The Effect of 3D Realism and Meaning Making: A Conceptual Model

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ABSTRACT

Field studies show that computer graphics, as in this case the 3D model of a heritage building, are only iconic representations rich perceived differently by individuals. Still, there is lack of evidence on how realistic 3D in contributes to the meaning making process. This article discusses on the proposed conceptual model for 3D realism towards meaning-making. It elaborates on principles of realism and 3D realism, meaning-making theories and processes and related works in the area. Based on four elements of 3D realism, it attempts to identify possible relationship with meaning making. The research methodology is outlined to achieve the intended research outcomes. The findings of this study would contribute to understanding of the ability to learning via 3D content.

Keywords: 3D realism, meaning making, virtual heritage.

I INTRODUCTION

Of late, there are numerous studies on evaluating virtual heritage such as user enjoyment in museums (Pujol-Tost &Economou, 2006, 2009; Forte et al.,2006) cultural presence (Champion, 2006; 2011) and interactivity (Abu-Bakar et al., 2011, Roussou, 2001). There are also studies that emphasis on evaluating virtual heritage in virtual realism on quality of reconstruction. However, they were interested on whether enhances user engagement (Forte et al., 2006) or how interactivity can increase user task performance and cultural presence (Champion, 2011). Field studies show that computer graphics, as in this case the 3D model of a heritage building, are only iconic representations rich perceived differently by individuals as also discussed in Pujol-Tost (2011). Still, there is lack of evidence on how realistic 3D in virtual heritage contributes to the meaning making process. Thus, as to fill in the gap of finding suitable methods to evaluating realistic 3D in order to better understand the meaning making process, we propose the integration of *meta-analysis* to be embedded in the evaluation metric for realistic 3D. This article discusses on the proposed conceptual model for 3D realism towards meaning-making. It elaborates on principles of realism and 3D realism, meaning-making theories and processes and related works in the area.

II LITERATURE REVIEW

Realism covers a significant amount of work from photorealistic to non-photorealistic rendering to the installation of crowd in virtual heritage (Foni et al., 2007). Virtual realism, in a laboratory setting, can enhance realistic responses (Yu et al., 2012) as the virtual environment used was triggering anxiety to subjects. Visual realism however, does not affect the search task performance in augmented reality (Lee, et al., 2013). (Mania, et al., 2010) and (Stinson, et al., 2011) recently looked at the effects of visual realism on training transfer. Mania investigated the effect different shading technique, (flat-shading or radiosity) on a memory task which result indicated that users in the flat shaded environment were able to better remember the location of objects. Stinson et al. studied how the complexity of the environment affects training transfer of a scanning task where it reveals a slight advantage for users who trained in the more realistic scenes.

For the past decades, the simulation of the past has seen numerous notable research and development projects in preservation and 3D reconstruction of the architectural heritage and acoustic studies (Foni et al., 2007); reconstruction of ruined citadel (Ono et al., 2008); and lighting studies on a historical building (Kalas, 2008). The past simulation of Virtual Hagia Sophia is targeted to perform realistic visualization of Hagia Sophia with real-time rendering (Foni, Papagiannakis, Cadi-yazli, and magnenat-Thalmann, 2007; Foni, Papagiannakis and Magnenat-Thalmann, 2002). Animated avatars with their clothes representing those dedicated years were added to depict the scenarios of ritual events.

While there are numerous studies emphasis on improving other features of virtual heritage such as spatial ability (Chen, 2007), cultural presence (Champion, 2006; 2011) and interactivity (Roussou, 2001), lack of evidence is found on the contribution of realism to communicate the historical facts on architectural heritage sites/building.

A. 3D Realism

According to Rieber (1994), ‘‘realism is somehow measured against the likeness of the object the picture is supposed to present’’ (p. 148). Realism may be achieved by copying the real-world object to shape, details, color, texture, or motion, irrespective of

whether these features are relevant to the identity of that object. According to this view, the maximum of realism in multimedia learning can be established by presenting photos or videos taken from a natural object or scene.

Photorealism image is designed and adapted from the original appearance of objects in either static or animated virtual walkthrough. To produce photorealism, a high computer with high specification is requires because of the high use of the rendering process to get the texture, shape and color images exactly like the original object. Figure 1 shows the Photorealism Pyramid which is the steps in producing a photorealism.

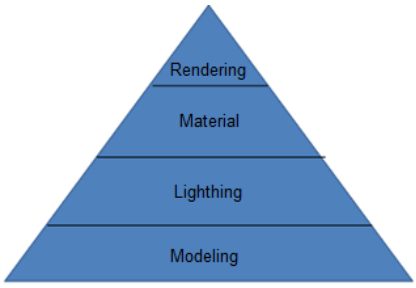

Figure 1. Photorealism Pyramid (Image courtesy from www.blenderguru.com)

A photorealism image also uses quite a lot of space to be stored in the computer because of the image quality produced are very high when compared with non-photorealism images. Therefore, the original shape and pattern of carved objects such as artifact, historic building or cultural heritage can be preserved with the production of photorealism images or virtual walkthrough.

Non-photorealistic is similar to photorealistic but with a few differences in terms of quality and also the time taken for the production of images. To develop non photorealistic 3D objects modest powerful computer can still be used against photorealistic that only requires high-powered computers to develop a 3D object. Rendering process is much faster when compared with photorealistic that takes a long time to get the output clear and real airliner texture and lighting. Figure 2 shows the different between low-resolution 3D rendering high-resolution 3D rendering.

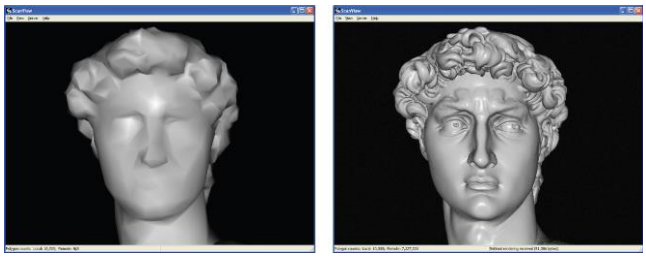

Figure 2. Non-photorealism using low resolution (left) and high resolution images (Image courtesy from Koller, Frischer, & Humphreys, 2009)

Memory usage is also much lower when compared with the use photorealistic large memory usage. Costs for developing applications that use non photorealistic also is much cheaper but the quality of care developed object is relatively low and there is little difference from the original object.

B. Meaning Making

Meaning making improves learning. Learning may happen anytime anywhere but without meaning one learn is meaningless. Constructivism is one of the theories used for learning. Constructivism is also used to make a description of the process of constructing knowledge and one of the ways constructing knowledge is to 'create meaning by performing' (Osberg, 1997, Copeland, 2004). Construction of knowledge is an active process and not a passive process. The process of knowledge construction involves two processes, namely cognitive and physical construction. Copeland (2004) suggests the use of constructivist approach to the interpretation of archaeological sites. This approach is focused on the interpretation of learning by doing. He explained that the constructivist approach is one way individuals construct meaning by their own feelings, acts, negotiation and interaction with the world. Therefore constructivist interpretation is intended to engage the user with evidence for creation and help them build their own meaning.

As meaning making is the upfront process of learning, it is found that numerous studies have been conducted to determine the relationship of realistic visualization (which covers the range of visual multimedia elements from format to dynamic). There are arguments that, realistic visualizations would comply ''that learning will be more complete as the number of cues in the learning situation increases'' (Dwyer, 1976: 8). An increase in realism in the existing cues in a learning situation would substantially increase the probability that learning will be facilitated. Therefore, realistic visualizations might especially be helpful for learning, if the learning objective requires interacting with realistic objects in natural settings (Be´trancourt & Tversky, 2000).

The use of 3D in virtual world has proven as a learning tool for students in classrooms and support learning experience of being there (known as presence) in the similar world to one another. Osberg et al (1997) discovered that the experience and the creation of a VR world to support students in the physical and mental involvement are actively in the process of knowledge construction. Understanding can foster in more depth if the user is involved in the process of designing their own. Loscos et al. (2003) states that in order to provide a good basis for the implementation of constructive activities using the

method of constructivist approach, the virtual simulation environment to be accurate, and this means that the environment must reflect a true as possible to the normal condition that user familiar with the environment. By using this method, users engaged in these activities can construct their knowledge by examining of ideas and concepts on the basis of the experience and observations.

It is argued that realistic visualizations are more engaging and entertaining, which may increase the students' willingness and persistence to work with them (Goldstone & Son, 2005; Joseph & Dwyer, 1984). On the other hand, there are also claims that learning will be hindered by realistic visualizations because of the high demands with regard to (visual) attention. Dwyer (1976: 8) suggested that, ''excessively realistic cues may be distracting or possibly even evoke responses in opposition to the desired learning''.

It is found that there are conflicting evidences on whether realistic visualization contributes to learning. While previous works focused on various representations (2D versus 3D, static versus dynamic) of realistic visualization, we attempt to determine the effect of 3D realism, particularly those used in virtual heritage, on meaning making.

C. **Virtual Heritage**

Virtual heritage is a computer based technologies that have been adapted based on VR technology (Stone & Ojika, 2000).The use of virtual heritage has growth rapidly from year to year and has helped in preserving heritage that has been abandoned. The rapid development in digital technologies in this recent year has been offering heritage new hope in the context of virtual reality (Addison, 2000). The use of virtual heritage is indispensable in preserving the nation's heritage, particularly heritage buildings are in this country. Apart from the advantages of virtual heritage is every development of 3D visualization can be more easily shared across different areas of the museum. So they are able to learn a virtual heritage without having to inheritance. Facilities such as this is highly desirable to encourage tourist industry developed in parallel with the increasingly rapid development of ICT. There are many heritage buildings especially - historic buildings should be preserved so that the legacy can still be enjoyed by future generations. Based on Stone & Ojika (2000), virtual heritage can be defined as a computer based technologies which was used to record, preserve, record or recreate artifacts, artistic religious and cultural significance.

In the era of modernization there are various technologies that increasingly exist and could indirectly alter the learning process in terms of both formal and informal. The uses of VR have grown extensively and provide new opportunities in the field of tourism such as museums, cultural heritage, archeological, and art-historical (Pujol-Tost & Economou, 2006). Originated from Youngblut (1998), recent studies have managed to provide statistical evidence which shows that students perform better and are actively involved in the learning process using a VR environment. The use of VR is a very appropriate method for parallel with the development of emerging technologies. At this time the use of technology is indispensable where practically every individual is more likely to use technology as it is more interactive, provides self-satisfaction and handy. This includes VR technology which may provide satisfaction, enjoyment and ease of understanding and being able to produce a positive learning experience for students (Abu-Bakar et al., 2011).

Based on these studies, it is evident that VR technology is an effective tool to be used in the delivery of information related to the history of cultural heritage. However, the realistic 3D content development is time and labor intensive. There is still lacking of evidence on, for instance, how such 3D realism of a gigantic pillar as in Figure 3 may contribute to provide meaningful representation of its real counterpart.

Figure 3. 3D realism of gigantic pillar (right) as to represent structural element of a hictoric building (Image courtesy from Juliana Aida et al., 2013)

While many researchers have focused on virtual heritage and learning in general, it is found that there is still lacking of evidence on whether these systems can contribute in the process of meaning making. Thus, this study attempts to focus at meta-analysis on 3D content of virtual heritage to find the relationship between 3D realism and meaning making.

III PROPOSED CONCEPTUAL MODEL

This study extends a CESSI metric for virtual heritage that is driven by set of rigorous expert requirements (Abu-Bakar et al., 2013). As CESSI (stands for Content, Experience, Setting, Support, and Interface) acts as a big picture of how VR may assist architectural heritage learning, this study attempts to focus on the Content alone – where the use of 3D is massive and relevant to the context of heritage. The meta-content (the details of the Content) is then based on 3D realism features as illustrated in Figure 4.

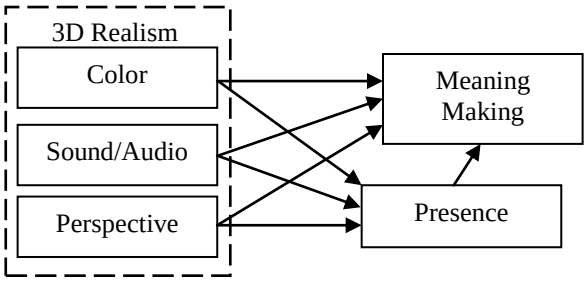

Figure 4. Proposed Conceptual Model of Meaningful 3D Realism

We anticipate that these four elements may contribute to the meaning making based on arguments from previous studies as discussed in subsequent sections.

Color and Sound. Previous investigation shows that realistic representation of 3D violent games such as emotional cues – blood color and pain sounds screams – does affect players' recognition memory directly regardless of players' arousal and presence (Jeong, Biocca, & Bohil, 2008). This indicates that color and sound may contribute to the meaning making in virtual heritage. The color of historical building is normally representing its building materials: be it red sandstone or thick black *cengal* wood. Sound must relay its surroundings; a historical fort would need to have the sound of nearby ocean, and a historical building uphill probably have the sound of chirping birds.

Perspective. Perspective is user viewpoint inside virtual heritage; the first-person perspective where the real world is experienced directly from the viewpoint of the body, or a third-person perspective, which is a viewpoint in virtual space that unnaturally hovers over the avatar body that represents the user in the virtual environment. In games, it is evident that from video game studies that first person video game playing increases arousal compared to third person perspective (Anderson & Bushman, 2002; Schneider et al., 2004; Tamborini et al., 2004). It is also shown that viewer perspective (first-person vs. third-person) has significantly influenced the sense of presence in games. Specifically, first person perspective games are reported to enhance the sense of presence through the identification process (Schneider et al., 2004; Tamborini et al., 2004).

Presence. Presence has been defined as the sense of "being there" in a virtual environment. The construct addresses the degree to which a user's sense of body location and experiential consciousness is focused on experience and action in the virtual environment. It is shown that 3D realism features (color and perspective) is relatively contributes to presence due to user appreciation of certain details such as ornamentation and enormous sizes of structural elements. Such appreciation may trigger the memory of such similar place have been visited or seen earlier. Likewise, we can assume that presence will also affect meaning making significantly.

IV METHODOLOGY

The nature of this study requires a mixed method: expert review by means of interview and experiment. Interviews will be conducted with several parties. In addition an experiment will be employed to evaluate the enhanced model.

A. Expert Review

The aim of this study is to determine the elements or variables that critically enhance the realistic 3D in the process of meaning making. Specifically this study seeks to understand in a richly detailed manner how effective meaning making of visual presentation can be constructed according to the expectation of end users or viewers.

Experts will be chosen based on purposeful sampling. Purposive sampling is applicable to gain information rich and in-depth data from a group of individual which include heritage agency officer, heritage site visitors, multimedia experts and the general public. For each mentioned group, three to four members will be purposively chosen. These groups are believed to provide maximum variation that con tributes to substantial understanding of constructivism in the meaning-making of virtual heritage. The nature of the interviews is semi structured using open ended protocols. Each interview is scheduled to run between 30-40 minutes. The interview will be audio recorded and transcribed. The interviews data will be manage and analyzed using thematic analysis technique to explore and discover the semiotics elements. In order to systematically handle the qualitative data, qualitative data analysis software will be engaged. The findings of this study will be adopted in enhancing the current model using 3D navigation metaphor. A prototype based on the newly enhanced model will be produced for further validation in an experimental study.

B. Experimental Design

In order to validate the influence of these variables on meaningful 3D realism model, studies need to be carried out to identify the impact on the user. Thus, an experimental research technique will be utilized for this purpose. This study will employ static-group comparison experimental design to explore the findings. This technique was chosen as it is one of the best basic experimental steps considering others limitation of the study (Baxter & Babbie, 2004).

To materialize this study, two groups consist between four to six participants each will be formed. Participants will be chosen using purposive sampling, depending on their availability. Group A will be exposed to the enhanced model and group B is not exposing to it. Using an instrument (structured closed and open ended survey containing the model framework dimensions), the results of both groups will then are compared and contrast. Data will be analyzed descriptively using simple statistical analysis and thematic analysis. The findings will hopefully reveal the effectiveness of proposed meaningful 3D realism.

V CONCLUSION

This article proposed a conceptual model of meaningful 3D realism. Based on three elements of 3D realism, it attempts to identify their possible relationship with meaning making. This article also provides an overview of related works on 3D realism and theories of meaning making. The research methodology is also outlined to achieve the intended research outcomes. The findings of this study would contribute to the understanding of the ability to learning via 3D content.

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