Chapter XIII
Wireless Collaborative Virtual Environments Applied to Language Education

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ABSTRACT

This chapter provides an overview of second language learning and an approach on how wireless collaborative virtual reality can contribute to resolving important pedagogical challenges. Second language learning provides an exceptional opportunity to employ mobility and multimedia in the context of just-in-time-learning in formal learning situations, or ubiquitous and lifelong learning in more informal settings. We hypothesize that virtual reality is a tool that can help teach languages in a collaborative manner in that it permits students to use visual, auditory, and kinesthetic stimuli to provide a more “real-life” context, based in large part on Computer-Supported Collaborative Learning. Studies are being conducted in which we assess usability, wireless multimedia technology, and collaborative learning aspects to discover how virtual reality can help students overcome language and anxiety barriers. Furthermore, we suggest carrying out longitudinal studies to determine to what extent wireless, mobile, and collaborative virtual reality can contribute to language instruction.

INTRODUCTION

The concept of education has greatly evolved over the last 30 years. Traditionally, the educational setting was confined to the classroom, libraries, or specific spaces set aside at home for doing homework. Technology, however, has significantly changed educational practices and has helped expand the confines
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of the classroom. Today, instructional settings are no longer limited to the physical structure defined by walls, and the time for learning is no longer limited to the school day or traditional times set aside for study and homework.

Wireless technologies provide information and learning opportunities for people, regardless of when or where they are physically located (Wagner, 2005). Different modalities of mobile learning such as just-in-time-learning offer dynamic, flexible learning opportunities on demand, according to the individual needs of the learner (Johnson & Johnson, 1994). Consequently, wireless network technologies, combined with information retrieval systems and multimedia applications, will soon provide an interesting option for lifelong learning. As wireless mobile devices become increasingly smaller and more powerful, they contribute to ubiquitous learning, which is one of the most common, effective, and persistent forms of learning (Holzinger, Nischelwitzer & Meisenberger, 2005).

Second or foreign language learning provides an exceptional opportunity to combine the elements of mobility and multimedia in the context of just-in-time-learning in formal learning situations, or ubiquitous and lifelong learning in more informal settings. Also, because learning and producing language depends on extensive and varied sensory input, virtual reality (VR) and future mobile delivery services represent a combination of technologies that can meet learner needs, based on sound pedagogical and technological foundations.

TRADITIONAL MULTIMEDIA

Multimedia has been used in education almost since the introduction of personal computers in classrooms and households. This technology can be defined as the combination of media elements of video, audio, images, text, and graphics in an interactive computer interface (Mishra & Sharma, 2005). Since the early 1990s, educational multimedia programs have been distributed using CD-ROMs, and more recently, the World Wide Web has become a powerful and practical way to distribute educational multimedia content in quasi-real time to a worldwide audience. Another reason is that Web-based multimedia learning offers synchronous, or real-time (e.g., audio and video conference, instant text messaging) and asynchronous, or non-real-time (e.g., e-mail, blogs, discussion forums) collaboration between students. Regardless of whether they are located in the same classroom or in different parts of the world, persons can communicate and share media content such as images or sound files (Shirmohammadi, El Saddik, Georganas & Steinmetz, 2001).

A number of research institutions around the world have developed and tested networked collaborative virtual environments since the early 1990s (Carlsson & Hagsand, 1993; Macedonia, Zyda, Pratt & Barnham, 1994). Until recently, however, there was insufficient computer and network power or adequate codification-decodification algorithms (codecs) to carry out smooth communications and immersion of participants in CVREs. Therefore, the result until recently has been a trade-off between realism and speed, as well as limited modality interactions that have focused almost exclusively on the exchange of visual and auditory information.

VIRTUAL REALITY ENVIRONMENT

Virtual reality (VR), a computer-based technology capable of generating a 3D space (also called virtual environment) that is multisensorial, interactive, and integrally engages its users (Vince, 2004), is today
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considered one of the new frontiers in Computer-Assisted Language Learning (CALL). The use of VR is indicated for language learning and practice as it simulates reality, while offering a nonthreatening and stimuli-rich environment for language students. In addition, research indicates that collaborative virtual reality environments can lower anxiety, which has been negatively correlated to language learning. The purpose of this chapter is twofold: to provide an introduction and theoretical background to 3D computer interfaces and virtual reality applications to CALL, and to describe the implementation of a Collaborative Virtual Reality Environment (CVRE) running on a wireless network.

Presently, VR technology offers students the opportunity to immerse themselves in more real-life language learning contexts. VR can be defined as a technology that creates a computer-generated graphical space, also called a virtual environment, where users can interact as they use various senses within a multimodal interface (Sherman & Craig, 2003). A virtual environment can be defined as a graphical representation of a particular context that is rich and diverse in stimuli. One of the main features of VR is that it produces an effect in participants called “immersion,” where users feel as if they are actually “there” as they interact from inside the virtual environment (Burdea & Coiffet, 2003; Sherman & Craig, 2003). According to Dede, Salzman, Loftin, and Ash (1997), both immersion and multimodality in VR are important because students receive different stimuli within a virtual environment, which promotes learning according to stimuli and constructionist learning theories. Early studies of collaborative virtual reality environments (CVRE) show the potential of this technology to engage a group of students in meaningful learning tasks (Jackson, Taylor & Winn, 1999).

A collaborative (also called multi-user or distributed) virtual reality environment (CVRE) is a shared virtual environment where people can meet and communicate via chat, live, synchronous voice, and gestures; and navigate (Burdea & Coiffet, 2003; Preece, Rogers & Sharp, 2002), which is based on Computer-Mediated Communication (CMC) theories. Each person is represented in the virtual environment as an avatar (the “incarnation of a god” in Hindu mythology), a graphical personification that represents a person’s gestures, navigates, and transmits real-time voice. The sounds and events activated in the virtual environment can also be shared.

Literature reports successful research and applications on Computer-Supported Collaborative Learning (CSCL) in the context of foreign language learning (Dlaska, 2002; Hudson & Bruckman, 2002; Zurita & Nussbaum, 2004), but very little has been done on collaborative virtual reality environments, in part because until recently, personal computers and their graphics video cards and network infrastructure were not fast, powerful, or efficient enough to support CVREs.

A number of collaborative virtual reality software applications have been developed in various research centers and commercially around the world. One of them is Distributed Interactive Virtual Environments (DIVE), an open source software for displaying virtual reality environments developed at the Swedish Institute of Computer Science (Carlsson & Hagsand, 1993). DIVE is versatile and has been used in a variety of operating systems, including IRIX, Linux, and Windows, among others. Through DIVE, users can share a virtual environment using a local area network (LAN) or the Internet. DIVE has a 3D graphical interface where a virtual environment is shown. In DIVE, users can communicate with each other either by microphone (Voice-over IP [VoIP]) and/or text messages. To ease identification, each participant is represented by an avatar, a personification, or a cartoonlike representation of the users participating in the virtual environment. It is also possible to hear almost real-life 3D (spatial) sounds in DIVE, and even the participants’ voices in real time. In addition, avatars can be programmed to communicate with gestures, an important element in nonverbal communication. DIVE can work as a stand-alone program, or it can be distributed as a virtual environment over a network using a multicast
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protocol. It is necessary, however, to install a DIVE server and a proxy to work as the carrier of the peer-to-peer communications between the computers that share the virtual environment over the network.

DIVE has been used at the University of Colima in Mexico for various research projects related to collaborative virtual environments. For instance, a CVRE was created to show bone foot trauma to a pilot group of medical students (Cervantes Medina & Garcia Ruiz, 2004). Participants in the study communicated using their own voices over IP (VoIP) and text messages using a chat window, both of which are provided by DIVE. The results of this research showed that the CVRE helped students overcome language barriers, effectively facilitating oral and written clinical diagnosis about the bone injury simulation they had to clinically diagnose in the virtual environment.

WIRELESS VIRTUAL REALITY

One of the purposes of the paradigm of Computer-Supported Collaborative Learning (CSCL) is to provide technological tools for students to work together to achieve an academic goal, where students may be present in the same physical learning space, collaborate synchronously or asynchronously on a local area network, or interact remotely through the Internet (McManus, 1997). There have been significant advancements in CSCL regarding student collaboration on wireless networks and the integration of mobile devices such as laptops and handheld devices into educational delivery systems.

The concept of “anytime, anywhere” learning has been expanded by handheld devices (e.g., personal digital assistants [PDAs]), which has been termed Mobile Computer Supported Collaborative Learning (mCSCL) (Zurita & Nussbaum, 2004). In mCSCL, the mobile devices can be either wireless or stand-alone, making access to educational services and content very portable. However, contrary to laptops, PDAs suffer from important limitations, including their small screen display size, limited screen resolution, and relatively limited computer power. In particular, the limited computer power of PDAs severely limits how virtual environments are displayed and minimizes actual immersion, especially if the VR application involves 3D simulations for the sciences, or when high-level spatial reasoning is involved. A solution to these visualization constraints is to represent the information through other sensory channels (Brewster, 2002). 3D graphical virtual reality environments have been successfully implemented and tested in PDAs since the early 1990s (Fitzmaurice, Zhai & Chignell, 1993) and more recently by Grimstead, Avis, and Walker (2005). The technological challenge today, however, is how to seamlessly integrate graphical, auditory, and tactile information in a virtual reality environment and distribute this multimodal information wirelessly in small mobile devices (i.e., PDAs).

In the context of virtual reality, a wireless virtual reality environment (WVRE) is a mobile application of a collaborative virtual environment using a wireless network. Since many CVEs function with peer-to-peer and client-server protocols, the core, traffic handling controls and network access, and the description database of virtual objects of the CVRE all reside in a computer server. This server can be accessed by a mobile computer such as a laptop or PDA using a wireless local area network (LAN) or wide area network (WAN), depending on the network protocols and equipment configuration. Presently, however, although much work has been done in the area of programming, protocols, and hardware, little research has been carried out regarding potential of mobile WVREs.

Because WVRE development and applications are now in the early stages of research and development, it is difficult to predict their medium and long-term pedagogical contributions. However, the developments described in this chapter confirm that it is economically and technologically feasible to
set up WVREs with actual computer and network characteristics that can be used by engineering-level students to carry out CSCL satisfactorily. Creating wireless semi-immersive environments does not require investing large sums in computer hardware or software since the CVRE can be open source (i.e., DIVE) and can work with almost any recent-model laptop computer functioning on a wireless network of at least 10Mbps, thus eliminating the need for investing in cabling all the network peers.

SECOND LANGUAGE INSTRUCTION

Second language learning potentially provides an extremely fruitful area of application for VR technology. However, despite being used in a variety of educational contexts, VR has still been used more for modeling abstractions or simulating situations that are difficult to experience in the real world (Burdea & Coiffet, 2003). Still, language learning does require certain criteria to be met; criteria that VR may be able to effectively provide. According to Edwards (2005), language learning shares important characteristics with VR in that it is the following:

- **Collaborative.** The communicative act requires the participants to be actively involved in negotiating meaning and turn-taking, among other things, as they carry out communicative functions such as agreeing, disagreeing, asking, answering, and so forth.
- **Experiential.** Language learning requires persons to have “real-life” experiences with the language in order to use and experiment with it in different contexts. Experiencing a language makes language learning more meaningful, thus contributing to motivation.
- **Situational.** Communication is realized in very specific physical (i.e., time, place, etc.) and socioemotional contexts. Because language use can differ greatly according to the specific needs of a situation, language learning implies presenting students with a variety of real-life situations.
- **Self-Directed.** Learners recognize their individual needs and motivations. Thus, language learning requires flexibility as to how individual learners receive input and an understanding of how learners processes information and produce language. Consequently, effective language learning is led by the student and supported by the instructor and materials.
- **Purposeful.** Humans communicate out of pragmatic need. The speech act is almost always accompanied by a purpose, be it to convince, ask for permission, inform, compliment, and so forth.

Virtual reality is also supported by many of the most recent language instructional methodologies, which are based on some of the following premises (Larsen-Freeman, 2000):

- Language is used within a context, and language learning often involves transferring what one knows to new contexts.
- Meaningful practice without repetition is important because meaningless repetition reduces motivation. Motivation theory states that it is important for students to feel success and low anxiety to facility learning. Novelty is motivating.
- Self-correction is a powerful tool that is nonthreatening.
- Learning is facilitated in a physically, psychologically, and socioemotionally relaxed environment.
In an atmosphere characterized by play, the conscious attention of the learner does not focus on the grammar, vocabulary, or syntactic structure (linguistic forms), but on how to achieve the goal or objective that makes the game fun. Language learning is more effective when it is fun.

Meaning in the target language can often be conveyed through actions.

Students can learn through observing actions as well as by performing the actions themselves.

Memory is activated through learner physical and affective responses.

The imperative is a powerful linguistic device through which the teacher can direct student behavior.

Students must develop flexibility in understanding novel combinations of target language chunks. They need to understand more than the exact sentences used in training.

Communicative interaction encourages cooperative relationships (collaborative learning).

Language learning is facilitated when the learner employs multiple sensory inputs.

Thus, employing VR in foreign language instruction is based on strong linguistic and methodological foundations, but more research has to be done regarding its actual application in second language instruction.

**VR APPLIED TO FOREIGN LANGUAGE INSTRUCTION**

One of the first and relevant applications of VR to foreign language learning is the Zengo Sayu Project (Rose & Billinghurst, 1996) carried out at the Human Interface Technology Laboratory of the University of Washington. The main research goals of this project were to determine if desktop virtual reality significantly contributed to learning, to comparing the proposed system to other Japanese teaching methods, and to determining the positive effects on student motivation and attitude toward learning Japanese. Although results from the study were inconclusive, the authors reported that the students were able to learn with Zengo Sayu and that the virtual desktop VR application allowed students to learn at their own pace and explore the virtual environment independently, thus promoting more active participation by the students.

Zohrab (1996) developed virtual models of ancient Greek and Roman buildings to be used in a distance-education classical studies course. He used Virtus WalkThrough Pro (a freeware program) for editing virtual environments. Although the virtual models were initially distributed on diskettes between the participants of the distance education course, this researcher planned to deliver the virtual models on the Internet. Zohrab considered virtual reality as “potentially the very best method available to teach a language outside the geographical and/or historical environment where it is/was used most commonly for communication” (Zohrab, 1996). He also emphasized the importance of networked virtual reality (he called it mutual reality) for second language learning. He and his development team hypothesized that an immersive virtual reality environment (including sounds, smells, and tastes) could take students on virtual field trips, allowing them to listen to a foreign language as spoken within a contextually rich virtual village.

Virtual reality has been used to teach business Chinese to intermediate and advanced Chinese learners. De Paepe, et al. (1998) constructed a series of virtual environments to develop listening, comprehension, vocabulary, and grammar skills. The environments were specific to each lesson and included representations of cultural situations and objects, as well as Chinese ideograms and narrations. The
VR system also evaluated the progress of participants by testing them after each lesson. If students had questions, they could communicate with the teacher and other students using a chat tool provided by the system. The researchers pointed out that the guiding principles of this project were creativity and self-exploration.

Another Internet-based application of collaborative virtual reality applied to second language education was developed by Milton and Garbi (2000), who developed virtual representations of a zoo, towns, and a shopping center, for foreign language teaching of primary school students. In the virtual environments, learners collaborated in activities using avatars (graphical personifications of the students) and chat rooms to communicate. The researchers reported that the participants in the study realized activities in a “relatively naturalistic way,” and their communication was unforced.

An ongoing attempt to incorporate VR into foreign language instruction is the Rapid Tactical Training System for Learning Arabic (Johnson et al., 2004) funded by the Defense Advanced Research Projects Agency (DARPA) of the United States. The objective of this project is to teach United States military personnel the communicative skills and socioemotional awareness necessary for them to establish the rapport needed to help them accomplish a variety of missions, including postwar reconstruction in Iraq. The system consists of a simulated village with a pedagogical agent that accompanies each learner through a variety of situations and corresponding speech acts. This project reported useful feedback on learner performance within a multimodal interface that provided a contextually rich setting that helped motivate and engage language learners. Participants reported confidence and interest when interacting with the virtual environment, stating that they felt like they were playing a video game.

Although most of the research projects reviewed in this chapter used high-end graphics, textures (images), and some integrated sounds, none of them reported technical configurations or encodings of multimedia elements, not even descriptions or discussions on network issues, such as multimedia transcoding or data transfers. Some of the virtual environments have been programmed in C++ and OpenGL. Although these languages are very effective for 3D graphics projection, only skilled programmers and technicians can effectively exploit their versatility. Additionally, this type of programming is not the most appropriate for virtual reality network applications, especially if there is a need for rapid prototyping. Furthermore, high-level languages such as DIVE, Java 3D, Python, and TcL/Tk better support multimedia encoding and are easier to program.

TECHNICAL ASPECTS OF MEDIA TRANSMISSION

The implementation and application of collaborative virtual reality faces important technical challenges. Audio files; images (called textures); the description, position, and orientation of virtual graphical objects; and sometimes video streams form part of a virtual reality environment. All of this information has to be distributed in a local computer network and the Internet, preferably using a highly effective transmission rate of at least 100Mbps for LANs, according to recent router and switching hardware specifications, while maintaining network size and mobility at a minimum. Simulation latency, which is greatly affected by network latency, is very important in virtual reality environments because it affects the synchronicity of interaction that is necessary for immersion. This type of latency is perceived as delayed feedback received by the user employing the virtual environment. Burdea and Coiffet (2003) recommend a visual latency of less than 100ms in order to provide acceptable user interaction. Additionally, in CVRE, since
all users can interact with and alter the virtual environment, it is necessary to quickly communicate and update participant interactions to all those participating in any given activity.

Multimodal virtual reality environment generally contains descriptions of 3D graphics, images, and text, accompanied by a sound and video stream projected onto a virtual object (Burdea & Coiffet, 2003). Literature also reports that tactile applications are also being incorporated into CVREs, employing force-feedback joysticks in virtual reality video games (Sherman & Craig, 2003). Although visual and auditory modalities will probably continue to predominate in CVREs, in the near future, other senses will be employed to convey information and provide more diverse interaction. For example, there is a growing body of knowledge that studies the design, development, and application of tactile (haptic) interfaces, including their distributed use through local area networks and the Internet (Burdea & Coiffet, 2003; Sherman & Craig, 2003). Furthermore, although the design and development of olfactory and gustatory interfaces are still in their infancy, there have been significant developments in this area. Recent developments (Dinh, Walker, Song, Kobayashi & Hodges, 1999; Nakaizumi, Yanagida, Noma & Hosaka, 2006) show that computer interfaces can effectively generate specific odors. Bodnar, Corbett, and Nekrasovski (2004) carried out a test comparing the efficiency and disruptiveness of visual, auditory, and olfactory information, delivered by a multimodal messaging notification system. Their results show that the olfactory sense was the least disruptive of the three modalities. In addition, the use of “olfactory icons” to aid information searches has been studied by Kaye (2004) and Brewster, et al. (2006). Currently, a handful of commercial applications is beginning to transmit odors over the Internet, including Trisenx (www.trisenx.com). Multimodal devices have recently been developed to simulate the texture of objects when being bitten (Iwata, Yano, Uemura & Moriya, 2004), but there are no reported developments on flavor delivery for representing meaningful information.

Haptic, olfactory, and gustatory information can be represented by numeric values and their position coordinates programmed into the virtual environment. However, the olfactory and gustatory information format is only a speculation and does not fall within the scope of this chapter. Thus, because of their relatively large file sizes, most present research concentrates on the encoding of video and sound compression, primarily because these slow the performance of virtual environments and increase virtual reality and network latency (Frecon, Smith, Steed, Stenius & Stahl, 2001). Consequently, choosing the optimal video and sound codecs is of extreme importance, as the time needed to code and decode

<table>
<thead>
<tr>
<th>Encoding Method</th>
<th>Characteristics</th>
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<tbody>
<tr>
<td>ULaw8</td>
<td>8 bits / sample, 64kbits/s</td>
</tr>
<tr>
<td>Linear8</td>
<td>8 bits / sample, 64kbits/s</td>
</tr>
<tr>
<td>Linear16</td>
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<tr>
<td>Linear24</td>
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<td>Alaw8</td>
<td>8 bits / sample, 64kbits/s</td>
</tr>
<tr>
<td>GSM</td>
<td>264 bits, 160 samples, 13.2kbits/s</td>
</tr>
<tr>
<td>Intel DVI ADPCM</td>
<td>4 bits / simple, 32kbits/s</td>
</tr>
</tbody>
</table>
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Figure 1. Percentages of file sizes of each sensory modality

may be significant. CVRE programs like DIVE (Carlsson & Hagsand, 1993) uses the audio encoding shown in Table 1.

The audio and MPEG-like video encodings used in DIVE are described in more detail in Adler (1996) and Frecon, et al. (2001).

The Ulaw8 codec was informally tested in a DIVE CVRE with two participants, one in Murcia, Spain, and the other in Colima, Mexico. The participants shared and manipulated virtual objects together and communicated for about 10 minutes via voice over IP (VoIP) (provided by DIVE), without noticing any significant delay or voice degradation (Garcia-Ruiz & Alvarez-Cardenas, 2005). This shows that DIVE has potential for future collaborative educational applications between two distant areas.

Figure 1 describes what we consider approximate percentages of file sizes of each sensory modality, to be transmitted in a collaborative virtual environment.

Fully fledged multimodal CVREs may occupy significant bandwidth in actual LANs and WANs (100Mbs-1Gbs). However, Internet2 is a viable option for multimodal CVREs. Internet2 is a global consortium of universities, research institutions, government bodies, and companies that carries out research and development of very high-speed network connections (using an Ethernet backbone with a bandwidth in the order of tens of Gigabits) and academic applications, linking universities and research centers across the world (Fowler, 1999; Matlis, 2006).

DEVELOPMENT

Having outlined some of the technological and educational theories and aspects of CVREs, we are currently researching whether CVREs applied to CALL on a wireless network using a multicast algorithm can be effectively used to assist students practicing foreign language listening comprehension. We believe that fully immersive VR applications using expensive equipment in traditional VR laboratories
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To test our research questions, we created a CVRE that represents a small and typical town, called Realtown, which contains an entire city of virtual buildings, including a supermarket, schools, a pharmacy, a bank, and so forth. Realtown contains background sounds and can be played through hi-fi headphones or speakers to help increase realism. Some of these sounds include traffic, children playing, sirens, and other common environmental noises. What makes Realtown interesting is that students simultaneously perceive and interpret three stimuli to help them incorporate their knowledge: visual, auditory, and kinesthetic.

Realtown runs on a DIVE server, which in this study is a Dell Poweredge 1800 computer with two 3.2GHz processors running in parallel and 2 gigabytes of RAM, using an Ubuntu Linux operating system connected to the Internet. Three 3GHz laptops with Windows XP and 512Mb of memory were wirelessly connected through a local area network (LAN) based on a Linksys wireless router model BEFW11S4 with a data transfer rate of 11Mbps and connected to the Internet. For our tests, the router was placed in the same room as the laptops at a distance of 8 meters. Interestingly, the setup used in this research operates across operating systems as the server functioned with Linux and the laptops used Windows.

Figure 2 depicts laptops employing a basic WVRE configuration running locally with a DIVE client interface. In this configuration, the laptop on the right works both as a server and as a peer (participant) of the collaborative virtual environment. Both laptops (peers) share the same virtual environment, and both peers update all the interactions and navigations made by each participant, respectively. Each participant is represented as an avatar that can be easily identified in DIVE as each avatar has a different color and the student’s name or nickname written over the avatar’s head. The router, or access point, shown between the laptops controls the network traffic wirelessly, thus connecting the laptops via their wireless network cards. Interestingly, preliminary results show that the Realtown CVRE can...
be accessed synchronously among peers working with the router’s network signal. This aspect is interesting and can have particular relevance in rural settings that have no access to traditional or wireless Internet infrastructure.

Usability studies (Dumas & Redish, 1999) are currently being carried out to measure efficiency, efficacy, and user satisfaction of the Realtown CVRE, as well as to assess collaborative learning aspects related to student interaction. Additionally, the hardware needed to run the CVRE is being studied, particularly from a multicast peer-to-peer perspective where the actual setup is comprised of laptops and a server. One of the first tests conducted in this project was carried out by Hernández Díaz and Yáñez García (2007).

PRELIMINARY USABILITY STUDY TO EVALUATE NAVIGATION

A limited usability study of the CVRE has been carried out to assess navigation issues in the virtual environment. This is important because in order to have an easy-to-use virtual reality interface in a virtual town, users need to seamlessly “walk through” the virtual streets without cumbersome input devices that negatively affect navigation and create distractions. The navigation characteristics of a conventional mouse, keyboard, computer game joystick, and wireless mouse were evaluated and compared to determine which was the most appropriate for controlling navigation within a CVRE.

Method

The Think Aloud Protocol usability method (Preece, Rogers, Sharp, Benyon, Holland & Carey, 1994) was used for this study. This usability method permits users to explore a particular computer interface and receive qualitative data about its use. In this method, the user is asked to say out loud what he or she is thinking and doing when selecting or conducting any specific activity (task) in the interface. Qualitative interview comments were recorded on paper for further analysis.

Materials

A wireless laptop, part of the CVRE described in this chapter, was used for this study. A conventional mouse and a Genius MaxFighter F31U computer game joystick (shown in Figure 3) were also used.

Participants

Participants in this study included four telematics engineering undergraduates, three males and one female, with an average age of 21 years. Only one male had extensive experience in playing video games, particularly in using game joysticks.

Procedure

Each participant received an explanation about the purpose of the test, how DIVE might be applied to CVRE, and how to navigate in DIVE using a mouse, keyboard arrows, or a joystick. The main task of the participants was to navigate around a virtual house using the keyboard arrows, the mouse, and the
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Figure 3. Joystick used in the pilot usability test

Figure 4. A participant using the joystick for navigating in the CVRE

joystick separately, one device at a time. Participants had unlimited time to do the tests. Figure 4 shows a participant testing the joystick in the wireless laptop. Participants’ verbal comments were recorded on interview sheets.

Results of the Preliminary Study

According to qualitative data provided by participant responses and researcher observations, the keyboard arrow keys were the easiest to use for navigating in the CVRE, and all participants felt comfortable using them. However, subjects reported they could make more precise turns with the mouse than with
any other device. The wireless mouse showed the poorest performance. Participants commented that they tired after a few minutes because they had to hold the wireless mouse in the air, without support. The wireless mouse also proved to be overly sensible, which made the students uncomfortable when changing direction or realizing turns within Realtown. Additionally, the study participants consistently reported difficulties with the wireless mouse, and most subjects had to hold the wireless mouse using both hands. Comments about the joystick were more positive than those about the wireless mouse, but not as positive as those about the direction keys. As expected, the participant with greatest previous experience with video games and joysticks proved to be the most skillful navigator, regardless of the navigation input device used. All participants reported feeling motivated when using the CVRE, declaring they considered it much like a video game. This is particularly significant since game playing lowers anxiety, which has been negatively correlated to language learning (MacIntyre & Gardner, 1991).

CONCLUSION

We hypothesize that virtual reality can function to teach languages in a collaborative manner in that it permits the student to use visual, auditory, and kinesthetic stimuli to place the learner nearer to the “real-life” context, also based on benefits of Computer-Supported Collaborative Learning principles, such as lowering student inhibition. Pilot usability studies are being planned in which we will assess usability and collaborative learning aspects, particularly to see how virtual reality can help them overcome language and anxiety barriers. Further, we need to carry out longitudinal studies to see whether virtual reality could cause a positive effect in students’ learning.

The preliminary usability study of navigation described in this chapter served to find out that the keyboard arrows and a game joystick are usable and can be used for navigating effectively in the CVRE.
Moreover, it paves the way for more extensive usability studies about actually performing more complex cognitive tasks about the navigation in Realtown, which will be integrated into second language learning exercises.

This is work in progress done at the School of Telematics in conjunction with the University English Language Program of the University of Colima, Mexico.

**FUTURE RESEARCH DIRECTIONS**

A future application to this research is to apply our Realtown virtual environment in a traditional classroom, where students will use their laptops on a local wireless network as a tool for learning a second language in regular courses. Additionally, we will conduct a usability study where students will use their laptops connected to a wireless virtual environment outside the classroom (but within the same installations) to see how Realtown is used in a mobile environment and how the wireless network responds to it. The in-class and outside-class application assessments of Realtown are necessary for ensuring ecological validity of the tests. We will carry out the network assessments by conducting usability studies and analyzing the wireless network performance, particularly analyzing packet loss, bandwidth occupancy, and wireless signal intensity, among other parameters. It is also necessary to apply various usability methods (using interface design experts as well) to triangulate the results and thus make further improvements and applications of Realtown.

Another future research is to analyze and test the WVRE under different types of access points running at different data transfer speeds (11Mbit/s, 54Mbit/s, and 540Mbit/s, according to the 802.11b, 802.11g, and 802.11n standards, respectively, and at different frequency channels (within the 2.4GHz range) to see how the wireless network behaves under different network characteristics, particularly to study how packet loss is affected.

We believe data transfer speeds will directly affect the 3D graphical and audio transmission of the WVRE, especially if the clients (the students accessing the WVRE with their laptops) are at a significant distance (more than 100 meters) from the access point. It will be interesting to see if this may cause a noticeable virtual environment lag (the delay caused when playing and refreshing the graphics and sounds of the WVRE in real time).

A future study with Realtown will be centered on the video and audio encoding algorithms that can be best used for playing video streams and sounds in the Realtown WVRE according to the wireless network characteristics, particularly its data transfer speed, since some encoding algorithms may compromise the sound and video quality and presentation speed in a WVRE, especially if the virtual environment is running over a congested wireless network.

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REFERENCES


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ADDITIONAL READING


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