

Cultural Learning in Virtual Environments

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Abstract. This paper is a survey of evaluation mechanisms that may be specifically suitable for virtual heritage environments and also to some extent for social learning environments. It suggests in particular new terms and criteria to assess the contextual appropriateness of various evaluation methods. From two working examples it also reviews issues and lessons learnt from current ongoing research. The first case study of Palenque in Mexico involved five types of evaluation specifically chosen to assess cultural awareness and understanding gained from different forms of interaction in a virtual heritage environment. The second case study, 'Virtual Babel', will attempt to use some of these evaluation methods to track cultural learning between students in Japan and in Australia using an online virtual world.

1. Introduction

"I argue that despite this widespread and growing interest in VR, researchers and commentators have not yet begun to grapple with the question: What does it actually mean to describe something as *virtually* real? It is my contention that until they do the unique potential VR has to change the way we approach, study and think about the physical world will not be fully exploited...archaeological use of VR is at present all about the creation of pictures...Only after they have been generated does attention turn to the uses to which such models can be put"[1].

There has so far been little research into evaluation best suited for evaluating and improving the experience and learning of participants in a virtual environment [2] and even less work done on virtual heritage environment [3], [4]. There are many usability techniques in related fields; in Presence studies, in Human-Computer Interaction research, and even in Ethnography. Yet the particular issues and demands of digital simulations of past cultures or exotic places necessitate specific and careful examination of user needs, technical feasibility studies, and appropriate content on a case-by-case basis.

It is self-explanatory that virtual heritage environments are concerned not just with recording and preserving but also with transmitting cultural information. And there is already a large body of work on how artefacts and sites are best recorded and preserved.

There is also evaluation of user-experiences in museums, and via their websites [5]. Yet this work tends to focus on travel information, not travel experience, and certainly not on the cultural learning experience itself. There is still work to be done on what is cultural

information, how it can be interactively experienced, how it is best experienced and learnt, and how to determine the strengths and weaknesses of a virtual heritage environment's ability to provide a cultural learning experience.

2. A Working Definition of Culture

As this process has been described elsewhere [6], for the sake of brevity, the following definitions, although open to argument, will be used in this paper.

Culture: Culture expresses shared beliefs and ritualised habits of social agents towards each other and their environment via artifacts and language. Cultural behaviour is a subset of social behaviour (behaviour between two or more people), where behaviour is governed by or understood in terms of a cultural setting involving the constrained use of artefacts.

We could summarise cultural learning as learning through observation, instruction, or by trial and error. So there are two major ways of transmitting culture: through other social agents (through the language actions and reactions of other people), and through artefacts (the objects created and modified by people). The former seems necessary for understanding a culture natively (from the inside as vicarious experience), and the latter seems necessary for extending cultural knowledge or developing cultural awareness of alterity (from the outside as observation or as extrapolated experience). The notion of cultural learning as a spectrum covering awareness to understanding, and nativity to alterity is also important for evaluation, even though it is seldom made [7].

Virtual heritage environments are a subset of virtual environments, so it may be helpful to study how the latter are evaluated. Many evaluations of virtual environments measure a sense of 'presence'. Presence is often defined along the lines of: The subjective sensation that one is 'present' in a three-dimensional environment that is mediated by digital technology [8]. Presence has also often been described as the sensation of "being there" in a virtual environment [9]. 'Being there' is usually tested as a combination of factors: Social presence, engagement, negative feelings, spatial presence etc in a virtual environment.

A further dimension of presence often mentioned in conjunction with multi-user environments is the notion of copresence or social presence (there is disagreement in the Presence Research community over these terms) [10].

Co-presence can only take place within a system where you have the sense of being in another place or environment other than the one you are physically in and being there with another person. This differs (in the author's view) from social presence. Social presence is rather the degree to which a person experiencing a virtual environment feels part of potential or actual social interaction with at least one other being also capable of social interaction and/or the degree to which they see social interaction (mutually perceived and understood) between two or more intelligent beings. Cultural presence on the other hand is the feeling of being in the presence of a similar or distinctly different cultural belief system.

As far as the author is aware, this notion of cultural presence is new, and especially suitable to evaluating virtual heritage environments. For this definition specifies a goal: to measure the change in understanding of another cultural perspective different to one's own, and to measure the significance of that change in perspective and in knowledge; and the effectiveness of the tools and methods required to effect this change.

When we judge the strength of cultural presence, our judgement can be etic or emetic. Cultural presence may cover a spectrum of understanding and viewpoint (from etic to emic) with varying intensity. It may be felt, understood, or entered unself-consciously, empathized with, or observed but not understood.

It must be stressed that this measure of change would be evaluated from at least two different viewpoints, the etic or the emic viewpoint. Etic means an outsider's (a stranger's) view of a culture. More specifically, it is used to describe the anthropologist's method of

describing cultures from their own external cultural perspective. Emic means the converse, an insider's (a local's) view of their own culture's inter-relationship of concepts and meanings. In anthropology it is used to describe the relevance and meaning of concepts and categories from within the same cultural perspective.

Finally, there needs to be a measure of the cultural 'immersivity' of a virtual heritage environment. For want of a better term, we suggest Hermeneutic Richness: The depth and vividness of a medium that allows for interpretation of different cultural and social perspectives as judged from an etic or emetic viewpoint.

3. Types of Evaluation

What types of evaluation are there?

3.1 Expert Testing

Expert testing is usually done via cognitive walkthroughs or heuristic review. A cognitive walkthrough is a sequence stepped through by reviewers [11]. While it is preferable to have cognitive walkthroughs undertaken by domain experts (visualisation experts and archaeologists or cultural historians) who then suggest ways of improving the intended design, it can be difficult to obtain such a range of expertise especially since this stage of planning and design is often running late.

Nielsen termed heuristics as "a usability engineering method for finding the usability problems in a user interface design so that they can be attended to as part of an iterative design process" [12]. There are indeed heuristics for web-design, but they are based on a long history of creating HTML pages. Usability standards for evaluating not just usability but also usefulness for three-dimensional environments are still some time away. And until there is a significant and substantial collection of virtual environments with similar aims and objectives, it may prove fruitless to attempt content comparison reviews, even if there have been cross-media presence surveys [13].

3.2 Physiological Testing

Lombard also notes that there have been several papers in presence studies on capturing presence using "changes in skin conductance, blood pressure, heart rate, muscle tension, respiration, ocular responses, posture, and so on..." However, presence may not directly equate to physical or physically observed mental changes, [14] and it certainly does not directly tell us whether virtual heritage environments are causing changes in cultural awareness and learning.

3.3 Task Performance

Tasks are often set to record the participant's performance in solving them, in order to ascertain the degree of usability of the project. The term 'usability' has achieved a great deal of fame via the website of Doctor Jakob Nielsen, [15]. He defines usability as having five components: learnability; efficiency; memorability; errors (how many and how severe); and (subjective) satisfaction. He also mentions there are other factors, such as utility; does it do what users want? Dr Nielsen's suggestion for basic user testing is to test the project with representative users, and ask them to perform tasks. One could rephrase the above as an evaluation of effectiveness (how well the user achieves the goals they set out to achieve using the system), efficiency (the resources consumed in order to achieve their goals), and satisfaction (how the user feels about their use of the system).

Typical virtual environment usability research [16] tests one audience (say 10 people) with three different techniques to solve a certain number of tasks (such as navigation or object manipulation). When evaluating task performance against technique selection, the permutations may become overly complex. The tests were conducted using simple environments-hence the complex interdependent features of the environments may produce significantly different results. These specific results may thus not be generally applicable and test usability, not usefulness. Are there discrepancies between usefulness and usability? Would contextual constraints be useful or educational for users?

3.4 Surveys/Questionnaires

There are several issues with questionnaires. One person who has both used them and criticised them is Professor Mel Slater. Slater et al has argued in the past that one can evaluate presence through asking subjects to rate their feeling of being in another place but in a yet to be published paper he now believes their value is negligible [17]. Further, Presence criteria are usually evaluated using questionnaires, but large test audience numbers are not always available to virtual heritage environment designers. Questionnaires interrupt the engagement of participants so are used at the end of the experience rather than during the experience itself but this relies on memory recall and a succinct understanding of what actually happened [18]. Some researchers also use a Prequestionnaire to gain demographic data and an idea of user expectations [19].

3.5 Ethnographic Evaluation

An alternative method as suggested by Lombard et al is an ethnographic approach. For example, in Ethnography and information architecture, Mark Rettig, [20] argued that information design tools were very similar to those used in archaeological and anthropological research.

These tools are: observation (shadowing, people watching, examine ‘artifacts’); interviews (contextual, story telling); sampling (randomly, users are asked to sample events); and self-reporting (users take pictures or keep journals etc). There are also a growing number of papers in applying discourse analysis and ethnographic observation on multi-user online game environments such as MUDs [21]. The danger is of course that one could be evaluating social presence (how effective the virtual environment is at supporting social communication) rather than cultural presence and how well it supports the learning of different cultural perspectives.

4. Evaluating Virtual Heritage Environments

“What does the user want? Experience the past...in an accessible way...with scientific accuracy...through sustainable techniques...linked with the community” [22].

People intending to travel to a site may have different requirements to people just exploring a virtual world. Designers may want to use virtual environments in different ways: used offsite to understand past imagined or present site, inspire them to visit the real-world site through past present or imagined depictions, create as background for an online community, or use onsite to augment the experience. Which features are necessary not just for efficient usability, but also for onsite and offsite usefulness?

Experience of virtual environments

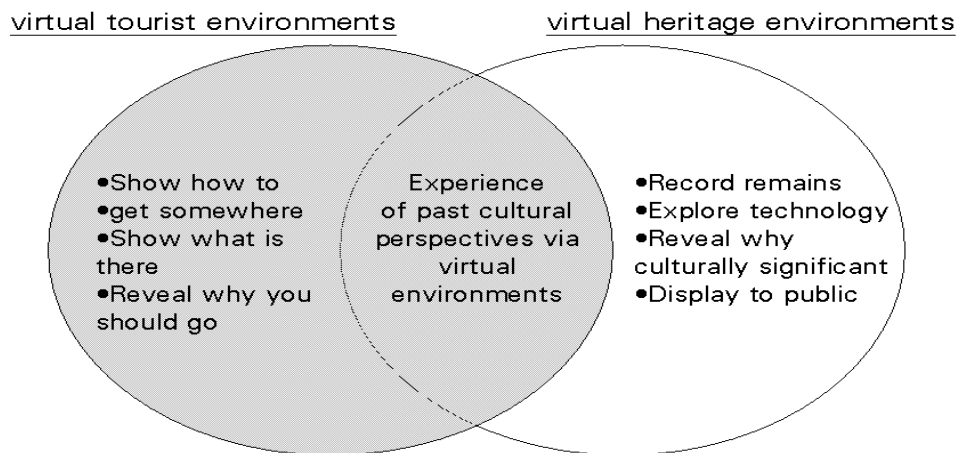


Figure 1: Diagram Contrasting Virtual Travel and Virtual Heritage

While the above diagram (Figure 1) may suggest virtual tourist and heritage environments have much in common (and indeed they do), it also highlights their differences. The former is more focused on travel information; while the latter is concerned with travel experience.

Evaluation of virtual heritage projects by Mosaker indicates interactivity and personalisation may be more important than realism [3]. Yet virtual heritage projects do not typically involve carefully modulated and monitored levels of interactivity. And hence we do not know which method of interactivity is appropriate and who or what it would be appropriate for.

5. Proposed Solutions:

Aoki et al [23] suggest 3 navigation paradigms for virtual environment travel, utilising vary levels of knowledge of navigation, goal or location. There are 3 suggested users, tourists, students and experts.

One could evaluate a group of tourists who explore the environment, and gradually add more levels of interactivity; does their sense of engagement increase? Or do different forms of interaction have a significant effect on virtual heritage experiences. Does game-style interaction, for example, increase or decrease a sense of cultural presence or cultural understanding? One problem would be that the more to an environment the more likely people will prefer it, and as their understanding of and skill in a virtual environment develops over time they may become more bored, or conversely, find it more enjoyable.

A computer model implies certitude. How do we present scientific uncertainty? Can we convey historical interpretation, hunches or imagined reconstructions? ArcDig is a “3D” (is really two-dimensional) game that allows students to guess where things are buried and then dig for them. It then provides answers as to where and why by professional archaeologists. Such a theme could be extended into a genuine three-dimensional game that explores the probable validity, the professional controversy and the eventual outcome of archaeologists’ hunches. [24]

One way of assessing cultural information transmitted is to see culture as a survival mechanism. Many “3rd person shooter” computer games such as Doom, Quake, Unreal, and Lineage, gain their popularity through challenging the participant to survive in a hostile world populated by aggressive agents. While such computer games can be highly engaging, and do offer interesting methods of interaction, they typically do so to the detriment of cultural

understanding, and certainly to the detriment of understanding and empathising with the local inhabitants and their unique cultural perspectives.

Nevertheless, we can adopt some game-style interaction techniques and evaluation methods for cultural learning in virtual environments. For example, we can note which artefacts users take with them on their virtual travels. We can check the usability of a travel diary / map, which acts as an on-screen inventory and memory recall device for the participants (players). We can observe what people do by replaying videos of their journey, and if there are scripted computer agents, we can check player and scripted-agent dialogue to see how quickly and easily actors learn to ask or write down the right questions and answers.

6. Case Study I: Palenque

The below case study has already been discussed at a previous conference [25]. However, the issues learnt from the evaluation will be discussed here. In brief, the site is a Mesoamerican temple-city. Three ‘world-slices’ of the environment were modelled, each with its own mode of interaction (refer Table 1 for time spent in each environment).



Figure 2: Temple of The Inscriptions (Activity-Based World)

In the ‘Temple of Inscriptions world’, people were asked to find artefacts and the accompanying web page of information, (Figure 2). In order to find and read the information they had to carefully re-position themselves while moving trapdoors and sarcophagus lids. In the second ‘Cross Group world’, people were asked to find and click on the Cross Group tablets; and listen to the scripted guides. In the third ‘Palace world’ they were asked to find as many of the hidden artefacts as possible, and read the related information. These phases were called Action-based, Guide-based, and Observation-based.

There were several affordances, proxemic music, glowing lights every twenty seconds, and buttons that would orient them to the next goal and tell them how far away they were. Photographs of real people available via the Lonely Planet Images database were mapped onto the face of each avatar. They were also allowed to fly since the steps were often huge, and the site was large for a one-hour experiment. Only the activity-based phase had serious constraints; that is, manipulation skills were required to move the giant slabs that hid the secret passages.

There were also four imaginative environments, which lasted for only three minutes, but incorporated one specific task.

In the ‘Primal Mountain’ world, they found themselves on top of a mountain, and were asked to find the mythical beginning of the world and then try to chase the paddler gods before the fog lifted completely.

In the ‘Mayan Village’ or ‘Milpas’ world, they were asked to chat to another player in order to find each other via the Mayan carving landmarks, and then together to find and make a Mayan village appear. The Mayan avatars were also sized appropriately (less than five feet tall) and only by changing into that smaller avatar were participants able to explore the interior of the Mayan huts.

In the ‘Mayan Cave’ world, when the avatar walks into the water, they automatically start swimming under water, blue fog appears and the sound of bubbling water drowns out the ambient Mayan music. If the participant does not keep pressing the forward arrow they slowly ascend back to the surface of the water. By finding, collecting and then dropping artefacts at a hidden shrine, a Mayan sky-snake appears and so does a portal that takes them back to the start.

In the ‘Mayan Ballcourt’ world, each participant turned into a Mayan ball player, and was asked to try to get the rubber ball to touch the hoop. If they did so, thunder and lighting were triggered.

These ‘imaginative’ environments were not evaluated by a general knowledge questionnaire, but they were evaluated by the other methods. As part of the evaluation participants were asked to rank the imaginative worlds against the archaeological worlds in terms of a range of presence criteria.

Table 1: Test Environments

No.	Environment	Objective of Environment
Warmup		
a	Teotihuacán	In 3 minutes learn how to use software
b	Milpas (village)	In 3 minutes discover / share /navigation
Archaeological and Imaginative Reconstructions of Palenque		
1	Inscriptions (action)	In 9 minutes move slabs to descend to bottom of temple
1a	Mayan Ballcourt	In 3 minutes Action-play
2	Palace (observation)	In 9 minutes Find artifacts and click on them.
2b	Cave	In 3 minutes Pick up and release artefacts
3	cross group (guides)	In 9 minutes find and listen to guides, then enter temple
3c	primal sea-mountain	In 3 minutes discover the world tree; reach the paddler gods.

The demographic data collected was of age group, gender, literary knowledge of Mesoamerican archaeology and culture, PC Internet and PC game experience, and travel knowledge of the region.

Before the virtual environments were finished, three domain experts (archaeologists and usability specialists) suggested refinements to the navigation and interaction. An archaeology teacher also provided feedback on the questions asked.

Her class of first-year archaeology students was evaluated against the prototype, in computer lab settings of up to fifteen people. They were asked general questions on cultural knowledge acquired, and were tested on what they observed, asked to rank the worlds in terms of several ‘presence-style’ criteria, asked to judge which world had the fastest speed (frame-rate), and their in-world task performance was also recorded.

The next stage was to evaluate 24 domain experts, cultural historians, archaeologists and designers of three-dimensional (especially virtual) environments with the same evaluation methods. The last stage was to evaluate another group of ten people from Lonely Planet but this time swap the interaction styles while keeping the content as similar as possible. The main objective was to gauge how interaction affected cultural understanding and collated results from this comparison will hopefully be published in an academic journal.

Apart from the quantitative results, there were several interesting observations to be made from testing the eighty-one participants. In the prototype students were keen on exploring what options were available to them to change avatars and talk to each other. There were

many requests on how to destroy or shoot things, which is rather disturbing given that they were archaeology students. Perhaps game-style interaction has created a game-genre at odds with cultural learning.

None of the groups enjoyed answering general knowledge questions, which were probably too hard. It is difficult to assess cultural learning via knowledge and recall questions. It is highly possible that people's answers to questionnaires do not truly reflect their sense of engagement. And although they ranked the archaeological worlds higher than the imaginative worlds in all the main criteria, it was difficult to coax experts and students from the two game-based worlds, the Cave-world and the Ballcourt.

7. Case Study II (Ongoing): Virtual Babel

We have argued that cultural transmission is mediated through artefact use and interpretation, and through social dialogue. We also believe that it is important for language learners to be in the target language community using the target language. Contextual placement allows them to quickly and effectively learn not only the linguistics aspects of the language but also the cultural aspects that underpin that language.



Figure 3: Virtual Babel screenshot

The purpose of the Virtual Babel project (Figure 3) is to address the above problem of contextual immersion, and social communication within a contextually appropriate simulation of the target culture, in order to provide an enriched and memorable learning experience. A web-based 3D virtual environment designed for target language immersion may enhance intercultural understanding for second language learning as it can provide for ostensive learning, social exchanges between people not physically in proximity, shareable and discussable objects and activities, as well as allow for trial and error learning between students without a sense of invigilation while at University or at home.

Virtual Babel is designed to support learner-centered learning outcomes of Australian university students through project-based collaboration in a virtual online 3D environment with their Japanese counterparts, who are the native speakers of the target language. In Virtual Babel the language learners can interact and improve their cultural understanding and language acquisition through social activities requiring communication and negotiation, as well as by user-based additions and personalisation of the virtual environment.

We are currently adding scripted tracking devices to record user conversation and encounters, the rooms that they visited, and object interaction. We are further investigating ways in which three-dimensional worlds and game-style interaction can integrate with dialogue and text-based commands to embed language learning in a cultural world and allow for enriched and embodied social interaction between different cultures.

8. Conclusion

Evaluation results from the case studies mentioned above have not yet been completed. The findings so far suggest that engagement relates to how appropriate the interactivity is rather than what type it is. While people are attracted to social agents (scripted guides) they soon tire of them if they can predict their behaviour. Task performance does not directly relate to knowledge learnt for short-term immersion in virtual environments.

It also appears very difficult to gain a sense of cultural learning from multi-choice general knowledge questions. Many people, students in particular prefer to randomly explore and then just guess answers when evaluated. This suggests that evaluation should be as much an integrated part of the virtual learning experience as possible. Usability experts seem to agree [26]:

“Museums and video arcades exploit similar themes: meaningful activities, learning that takes place invisibly, not as the objective, but naturally, effectively. Exploiting social interaction and discussion. Participants don't think of themselves as interacting with technology, they think they are doing something interesting: discussing an interesting topic, playing basketball, riding a jet-ski, skateboarding. They exploit social interaction and cooperation. The result is high intense concentration, true learning, with people anxious to go back and do it again, paying for it out of their own money.”

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