The Virtual Immersion Center for Simulation Research: Interactive Simulation Technology for Communication Disorders

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Abstract

The Communication Sciences Department at Case Western Reserve University is building an immersive virtual reality (IVR) cave simulation research laboratory to increase student clinical competency skills and carry over of therapeutic skills for children and adults with communication disorders. The use of this IVR simulation lab known as the Virtual Immersion Center for Simulation Research (VICSR) has the potential to provide computerized training in a safe, controlled, learner-centered environment wherein students and clients can repeatedly practice a range of skills in natural contexts. Previous research has shown that VR learning environments demand a high level matrix of knowledge, skill and judgment; qualities that contribute to successful, competent clinicians and rehabilitated clients [1]. The focus of VICSR is to design and implement a clinical VR simulation training program to target a variety of communication disorders to determine its effectiveness in increasing student clinical competency skills and generalization of therapeutic skills for clients with speech and language disorders.

Introduction

According to a recent survey conducted by the University of Cincinnati (2004), speech-language pathology (SLP) graduate students often feel apprehensive in their clinical abilities when diagnosing and treating childhood speech and language disorders. They report difficulty with understanding children's developmental levels, applying and interpreting appropriate assessment measures, and translating this into an appropriate therapy program [2]. These skills are critical for successful speech-language clinicians.

Furthermore, a large number of clients with speech and language disorders often report high levels of frustration with their therapy programs due to lack of generalization [3]. Owens (2005) defines generalization as the transfer of speech and language gains made in treatment to real world settings [4]. Generalization is the most challenging part of any client's speech and language rehabilitation program – learning to apply newly acquired therapeutic techniques and skills in a variety of contextual, natural based settings.

Given these data, there is an urgent need to examine learning from a practice-based approach using routine, everyday activities which promote successful transfer of clinical and therapeutic skills. This practice based approach is referred to as a situated learning paradigm [5]. According to this learning model, knowledge is situated; it is a product of the activity, context and culture in which it is developed and used [6].

There are a number of advantages to a situated learning paradigm such as (1) learning is always contextual, situated in a particular everyday practice (2) learning is culturally and socially diverse in nature (3) learning is dynamic with a community of learners [5]. Research shows that situated learning experiences are highly motivating and create autonomous learners – gaining insight and understanding into information presented [7].

Immersive virtual reality (IVR)-based learning environments support situated learning paradigms [7]. Immersive virtual reality can be defined as an artificial environment or setting that is created by a computer in which the user feels present [8]. Steuer (1992) refers to this phenomenon as telepresence – the extent to which the user feels present in an artificial environment rather than the immediate physical environment [9]. This sense of immersion or telepresence in a virtual setting is critical for creating a situated learning environment that promotes transfer of skills to real world situations.

The Virtual Immersion Center for Simulation Research (VICSR) has the potential to provide computerized training in a safe, controlled, learner-centered environment wherein students and clients can repeatedly practice a range of clinical skills without endangering patients. VICSR has the power to create an effective virtual learning environment for the field of speech language pathology that will promote transfer of skills into real world settings.

Initial Research Agenda for VICSR

The research agenda for the creation and implementation of this IVR simulation training center consist of the following:

1. To determine the effectiveness in increasing clinical competency skills for SLP graduate

students for identifying speech and language disorders using IVR simulation technology compared to traditional based learning methods
2. To determine the effectiveness in increasing speech and language skills for clients with communication disorders using IVR simulation technology compared to traditional intervention learning methods.
3. To measure transfer of speech and language skills to every day situations for clients with communication disorders using IVR simulation technology compared to traditional intervention learning methods.
4. To explore the relationship between learning environments and telepresence for SLP graduate students and clients with communication disorders

Significance of VICSR

While virtual reality training simulation technology has been applied to the military, airline industry and a variety of medical specialties, it has yet to be investigated in the field of speech-language pathology. A field that requires high levels of patient interaction and communication skills.

In the medical field, an increasing number of higher education institutions are beginning to seek more effective and efficient means in both teaching and assessing their medical students' implementation of clinical knowledge and critical reasoning skills. A survey of medical institutions found that 73 of 124 schools are using some form of simulation for evaluation or teaching purposes [10]. Students participating in computer simulations performed significantly better and faster when compared to students in a traditional classroom [11]. Furthermore, studies have found that VR training simulations can improve the acquisition and retention of knowledge in comparison with the traditional lecture [12].

Successful use of VR technology with patients requiring rehabilitation has been demonstrated in fields such as cognitive rehabilitation [13] spinal cord injury [14], children with visual impairments [15] and children with Asperger's Syndrome [16,17]. Preliminary data regarding VR technology with these patient populations has shown that applied VR training shows promise for learning specialized skills and generalization of those skills into natural contexts.

These research studies regarding the effective use of computer simulation demonstrate the need to not only expand simulation technology to other fields, but improve upon the technology to create a highly sophisticated simulated environment. This optimal learning environment would allow learners to interact and carry out "sustained deliberate practice with expert feedback which is an essential prerequisite for expert performance, yet within an authentic context relevant to learning needs" [1].

Steuer (1992) provides the conceptual framework necessary for developing new IVR simulation technology that incorporates visualization and interactivity - key telepresence variables that promote learning and bridge the transfer of knowledge to real world situations [9]. This sense of "being in a virtual environment" is critical for students and clients to become engaged and active in the overall learning process [18].

Creation of VICSR

Recently, the Department of Communication Sciences at Case Western Reserve University and Virtra Systems, Inc. has designed a revolutionary interactive 180 degree immersive virtual reality (IVR) cave simulator for communication disorders called the Virtual Immersion Center for Simulation Research (VICSR). This IVR-Cave research environment surrounds the user with three eight by ten foot screens and enables them to experience an interactive training simulation which utilizes state-of-the-art rear projection-based technology.

VICSR's features include:

- Customized two dimensional branched HD films targeting "real life" scenarios
- External displays and supplemental computer monitoring/recording systems to track users virtual experiences
- Specialized authoring software allowing for high levels of social interactions with "real life" scenarios
- Dynamic instructor station allowing SLP clinicians/instructors the ability to control social interactions within a given virtual setting
- Biometric feedback data for monitoring indices of telepresence throughout a virtual experience (heart-rate, skin conductance, respiration)
- Observation room for family members, teachers and other professionals to observe virtual experiences

Interactive IVR simulation films consist of multiple branched video segments to allow for a variety of user interactions and are created using high definition (HD), two-dimensional recording devices. Scripts for the HD films are created by faculty members from the Communication Science Department at Case in collaboration with the Cleveland Hearing and Speech Center.

MediaVision, a Department of Instructional Technology and Academic Computing (ITAC) at Case carries out the IVR filming production at low cost which promotes interdisciplinary research to be conducted into effective real learning experiences for students as well as clients with communication disorders. The interactive nature of the IVR environment is the unique element that makes this simulator one of the first of its kind.

Future Research Initiatives for VICSR

This simulation technology allows for the education, evaluation and preparation of students and patients with a variety of communication disorders targeting "real life" scenarios. This situated approach to learning speech-language pathology offers the potential to increase generalization of both clinical skills and therapeutic skills into everyday situations. This is the premiere objective for every student and client with a communication disorder.

Currently, IVR film production is targeting two research initiatives:

Simulation program for working with clients with communication disorders targeting fast food restaurant ordering

The first IVR film production has targeted aMcDonald's fast food restaurant setting to work with clients with stuttering disorders as well as non-verbal communication disorders requiring the use of augmentative communication devices for ordering food items at the counter as well as the drive-up window.

The McDonald's IVR simulation film consists of several branched segments allowing clients the ability to interact freely with the McDonald workers and restaurant patrons. Interactions with the McDonald's workers and patrons are determined by the questions, comments and social behaviors derived from the client in the simulator. The speech-language pathologist controls the overall interaction by selecting the appropriate response and behaviors for the virtual worker. Hence, there is a need for multiple branched film clips to allow for a variety of interactions and outcomes.

VICSR is equipped with digital video recording equipment to provide visual support and feedback to clients following each virtual experience. In addition, clients will be encouraged to wear biometric feedback instrumentation to track their heart rate, skin conductance and respiration to gage autonomic levels of presence during interactions in the virtual settings. Clients will be permitted to repeat the IVR- simulations as many times as they desire since there are many outcomes depending on their communication skills.

Preliminary data for determining the effectiveness of interactive IVR-CAVE simulation training will be available Fall 2006.

Simulation program for training graduate students diagnostic procedures for identifying speech and language disorders

The second IVR film production has targeted a third grade child with a suspected speech and language disability and her family for graduate students learning to become future SLPs. This patient scenario consists of several branched segments allowing students to interact freely with the virtual patients and their families while attempting to determine if a speech and language problem is present.

SLP graduate students will be provided with a basic case history of the virtual patient prior to entering VICSR. A designated instructor will be seated at the instructor station so that they can control the responses and behaviors of the VR patient. Once in the simulator, the student will introduce himself/herself to the VR patient and his/her family and begin conducting a thorough case history. Interactions with the virtual patients and their families are determined by the questions and behaviors derived from the student in the simulator. Students can request to observe the child in a particular setting if they feel they need additional information to make an informed decision, but this will only be made available upon the student's request.

Once the student feels that they have obtained all necessary background information, the student will complete a more in-depth analysis of the case by determining appropriate diagnostic assessment protocol and administering a thorough diagnostic battery. After the evaluation process, SLP graduate students will determine an appropriate diagnosis and consult with the VR patient and family regarding treatment options.

Digital tracking capabilities and biometric feedback data will be recorded throughout the virtual experience for student performance feedback and physiological measurement of presence.

Preliminary data for determining the effectiveness of interactive IVR-cave simulation training will be available Fall 2006.

Summary

IVR simulation technology for communication disorders has many uses beyond preparing students for real world challenges; it also has the power to offer new therapeutic training techniques for children and adults with a variety of communication disorders. The goal of VICSR is not only to develop IVR training modules for students to become expert clinicians in their fields of study, but to offer this technology as a means to promote generalization of therapy skills into real life settings. IVR technology has the ability to offer an unlimited supply of lifelike settings for students and clients with speech and language disorders to practice their clinical skills in a safe and controlled environment.

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