understanding of the city through solving different tasks. [5] | <p>Advantages [5]:</p> <p>1) Integrated with different type of application such as Shazam, ShopSavy, Google Goggles and Layer into the pervasive game.</p> <p>2) The pervasive game supports experiential learning where allow the users to move around certain places in Trondheim.</p> <p>Disadvantages [5]:</p> <p>1) Complicated application (refer to Shazam) cause the novice user faces difficulties to complete the task.</p> | <p>Augmented Reality (AR)</p> <p>Augmented reality is a live direct or indirect view of physical, real-world environment whose elements are augmented by computer-generated sensory. [4, 7]</p> | <p>To promote the usage of Augmented Reality at cultural heritage sites by examining the applicability of mobile augmented reality usage at Melaka heritage sites. [4]</p> <p>Provides a review on related literature in Augmented Reality application. [7]</p> | <p>Advantages [4]:</p> <p>1) Learn informally in enjoyable way.</p> <p>2) Enable the users to have the experience between virtual and real world.</p> <p>Disadvantages [4]:</p> <p>1) Required to use Internet connection.</p> <p>2) The graphic is only in 2D modelling.</p> <p>Advantages [7]:</p> <p>1) Provide direction for future research and contribute the findings to the body of knowledge.</p> <p>Disadvantages [7]:</p> <p>1) Lack of further explanation on how to implement Augmented Reality in heritage content.</p> |
| <p>Location-based Game</p> <p>A location-based game is a game in which the gameplay evolves and progresses via a player's location. Thus, location-based games must utilize the localization technology such as satellite positioning through GPS. [2, 6]</p> | <p>Presented a mobile game : "Invisible City: Rebels vs, Spies", a game to be played in a city centre using the technology of location-based which designed for learning in modern technology enhanced public spaces. [2]</p> | <p>Advantages [2]:</p> <p>1) The mobile game relates learning with the physical experience of playing in an urban setting.</p> <p>Disadvantages [2]:</p> <p>1) Lack of engagement for the player if eliminated from the game.</p> | <p>Virtual Reality (VR)</p> <p>Virtual Reality also known as immersive multimedia which is a computer technology that replicates an environment, real or imagined, and simulates a user's physical presence and environment to allow for user interaction. [8, 9]</p> | <p>Presented a virtual walkthrough application which is DentoTrento where is able to promote historical, artistic and cultural heritage in the area of Trentino through the use of Virtual Reality technologies. [8]</p> | <p>Advantages [8]:</p> <p>1) The VR system can play as edutainment tool.</p> <p>2) Help to learn the history of the cultural patrimony by exploring the archaeological site across space and time.</p> <p>Disadvantages [8]:</p> <p>1) Expensive to build the virtual reality system.</p> |
| | Presented an interactive game of tag or catch that is played between individuals sitting at a computer and the actual people are designated as "runners" that are scattered throughout a particular location. [6] | <p>Advantages [6]:</p> <p>1) Utilized the location-based technology in a large scale setting rather than in a closed environment.</p> <p>2) Explore a new artistic and collaborative form of gaming that could show the future gaming may take place.</p> <p>Disadvantages [6]:</p> <p>1) Internet dependent.</p> <p>2) Inaccurate of GPS</p> | | <p>Reconstructed and explore the ancient and historic city building through the virtual reality technology. The process was divided into three phases which are 1) historical data gathering and analysis, 2) 3D reconstruction and modeling, and 3) interactive immersive visualization, auralization and display. [9]</p> | <p>Advantages [9]:</p> <p>1) Utilized the X3D to improve the design review process which consume less time for developers, users and specialists.</p> <p>Disadvantages [9]:</p> <p>1) Required a high-end processor and graphic card to construct the model.</p> <p>2) Lack of parallel rendering algorithm in this research,</p> |
| <p>Game-based Learning</p> <p>A game-based learning is a type of game play that has defined learning outcomes. In general, game based learning is designed to balance a subject matter with gameplay and the ability of the player to retain</p> | <p>Presented an authoring framework that aims to provide structured support, from content design to final implementation. Besides, a conceptual model – The SandBox Serious Game was introduced which relies on a generalization of task-based learning</p> | <p>Advantages [3]:</p> <p>1) Game forces the player to focus on problems and this will help for knowledge acquisition and retention.</p> <p>2) Simplifies authoring work that is supported by a visual authoring tool.</p> <p>Disadvantages [3]:</p> <p>1) Lack of extensive user testing to assess and analyze the support of the porposed framework for</p> | | | |

III. SYSTEM OVERVIEW

MIGHT consist of three components namely 1) 3D Character Design, 2) 3D Object Design, and 3) Exploration Mode while the Exploration Mode consists of 1) Story Line, 2) Clues, 3) Augmented Reality (Pit Stops), 4) Ending Scene, and 5) Quiz as shown in Figure 1. It is essential for

MIGHT to have its own 3D Character since the main platform that is used is the Augmented Reality technology. In addition, this is an exploration game with historical elements combined, it is necessary to have a narrator to narrate the historical information for each checkpoint or pit stop. The 3D character is designed by using Adobe Fuse CC (refer to Figure 2 (a)) and the animation for the character by using Mixamo (refer to Figure 2 (b)). Each character is designed based on the images of the historical figures with a little bit of adjustments in term of the clothing and textures. William Kellie Smith and his children are designed to be a noble Scotland's family since they are originated from Scotland. In term of animation, all the characters need to be rigged before choosing the right animation. William Kellie Smith character will have many animations since he is the main character in the Kellie Castle location.

Apart from designing 3D characters, MIGHT also require 3D objects as shown in Figure 3 which is the 3D model for Kellies Castle. This 3D objects are the historical objects that can be found on the historical site. Blender was used to design complicated shapes that such as torus shape and cone shape. These 3D shapes are then imported to Unity to design and assemble the rest of the 3D shapes to form a complete 3D objects. In addition, Sketch Up was also widely used in designing the 3D objects for less complicated shape.

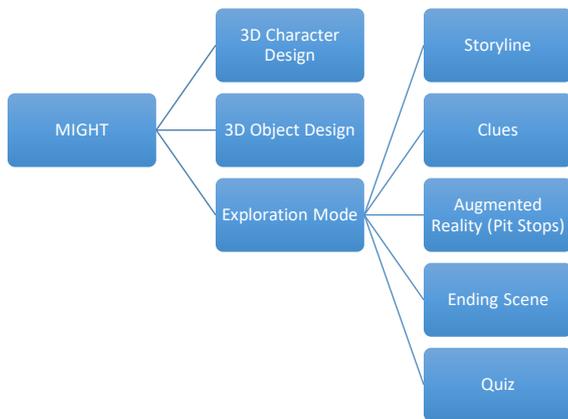


Figure 1. Overview of MIGHT

Basically, the module of Storyline is the main content for this mobile game. The mobile game contains a story mode where it will explain about the goals and objectives of the Exploration Mode. Figure 4 shows some of the storyline interface of MIGHT where Figure 4(a) contains the text which represent the storyline and indicator arrow which link to the next storyline and Figure 4(b) contains a storyline in the form of a dialogue where a 2D character called Si Kuntum who will be the user tour guide.

Essentially, the module of Clue is to indicate the tasks that the user need to complete in order to proceed the game while the module of Augmented Reality (Pit Stops) are the most important interfaces that are available in this mobile game. Fundamentally, the module of Clue and Augmented Reality (Pit Stops) is related because the user need to follow the clue in order to arrive at the Pit Stops. There are eleven Augmented Reality interfaces as there are eleven pit stops in Kellies Castle. Figure 5 shows an Augmented Reality

interfaces which contain a 3D character named William Kellie Smith. This character will appear at each Augmented Reality interfaces to explain some historical info about the places except Figure 5(a) contains the character himself and a 3D particles. Figure 5(b) shows the second Augmented Reality screen when the user has successfully located the marker. Then, a 3D model of Kellie Castle will appear along with William Kellie Smith as shown in Figure 5(b).

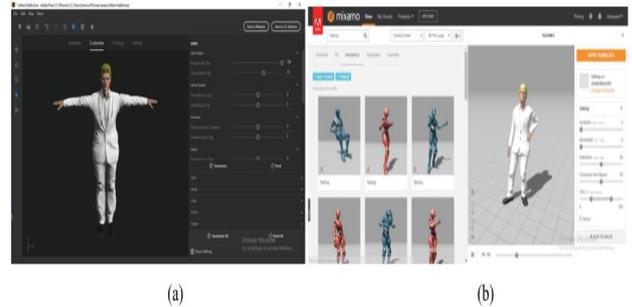


Figure 2. The Character of William Kellie Smith for (a) Design Process and (b) Animation Process

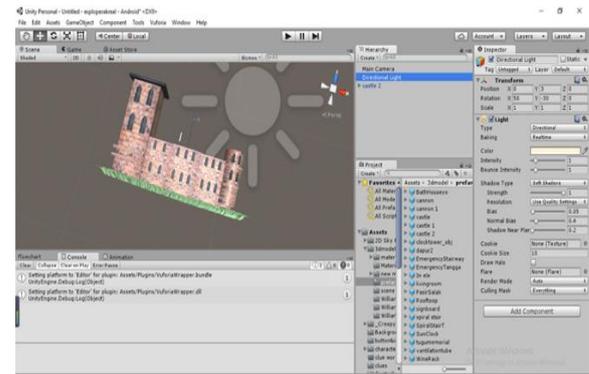


Figure 3. The 3D Model for Kellies Castle

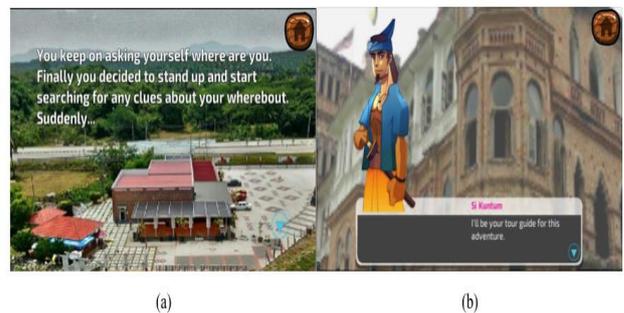


Figure 4. The Interface of Kellies Castle for Storyline (a) Main Screen and (b) Conversation Screen

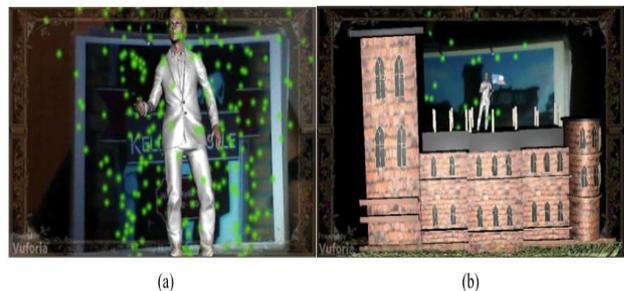


Figure 5. The Interface of Augmented Reality (a) First Pit Stop (William Kellie Smith) and (b) Second Pit Stop (William Kellie Smith and the Castle)

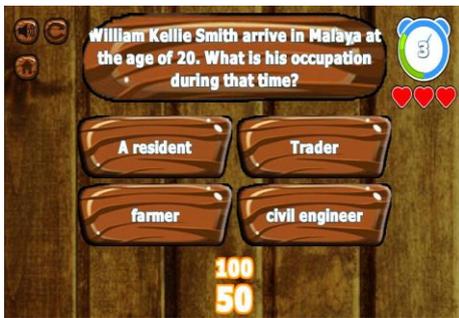


Figure 6. The Quiz Module

After the users have completed all the pit stops, then the Ending module will pop up following by Quiz module. Fundamentally, a 2D character who is Si Kuntum will provide a short dialogue conversation to conclude the mobile game. After the short dialogue, the users can also access the quizzes at Quiz module as shown in Figure 6. This mode has the same background as the title menu which is the old wooden background and this mode also have been integrated with a background sound. To make it more interactive at Quiz module, timer in a form of a clock is also added. If the user is not able to answer the questions in eight seconds, then it will deduct one life points where all the users start with three life points.

IV. EVALUATION AND DISCUSSION

In this section, two methods of evaluation namely 1) Pre-and-Post Testing and 2) Questionnaires are performed. Pre-and-Post Testing are conducted to measure the learning outcomes during the evaluation to compare the user know before in a pre-test and after the game experience in a post-test. The reason to use Pre- and Post- Testing is to quantify the knowledge attained in the game experience from the user with diverse learning styles and educational background. In other word, is a test to indicate how the users are learning in the game experience. Pre-and-Post Testing is divided into three section which consists of twenty Questions. Section A is about matching an image to a correct answer (6 Questions), while Section B is about objectives questions with four possible answers (10 Questions) and Section C is about true or false statement (4 Questions). A set of rubrics

(1 mark will be given if the answer is correct) will be used to assess different levels of performance from the respondents and the scale are: Poor (0 to 5), Fair (6 to 10), Good (11 to 15), and Excellent (16 to 20).

Questionnaires are also used to access the overall application. The questionnaire is concerned with the opinions and feedback from the users on the content design of this application. The questionnaire was designed in the Level of Satisfaction (5 Point) which are “1-Very Dissatisfied”, “2-Dissatisfied”, “3-Unsure”, “4-Satisfied”, and “5-Very Satisfied”. In the evaluation of the application, fifty participants were invited to evaluate the application by using the technique of simple random sample. The aim of the simple random sample is to reduce the potential for human bias in the selection of cases to be included in the sample. The respondents comprise Malaysian and Non-Malaysian. The population is 85 and the sample size is 50 in this evaluation. The group consisted 32 males and 18 females with an average age 31.8 and proficiency with English.

Figure 7 shows the result for Pre-and-Post Test and it was found that the changes are very obvious which mostly of the respondents (49 out of 50) improve their result except “User 7” which decline from the score of 12 (Pre-Test) to 11 (Post-Test). In addition, the respondent (User 43) achieved the most significance improvement (750%) from the score of 2 (Pre-Test) to 17 (Post-Test) while the respondents the respondent (User 4) achieved the least improvement (10%) from the score of 10 (Pre-Test) to 11(Post-Test). In a nutshell, we can conclude that the respondents have learned and gained the knowledge from MIGHT where thirty-two respondents achieved in the scale of Good and eighteen respondents achieved in the scale of Excellent in Post-Test if compare to Pre-Test where only eight respondents in Good and zero in Excellent.

The questionnaire contains a section dedicated to the content design of the mobile game. For question one, forty-three among fifty respondents gave “Satisfied” or “Very Satisfied” and agreed that the learning method contained in MIGHT is appropriate. This showed that the learning method which is through narrative and quizzes is affective. For question two, a whopping of forty-eight respondents under the combination of “Satisfied” and “very Satisfied” that information about historical places presented by MIGHT is easy to understand. A small portion of number

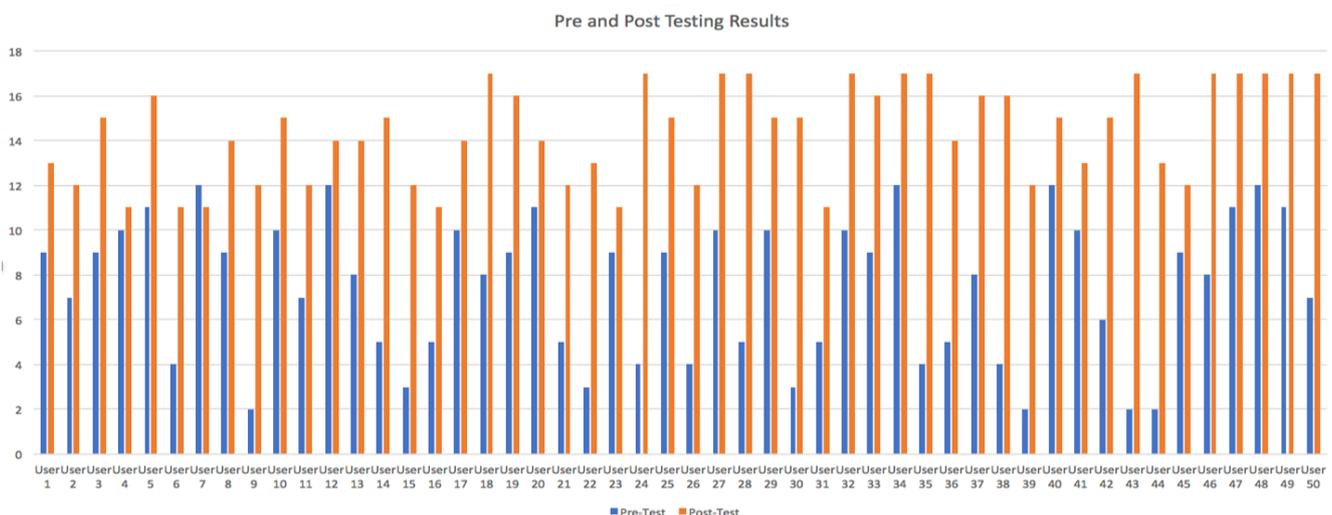


Figure 7 : The Result For Pre-And-Post Test

(2) dissatisfied due to small size of the screen and unable them to zoom especially for the 3D objects. For question three, thirty-eight respondents satisfied that the content delivery in MIGHT is in proper order and easy to follow. For question four, forty-eight respondents satisfied that MIGHT is able to encourage them to visit other historical places by using same way of this application. This means that the application has the commercialized values as it able to attract tourists especially foreigners to go and visit other historical places in Malaysia. For the last question to evaluate whether this application is able to encourage the users to learn about the history and thirty-three users gave "Very Satisfied" with this statement

In general, MIGHT uses the 3D modelling and provides offline mode (refer to Figure 3 and Figure 5) to provide better visual views to user instead of 2D modelling and is able to play without the Internet connection which solved the shortage from [4]. In addition, the total number of sample size for this evaluation is fifty (tourists who visited the Kellie Castle) if compared to the paper from [3] where the respondents come from MSc and PhD students which our results can be reflected to the real scenario. Furthermore, William Kellie Smith is the personal narrative in MIGHT which able to guide the users to explore the heritage sites to solve the constraints from [1]. In addition, MIGHT is able to run in smartphone which powered by a Qualcomm Snapdragon 801 processor that required low end processor to operate compare to the proposed system [9] which required high-end processor and graphic card to render the model.

V. CONCLUSION & FUTURE WORKS

In conclusion, it can be concluded that the mobile game application has meets the objectives of the research which are 1) modelling and design of innovative mobile game for virtual walkthrough application which is MIGHT, and 2) to attract tourist to explore and learn historical places by using sophisticated graphics from Augmented Reality. Most respondents agreed that this application have an amazing and attractive yet suitable content, presentation and

interaction design. Although this application is successful and fully developed, but there are still a few lacking criteria in this application. These lacking criteria could be improved to produce a better and more efficient application. One of the future works is to provide a zoom tool button to let the user to have a better view for the heritage sites due to small size of the smartphone.

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