Collaborating through Space and Time in Educational Virtual Environments: 3 Case Studies

Ali Arya, Peggy Hartwick, Shawn Graham, Nuket Nowlan

Carleton University, Ottawa, Canada

Abstract: In this paper, we address the use of "virtual space" as a learning environment. With the advances in e-Learning systems, the education community shows a growing interest in using online tools for educational purposes. The case studies presented in this paper demonstrate how a 3D Virtual Environment can be used as a learning tool by providing a virtual space that allows people in different locations to interact and gives users access to facilities, settings, and even people not available physically. We demonstrate these advantages through three case studies that offer a framework for presentation of Native dance styles, language learning for English as Second Language students and a simulated archaeological excavation site for History students, in the context of Carleton Virtual, a 3D virtual environment for Carleton University. Based on the results that show the advantages of using the virtual space as a learning environment, we argue that Virtual Space can introduce a new educational paradigm.

Keywords: 3D Virtual Environment, Avatar, Virtual Space, Education, Interactive, Digital Media

1. Introduction

As educators, we are interested in making our teaching and research as accessible as possible. Sometimes, it is a question of geography- physical facilities and spaces such as research labs and university campuses are location-dependent and only accessible to those in that geographical location. Othertimes, some training and research activities require the development of fieldwork or complex simulated environments that are either too costly or impossible to arrange (e.g. training emergency personnel on handling major disasters). In addition, it has been recognized that innovative work requires collaborators to share tacit and explicit knowledge freely (Brown and Duguid, 2001) which requires the rich communication usually associated with face-to-face interaction, enabling people to transfer individually-held knowledge, and synthesize it to fashion new collective knowledge.

In this paper, we discuss three case studies that demonstrate the use of a Three-Dimensional Virtual Environment (3DVE) as a ‘virtual campus’, and a step towards widening access to both research and teaching. Our case set consists of (1) a virtual presentation of the dance styles of native North-American people used as an example in a course on Interactive Media and Digital Art, (2) a framework for language learning for English as Second Language students and (3) a simulated archaeological excavation site for History students. The 3DVE used in the discussed cases is called *Carleton Virtual*, a virtual campus developed by researchers at Carleton University using Web.Alive avatar-based 3D tool by Avaya (http://avayalive.com/Engage/). As briefly reviewed in Section 2, the academic uses of 3DVEs have been reported and discussed by other researchers, but serious limitations exist in provided functionality and evidence of usefulness as academic tool. Through the presented cases, we hope to show the particular features of our proposed solution (intelligent agents, communication and collaboration, 3D spatial voice, scripted events and interaction, etc) and also the advantages of 3DVEs in general as educational tools. These case studies collectively and progressively demonstrate a series of feature that can improve the educational experience: The first case shows the ability of 3DVE to provide information in a more engaging way including NPCs and some AI. The second case adds communication, collaboration, and environmental simulation. Finally, the third case advances the simulation to a more interactive task and also shows how the 3DVE experience can be customized and integrated within a special web page.

In the following sections, we begin with a review of some related work, then the general structure of our framework and particular structure and results of three case studies will be presented. Finally, we will provide a discussion and some concluding remarks.

2. Related Work

Eysenbach et al. (2004) have argued that the advantages and disadvantages of using virtual communities for health and education still need to be studied. This point is also raised by some other researchers such as Demiris (2006 and 2008) and shows the need for further studies on the use of 3DVEs for education, and required functionality. Second Life (http://www.secondlife.com) is a 3DVE that has been widely used for social, educational, and commercial purposes. Boulos et al. (2007) have provided a good review of potential uses of Second Life and other 3D virtual environments for health and medical education. They argue that 3D environments provide an immersive realistic experience that can combine communication, entertainment, training, and access to a variety of data types. Callaghan et al. (2009) also report the use of Second Life for technology education. They notice the need for some simplifications (for example in teaching engineering equipments) which can be a problem but also mention partial integration with a content management system (Moodle) which is a considerable advantage. Danilicheva et al. (2009) explore the educational values of 3D virtual worlds but from a storytelling point of view. Their work points to the value of artificial intelligence and also uses stereoscopic 3D to increase immersiveness. The common conclusion seems to be that virtual communities may provide a more flexible and accessible learning experience, empower users (students, professionals, patients, etc) and enhance coordination of education/care services.

Issues with Second Life and similar products mentioned by these and other researchers include scripting and artificial intelligence (used for Non-Player Characters and events), integration with other tools, web-based operation, spatial 3D voice, and business model. Unity (http://www.unity3d.com) is a 3D game engine with growing popularity that addresses some of these issues but still doesn't provide proper integration with other applications (e.g. the containing web page), spatial voice, user customizable avatars, measurement tools, and some other features. Web.Alive tries to address some of these issues as discussed in the next section.

3. Virtual Framework

3.1. Carleton Virtual

Carleton Virtual is a 3D educational virtual environment developed by researchers at Carleton University built using support from Avaya (http://www.avaya.com) and its web.alive technology (http://www.avayalive.com), itself based on Unreal Engine (http://www.unrealtechnology.com). The research group (including faculty, graduate and undergraduate students) initially reviewed and tested some major alternatives for 3DVEs including Second Life, OpenSim, Wonderland, Unity, and some in-house solutions, then established a partnership with Avaya to provide the base technology, servers, and technical support. The researchers then developed the base campus and also specific elements for three courses as pilot projects (case studies presented in this paper). The research group consists of technical members (faculty and research assistants for system design, content creation, scripting, etc) and educational members (faculty and teaching assistance for the course design).

As shown in this figure, CV provides spaces for lectures, various presentations, collaboration, social interaction and special activities. Figure 2 captures some views of the virtual environment that was designed to resemble the actual Carleton University campus. The design keeps some of the characteristic features and elements of the campus but allows modifications to improve the space usage and customize it for the virtual activities. Current implementation of CV includes only the main “quad” area of the university campus. Quad consists of a recreational area with library, main administrative building, one academic tower and two other smaller buildings. Actual Carleton University campus is much bigger and is not fully implemented. The quad area buildings are also significantly simplified. On the other hand a new gallery building, native village, and dig site are added. Researchers from the School of Architecture in addition to the faculty members have helped design the CV environment.

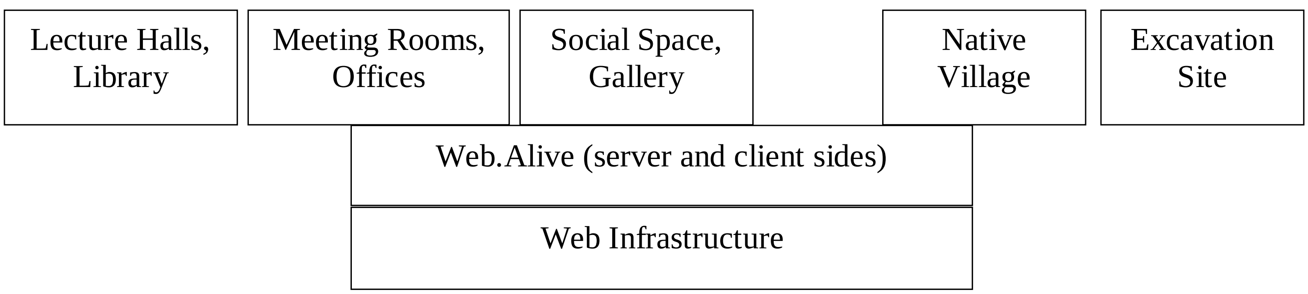

Figure 1. General Structure of the Carleton Virtual

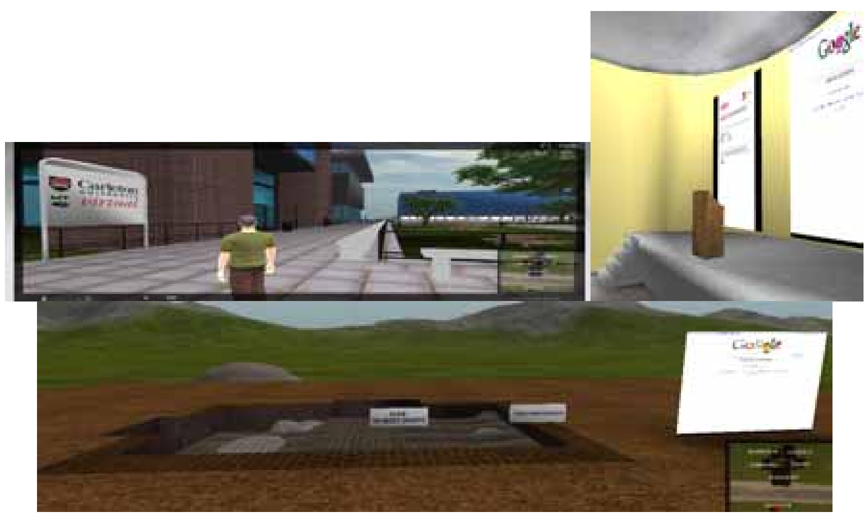

Figure 2. Sample Views. Top-Right, general campus area, Top-Left, classroom, Bottom, virtual excavation site.

The content presentation is done through surfaces (screens) that can show videos, images, presentation files (supporting Powerpoint and PDF), and real-time web pages. This will allow instructors and other participants to easily access content and update it in real time while in the environment. The system allows 3D spatial audio. The sound level can be independent of distance (e.g. for speakers in the lecture hall) or change based on avatars distance (for local talks). At any time, users can know who can hear them, and also can control different audio features such as temporary mute. Different “areas” can be defined to simplify environmental control (e.g. private meetings) and behavioural monitoring (e.g. who goes where, etc).

The same 3DVE can be integrated in and accessed through different web pages, which means each course can have its own customized interface with different information and interaction. Creating events and interaction can be done through scripting at two levels: UnrealScript (when creating the 3D content and done by more expert developers) and Javascript (when embedding the 3DVE on a web page and done by less experienced users with some HTML/Javascript knowledge). Developing 3D content (using standard 3D software and Unreal Editor) and UnrealScript code can be done only by a technical group with development access and specialized expertise. Typical end users (instructors) will need to coordinate with this group in order to make changes to the 3D environment.

General activities like lectures and collaboration involve tasks like presenting content in different forms, meetings, and social interaction. They are used in both case 2 and case 3. Special activities are those not commonly used by educators and students. The primary examples are the virtual dance and the excavation site discussed in cases 1 and 3. The un-official PC-only prototype for CV can be publicly accessed at http://img.csit.carleton.ca/vcu.

3.2. Implementation with Web.Alive

The implementation of this solution is broken down into two parts: (1) CV content, (2) web.alive base. The content is a set of 3D assets generated using standard software tools and environmental controls such as events, triggers, scripts, and volumes, defined using web.alive editor (which also serves as the tool to put together all the assets). Content development is done at system and course levels. The general CV system is designed for basic academic functionality by the technical members of the research team. Instructors then design their courses and the related tasks based on existing general features (like presentation space) or ask for specific features (like a dig site) to be developed specifically for their courses. This development is done by the technical team with occasional support from the Avaya staff. Since the basic system design includes many required academic features such as communication, presentation, submission, etc, it is expected that many new courses will not need extra content and can be developed by the instructors with minimal technical support.

Web.alive technology is based on the Unreal Engine by Epic Games (http://www.unrealtechnology.com). It embeds the Unreal Engine within a web-based product and adds a series of commonly needed features such as web integration, security and user authentication, measurement and inspection tools. At this time, web.alive supports PC and Mac but no mobile devices. Web.alive content are located on special servers that can be run by Avaya or content owners. For the purpose of this research project, we used servers provided by Avaya as in-kind support.

One of the strengths of Web.Alive technology is instrumentation and measurement. An overview of the telemetric instrumentation and data collection tools in Web.Alive is out of the scope of this paper as they have not been widely used in the presented cases. Using these tools existing analytics, we can browse through encounters of each user, view conversations (who, where and when) that occurred within the environment, observe traffic and conversation patterns based on the interactive heat-map tool and much more.

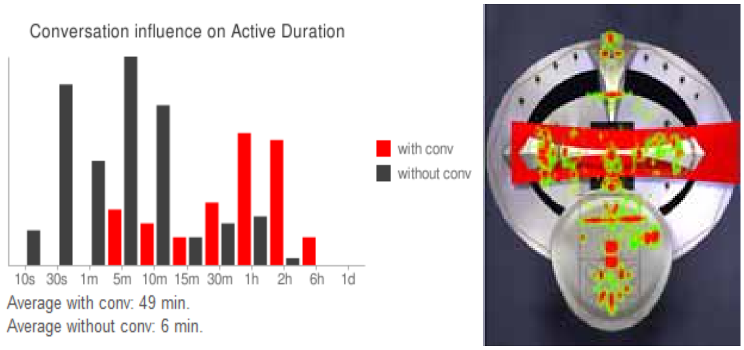

Figure 3. Example of Conversation Influence on Active Duration (left) and heat-map (right)

For example, using the tool we are able to observe (see Figure 3) the influence of conversation on active duration within the environment. As indicated by the graph, those users who did not actively participate in conversation within the environment during the pilot window were far more likely to idle or leave the environment. This is an excellent indicator of the importance of encouraging user participation in conversation during learning sessions. We can also see the distribution of logins to the environment both daily and hourly. What is most important to note from this type of data is that users not only enter the environment for the specific task, but also enter and spend time at other points, likely to collaborate with others and practice their simulations. Other available analyses allow us to identify those that were most active in encouraging participation from others, and the most popular actions and locations within the environment (through heat-map).

4. Virtual Pow-wow

4.1. Design

Native dance is an inseparable part of First Nations' culture and understanding it is necessary for relating to this culture and preserving its heritage. The study of First Nations' culture, including their music and dance styles, has received considerable attention from both the aboriginal community and other scholars. Recently, with the growth and popularity of the Internet, some dedicated websites have provided invaluable content for those who wish to learn about these subjects. But digital and interactive technologies are more than a means to collect content on the web. New media present new possibilities for understanding, presenting, and preserving any type of information, and these possibilities have not been fully utilized for First Nations' cultural heritage. As part of a graduate research, and also a proposal for undergraduate or graduate courses in Canadian Studies and before development of *Carleton Virtual*, we have developed *Virtual Pow-wow* (VP), using the state of the art in multimedia and human-computer interaction to provide a new dimension to the way we understand and enjoy native dance.

Designed authentically, VP allows users to experience an authentic pow-wow online, interact with it (get closer, pause, and look from different points of view), study the movement in details, and get extra information as text, audio, video, etc. Photographs of native villages and dancers are used for modeling object and clothes while the performances of real native dancers invited to a motion capture studio is used to create animation of virtual characters. VP was originally designed as a separate project using Unity game engine (http://www.unity3D.com). After development of CV, sample parts of it were ported to CV to be used in some possible courses. Integrated within the Carleton Virtual environment, it has become part of the virtual campus while in physical campus no such ability exists except for occasional events. At this time the interaction between users and VP is limited to browsing through the environment and starting/pausing the dance. Figure 4 shows some views of VP and sample videos can be seen on the website: http://img.csit.carleton.ca/vpow . It has links to original Unity-based 3DVE and sample videos, for example: http://img.csit.carleton.ca/vpow/GrassDance-July-22-08.wmv

4.2. Pedagogical Motivation

VP can be a significant educational tool for any course that deals with native dance styles, from North American history to arts and culture. Although the native community has always respected and preserved its traditions to the best of their abilities, and a considerable number of scholars have done valuable research on this, advances in multimedia hardware and software have not been fully utilized in this regard. For instance, Native Dance (http://www.NativeDance.ca) and Native Drums (http://www.NativeDrums.ca) are two websites supported by Carleton University that provide a wealth of information on these subjects. However they are still collections of text, image, and traditional audio/video recordings. New media and interactive digital technologies provide much more capabilities in the way of the above mentioned objectives for native dance. Certain native dances have been studied by a few scholars and researchers. Well detailed analyses of movements and styles are extremely limited, especially those using new technology. Franz Boas (1944) was one of the pioneers in such studies. Gertrude Kurath (1986) produced the most detailed native dance studies. Her studies of native dance for Iroquois nations (Kurath, 2000) combine the musical information with her own notation system for recording dance moves and choreography. Kurath's notation consists of ground plan, choreography (sequence of moves), and music, as shown in Figure 5. Kurath's primary movements are mostly limited to lower body steps. Her notation does not provide enough details for proper understanding of dance styles, especially without a video recording.

Figure 4. Virtual Pow-wow at Carleton Virtual

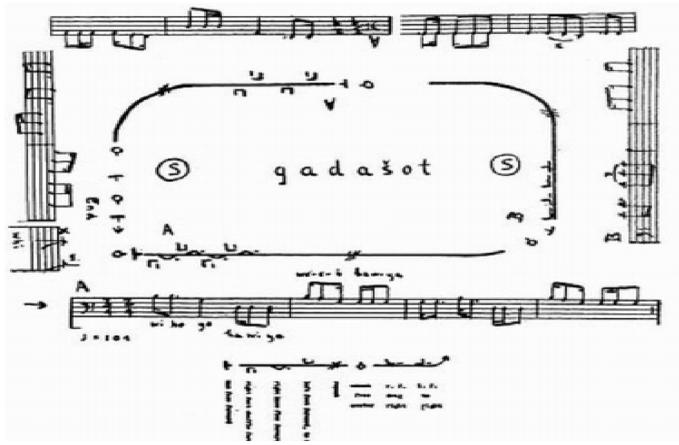

Figure 5. Example of Kurath's Notation. Dance cycle is shown using special symbols, and the music is written around it.

Unfortunately, more recent works do not provide more detailed (and quantitative) analysis for native dance (Wright-McLeod, 2005). Those accompanied by videos try to address this shortcoming but are limited to quality, point-of-view, and other video properties.

Using VP, instructors and students can interact with authentic virtual native dancers, browse through a native village, and learn about First Nation's art and culture that wasn't possible otherwise unless with expensive and difficult field trips and attending occasional ceremonies.

4.3. Task

During the pilot phase of CV, ten graduate students (mostly from Engineering programs) in an introductory course on Interactive Media and Digital Art were asked to compare four different media types (books, videos, multimedia websites, and virtual environments) for the common task of finding information on native dance styles. They were instructed to use books and videos available in university library, the native-dance.ca website and the VP environment in Carleton Virtual. The students were given a series of evaluation criteria but were also told to add other criteria if the given set does not include what's important to them. The purpose of the task was to understand the role of features of digital media compared to more traditional ways of accessing data. The native dance was only chosen as an example because information about it was available in different media types.

4.4. Learning Outcomes Observed

Overall, the results show that a 3DVE such as VP can provide significant learning potentials that makes it a strong candidate for a learning space. The assessments were done on a 5 point Likert scale, where the students evaluated each media type using a set of criteria, as shown in Table 1 (average values).

Table 1. Comparing Media Types for Native Dance Study

	Book	**Video**	**Multimedia web**	**3DVE**
Ease of use	2.9	3.5	4.4	3.4
Access to different types of info	3.3	3.4	4.8	4
Level of engagement	2.5	4	4	4.8
Overall pleasantness	2.3	4.1	3.6	4.5
Criteria suggested by only one participants				
Usefulness	5	2	4	3
Speed	2	3	5	3
Memorability	3	2	2	3

The students found 3DVE the most pleasant and engaging method but it received lower scores for access to different types of info and ease of use. As mentioned by some students, the types of information available on VP was limited not because of the medium itself but mainly because textual information has not been implemented in VP yet. As the next two cases show, the 3DVE method can easily be integrated within a website or have built-in textual parts such as notice boards, presentation surfaces, and interactive submission tools. On the other hand, the ease of use may remain an issue for some users and for some types of data as it is a more complex navigation system compared to other methods, while it will be easier with practice. This was also confirmed by some students.

4.5. Student Reflection

Most students believed that a multimedia website is the easiest way for finding different types of information:

- "Websites with text and video scored the highest for the ease of use and ability to access categories."
- "Comparison table shows that websites with text and audio are still the best way to research compared to books, videos and the virtual Pow-wow environment."

At the same time, some students found face-to-face or video easier (not necessarily with better access to different types of information):

- "Videos are very easy to have short and fast idea about anything you want."
- "Videos is the best method regarding ease of use because it is just one click and you are already watching a powwow dance live on your device. Websites and books needs more navigation and searching to see the dance you want, although it is not that difficult to do so, searching for a video of specific dance is still easier"
- "Person to person learning is the easiest form of learning in my option."
- "People can obviously search their knowledge quite rapidly. "

3DVE was generally considered the most engaging and pleasant but there were those who did not agree and still thought the traditional methods are valuable:

- "This virtual environment has better level of engagement because it's like a game you go inside this virtual word and walk for different side of this word and see whatever you want. As a result you feel better with virtual pow-wow as a source of information than other sources because you enjoy and collect information about your research."
- "Person to person communication was rated the most engaging."
- "The Books option had the lowest ratings comparing to other media, even though I personally still enjoy reading books. "

Some observations made by participants included options we did not consider in the task, and also the limitations of the current 3DVE system which can be improved:

- "E-books should be added to this comparison as they provide a new alternative with advantages of traditional books and websites."
- "The VP environment does not provide enough information at this time but has the potential of embedding more."
- "The VP environment is not easy to use for some users but will be after proper training."
- "Watching virtual dance was as pleasant as watching the video but the Internet speed reduces the pleasantness a little bit."

- "Virtual environments were rated mediocre since they vary from poor to good. It is likely that in the future virtual environments will make it easier to find information."

The course was not about native dance styles, and understanding them was not the real objective of the course. Consequently, the task was only one short assignment within a course related to interactive technologies and digital art which included many other tasks not related to this paper. Compared to other case studies, this case was relatively small although development of VP was a big project done before this study.

5. Language Case

5.1. Design

The current trend towards "hybrid" or "blended" learning in post-secondary education is driven by the ever increasing access to various modes of technology, student familiarity with these technologies and changes in learner attitudes towards learning. Today's tech savvy students want more choices in education delivery as a result of different learning styles, work and study schedules, and access to new technologies. For language learners, computers and internet technologies can provide exciting new opportunities, but require careful planning, collaboration, time and some technical know-how on the part of the teacher. In the *language case*, we investigate the use of CV for a language learning scenario. Initially the teacher, who had no prior gaming experience and was a novice to 3D immersive environments, was hesitant to design and pilot a task, but she was keen to experiment with this new learning platform and motivated by the opportunity to collaborate with colleagues from other departments.

Designing 3D learning scenarios and tasks requires collaboration with experienced technical and educational designers – a design team. After several frustrating attempts at designing a language learning task for CV in isolation, the teacher took the opportunity to experience the environment with one of the 3D technical designers who demonstrated the many benefits of the environment including classrooms, collaboration surfaces and synchronous voice and movement. This hands-on experience helped the teacher conceptualize the types of language learning tasks and opportunities best suited to this type of learning environment. The team then focused on designing learning scenarios that might not otherwise be possible in a traditional language classroom. The teacher's initial frustration was likely caused by trying to replicate tasks used in a traditional language classroom. The challenge now was to create a learning scenario or task late in the term that might help motivate and engage this particular group of learners.

Teaching English for Academic purposes to international students can be pedagogically challenging at the best of times as some students easily become disenchanted, unmotivated and have difficulty appreciating the value of the course, especially towards the end of term. Traditional classroom tasks attempt to promote collaboration and critical thinking through group work and careful task design, but too often are overshadowed by teacher-talk and instruction. Consequently, any method of delivery that might engage and motivate students was worth pursuing. Further, any context or task that that might promote oral interaction, and opportunities to speak, collaborate and negotiate by its very nature should produce rich opportunities for language use and production – something the classroom was not necessarily providing at this point in the term. Intuitively, using CV as a learning environment might lead to increased language proficiency and accuracy.

This pilot project was designed so that students and teacher from an Academic ESL class could explore a learning opportunity in a 3D immersive environment. It made use of the existing Carleton Virtual framework, which provided participants with a unique opportunity to practice interacting with classmates and teacher using a common linguistic reference (English) in a risk-free environment. CV allowed students to collaborate, at their convenience, in a space that replicated the Carleton campus library and other buildings, but that was mutually convenient to the participants in terms of time and accessibility. In particular, students were encouraged to meet in any of the ten designated library rooms and final presentations were held in a replicated auditorium.

5*.2. Tasks*

This project was piloted with advanced English as a Second Language Academic (ESLA) class. To begin, students were introduced to the concept of online learning, and virtual worlds and virtual learning environments through several related sources (Ally, 2008; Augar, Raitman, Lanham & Zhou, 2004; Sweeney, 2008; & Vickers, 2010). These reading and listening sources were assigned during regular class time and for homework. Corresponding tasks were designed to help students develop an initial understanding of the issues and challenges associated with learning in a virtual or online environment. For example, in-class activities alerted students to the advantages and disadvantages of online and 3D immersive learning, and identified some basic learning theories. In-class activities included debating pros and cons, comparing traditional to 3D learning contexts and using specific learning examples to describe the benefits of immersive learning. Additionally and through specific exercises, these readings and activities helped to establish some academic and topic related vocabulary such as “virtual”, “theory”, “participate”, “environment”, “communicate” and “immersive”. Students later attended a *virtual workshop* wherein they were to have experienced first-hand the CV environment. Unfortunately, students were not able to login as actual users due to an unexpected “plug-in” issue in the school’s lab; however, workshop facilitators were able to demonstrate how the avatars moved around and the different physical meeting spaces within the virtual environment on personal laptops.

Next, students were given the actual task. This consisted of a choice between a more traditional group research project and presentation or a virtual group research project and presentation. Student groups then had the choice to compare either two non-governmental organizations or two virtual learning platforms. These sub-topics were related to broader course themes, *sustainable development* and *eLearning*. Students who chose the traditional group presentation had to arrange their group meetings on campus and the final group presentation took place during a regularly scheduled class time. Alternatively, students in the virtual groups were required to meet, collaborate, research and present exclusively in Carleton Virtual at a mutually suitable time. During the course of this task, students were encouraged to reflect upon and keep notes on any experiences (actual or anticipated) and try to articulate on any apprehensions about learning in a 3D environment. Group presentations, traditional and virtual, were evaluated as part of the final grade.

The five virtual groups had 3-4 students each. Each group was required to meet at least 3 hours per week for the duration of the course (two weeks) and once more just prior to the presentation. Groups met in designated meeting rooms in the CV library in order to collaborate on the research, prepare the slides and practice the group oral presentation. The teacher held *virtual* office hours each week and randomly joined the groups to troubleshoot and to verify groups were on task and working in the target language.

The final group presentations were made on stage in one of the simulated university auditoriums. Members of the other virtual groups and non-virtual groups attended the live presentations.

Participants, the teacher, and a member of the research team logged in from their homes to either present or listen.

Figure 6. Student in CV library interacting with NPC

Figure 7. Students interacting in CV library room. For each avatar, name and sound volume can be presented in a small box over the avatar.

5.3. Tools and Functions within Carleton Virtual

Understandably, the ultimate success of a virtual learning task depends not only on the actual task design, but largely on the environment and the tools available within the immersive environment. As CV physically replicates the Carleton University campus, tools available to users are similar to those which students depend on normally to accomplish their academic assignments. The additional bonus is this environment gives students the flexibility to work from home and at any time. For instance, in each of the library study rooms, students can use either of the two available collaborative surfaces to jointly access content from the Internet and/ or upload files from a shared drop box. While these tools are available in traditional working environments, what makes this experience unique is that the students can perform from home and under the persona of their avatar.

The option to personalize their own avatar was appealing to many students as they could choose to alter such avatar traits as hair, skin and eye colour, clothing, height and weight, and even gender. This simple act of representing oneself somewhat fictitiously (through a personalized avatar) generated spontaneous language production and even humour as group members commented on each other's changing appearance from day to day. Students liked the "game-like" scenario and had fun using the avatar options. Further, students appeared to take advantage of the relative anonymity of their avatars to take risks with their language without the worry of being judged by their teacher or classmates as in a traditional classroom setting.

We observed an increase in learner oral interaction and collaboration through real-time voice and movement. Students actively communicated with each other using a USB headset, easily maneuvered their avatars with 4 keyboard keys and made use of some of the 9 basic gestures like a hand wave, head nod, clap and bow. In comparison, Second Life was found to be more tedious in terms of user-ease. The number of movement options and gestures, landing areas and presence of random avatars was overwhelming. The interaction was mostly confusing, language of interaction varied, and many avatars did not engage or were inappropriately dressed (for an academic learning context).

Figure 8. Student oral presentation in auditorium.

5.4. Learning Outcomes Observed

Perhaps our most exciting observation was how some student groups embraced this opportunity with new-found enthusiasm and energy (this project was introduced towards the end of term and so motivation was beginning to wane); this enthusiasm translated into professional and well executed group oral presentations. Not only did several groups pull-off strong content in their slide presentations, but they had clearly practiced their presentation "etiquette" as evidenced by their stage presence, authentic and "true-to-life" mannerisms and well-timed delivery. Some student groups also demonstrated great pride and care as substantiated by their carefully groomed avatars.

In addition to apparent increased levels of motivation and task engagement, we observed that some learners appeared less reticent about presenting to other non-native speakers and actually demonstrated more initiative and problem solving skills than had been observed during group work situations in the traditional classroom. In one instance, a student became the group leader and quite outspoken, a complete contrast to this student's typical classroom demeanor.

The 3D environment appeared to generate excitement and gave students the freedom, flexibility and autonomy which ultimately motivated them to work more collaboratively in a "fun", risk free environment – a gaming environment for which many of them participated in easily as experienced "gamers". Consequently they felt comfortable manipulating and moving around this new learning space, perhaps more so than moving around the traditional language classroom.

It is important to note that this task was executed and piloted during a very short period of time and at the end of term. The teacher and students were all new to 3D environments and had no previous gaming experience. Yet, preliminary teacher observations suggest that ESLA learners might benefit from alternative learning environments like CV, because they are fun, autonomous, and relevant, providing the task is challenging and generates opportunities for language production. Historically, language and immersion are mutually complimentary terms. Intuitively, 3D immersive environments could be exciting new venues for exploring future language teaching and learning initiatives.

5.5. Student Reflection

As part of the presentation, student groups were asked to reflect on the advantages and disadvantages of collaborating and presenting in CV. While student feedback was generally positive, there were some challenges. Overall learners liked this unique and interesting learning opportunity and commented on how it was more active and attractive to their generation who liked and were at ease with technology. They liked the fact that communication was easy, synchronous and most similar to face to face communication compared to using other learning platforms common to them. Students commented on the ability to integrate other web-based resources, like web render screen while in the environment. Challenges included technology and the Internet access, which were not always compatible or working. Additional comments included a lack of privacy in the environment and lack of eye contact or body language, which might be particularly challenging for students with poorer oral communication skills.

We believe this context for learning has tremendous potential as a possible alternative, but most certainly an "extension" to the traditional language classroom. Environments like CV provide alternatives to the traditional language classroom that some students might find beneficial, because they permit students to experiment with new roles as they form their own learning communities in a safe environment. This pilot describes just one possible scenario for language learning in 3D immersive environments. Task design should promote interaction and communication through role-play, exploration, information quests and so on. CV provides a physical space wherein students practice and use the target language with other students and native speakers.

6. Archaeology Case

6.1. Design

The truth-value of archaeology is not self-evident. There is a huge gulf between the primary data and the "final" interpretation. The training of archaeologists typically takes place in North American within the confines of academic archaeology. In that context, students' experience of archaeology tends to be short summer field experiences. We are loath to allow students to really get their hands on real archaeology because it is a limited resource and there isn't the time, money, or resource to allow our students to make mistakes. There is of course more to archaeology than simply field work, but even in those cases, there is a reluctance to allow students to actually work with the materials, to make mistakes. In some institutions, it is entirely possible to graduate with a degree in archaeology without ever having spent more than two weeks doing field work (Graham's experience). Yet, by some estimations, the typical student only ever takes in about 10% of a lecture – a 5000 word lecture distills in the student's notes to a mere 500 words (Johnstone and Su, 1994). This kind of teaching/learning has been disparaged as "One tape recorder talking to another" (Foreman et al., 2004).

The prototype immersive archaeological experience is built on the results of a 2003 excavation conducted by Shawn Graham (Carleton University) and Andrea Bradley (Institute for Field Archaeologists, UK) in Shawville Quebec (Bibliographie de l'inventaire des sites archéologiques du Québec MCCQ 3453, rapport inédit). That excavation was conducted in the context of a community revitalization project, and was designed to introduce high school students to their community's heritage as a summer field school in archaeology. The site was the Armstrong Brickyards, an industrial heritage site. A heritage park was proposed for the site, the 'Armstrong Heritage Farm' which covers an area of ca. 37 acres in Lot 6, Range 6 of Clarendon Township. The village of Shawville is notable in Quebec for its ethnic make-up of primarily Irish Protestants. Shawville sits on clay beds left over from the Champlain Sea; these clay beds were the source for a thriving brick industry in the late 19th century. One brickyard belonging to G. F. Hodgins was situated south of the village; another, belonging to the Armstrong family was situated to the east on Lot 6. All surface traces of this brickyard have long since been erased. The excavation was directed with the intention of discovering the functional layout and extent of this brickyard on the property slated for development. We took the results of that excavation, and simulated one of the 2m x 2m trenches in the web.alive environment, creating soil layers, features, and artefacts in their relative correct positionings. The video below shows how the simulation works, and what kinds of interactivity can be performed there.

http://www.youtube.com/watch?v=cGqahsJY67M

Online multi-user archaeological simulations do exist. The University of North Dakota uses a stand-alone text-based simulation of the village of Like-a-fishhook (Slator, 2001). In Second Life, archaeological themes do occur frequently (Graham, 2007). An example with archaeological implications is Vassar College's recreation of the Sistine Chapel (http://www.vassar.edu/headlines/2007/sistine-chapel.html). The Pyla-Koutsopetria Archaeological Project (http://www.pkap.org/) has used Second Life as a place to organize the logistics of their excavations, while the "Remixing Çatalhöyük" project (http://okapi.wordpress.com/2007/04/07/constructing-knowledge-virtual-places/) (Morgan, 2009) uses it to understand the architectural layout of that city and the social life lived within it. None of these simulations though recreates the logic of excavation, nor allows the user to interact with the basic building blocks of archaeological knowledge creation.

6.2 Task

In our initial assessment of the excavation, we wanted to explore whether or not the system made sense intuitively: if, in interacting with it, some appreciation of how archaeological knowledge is created was developed. A second aim was to understand how engaging it was, and what worked, or did not work, for the students in this regard. Archaeology in the 'real world' is often compelling due to its romantic or mysterious nature: its social context of practice. While often decried, this romanticism is a major factor in maintaining interest in what is a physically and mentally tedious process. In the 'doing' of archaeology, the social aspect, the conversations, that surround the process are formative in the development of understanding (Wilkinson 2007). Accordingly, we encouraged the students to 'talk aloud' throughout their interaction with the excavation, and with each other.

None of the student volunteers had any archaeological experience, aside from one introductory lecture on archaeological landscapes. The students were divided into two groups. One group was introduced immediately to the 3D simulation; the other group interacted with a 2D simulation developed by the Friends of Bonnechere Parks (http://www.virtualmuseum.ca/Exhibitions/Spirits/English/Dig/digdown.html). The 2D simulation was selected for comparison as it is a well-developed example of archaeological outreach and a teaching tool expressly meant to address the same issues as our own prototype.

Both groups of students were given graphing paper and recording sheets, and instructed to talk aloud as they sought to understand what the site they were looking at represented. Afterwards, they were asked to complete a questionnaire that reproduced the questions asked by Getchell et al. (2007), (where they detailed a similar experiment), in order to enable cross-project comparability. These questions were assessed on a 5 point Likert scale, where the respondents indicated their degree of agreement with various statements, as shown in Tables 2 and 3.

Figure 9. Student interacting with a dig site (top), and extra information provided about items on the web page containing the 3DVE (bottom). Interaction between the page and 3DVE is done through Javascript.

6.3 Tools and Functions within Carleton Virtual

Game world environments are not designed with the intention that the players or participants can make substantial changes to the underlying simulated geomorphology. The initial problem then was to work out how to translate the metaphors of archaeology - layers, contexts - into three dimensional manipulables within a world not meant to allow the manipulation of the underlying geomorphology. In essence, to allow users to dig down, we had to *build up*. We translated each excavated context into an object within the web.alive environment. Each context was then positioned to match the x,y, and z relationships observed in the real-world excavation. Artefact models were created, and positioned within the appropriate context. Each artefact model was linked to a webpage giving a basic physical description of the artefact. Each of these information pages contained links to archaeological databases, catalogues, or other secondary sources. Each context contained a trigger to cause it to 'melt away', to simulate the careful removal of the soil. A trigger was positioned outside the excavation which when pressed would overlay a horizontal grid on the excavation, to allow users to measure and plot the positioning of contexts and artefacts. Finally, a browser window was provided near the excavation site, to allow users to perform web-based research from within the simulation.

6.4. Learning Outcomes Observed

The questions and answers for 2D and 3D tools are shown in Table 2 and Table 3, respectively. Same questions were used for both tools. The answers were from Strongly Agree to Strongly Disagree. The data in each column of the tables show the number of participants who selected the corresponding answer.

Table 2. Questions and Answers for 3D Tool

3D	**Strongly Agree**		**Neutral**		**Strongly Disagree**
1. I feel that I have learnt something by using this system.	1	3	1		
2. The excavation simulation reveals believable information.	3	2			
3. I found it difficult to find out information about the archaeological site.			2	3	
4. The quality of the material presented was consistent.	1	3	1		
5. I feel that using this system helps develop my understanding of fieldwork methods and techniques.	1	3		1	
6. I found the system educationally stimulating.	3	1	1		
7. I was easily able to identify material culture.	1	3	1		
8. The tools provided by the system allowed me to practice the theory that I have learned relating to how archaeology creates knowledge.		3	1	1	
9. Working in a group helped me understand the excavation process.	4	1			
10. I found it useful to be able to identify where finds were located within the site.	2	2			
11. The descriptions of the artefacts I found were reasonable.	2	2	1		
12. I was able to find the tools and information I needed to maintain my context sheets.		2	1		1
13 I would have preferred to work individually using the system.		1		1	3

Table 3. Questions and Answers for 2D Tool

2D	**Strongly Agree**		**Neutral**		**Strongly Disagree**
1. I feel that I have learnt something by using this system.			2	1	2
2. The excavation simulation reveals believable information.	1	3		1	
3. I found it difficult to find out information about the archaeological site.	1	2	1	1	
4. The quality of the material presented was consistent.		1	2	2	

5. I feel that using this system helps develop my understanding of fieldwork methods and techniques.		1	1	1	2
6. I found the system educationally stimulating.			1	2	2
7. I was easily able to identify material culture.			3	1	1
8. The tools provided by the system allowed me to practice the theory that I have learned relating to how archaeology creates knowledge.		2		3	
9. Working in a group helped me understand the excavation process.			2		1
10. I found it useful to be able to identify where finds were located within the site.		2		3	
11. The descriptions of the artefacts I found were reasonable.		2		1	2
12. I was able to find the tools and information I needed to maintain my context sheets.		2	1	1	1
15 I would have preferred to work individually using the system.			3		

6.5. Student Reflection

The prompt to ‘think aloud’ seemed to generate a good deal of critical reflection amongst the participants. The 3D environment provided tangible feedback in a way that the 2D simulation did not (could not?). The students felt that the 'basics' of archaeology were well enough conveyed by both simulations, but they certainly were more excited by the 3D world.

- [On the quality of interaction with the 2D world] “Measured it at i6 at the grid - probably the most exciting part, recording what you’ve found”
- “[The simulations] really convey the idea that archaeology is systematic and organized. You get the different tools, you get the brush, and I think what the [simulation] is trying to say, to argue, is that ‘this is how it’s done’. It might be boring for us as undergrad students to be clicking brush, trowel over and over again but for a younger student I think it’s good for them to see that *this* is the process of archaeology and all the steps are important.”

It was more 'dangerous' some of them felt, in that if they interacted with it in the wrong way, things could break:

- Student A: “I can see [B] jumping up and down, but it's like he's in a swimming pool of archaeology. “
- Student B: “I’m trapped under one of the contexts!”

Rather than seeing this as a design flaw, in discussion amongst themselves, they felt that it could in fact be a feature if it were tied to the logic of excavation - if for instance one dug too deeply too quickly, maybe the site would collapse (a real danger in real-world archaeology); or if one 'ripped out' artefacts (that is, clicked on artefacts visible in lower levels, even though the overlying contexts had not yet been removed), one could damage the artefact and lose the information. Unprompted, they had stumbled into an understanding of why looting matters.

- “There needs to be some sort of danger, because, if you’re just clicking wildly, you could clear the site quickly but maybe if you had to take your time, you can crawl underneath layers and remove them before the top layers so something needed to stop that, some sort of ‘uh oh you damaged the artefact’ if you go about things the wrong way… gravity [to allow collapse]”

The students were directed to work out what the site represented. With that minimal instruction, the students would position their avatars at different points of the compass so as to get a camera view of the excavation from all angles, directing each other over the voice channel of where to stand. Then, they'd discuss how things looked from their particular point of view in order to record relationships.

- "It might be really hard for you to see, cause the avatars can't really see down like that; come around over here, yeah, doesn't really look like a smoking pipe but that's what it says…"

This was in reaction to the default setting for their avatars to restrict the camera angle (the view downwards), and this restriction actually promoted a kind of emergent group solution. Finally, the students reflected on how they would improve the 3D simulation:

- "I think it would've been nice if there'd been more choice, if there'd been more to uncover, because the dig starts, and there's already something there, something uncovered [in the initial state of the simulation, the topsoil is already removed] it would've been very interesting, if as aspiring archaeologists we could've looked at the landscape and chosen our site, decided where to dig based on land formations or what we were told in the lectures…we would be able to decide a bit, 'oh we want to dig here, or we want to dig there' as we've learned that's part of the process."

These results can be considered no more than anecdotal, of course. However by focusing our design on engagement, we seem to be reaching our initial group of use-testers at the level that we desired. The design of the simulation, and the affordances of immersive virtual experience, seem to be promoting the kind of emergent learning about archaeology that we should wish to promote to a wider public. When things broke in the excavation, or the students pursued a blind alley, they could hit the 'reset' switch, and start again. It was safe to fail, and thus promoted exploratory and constructivist learning. Both kinds of simulation had their strengths and weaknesses (see tables), but the 3D simulation seemed to elicit stronger agreement from our use testers when asked if it helped develop understanding; it also seemed to be a better environment for fostering group learning.

7. Conclusion

While our results cannot be considered quantitative, they do demonstrate ways in which this particular 3DVE can promote accessible learning. Web-based design, scripting and customization, 3D spatial sound, AI and NPCs, and various other features allow the proposed 3DVE to provide a useful, effective and affective framework for academic activities; communication and collaboration, simulation, and presentation.

The first case demonstrates the ability of 3DVE to provide information in a more engaging way including NPCs and some AI. The second case adds communication, collaboration, and environmental simulation. Finally, the third case advances the simulation to a more interactive task and also shows how the 3DVE experience can be customized and integrated within a special web page.

As the case studies indicate, 3DVEs on their own may not offer a full alternative for other learning tools but when carefully designed with an eye towards the affordances of the technology, they can supplement other forms of pedagogical practice. Lack of real face-to-face communication, learning curve and usage difficulty for many users, and hardware and software requirements are among the barrier to more wide-spread use of 3DVEs. Although they may provide a less expensive solution compared to setting up physical facilities, 3DVEs still involve development costs and skills not available easily and affordably in some cases. Simulating more complex tasks (such as those involving fluids and complicated machines or requiring realistic human expressions) are also challenging while advances are rapidly made towards making them possible. Developing proper evaluation criteria and performing more detailed qualitative and quantitative studies on functionality and usability of 3DVEs are also among further direction of this research.

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