SOCIAL CONSTRUCTIVISM BASED GAMIFICATION FOR HERITAGE SITES EXPLORATION AND LEARNING

Kian Lam Tan[1]
Chen Kim Lim[2]

[1,2]Faculty of Art, Computing & Creative Industry (FSKIK), Sultan Idris Education University (UPSI), 35900 Tanjong Malim, Perak
[1]KianLam@fskik.upsi.edu.my

_____

Abstract: *Visitor would usually like to explore and learn more about the attractions of a place before their physical visit. With the help of Information and Communication Technology (ICT), humans have simplified their lives and this also applies to tourism industry. Nowadays, there are various applications available for the learning of heritage sites. However, there is a need for applications that are more highly accessible with adventure and integrate the theory of social constructivism where it supports inquiry, experiential, and situated learning in a more entertaining manner on mobile platform. Mobile Education, Entertainment, and Exploration (MEEE) aims to allow users to have an immersive experience and first-touch sensation by roaming the 360◦ panoramic views of the cultural heritage sites together with acoustical heritage simulation and push notification on an interactive mobile device with trendy and stylish interfaces. Furthermore, anyone can acquire the knowledge of cultural heritage sites through a mobile game that integrates with the treasure hunt and the classical board games of monopoly. The mobile game is played with the customized avatars that are dressed in traditional garments. With these elements of audio, visual, accessibility and educational perspectives of the heritage sites are incorporated into a single application. The current implementation is based on the cultural heritage sites of Georgetown, Penang, Malaysia. Based on the survey and the comparison that were carried out, the outcome is very satisfying and the respondents were very pleased with the product of this research. With this application, local and international visitors can make use MEEE to explore and learn the various heritage sites through inquiry, experimental and situated learning.*

Keyword: *Cultural Heritage, Virtual Heritage, Digital Conservation, Mobile Device, Edutainment.*

_____

Introduction

Mobile phone technology is a growing phenomenon in the world today. One of the advantages of mobile phone is that it can provide formative stages of sense of direction and educational experience, and not just for making phone calls and Short Message Service (SMS). It has also become an integral part of many peoples way of life and the integration of mobile phone technology as a tool to support the visit of museums since cultural heritage sites has become very well established in recent years [1,2,3,4,11]. By taking advantage of this advancement, the creation of an application that allows digital and virtual pictures of cultural heritage sites to be viewed in an immersive 360◦ panoramic view on their smartphone is essential for tourists as a guide before their physical visit to the heritage sites. This integrated virtual environment thus serves an ultimate platform to stir the interest of both virtual explorers as well as potential tourists for a virtual tour of cultural heritage sites. In this mobile application, MEEE was developed and running in the platform of iOS (Apple) and the environment was based on Georgetown, Penang, Malaysia. The benefits of this application include better adventure learning where it supports the theory of social constructivism through gamification (it can help to improve user experience and user engagement in non-game services and application) and leading edge technology, and the high accessibility of edutainment application since the public is able to download it whenever and wherever possible.

Motivation

The video games industry has branched out into a mystifying variety of subsectors and niches. At one extreme, companies of video games such as Sega and Nintendo are charging USD 50-75 for the console games with cinematic game play and ultra-realistic graphics such as Metal Gear Solid V: Ground Zeroes.

One of the biggest changes in video games industry is the invented of smartphone which running in the platform iOS or Android. Based on the report from Economist, mobile games already achieved USD 8 billion out of the USD 57 billion in the video games market even though mobile games typically sell at less than USD 5 in AppStore or Google Play if compare to traditional console game. Besides, mobile games such a Angry Bird and Flappy Bird are simpler to play and require lesser comprehensive (the users only can perform one action) to control the character compare to the console titles which the users can perform several actions for the character such as World of Warcraft. Furthermore, the low developments costs and the mobile games can be downloaded over mobile networks at any time and from anywhere are the few factors that brought mobile games into impulse-buy territory.

With the current trend, it is imperative for virtual heritage applications to incorporate gaming element and be developed on mobile platform [4, 5, 15]. The main purpose of this study is to explore how mobile application can be developed as learning tools specifically for the novice tourists at Georgetown, Penang, Malaysia. MEEE as presented in this paper is a mobile e-tourist guide application which provides the user to learn the various cultural heritage sites through panoramic view with minimum memory and disc space in mobile devices. MEEE is believed to be able to penetrate the market demand of virtual heritage applications. Beside the panoramic views, MEEE also includes push notification function where MEEE will push the information such as historical background or additional building information to the user when they enter the heritage

site based on their current location. MEEE also includes acoustical heritage simulation that provides background sounds according to the heritage sites when the user is viewing the panoramic view.

Related Works

A number of applications have been developed to help the user to access, learn, and explore the information on cultural heritage such as GUIDE [5], AmbieSense [6], LISTEN [7], COMPASS [8], iCITY[9]. AgentSalon [10], and Smartmuseum [7]. A summary of the features of this type of approach is given in Table 1 based on three types of dimension namely 1) Setting, 2) Device, and 3) Presentation Style. The detail of the dimensions are as follows:

- **Setting**: This dimension represents the situation where the interaction occurs. With this dimension, three types of setting can be represented such as 1) Indoor (I), 2) Outdoor (O), and 3) Virtual (V). Indoor and outdoor indicate the physical presence at the site, while virtual indicated that the user is using virtual reality to view the gallery.
- **Device**: This dimension represents the different devices that are able to afford different interactions. Therefore, three types of device can be distinguished that can be used to access the information on cultural heritage namely 1) Desktop (P), 2) Mobile (M), and 3) Wearable (W) devices.
- **Presentation Style**: This dimension represents the way to deliver the information on cultural heritage to the user according to the dimensions of Setting and Device. In this dimension, there are four types of Presentation Style namely 1) Map-based (MB), 2) Web Page (WP), 3) Character (C), and 4) Audio-Visual (A-V). Map-based is used to show the point of interest through a map such as Google Map or Bing Map. Web Page refers to traditional Web layout, while Character uses a virtual character or agent to deliver the content. Finally, Audio-Video refers to the animation clips.

Application	Setting			Device			Presentation Style			
	I	O	V	P	M	W	MB	WP	C	A-V
GUIDE		*			*		*	*		
AmbieSense		*		*	*			*		
LISTEN	*					*				
COMPASS		*			*			*		*
iCITY		*		*	*		*	*		
AgentSalon		*			*				*	
Smartmuseum	*	*		*	*		*	*		*

In a nutshell, mobile technologies have become the common sight in the sector of cultural heritage while social web technology is also spreading fast in this sector. In addition, the focus has shifted from individuals engaged in a single visit to: 1) supporting a more realistic scenario which complies with the fact that most people visit physical sites in small groups, 2) managing a long-lasting interaction between the visitors and the cultural heritage site, 3) enabling group collaboration in both physical and online in order to support the formation of virtual communities.

System Overview

The main idea in designing MEEE is to assist the user who has little knowledge of the content to search on cultural heritage. In addition, the mobile game is also suitable for the users to access, learn, and explore the content of cultural heritage. Basically, the concept of MEEE is to provide an information on cultural heritage through the game based on the theory of social constructivism as suggested by Lovell [12]. So, MEEE should be able to carry out three types of learning which are 1) inquiry learning, 2) experiential learning, and 3) situated learning. Inquiry learning is an instructional strategy that is used as the basis to design the active learning where the students are engaged in some kind of investigation that involves questions and require the student to find the answers based on the questions. Experiential learning is viewed as a process to create a new knowledge through transformation of the experience. Situated learning can be viewed as complementary to the experiential learning and emphasizes the role of exploratory spaces and practical activities to enhance the learning process. Therefore, MEEE is able to provide an indirect way to access the information through text, visual, and audio effect. In general, MEEE can be used by various users in the following different situations:

- **Inquiry Learning**: In a history class, students are working in groups of three or four. The students can use the MEEE to find out more information on certain heritage site inside the classroom. Through the MEEE, the students can get more meaningful information through the panoramic views and acoustical heritage simulation. In addition, the students are required to answer a question in order to proceed with the game.
- **Experiential Learning**: Jean is relating to her friends on his experience in visiting George Town, Penang. All her friends are so excited with the way in which Jean presents it, that is through MEEE. They get to learn and know the heritage sites through MEEE.
- **Situated Learning 1**: A family is looking for a city to visit and they plan to get to know the heritage sites before the real visit. The family can launch the MEEE to get first hand image and audio experience before their physical visit.
- **Situated Learning 2**: A tourist group arrives very early in the morning at heritage site. When they arruve in one of the heritage buildings, they could not find propoer information on the heritage building. The tourists can launch the mobile game to get the information of the heritage building.
- The MEEE architecture is based on multi-tier modules that consist of Monopoly and Treasure Hunt modules as shown in Figure 1. The MEEE gaming application is developed based on the classical board game called Monopoly together with the game of Treasure Hunt. Players are brought to the Monopoly platform before the Treasure Hunt. The Treasure Hunt comes in when the player would like to upgrade their site in the Monopoly game as shown in Figure 2 where it supports the inquiry learning through Treasure Hunt.
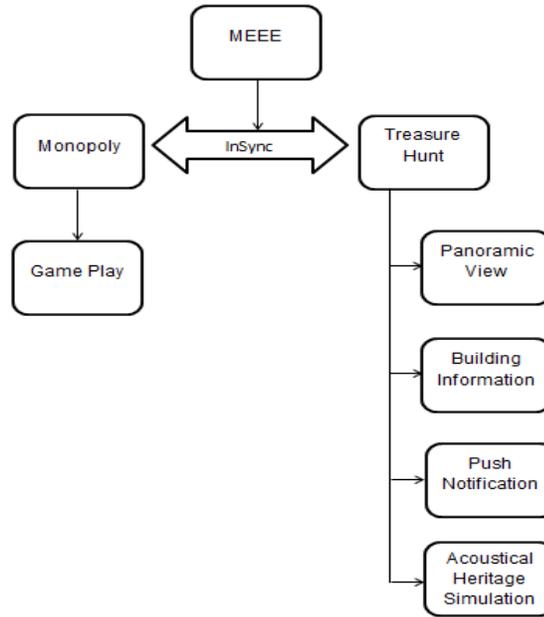
Figure 1 Overview of the framework of MEEE

Basically, the user can command the avatar by rolling the dices (two dices per turn), so the maximum movement is twelve (12) per user. The monopoly component includes of the Game Play module where it stores all the avatars, board games and properties are stored. Three types of avatars are available which are Malay, Chinese, and Indian in MEEE. These three avatars represented the three largest ethnicity groups in Malaysia as shown in Figure 3 where the Game Play module is able to support experiential learning.
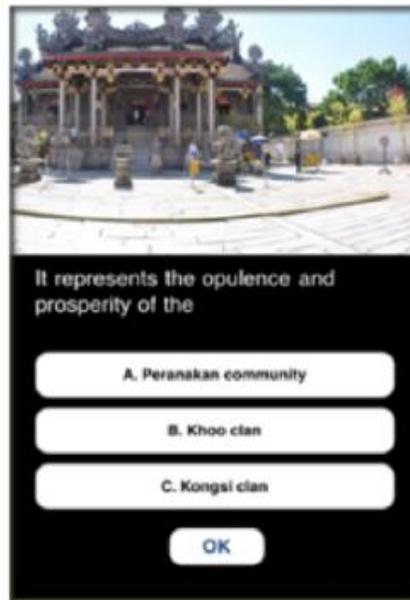
Figure 2 Sample of Treasure Hunt Questions Support Inquiry Learning)

In Sync is the element that perform as a bridge between Monopoly and Treasure Hunt so the users are able to play Monopoly and Treasure Hunt concurrently without any slowdown. The Treasure Hunt component consists of Building Information, Panoramic View, Push Notification and Acoustical Heritage Simulation. The Building Information module stores all the information such as the brief description of the heritage sites such as "Khoo Kongsi is a large Chinese clan house with elaborate and highly ornamtated architecture, a mark of the dominant presence of the Chinese in Penang, Malaysia". Besides, it shows the business hours for the heritage sites. The panoramic view stores the visual entity of all the panoramic view for all the heritage sites. Push Notification is an ingenious way of interacting with the users in the background by sending short message on the building information. Acoustical Heritage Simulation module allows the users to get more useful and meaningful information and sensibility about the virtual environment surrounding the heritage sites. MEEE is able to provide situated learning to the users through the modules of Building Information, Panoramic View, and Push Notification as shown in the Figure 4.

Figure 3 Game Play Interface Supports Experiential Learning

Details and Implementation

MEEE was implemented by using the Xcode as the Objective C programming language and Apple X-Code 4.2 as the Integrated Development Environment (IDE) due to the Operating System is running on Snow Leopard.

A. Monopoly and Game Play

The Monopoly module is a multiplayer game which can be played by two to four players. A user can choose one of the avatars to represent himself or herself. The avatars are costumed with traditional clothing. The Monopoly module contains Game Play module which consist of forty movable cells. Twenty-six cells are for the building objects, six cells are for the fate corner, four main cells are distributed at each corner of the board as in the game of monopoly, two cells are for the public transport services, while the last two cells are for the service tax [13].

B. Treasure Hunt

The Treasure Hunt module is where users are required to answer some questions based on pre-defines questions. A player of the game is required to answer a series of questions in order to upgrade their property. The main reason to upgrade their property is to allow the player to earn

more rents if the opponents step on the cell. If the player fails to answer the question, the hunt is considered to be unsuccessful and the role of the game will go to the next player. Treasure Hunt is implemented by using Alert Dialog (UIAlertView) and Action Sheets. Alert Dialogs and Action Sheets are temporary views used to prompt the player for special input or to bring the players attention to some detail.

Figure 4. Steps by steps for Situated Learning

C. Panoramic View

Panoramic View is an image made with an ultra-wide angle or fisheye lens which provides a 360-degree view. A user is able to view both inner view and outer view of a heritage site using panoramic view. Panoramic view module allows users to view the buildings and control the view by themselves while viewing 360-degree cylindrical panoramic view [13] of a heritage site as shown in Figure 6.
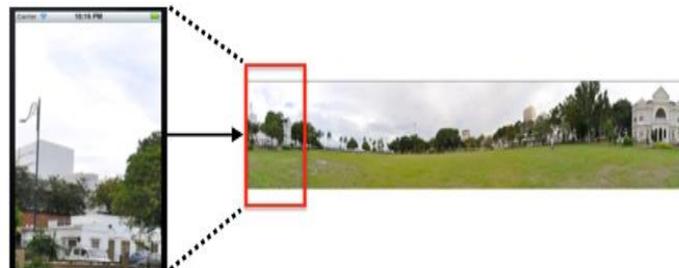

Figure 6 An example of panoramic view: City Hall (left) and a 360-degree panoramic view with highlighted display of the City Hall (right)

D. Building Information

Building Information module is vital in giving constructive information to the user on the historical aspect of a place. It is designed in table views in order to communicate long lists of information to the user effectively and efficiently. This module allows the user to obtain the information and provides the flexibility of viewing at any time any anywhere. This module was implemented by using UITableView and UITableViewCells.

73

E. Push Notification

Push Notification allows an application to notify new messages or events without the need to actually open the application. The user can receive the message automatically when they enter the heritage sites. In general, if the user enters to the physical location in the range of 60 meter with a certain level of tolerance, the Push Notification will be activated and the user will receive the information of heritage site automatically.

F. Acoustical Heritage Simulation

A multimodal application inclusive of sound is important in building a virtual heritage application. Therefore, Acoustical Heritage Simulation is a high quality semi-interactive where the novelty of this work is in innovating of imaginary sound in 360-degree panoramic views [14].

Evaluation

In order to evaluate the features, usefulness, effectiveness and accessibility of the application, a survey on the application is performed. The questionnaire is concerned with the opinions and feedback from the users on the usefulness, effectiveness and accessibility of the application. User-centered evaluation is used rather than system- centered evaluation because knowledge of a user is qualitative. Therefore, questionnaire is used to evaluate the application. The respondents were required to rate their satisfaction based on a scale of 1 to 7 where the value of 1 is the lowest and the value of 7 us highest degree of satisfaction in all of the questions. The reason to use 7-point scale among the respondents because it is more cognitive ability like student [14] where the respondents in this evaluation stage comprised non-expert in the field of Information Technology and most of the respondents are International postgraduate students in the program of Master or PhD in Universiti Sains Malaysia (USM) who arrived in Penang, Malaysia for the last 3 months. In addition, people tend to answer slightly positively to please the question setter so there is no bias in including a middle value. Furthermore, working memory modeling indicated that people can handle up to seven pieces of information at once so they should be able to discriminate between 7 choices. In general, 5-point scale is more suitable when the respondents are general public [14]. Therefore, 7-point scaled was selected in this evaluation instead of 5-point scaled.

The population is 79 International postgraduate students and the sample size is 50 in this preliminary evaluation. The group consisted of 34 males and 16 females with an average age 34.4 and proficiency with English. The reason to use international postgraduate students in this evaluation is because of the knowledge about cultural heritage in Penang is low.

In the evaluation of the application, fifty participants were invited to evaluate the game contents 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 first question is to evaluate the effectiveness of the game while the second question is to evaluate the effectiveness of the panoramic views. The third questions are to evaluate the Building Information module in exploring the heritage site while the fourth questions is to evaluate the usefulness of additional information obtained from the Push Notification module. The fifth question is to evaluate the Acoustical Heritage Simulation module of the application and the final question is to evaluate the overall usefulness of the application for heritage exploration.

From the result of the surveys, we can summarize that 84% of the respondents have given a good rating (rating 6 and rating 7) for the first question. For the second question, majority of the respondents (76%) have given the full rating (which is rating 7) on the panoramic views. Most of the respondents (50%) gave the highest scale (7 out of 7) on the Building Information module. For the fourth question, only 17 respondents (34%) have given the highest rating (7 out of 7) and only 6% of the respondents gave the rating of 4 on push notification. We can speculate that the GPS signals are not accurate due to a few heritage sites that are next to each other will results in the same GPS reading. This gives a positive correlation between the small difference in distance of heritage sites and the accuracy in the GPS detection. For the last two questions, majority of the respondents (78%) are happy with the acoustical heritage simulation. Finally, in the general usefulness of the application, 80% gave the rating of 6 and 7 which mostly of the respondents agreed that MEEE is useful to explore the heritage sites. In a nutshell, the overall positive result showed that MEEE is able to help the postgraduates from overseas to explore and learn the cultural heritage at Georgetown, Penang, Malaysia.

Conclusion and Future Works
The application is created as similar as possible to the heritage sites in Georgetown, Penang, Malaysia where it allows the users to explore and learn about the heritage sites through adventure learning and provides better access to the heritage sites anywhere and anytime. Besides, MEEE is a good platform to highlight various tourist attractions because of the increasing difficulties in maintaining and disseminations of our long-forgotten cultural heritage sites to the world. In addition, MEEE also help in building the vocabulary of the users since playing activities is one of the most effective ways that the users can gain their knowledge. Furthermore, the mobile game which are monopoly and treasure hunt from MEEE is able to provide en engaging learning medium for the teaching and learning process. Some limitations in this work was presented such as the small dataset in the evaluation. Therefore, we proposed to use a larger dataset and the sampling should be the international tourists rather than local tourists in our future work because a larger dataset may lead to improve and validate thoroughly whether the application provides the usefulness to the tourists.

References
S. Boiano, J.P. Bowen, and G. Gaia, "Usability, design and content issues of mobile apps for cultural heritage promotion: The malta culture guide experience," CoRR 2012, arXiv/1207.3422, 2012.
M. Economou, E. Meintani, "Promising beginning? evaluating museum mobile phone apps," pp. 87–101, 2011.
C. Emmanouilidis,.R.A. Koutsiamanis, A. Tasidou, "Mobile guides: Taxonomy of architectures, context awareness, technologies and applications," *Journal of Network and Computer Applications* vol. 36, no. 1, pp.103 – 125, 2013.

M. Mortara, C.E. Catalano, F. Bellotti, G. Fiucci, M. Houry-Panchetti, and P. Petridis, "Learning cultural heritage by serious games," *Journal of Cultural Heritage*, vol. 15, no. 3, pp.318 – 325, 2014.

K. Cheverst, N. Davies, K. Mitchell, and P. Smith, "Providing tailored (context-aware) information to city visitors," *Proceedings of the International Conference on Adaptive Hypermedia and Adaptive Web-based System*, pp. 73-85, 2000.

A. Goker, and H.I. Myrhaug, "Evaluation of a mobile information system in context," Inf. Process. Manage, pp. 39-65, 2008.

L. Ardissono, T. Kuflik, and D. Petrelli, "Personalization in cultural heritage: the road travelled and the one ahead," *User Modeling and User-Adapted Interaction*, vol. 22, no.1-2, pp. 73-99, 2012.

M.V. Setten, S. Pokraev, J. Koolwaaij, and T. Instituut, "Context-aware recommendation in the mobile tourist application compass," *3rd International Conference Adaptive Hypermedia and Adaptive Web-Based Systems*, pp. 235-244, 2004.

F. Carmagnola, F. Cena, L. Console, O. Cortassa, C. Gena, A. Goy, I. Torre, A. Toso, and F. Vernero, "Tag-based user modeling for social multi-device adaptive guides," *User Modeling and User-Adapted Interaction*, vol. 18, no.5, pp. 497-538, 2008.

Y. Sumi, and K. Mase, "Agentsalon: facilitating face-to-face knowledge exchange through conversations among personal agents," *5th International Conference on Autonomous Agents*, pp. 393-400.

N. Shiratuddin, and S.B. Zaibon, "Mobile game-based learning with local content and appealing characters,: *Int. J. Mobile Learning*,, vol. 4, no. 1, pp.55–82, 2010.

K.L. Tan, and C.K. Lim, "Mobile education, entertainment and exploration (MEEE) at heritage site," *Proceeding of the First International Conference on ICT for Transformation*, pp. 152-157, 2016.

C.K. Lim, T.P. Tan, K.L. Tan, A.Z. Talib, "Randomized psychoacoustic model for mobile, panoramic, heritage-viewing applications," Proceedings of the 11th ACM SIGGRAPH International Conference on Virtual-Reality Continuum and Its Applications in Industry;" VRCAI '12. New York, NY, USA: ACM, pp. 315–322, 2012.

B. Weijters, E. Cabooter, and N. Schillewaert, "The effect of rating scale format on response styles: The number of response categories and response category labels," *International Journal of Research in Marketing*, vol. 27,no. 3, pp. 236-247.