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Virtual Museum Design to Enhance Learning Efficiency and User Experience for Thai National Museum*

การออกแบบพิพิธภัณฑ์เสมือนเพื่อเพิ่มประสิทธิภาพการเรียนรู้และประสบการณ์ของผู้ใช้พิพิธภัณฑสถานแห่งชาติ

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Abstract

The virtual museum offers an approach to presentations that respond the needs of individuals who are unable to visit a physical museum; it reduces gaps in terms of distance, time, and cost, as it connects people to virtual reality. This study aimed to 1) design a virtual museum model as communication tool that enhance the learning efficiency and user experience; and 2) examine the outcomes of the virtual museum model in communicating and enhancing learning efficiency and user experience. The current mixed methods research involves 2 stages. Stage 1 explores the concept of constructing a virtual museum model by means of data analysis and interviews with specialists, drawing conclusions, and the focus on group discussions. Stage 2 investigates the user experience with a sample of 20 online virtual museums, 30 carefully selected specialists of virtual reality study, research, design, and technology, as well as 100 virtual museum users. The research instruments include an

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interview form, a questionnaire, and a test of knowledge about the use of virtual museums. The analytical statistics comprise percentage, mean, and standard deviation. The results of specialists' opinions suggest that the virtual museum model include 3 features of 1) access; 2) education; and 3) conservation, at a high level of propriety. The user interface design comprises 4 principles of 1) simplicity; 2) consistency; 3) objective clarity; and 4) aesthetic values. It was reported at a highest level of propriety by both the specialists and the users. The virtual museum thus appears as an effective medium to connect the museum and its users, aiming at providing access, education, and conservation by presenting interactive media with suitable, novel, concise, and attractive designs and contents corresponding to the current user behaviors, which in turn enhances learning efficiency and user experience.

Keywords: Virtual Museum, Virtual Tour, Learning Efficiency, User Experience

Introduction

The imagination of places with exhibits of non-existing pictures and objects was represented in a way that has changed with technological advancement in different periods of time. The early concept of a virtual museum describing an imaginary environment using printed media and photographic technique to present a variety of arts and cultural works within and outside of Europe was displayed in the book "The Voices of Silence" by André Malraux as a virtual space with systematic arrangement and composition in details as in the exhibits in the real place (André Malraux, 1953). Myron Krueger recognized as the father of virtual reality, referred to artificial reality as the digital substitute to the real world (Myron Krueger, 1974).

First time that word virtual museum had been mentioned was by Dennis Tsichritzis and Simon Gibbs, and referred to as a museum created in a virtual environment that could provide services similar to a real museum (Archives & Museum Informatics, 1991). In 1969 the Internet allowed connections between several networks worldwide. The earlier use of internet was limited to military cases. In 1989, Tim Berners-Lee (2017), a British computer scientist invented the World Wide Web (www or The Web) The virtual museum had accordingly changed from being previously created and stored on computer and accessible only in one location to being accessible by web browsers, allowing for convenient and quick revisions of information, as well as a more effective dissemination. Dr. James G. Jones and Mark Christal (Created Realities Group, 2002) stated that the future of the virtual museum will be with on-line immersive 3D rendered environments, and these subsequently happened.

In 2004, Laia Pujol (2004) compared the analysis of selected examples of virtual reality in museums with the definition of virtual reality and the conception of archaeology, and drew conclusions in 3 points, demonstrating that the level of realism depends on the technological capacities—virtual reconstructions involve technical interaction. In the same year, Mark Zuckerberg and his colleagues created a website that will later develop to contemporary Facebook, a simulated human physical social network of identity allowing for interactions between individuals and groups of individuals. These events and developments in social networking greatly impacted and influenced today's society.

In 2007 the Apple Inc. started to produce smartphones with large touch screen display to replace the push buttons: it became a user interface revolution (Macworld Conference, 2007). The virtual museum then shifted its design concept in order to present contents that fit mobile devices in various sizes, advanced wireless communication that generated the preference of a convenient and quick access to virtual museums therefore led to a general growing concern that the virtual museum will substitute a real one. In response to Assistant Professor Werner Schweibenz (2004) of the University of Saarland, Germany stated that the virtual museum is not a competitor or a danger to the real museum because of its digital nature that cannot exhibit real objects to visitors, but can extend ideas and concepts of collections to the digital space, and allow for virtual visitors who might otherwise not be able to visit a museum in person to discover artworks and historic artefacts. Additionally, the former director of the Thai National Museum (Tossaporn Srisamarn, 2015) agreed with that and suggested that the digital virtual museum cannot replace real artifacts, but can promote learning of the real museum.

In fact, several world-class museums recognized the significance of this change, and made improvement to their virtual museums in terms of contents, models, and user interface. In 2011 Google Inc. founded the Google Cultural Institute (Emily Magnuson, 2011) that partners with international cultural organizations and uses technologies to offer access to and learn about global cultures from everywhere in the form of virtual museum without referring to the real places or museums. It provides virtual environments containing a wide range of media that can be connected through the Internet. Richard E. Mayer (2016) outlined the principles for effective use of media as better learning occurs when using multimedia rather than using words alone, better learning occurs when words, pictures, and sound are presented near each other, simultaneously rather than successively. For the types of media used in the virtual museum, the Worcester Polytechnic Institute (Museum Virtual Tour Design Guide, Worcester Polytechnic

Institute, 2006) identified 5 media types in virtual tour, as follows: text-based, photo-based, panoramic, video-based, and real-time virtual reality. These types accord with the types of multimedia classified in the book Multimedia for Learning: Design and Development (P.5, 2557) into different types by perception as text, still images, animation, sound, video, and interactivity. These media elements can be combined with educational curricula, as part of class teaching and learning, therefore digital learning skills become core skills for education and living as stated by Nittaya Wongyai (2017). It satisfies a fundamental demand of virtual visitors, and at the same time offers new features to enhance learning efficiency of users in addition to the virtual museum. These design process affect the user learning behavior, and how the virtual museum should be today.

Research Objectives

1) To design a virtual museum model for communication and enhancement of learning effectiveness and user experience. (Phase 1)

2) To examine the outcome of virtual museum model design for communication and enhancement of learning efficiency, as well as user experience. (Phase 2)

Methodology and Procedure

The current research seeks to find and develop a virtual museum model to enhance learning efficiency and user experience, using the National Museum of Bangkok as a case study. It examines the outcomes of the virtual museum model design on the perception that enhances learning efficiency and user experience, taking into consideration its compatibility with the present social and technological developments. The research scope is identified as follows:

1. The virtual museum model aims to enhance the learning efficiency and user experience of national museums, taking the National Museum of Bangkok as the model of investigation.

2. The sample in phrase 1 includes a total of 30 carefully selected individuals as museum operators, experts of study and research, design, as well as technology of virtual reality.

3. The sample in phrase 2 includes a total of 100 individuals as Thai and foreign museum users.

Expected Benefits

To obtain a virtual museum model that can enhance learning efficiency and user experience of national museums, that corresponds to the needs of actual users, and that can be applied to national museums and other museums in developing their virtual museum as a learning source for dissemination of knowledge.

Research Procedure

Phrase 1: Developing a virtual museum model for communicating and enhancing learning effectiveness and user experience.

1. Review of related literatures and research;

2. Create a conceptual framework and hypotheses for the virtual museum model;

3. Build a structured interview form for data collection;

4. Interview 15 specialists in museums, museum design, media design, learning efficiency and user experience. The data was collected on rating scale;

5. Perform a comparative analysis of concepts with 20 world-class virtual museums obtained from the comparative screening by various organizations;

6. Bring the analysis results of components, features, types, and guidelines for enhancing learning efficiency and user experience to create a virtual museum prototype that can enhance learning efficiency and user experience of national museums.

Phrase 2: Examining the outcome of the virtual museum model design for communicating and enhancing learning efficiency and user experience;

1. Design a virtual museum for enhancing learning efficiency and user experience, using the summary results from phrase 1;

2. Create a virtual museum prototype for enhancing learning efficiency and user experience;

3. Create an evaluation form for learning efficiency and user experience based on the conceptual framework and hypotheses in phrase 1;

4. Contact specialists to examine the validity (IOC) of the questionnaire for the virtual museum users;

5. Test the reliability of the questionnaire with a sample of 30 people using the formula for Cronbach's alpha;

6. Install the virtual museum prototype on an Internet server for dissemination through Internet network along with a questionnaire for the on-line virtual museum users;

7. Collect the data from a sample of 100 virtual museum users;

Conclusion and Discussion

1. The results on specialists' opinion about the virtual museum design can enhance learning efficiency and user experience. The features of virtual museum comprise: 1) access; 2) education; and 3) conservation, which were seen by specialists and users at a highest and high level of propriety, respectively. The user interface design principles comprised: 1) simplicity; 2) consistency; 3) objective clarity; and 4) aesthetic values, and were seen by specialists and users at a highest and high level of propriety, respectively. The details are in Table 1 and Table 2.

Table 1: Result of specialists' opinion about virtual museum design

Part 1: Components of Virtual Museum			
Topic	$\overline{X}$	S.D.	Score
Features			
Access and Display	4.54	0.70	strongly agree
Education	4.69	0.61	strongly agree
Conservation	4.75	0.62	strongly agree
Total	4.66	0.64	strongly agree
Media			
Text	4.26	0.88	agree
Images/Photographs	4.93	0.25	strongly agree
360-Degree Panoramic Images	4.66	0.61	strongly agree
3-Dimensional Objects	4.46	0.64	agree
Video/Animation	4.73	0.45	strongly agree
360-Degree Panoramic Video	4.13	0.74	agree
Others: Augmented Reality (AR), Hologram, Game, Mobile Apps	4.2	0.77	agree
Narration	4.73	0.45	strongly agree
Music and Sound Effects	4.53	0.74	strongly agree
Total	4.51	0.61	strongly agree
Design Principles			
Simplicity	4.93	0.25	strongly agree
Consistency	4.86	0.35	strongly agree
Objective Clarity	4.93	0.25	strongly agree
Aesthetic Values	4.73	0.59	strongly agree
Total	4.86	0.36	strongly agree

Table 1: Result of specialists' opinion about virtual museum design

Part 2: Learning Efficiency and User Experience Enhancement			
Topic	$\overline{X}$	S.D.	Score
Recreational and attractions	4.68	0.55	strongly agree
Sociability	4.36	0.76	agree
Edutainment	4.54	0.62	strongly agree
Participation	4.62	0.59	strongly agree
Total	4.55	0.63	strongly agree
Grand Total	4.64	0.56	strongly agree

2. The results on guidelines for enhancing learning efficiency and user experience of the virtual museum suggested that the media used include text, 3-dimensional objects, 360-degree panoramic videos, and other media such as AR (Augmented Reality), AI (Artificial Intelligent), Hologram, and IOT (Internet of Things), with a score difference as they were perceived by specialists at a high level, but by users at a highest level of propriety. Score agreement was found for images/photographs, 360-degree panoramic images, videos and animation, narration, music and sound effects, as they were perceived at a highest level of propriety by specialists and users, as depicted in Table 2.

3. The results on learning efficiency and user experience enhancement suggested the following components of recreation and attractions, edutainment, and participation, with score agreement, as they were perceived by specialists and users at a highest level of propriety. However, with score difference for sociability was perceived at a high level by specialists but a highest level of propriety by users, as seen in Table 2.

Table 2: Result of End Users' opinion about virtual museum design

Part 1: Components of Virtual Museum			
	$\overline{X}$	S.D.	Score
Features			
Access and Display	3.98	0.93	strongly agree
Education	3.93	0.91	strongly agree
Conservation	4.05	0.89	strongly agree
Total	3.98	0.91	strongly agree

Table 2: Result of End Users' opinion about virtual museum design

Media			
Text	3.83	0.91	strongly agree
Images/Photographs	4.24	0.90	strongly agree
360 Degree Panoramic Images	4.21	0.89	strongly agree
3-Dimensional Objects	4.14	0.91	strongly agree
Video/Animation	4.15	0.91	strongly agree
360-Degree Panoramic Video	4.10	0.95	strongly agree
Others: Augmented Reality (AR), Hologram, Game, Mobile Apps	3.84	0.97	strongly agree
Narration	3.84	0.97	strongly agree
Music and Sound Effects	3.96	0.88	strongly agree
Total	4.03	0.92	strongly agree
Design Principles			
Simplicity	4.02	0.88	strongly agree
Consistency	4.05	0.78	strongly agree
Objective Clarity	4.01	0.95	strongly agree
Aesthetic Values	4.02	0.82	strongly agree
Total	4.02	0.82	strongly agree
Part 2: Learning Efficiency and User Experience Enhancement			
Recreational and attractions	4.12	0.86	strongly agree
Sociability	3.86	0.92	strongly agree
Edutainment	3.99	0.85	strongly agree
Participation	3.97	0.84	strongly agree
Total	3.98	0.86	strongly agree
Grand Total	4.0	0.87	strongly agree

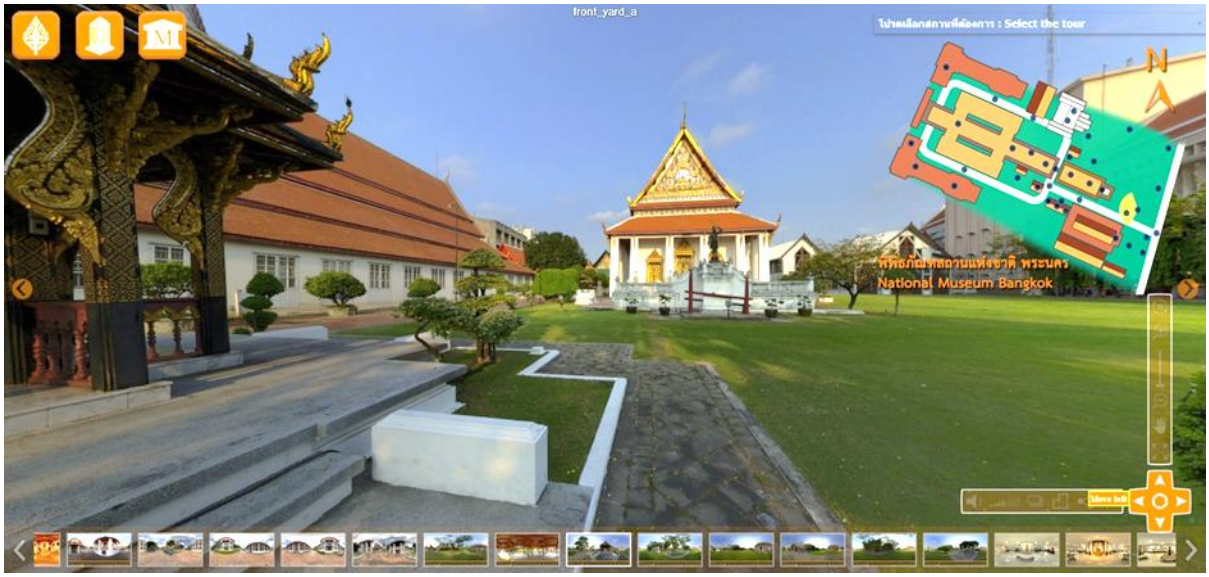

Figure 1: Complete set of user interface is shown when pressing the icon for menu at the bottom right. It consists of icons at the top left with 3 modes of exhibitions to choose from. The first icon at the far left is for artifact exhibits, the next icon is for Thai history exhibits, and the last icon is for the whole image of the National Museum of Bangkok. At the bottom of the display are icons for various spots within the National Museum of Bangkok.

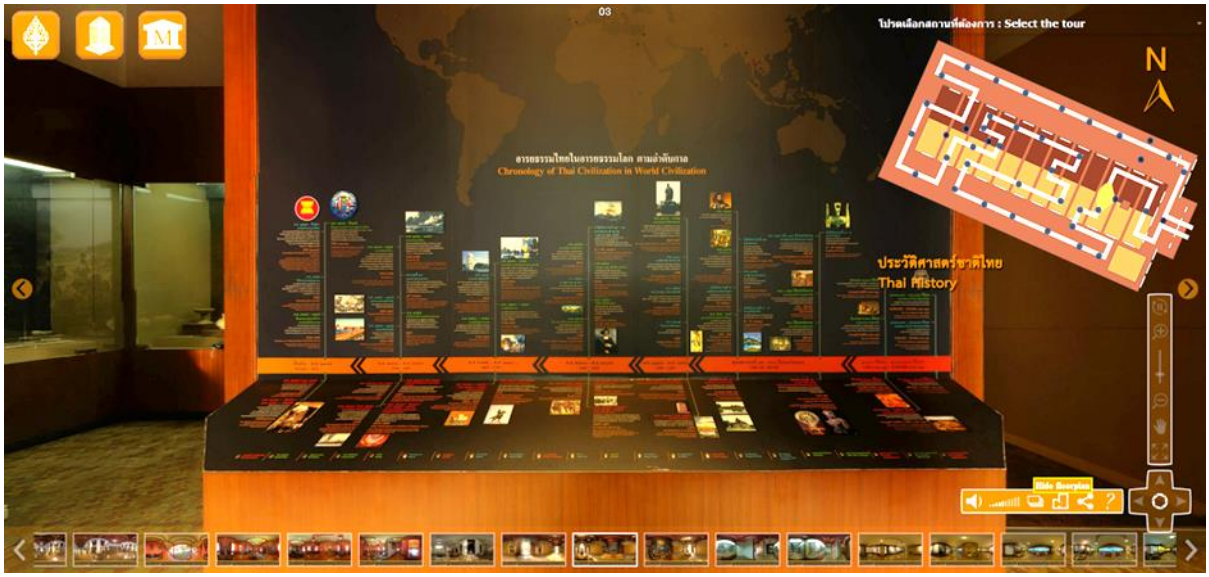

Figure 2: Thai history exhibition has been presented in a timeline format from past to present, pre-historic to Rattanakosin era. There is a floor plan map on the top right corner, indicated user current position, field of view, and position in the history timeline as well as exhibition hall.

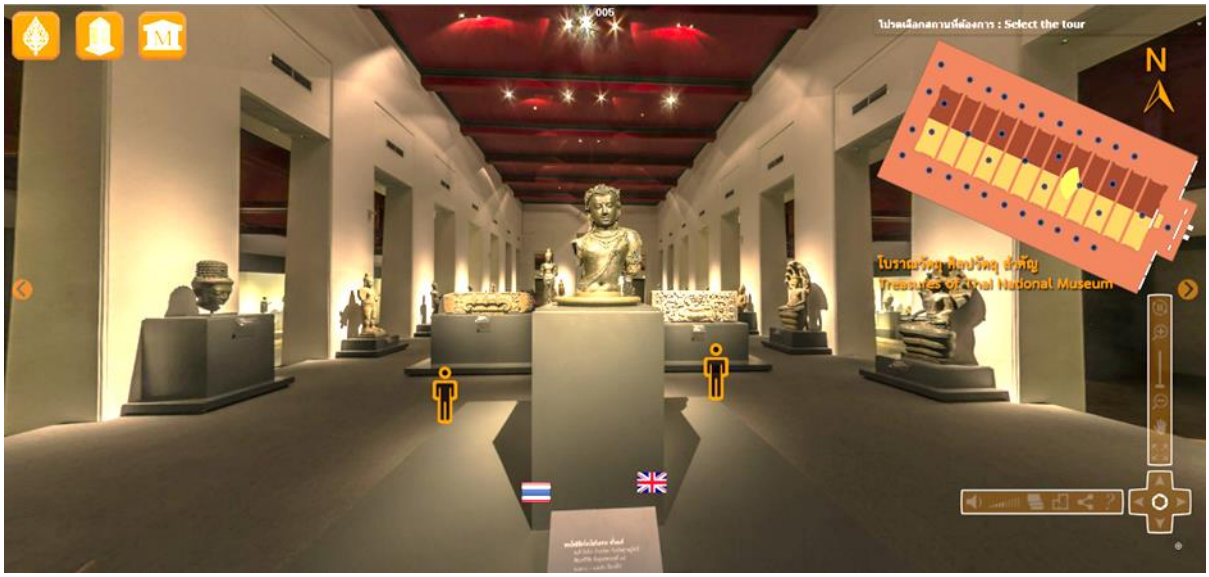

Figure 3: Exhibition presenting the significant artifacts from different eras with description and narration in both Thai and English languages. There is a floor plan map on the top right corner, indicated user current position, field of view, and position in the exhibition hall.

Discussion

The researcher has drawn conclusions, discussed, and provided recommendations for the virtual museum model to enhance learning efficiency and user experience that is applicable to national museums and other museums. The virtual museum requires the following essential 3 features:

1. Access: The virtual museum requires a quick display for immediate use with a range of devices: computers, tablets, and smartphones. These elements need to comply with the 4 following design principles:

1. Simplicity: balanced mixture of text, picture, color, and sound; easy understanding; and use of full features of multimedia;

2. Consistency: type, size, and color of multimedia, including various elements following the same direction from the beginning to the end of content;

3. Objectives clarity: allowing users to know what will be, or should be learned; and

4. Aesthetic values: facilitating to create the distinct, interesting, and efficient content.

The design with simplicity, consistency, objectives clarity, and aesthetic values being applied to the virtual museum will affect the user behavior and, in turn, will enhance the learning efficiency and user experience.

2. Education: The virtual museum should allow for a use with diverse presentation techniques, create motivation and stimulate user learning. The virtual museum provides a social platform connectable to other social media accounts, for communicating and sharing knowledge and opinions, networking educational activities, and specific knowledge, all of which will serve in ways to enhance learning efficiency and user experience of the virtual museum.

- Recreational and attractions: aesthetically pleasing and proper displays that entertain and satisfy users;
- Sociability: users meet and chat, and exchange opinions with the museum;
- Edutainment: information is organized, categorized, and easy to memorize; and
- Participation: allowing for users' correspondence, analytical thinking, and creating activities.

Which comply with learning format that support critical and logical thinking methods by Chaiya Burisuwan (2017), his format consisting of 6 components; Principles, Objectives, Knowledge, Classes Activities Processes, Social Systems, and Learning Promotion Elements.

3. Conservation: The virtual museum reduces risks of damaging artifacts from display, handling, as well as light, air, accidents, and theft, by means of digitized data record and storage. It also solves the problem of limited space, number of work, and size of exhibits. The database is produced for the purposes of preservation, restoration, storage, dissemination, and generating value added.

Recommendations

According to the research results, a virtual museum design model with simplicity, consistency, objectives clarity and aesthetic value considerably increases functional efficiency. These principles should thus be embraced when designing a virtual museum, so that it offers ease of use, understanding and encourages the users to revisit. In addition, to enhance the real museum visitor experience, the virtual museum can be used as a planning tool for pre-visits, such as floor plan, high resolution images and audio guide, which could offer real-time incentives to current visitors. Since there is no time limit, through the virtual museum, past visitors can review exhibits of their interest, or missed ones at a more convenient time and place.

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