Enriched Player Situated Learning in Serious Game for Cultural Heritage Learning

Jung-Tsung Chen¹, Chih Ming Chiu², Shao-Shin Hung³, Derchian Tsaih⁴, Hui-Ling Lin⁵,⁶ and Jyh-Jong Tsay⁷

¹ Department of Applied Game Technology, WuFeng University, Chiayi, Taiwan
² Department of Computer Science and Information Engineering, National Chung Cheng University, Chiayi, Taiwan
³ Department of Computer Science and Information Engineering, WuFeng University, Chiayi, Taiwan
⁴ Department of Electronic Commerce Management, Nanhua University, Chiayi, Taiwan
⁵ Department of Industrial Engineering and Enterprise Information, Tunghai University, Taichung, Taiwan
⁶ Department of International Business, Ling Tung University, Taichung, Taiwan
⁷ Department of Computer Science and Information Engineering, National Chung Cheng University, Chiayi, Taiwan

Corresponding author: Email: hss@cs.ccu.edu.tw

Received Nov. 25, 2011; Revised Jan. 8, 2012; Accepted Jan. 31, 2012
Published online: 2012

Abstract: Living and being part of today’s Knowledge Society implies recognizing the importance of the past and imposes considering cultural heritage as a fundamental background of our identity. This paper investigates how a serious game can contribute to enhancing cultural heritage education. It is an attempt to answer the question concerning whether serious game can really provide any added value to cultural heritage pedagogy, education and learning. By focusing on those cultural heritage artifacts that pertain to the field of arts and archaeology, the paper assumes a methodological perspective and provides examples of some of the most innovative experiences in the field, thus driving the reader to reflect on the pedagogical impact that may derive from exploiting serious game potentialities. Serious Game, in fact, on the one hand, offers an easier access and a multi-perspective view of cultural heritage artifacts, and, on the other, may also enrich and improve cultural heritage education thanks to the adoption of innovative learning and teaching methods.

Keywords: Serious Game, Cultural Heritage, Situated Learning, Education, Artifact

1 Introduction

Over the last few years, serious games integrating simulated experiences have increasingly attracted the attention of professional trainers and educators. [1] argues that there is clearly a need for baseline research into how games and simulations are currently being used in the home and for learning and there are general trends in the research indicate the increasing popularity amongst learners for using serious games and simulations to support curricula objectives. It is not surprising that computer games are being incorporated more and more into learning environments, e.g. classroom education, government, financial services, healthcare, hospitality and catering, science and technology, telecommunications, corporate and military training, etc [2]. Computer games with complex virtual worlds for entertainment are enjoying widespread use and in recent years we have witnessed the introduction of serious games, including the use of games to support cultural heritage purposes, such as historical teaching and learning, or for enhancing museum visits [2].

The successes of games that cross over into educational gaming – or serious gaming, such as the popular Civilization [3] and Total War [4] series of entertainment games, as well as games and virtual worlds that are specifically developed for educational purposes, such as Revolution [5] and the Virtual Egyptian Temple [6], all of which exist within a cultural heritage context, reveal the
potential of these technologies to engage and motivate beyond leisure time activities.

However, there are two main basic methods of virtual heritage representation, it is evident that PhotoRealistic (PR) accuracy-rendering is important for scientific reasons, but Non Photorealistic Rendering (NPR) could also be important for education and dissemination of information through artistic or cultural interpretation [7]. First, PR works on geometry recording and virtual reconstructions that are intended for scientific analysis, preservation-restoration and conservation purposes. On the other side, NPR produces models that could be conceived as ones being closer to art [8]. In general, most model features such as shape and texture are represented by strokes and artistic techniques that render the most salient features of real models with special meaning, catching players’ impressions and artistic interpretation [9].

Cultural heritage education [10] in most countries was based for a long time on traditional teaching methods; this meant that it usually relied on face-to-face classroom lessons held by one single teacher (often the one in charge of “Arts”), on the study of printed materials (texts and images), and very seldom on watching videos. Occasionally, the study of cultural heritage artifacts was accompanied by on-site visits where students could come directly in touch with the artifacts [6]. In any case, the study of cultural heritage usually did not cross national borders [11], perhaps with the exception of those artifacts belonging to the closest cultures/countries. Moreover, with the advent of digital technologies, cultural heritage artifacts can be viewed both as a whole and in their minimal details, images are no longer strictly bi-dimensional, and detailed study and zoom possibilities of every kind/level are possible. What’s more, the representation of artifacts becomes dynamic and interactive it is the user herself who can directly choose the dimension, the level of detail and also the viewpoint to access each single artifact.

In order to improve the efficiency of learning cultural heritage artifacts, the popular serious game was elected to as a mean of dissemination the knowledge to the public [12]. The term ‘Serious Games’ covers a broad range of applications from Adobe Flash-based applications to fully immersive 3D environments where users interact with large volumes of data through sophisticated digital interfaces [13]. The shift towards immersive world applications being used to support, among others, education and training activities, marks the beginning of new challenges that present considerable scope for collaborative and multi-disciplinary research solutions, as well as opportunities for innovative development.

The popularity of video games makes them an ideal medium for educational purposes [13]. As a result there has been a trend towards the development of more complex, serious games, which are informed by both pedagogical and game-like, fun elements. The term ‘serious games’ describes a relatively new concept, computer games that are not limited to the aim of providing entertainment, that allow for collaborative use of 3D spaces that are used for learning and educational purposes in a number of application domains. Typical examples are game engines and online virtual environments that have been used to design and implement games for non-leisure purposes, e.g. in military and health training. The migration of education from the real life to virtual is growing fast and with the technology playing a crucial role, the educational institutions are trying to make students participate in online virtual learning environments. The main advantage of these environments is the remote participation of learners of all ages from all around the world by providing: (a) easier access to higher education and at the same time (b) an online knowledge based centre. Obviously, the learners behavior will differ compared with teaching in the traditional manner. Learners in the form of active participants could learn from their own responses and make improvisation in their own direction.

Serious games also support a range of functionality that includes supporting social interactions, modeling real environments, document sharing and recording facilities that allow users to replay activities undertaken in-world [14]. According to recent research [15], the introduction of virtual environments into higher education has the potential to bring a positive change in the learning experience. However, not many of the institutions make use of this method of teaching [16] and some common issues include: what is the best serious game; what is the level of realism and interaction required; how best to design activities and experiences for learners.

The aim of this research is to address some of the above issues by designing a novel online virtual learning classroom like environment and experimentally delivering a 3rd year and 4th
elementary school module. Students can login to the environment in the form of their avatars and learn remotely new things as well as interactively share their views and opinions with other students. To prove the feasibility of the system, the lecture materials from Taiwan “Hakaa Cultural Stories” module were ported into the online virtual environment. Initial evaluation with 35 players showed that overall the online virtual learning environment is enjoyable and has the potential to be used for the development of distance learning courses and degrees.

The rest of the paper is structured as follows. Section 2 provides a brief overview of related work. Section 3 presents how our online virtual learning environment was designed. Section 4 describes the overall functionality of the virtual environment and discuss the advantages of serious game why applied to cultural education. Finally, section 5 presents conclusions and future work.

2 Related Work

Today’s students represent the first generation to grow up with new technologies, such as computers and video games and all the other tools of the digital age [17]. When it comes to raise the interest in cultural history of a younger audience, museums are keen on presenting their collections in a more appealing and exciting manner [18]. There is no doubt that a traditional museum has the power to create an incomparable atmosphere to experience art. However, it also has limitations that include restricted display space and opening hours. In addition, static displays often do not inspire greater interest on the part of the viewer [19]. Therefore, many researches propose different learning environments for cultural teaching and training. [20] describes a game-engine based virtual museum authoring and presentation system. The system enables curators to design the virtual museum without any specialized knowledge, at minimal cost, and with good performance. The placement procedure is performed visually by clicking, dragging and scaling the artworks in the 3D world. This approach significantly facilitates the creation of one personalized museum on the web. However, the result still resembles a traditional museum and does not completely take advantage of the possibilities that Web 2.0 and Web 3D may offer for future approaches.

However, the main issues involved and technologies used in online virtual environments have been documented in a recent white paper [1]. The main strengths of virtual worlds could be generalized as being in the areas of communication, visual expression of information, collaboration mechanisms, interactivity and entertainment [13]. As a result, virtual worlds have the potential of offering new capabilities for users to enhance and promote educational and learning in a number of potential scenarios such as higher education. Some of the most characteristic examples of virtual worlds include Second Life [14], Active Worlds [15], OpenSimulator [16] and the OLIVE platform [21].

It is worth-mentioning that there are also custom online virtual gaming platforms originating mainly from Universities and research institutes. As a result, a number of experimental systems have been prototyped, but also custom online virtual gaming platforms originating mainly from Universities and research institutes exist [13]. An early example is an engineering educational online virtual and augmented reality (AR) environment that allows users to interact with 3D Web content (Web3D) using natural interaction techniques [22]. In this approach the lecturer’s traditional delivery is enriched by displaying multimedia content locally or over the Internet, as well as in a tabletop AR environment. Liarokapis et al. [23] present a system for supporting learning based on Web3D and Augmented Reality technologies. The system is targeted at increasing the level of understanding of students through interactive Web3D and AR presentation scenarios. The same authors have demonstrated the usage of these technologies in the application domain of virtual museum exhibitions [24]. We enhance this approach and suggest a 3D multiplayer game that, on the one side, acts as a Web3D exhibition platform and, on the other side, helps students to learn art history in an entertaining and motivating way.

Apart from the provision of educational content, some serious games try to improve the student's learning experience through the provision of realistic virtual tutors that they can interact with in a similar manner to a human lecturer. These autonomous intelligent tutoring systems allow students to learn at a pace that they have set themselves by adjusting their virtual teaching strategies to the needs of the students [21]. Virtual tutors in such serious games often resemble the human tutors' avatars that can be found in virtual multi-user learning environments, employing additional techniques from the domains of
conversational user interfaces and interactive digital storytelling [22]. We improve this approach and suggest a serious game that, on the one side, acts as a Web-based exhibition platform and, on the other side, helps students to learn cultural history in an entertaining and motivating way.

3 Design the Serious Game

When analyzing player engagement, traditional research focuses solely on tangible aspect of classrooms, e.g., attendance, or absence. Using prevalent teaching methods, such as classroom teaching, art or cultural historical facts can be tedious to communicate. Because a game is comprised of many aspects (audio, visual, logical), and each aspect has its own set of assets (sound files, meshes and animation, scripts), it is important to consider each aspect individually as it relates to game portability.

Especially when it concentrates on teaching artists names, artworks and their corresponding era of art. Knowing about the background of cultural history can play an important role in raising a student’s interest in contemporary culture and cultural heritage. It is vital to create an entertaining and hands-on learning experience for students to learn cultural history. In our paper, the term Serious Game [3] describes a game designed for a primary purpose other than pure entertainment. This playful approach is intended to not only increases the motivation to learn but also compels the player to think about, organize and use information in ways that encourage active construction of knowledge. In this context, Mike Zyda [25] created the term “collateral learning” - the learning that happens by mechanisms other than formal teaching. In this paper, the following different purposes should be fostered: (1) combine aspects of learning and fun in an immersive serious game environment to make the communication of interesting historical facts an entertaining experience; (2) create a game-like environment that fosters a collaborative learning experience; (3) raise the interest in history contemporary culture and cultural heritage.

In addition, “participating in a learning community may have a salutary effect on academic performance” [26] and this is regarding the quality of student engagement. Hence, it requires to have a balanced view and take both tangible and intangible aspects into consideration, through the “inner eye of the soul” [27], i.e. narrative; and the “physical eye of the body” [27], i.e. avatar, because a narrative is the glue that binds the community together and the way by which a community of practice develops; an avatar is the mechanism by which a narrative is implemented in-world. Therefore, we divide them into two design issues — narrative and avatar — as our main design principles.

Game design is a relatively new, unaccredited discipline with roots in both psychology and systems-thinking. When creating a gamified experience [28], we leverage many aspects of game design, while focusing on the core elements that will produce the greatest impact for our players. For example, we generally ignore narrative structure in gamification because we are building “nonfiction” experiences. That is, the arc of your gamified system is based on your player’s and your brand’s stories — as they already exist.

However, you don’t need nor should you want to become a full-fledged game designer. While many reference works can help deepen your understanding of how to make games, we have filtered the key elements of the discipline here to focus on the most important. Our view of game design is narrow, but it is highly optimized for gamification.

Definition 1 (Narrative) Narrative creation is a (meta-) cognitive process, is essential to student engagement.

When the system revolves around human input, as in the case of serious games, “every visit to the system actualizes a different narrative path” [27]. Eventually all such sequential events will fit the looser pattern of episodic narrative. Therefore, the
efficacy of player engagement in serious games will be multiplied.

As discussed in the related works, built in narrative is vital but external to students because they are tutor-created. In other words, where learning content can either be defined by the environment (e.g. a tutor or a thematic game), or by the students themselves (i.e. user generated content)” [29] or both.

In order to achieve the above purposes, we first study the historical photos and literatures and set down the contents of components of system for development. Besides, some interesting dialogues were embedded the serious historical stories and folktales. Folk music was also re-mixed for the new purposes. They are shown in the Figure 1-7.

Banded about as the marketing buzzword of our time, avatar can mean different things to different people. Some view it as making games explicitly to advertise products or services. Others think of it as creating 3D virtual worlds that drive behavioral change or provide a method for training users in complex systems. For our purposes we will define the term avatar [30] as follows:

**Definition 2 (Avatar)** Avatar is an interactive, social representation of a user, the animated agent that connects sociability and interactivity.

Avatars have a significant impact on virtual identity, because students will not engage in the process of learning unless they feel that they are engaged in the community of learning. Therefore, in serious games, “the motive is to define the boundaries of identity rather than the boundaries of land” [30] because “avatar is a specific persona, and different identity, of the driver” Behavioral
rituals “require specific sort of personalities” and “give archetypes meaning and expression, and vice-versa. The visual representation that a person chooses for their avatar has something to do with their role in the society [31].

In our system, our avatars can be classified into several peoples, like the adventurous traveler, friendly men and women, dangerous and fearful dragons, and magic stick, whenever can fire if in danger. They also are shown in the Figure 1-7. The web site for our system can be visited [32].

In order to achieve the above purposes, we first study the historical photos and literatures and set down the contents of components of system for development. Besides, some interesting dialogues were embedded the serious historical stories and folktales. Folk music was also re-mixed for the new purposes.

First of all, if we look at the field of cultural heritage education in the light of the tools and educational methods made available by serious game, we see that a number of new scenarios are opened, where barriers, boundaries, time and space limits seem to diminish or almost disappear. Serious game may also allow one to approach the study of cultural heritage artifacts by shifting from a subject oriented approach to an inter/ cross/multidisciplinary one, in such a way that, despite the subject-based approach of many educational systems in many regions may by contrast appraise the very nature of learning and of knowledge, which are intrinsically interdisciplinary. In order to discuss more deeply, the following categories are presented (as defined in Definition 3- Definition 8).

**Definition 3 (AI/ Path Finding)** AI decision-making and character personality models are intrinsically in the Hakka game logic domain and can be isolated pretty easily.

Normally path finding is integrated into the engine proper, but Autodesk Kynapse is becoming a viable alternate middleware solution to this problem. In our system, we design a new automatic level-generation mechanism to generate different but more interesting levels of game for players in a fly. The idea is simple and easy to follow. First, as the scripts for different layouts of levels were ready, our system can verify them and generate the corresponding levels of game for players. In the near future, we will focus the applications of Game AI applied into our serious game.

**Definition 4 (Animation)** Animations are fairly engine agnostic as long as they can be converted to a file format that the engine accepts.

Some of the animation re-targeting onto other characters would have to be redone in each engine as well as some of the animation blending and synchronization, but these tasks are not that time consuming compared to the creation of the animation. In our system, only 2D game engine was used for our serious game. To enhance more animation and fidelity, famous 3D game engine should be introduced.

**Definition 5 (User Interface)** All button graphics can be created and sized outside of the engine.

The buttons would have to be coded into their respective engines using different methods, but if these graphics and resolution stay consistent outside, that may avoid trouble. Our main rules for
design user interface are simple and easy to use for different levels of players.

**Definition 6 (Character Generation)** The visual object that represents a character and its corresponding physics object are engine dependent. However, the model of a character is bound to the AI object model and thus can be isolated from the engine. The NPCs and avatars would be responsible for attaching these AI objects to their engine visual/physics counterparts. In our system, we design many cute characters to catch the attentions of players. In the design phase, the shapes, weapons, and clothes were designed according to the scenarios.

**Definition 7 (Materials)** The easiest way to create material assets for use in web-based development is by creating high-resolution Photoshop files of each texture. All files can be batch converted from Photoshop in any size or format required. Materials themselves will still need to be re-created in each engine, as shader codes and material assembly differs engine to engine.

**Definition 8 (Sound)** All sound files should be cut, mixed and compressed outside of the engines even though the engines support built-in mixing, so that audio doesn’t have to be retuned when bringing it from one engine to the next. Sound streaming does not seem to be supported by all engines, so any sound streaming should be specific to mobile engines. To overcome the above problems, we design multi-threaded mechanisms to ensure the system operate properly.

## 5 Conclusions and Future work

In this research, we propose a generic framework to manage players’ behavior in serious game. The two properties-narrative and avatar which populate a virtual space and is exploited in two ways: it allows normal interaction as it would do in the real world, and its virtual nature gives an added value to the provided information.

The central question of whether a significant added value is offered by serious game to cultural heritage education has been answered above: Serious Game, if properly and suitably used, can contribute to innovate and improve educational interventions also in this field. Essentially, the cultural game play unfolds through the story of the environment told through conversations with the NPCs that the player meets and the nonverbal communication and other reactions to the other characters of the story. The story includes the golden nuggets of the environment.

The criteria for virtual cultural training in a game-based environment still serve as a core means by which to analyze ongoing development strategies. The most powerful virtual cultural training will be more effective if it has non-platform flexibility. At the same time, market forces may continue to reshape the game engine space and the types of devices are likely to evolve. The iPad, for example, may create a catalyst to the tablet computer space as the iPhone did for smart phones. To this end, regardless of how the various engine competitors and devices shape up, the non-platform-specific development that is advocated in the paper should make the key assets and development of virtual cultural training viable and enduring.

In addition, digital technologies also offer significant new possibilities for both actualizing active learning approaches and personalizing learning activities according to specific attitudes, tastes, talents and needs of players. Based on the above initial observations of an ongoing evaluation study we support the argument that a combined narrative and avatar principles in a serious game will assist the traditional methods of disseminating Hakaa art, especially towards the younger generations.

## References


[32] Web site link for Hakaa-based web game site:
http://h1688i.sg1004.myweb.hinet.net/game2.html

Jung-Tsung Chen received the M.Sc. degree in Department of Applied Mathematics from National Cheng Chung University, Chia-Yi, Taiwan, in 1992. He is currently an instructor in Department of Applied Game Technology at WuFeng University, Taiwan. His research interests include differential equations analysis, differential geometry, 3D shape modeling, and 3D computer animation.

Chih Ming Chiu received the M.Sc. degree in Computer Science and Information Engineering from Arizona University in 1995. He is currently working toward to the Ph.D. degree at the National Cheng Chung University. His research interests include computer animation, MMORPG, virtual reality, P2P, and Game AI.

Shao-Shin Hung received the M.Sc. degree and Ph.D. degree in Computer Science and Information Engineering from National Cheng Chung University in 1993 and in 2007, Chia-Yi, Taiwan, respectively. His research interests include spatial data bases, data mining, MMORPG, P2P, intrusion detection system, knowledge management, ontology system, and social mining. He is a member of the ACM, EG, and IEEE Computer Society.

Derchian Tsaih was born in Chia-Yi, Taiwan, in 1961. He received the B.Sc. degree in electrical engineering from the Chinese Culture University, Taipei, Taiwan, in 1984, and the M.Sc. degree in electrical engineering from George Washington University, D.C., in 1989, and Ph.D. degree in electrical engineering from Polytechnic University, Brooklyn, NY, in 1995. In 1996 he join the faculty of Wu-Feng Technical Institute, as an associate professor in the department of information management, Chia-Yi, Taiwan, where he is now associate professor in the Department of Electronic Commerce Management, Nan-Hua University, Chia-Yi, Taiwan. His research interests include network flow analysis, P2P, mobile networking and management, mobile web applications, and quality of experience in mobile networks.

Hui-Ling Lin received the M.Sc. degree in Department of Economics from National Cheng Chung University, Chia-Yi, Taiwan, in 1992. She is currently an instructor in International Business at Ling Tung University, Taiwan. Besides, she also now pursues her Ph.D degree in Department of Industrial Engineering and Enterprise Information, Tunghai University, Taiwan. Her research interests include automatic manufacturing system, neural network, knowledge engineering and artificial intelligence.

Jyh-Jong Tsay is an Associate Professor at the Department of Computer Science and Information Engineering at National Chung Cheng University, Chiayi, Taiwan, Republic of China. He completed his PhD Degree at Purdue University, USA, in 1990. His research interests include data mining, machine learning, information retrieval and game AI.