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Using virtual worlds in medical and health education

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Abstract

This review examines the use of virtual worlds in medical and health education. The purpose of this review is to outline various, enabling and three-dimensional, virtual world technologies that prove to have a positive impact on the development and retention of medical knowledge and skills. Virtual worlds offer unique design features for disseminating health information, training health professionals, and enabling patient education. The primary sources used in this review include published literature and electronic media sources. Conclusions derived from this review support the use of virtual worlds as part of the educational technology landscape. Although the potential of virtual worlds has been noted for health education, there are limited formal applications and minimal evaluation of educational outcomes.

USING VIRTUAL WORLDS IN MEDICAL AND HEALTH EDUCATION

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ABSTRACT

This review examines the use of virtual worlds in medical and health education. The purpose of this review is to outline various, enabling and three-dimensional, virtual world technologies that prove to have a positive impact on the development and retention of medical knowledge and skills. Virtual worlds offer unique design features for disseminating health information, training health professionals, and enabling patient education. The primary sources used in this review include published literature and electronic media sources. Conclusions derived from this review support the use of virtual worlds as part of the educational technology landscape. Although the potential of virtual worlds has been noted for health education, there are limited formal applications and minimal evaluation of educational outcomes.

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INTRODUCTION

The study of virtual worlds is an emerging topic in education that presents fascinating opportunities to observe learning in non-traditional, large-scale environments. Three-dimensional technologies have become a fundamental element of almost all modern computer games and are also central to the new generation of immersive virtual worlds, such as Active Worlds and Second Life. Internationally, educators and educational institutions envision great potential for use of three-dimensional simulations, games, and virtual environments (VEs) for teaching and learning, as they provide the possibility of rich learner engagement, together with the ability to explore, construct, and manipulate virtual objects, structures, and metaphorical representations of ideas. The analysis of this topic is important because through examining the use of virtual worlds in medical and health education, we can create a culture of immersive three-dimensional learning environments that support a high level of social networking and interaction with information to enhance the patient's quality of care and lead toward building active educational communities of practice.

Using virtual worlds in medical and health education is important because these technologies create unique ways to design powerful life-long learning experiences and develop professional expertise. There are a limited number of research articles describing or surveying the range of health-related activities in virtual worlds, such as Second Life, and minimal evaluation of educational outcomes. Similarly, the use of virtual worlds for continuing health professional development appears to be largely unreported. A notable exception is Kamel Boulos et al's (2007) overview of several health sites, *Second Life: An Overview of the Potential of 3-D Virtual Worlds in Medical and Health Education.* Kamel Boulos has also compiled a list of Second Life health resources on a website, Health

Cybermap (Boulos, Hetherington, & Wheeler, 2008). Hansen (2008) describes the potential of three-dimensional healthcare learning environments on Second Life in her review of existing literature. Other Web 2.0 sites describe a range of health resources in Second Life, such as Mesko's blog, "Top 10 Medical Sites in Second Life" (Mesko, 2007) and websites that provide direct link (SLurls – Second Life URLs) to sites in the program.

This review will discuss topics of effective virtual world medical and health educational applications, examine how virtual worlds fit into the healthcare landscape, and determine which virtual world medical and health educational applications have proven to be successful. The author intends to use this literature review as a foundation for future research in the development of virtual world medical and health educational applications for medical students, healthcare professionals, and patients. As the application of virtual worlds within a healthcare environment is discussed, future development will be more effective in meeting the needs of healthcare professionals, medical students, and patients.

This review will answer the following questions:

1. What are the attributes of effective medical and health education; virtual or otherwise?
2. How do virtual worlds fit and exceed the needs for effective medical and health education?
3. Which virtual world medical and health educational applications are successful?

METHODOLOGY

In researching the topic, *Using Virtual Worlds in Medical and Health Education,* the author used reliable and valid resources. Availability of resources was more limited when specifically researching virtual worlds in *medical and health education.* The primary online database used to locate the resources for this review was UNISTAR. Both the UNISTAR (online database) and Panther Prowler (online metasearch engine) were useful in providing the author with full-text articles from well-known medical research journals such as Medical Teacher. The full-text articles were cited multiple times in other related articles and publications, and were considered credible and worthy of reference for this review. The Google Scholar Internet search engine was also used for finding resources.

To check for author credibility, the researcher was able to locate background information and determine if the information they presented to the reader was credible. This was accomplished by entering the author's name into a search engine such as Google. Many of the authors were credible and have published articles relating to three-dimensional virtual simulation and Second Life as it pertains to medical and health education in juried journals.

This reviewer was most successful in locating valid and relevant information when using the following descriptors: medical education, health education, continuing education, continuing medical education, healthcare, healthcare professionals, virtual worlds, virtual simulation, virtual reality, Web 2.0, 3-D, three-dimensional, Second Life, technology, and utilization.

The information selected for this review was evaluated based on the quality of the content examined, relevance to the topic selected, author and journal credibility, reliability of the institution through which the article was published, and aimed for a publication date no

earlier than 2005. A limited number of resources dated as early as 2000 due to the credibility of the author and institution through which the article was published.

ANALYSIS AND DISCUSSION

Despite the accelerating momentum of the development, application, and adoption of immersive three-dimensional (3-D) virtual worlds by academics as learning innovations (Kusumoto, Shorrock, Heinrichs, Dev, & Youngblood, 2007), there are some fundamental questions that remain unanswered. Without doubt, one of the most widely discussed of these is the relevance associated with teaching medical and healthcare professionals (Hansen, 2008). Similar to most basic issues in education, this question leads to challenges at various levels of thought, and it is beneficial to address while the race to adopt and implement highly engaging Web 3-D virtual worlds is watched in healthcare professional education (Hansen, 2008). There are three specific areas that will be reviewed within the use of virtual worlds in medical and health education. These areas are: attributes of effectiveness, need, and successful virtual world applications in medical and health education.

Virtual Worlds

Overview

You cannot be passive in a game or simulation. Students engaged in educational games and simulations are interpreting, analyzing, discovering, evaluating, acting, and problem solving. This approach to learning is very consistent with constructivist learning where knowledge is constructed by the learners as they actively problem solve in an authentic context as opposed to more traditional instruction where knowledge is seen as an object transmitted from teacher to learner (Jonassen & Land, 2000). In constructivist learning, collaboration is important, as knowledge is socially constructed. The constructivist learning theory is an essential educational technique to consider when designing and utilizing effective educational virtual world simulations. Most virtual worlds have a community of

players who interact socially to discuss strategies, share experiences, and provide encouragement through websites, discussion boards, blogs, and wikis. Involvement in these gaming communities can greatly improve a player's game performance and enjoyment (Antonacci & Modaress, 2008).

Recent technical advances in massively-multiplayer, user-created, virtual worlds, such as Second life, Active Worlds, and There, have made this technology both affordable and accessible. Additionally, these advances have expanded the capabilities of user interaction and development within these simulated worlds. Unlike most computer games, even multiplayer games, these virtual worlds allows the users to create their own worlds and interact with them and with other users in them, rather than simply interacting with an existing, preprogrammed world (Antonacci & Modaress, 2008). This ability to develop and interact with your own simulated world offers many new and exciting educational possibilities. Educators can create their own simulated worlds and have their participants learn by exploring, interacting, and reflecting on their experiences in this world. Alternatively, learners can actively apply course content and problem solve as they create and interact within their own worlds.

Weicha, Heyden, Sternthal, and Merialdi (2009) designed and delivered a pilot postgraduate medical education program in the virtual world, Second Life. Fourteen primary care physicians were trained and enrolled in an hour-long, highly interactive event in Second life on the topic of type 2 diabetes. Participants completed surveys to measure change in confidence and performance on test cases to assess learning. The post survey also assessed the participants' attitudes toward the virtual learning environment. Overall, this pilot was very successful. The participant physicians' responses indicated that this was a positive and

engaging experience that could meet their training needs and fit their busy schedules. All respondents agree it was superior to other methods of actual online training they had experienced. Many of the participants noted the convenience of an online seminar as one of the most important advantages – no travel is required, and they can participate from the comfort of their own homes. The pilot points to at least two important virtual world advantages over other online methods of instruction: (1) the added sense of presence afforded by a representative avatar, and (2) the added real-life application provided by mock-patients (Zhao, 2003 & Messinger, 2008).

Organizers are very optimistic about future use of virtual worlds applied to all phases of medical education. The enriched environment, convenience, and possibilities for constructivist approaches all add up to tremendous potential. The results of this pilot suggest that virtual worlds offer tremendous opportunity to provide space for constructivist learning at its best and to enhance learning outcomes beyond that provided by traditionally designed training courses.

Web 2.0

A 3-D virtual world, also known as Massively Multiplayer Virtual World (MMVW), is an example of a Web 2.0/Web 3-D dynamic computer-based application. According to Utecht (2008), the vague term "Web 2.0" is used for what people see as a second form of the World Wide Web (WWW) architecture and applications that enable social publishing, such as blogs and wikis. A few examples of this interactive Web are podcasts, YouTube, and social networks, such as Facebook, Twitter, and TeeBeeDee. Murray (2008) outlines many examples of Web 2.0 applications on the Web. Eysenbach (2008), found in Barreto (2008), explains:

Web 2.0 is a term which refers to: (a) improved communication and collaboration between people via social-networking technologies, (b) improved communication between separate software applications ("mashups") via open Web standards for describing and accessing data, and (c) improved Web interfaces that mimic the real-time responsiveness of desktop applications within a browser window.

Compared with the conventional 2-D Web, Web 2.0/Web 3-D virtual worlds offer novel, intuitive ways to:

- Navigate multi-media content (streaming audio/video/TV collections – see, for example, Second Life SONY BMG Music Entertainment on Media Island) (Second Life, 2007);
- Browse information spaces/document collections in 3-D virtual libraries (see, for example, Second Life Medical and Consumer Health Libraries in HealthInfo Island) (Second Life, 2007) – described later in this review;
- Relax, visit new places, and sample new cultures (virtual tourism – see, for example, Virtual Morocco in Second Life (Second Life, 2007) or Egypt's pyramids and sphinx in There.com);
- Play multi-player games in the virtual world, including educational, health-related games;
- Buy, sell, and advertise virtual and real-life goods and services – many real world, famous brand names have already established a presence in Second Life (2007);
- Develop social skills (and even clinical skills – see, for example, Second Life Heart Murmur Sim (Second Life, 2007), – described later in this review)/socialize and interact with other people via customizable, realistic, 3-D, fully textured and animated avatars (3-D social networking);
- Attend and participate in live events like Second Life lectures, conferences, festivals, and

concerts; and build communities, including learners' communities and patient support groups among many other things.

Second Life

Currently, the most popular virtual world used by the general public is Linden Lab's Second Life (2008). More than 700 educators from around the world currently use Second Life for education (Appel, 2006). It portrays the general qualities of a MMVW which include, but are not limited to, streaming audio/visual/TV/YouTube collections, 3-D virtual libraries, virtual tourist attractions and destinations, social interactive venues used by multiple, customized animated characters, a health information island, global preparedness discussions, lectures, conferences, and support groups (Boulos, Hetherington, & Wheeler, 2007). Presently, it has 6.5 million virtual residents (Sims, 2007) from over 100 countries. United States agencies such as the Centers for Disease Control and the National Institutes of Health conduct meetings in Second Life to discuss the educational potential of Second Life (Pellerin, 2008). Kusumoto, Shorrock, Heinrichs, Dev, and Youngblood (2007) describe a 3-D virtual world online simulation incorporating a Massively Multiplayer Online Game (MMOG) platform, which trains healthcare professionals for a mass casualty event. This is an example of how a virtual world may offer information about disaster preparedness in healthcare.

Furthermore, virtual medical universities exist all over the world (Morin, Benhamou, Spector, Bonnin, & Debry, 2004). Therefore, 3-D virtual worlds may include MMOGs, which is one type of a 'serious game' including educational goals; however the authors of the Horizon Report (New Media Consortium & Educause, 2007) argue virtual worlds are not games and provide examples of 'pure' virtual worlds, which include Second Life (2008),

There (2008), and Active Worlds (2008). Many of the programs allow the user to create 3-D virtual worlds, socialize, and participate in an educational universe, whereas MMOGs are considered to be more 'goal-oriented' and may include latitude of players engaged in 'collaborative' gaming events of competitive nature within a 3-D environment (Bainbridge, 2007 & New Media Consortium & Educause, 2007).

Second Life is a simulated environment rather than a game, although it may also be considered a 'game engine' in that games may be, and are, constructed within the Second Life world. De Freitas (2006) explains that simulations attempt to represent reality, in contrast to the clear fantasy environment of most games. However, any virtual world will have some element of fantasy, and Second Life does not attempt to constrain itself to the boundaries of simulating reality alone.

Informational technology, simulation, and virtual reality, already an integral part of medicine and medical education, will continue to advance medical practice in the 21st century (Harden, 2006). Information and digital technology has also facilitated the realization of what some may have considered revolutionary a decade ago – a virtual medical school. Resource development for this virtual medical school involves collaboration of 30+ medical schools representing more than a dozen countries. Not only does this virtual 'medical school' offer tailored 'just for me' and 'just in time' learning opportunities for students across the globe, but it also provides an international flavor to online learning (Mclean, Cillers, & Van Wyk, 2008) – truly a global community. Like healthcare, medical education is fast becoming a business. Commercialization and internationalization of medical education have been supported by the online, virtual world, and distance learning opportunities.

Avatars

Within the virtual 3-D platforms, end users choose a fictitious name from an online menu and have the opportunity to create a unique self, known as an 'avatar.' The term 'avatar' is an old Sanskrit word portraying a deity which takes on a human shape (Sibbet, 2008). These are animated figures the user may navigate to stand, sit, fly, dance, gesture, open doors, and 'teleport' to various regions and areas within the virtual world via a computer's keyboard. The colorful and creative day-night environment that has a built-in weather system incorporates other Web 2.0 social-networking capacities, such as instant-messaging (IM), wikis, users' ratings, profiles, podcasts, and sharing user-created objects that may be viewed in a virtual world.

According to Boulos (2007), Second Life is voice-enabled and provides the player the opportunity to hear other avatar voices based on the avatar's physical location. For example, if an avatar moves away from another avatar, the avatar's voice will become fainter and, vice versa, louder as you navigate closer. Avatars can publicly or privately chat with each other through voice or text tools. When using text chat, avatars automatically become animated and type in the air as their user enters a message. Instant messaging and note cards – text files that users receive when entering certain spaces – are other ways that people can communicate with each other both online and offline. Avatars also come with a variety of common, human gestures that can be activated by the user allowing them to communicate with virtual body language (Beard, Wilson, Morra, & Keelan, 2009). The New Medium Consortium (NMC) offers a symposium on the evolution of communication and how to use it in Second Life, as well as offering media presentations about the creation movement and emotion in Second Life educational virtual worlds (New Medium Consortium, 2008).

Effective Medical and Health Education Attributes

Virtual Attributes

Virtual worlds have been portrayed in film and literature for many years and may play a role in education, business, and healthcare education because this technology may change the way people learn and live in the future (New Media Consortium, 2008). The major strengths associated with virtual worlds are one's ability to design and construct unique environments and then share then with others in a collaborative fashion. Sibbet (2008) outlines how virtual worlds are "reshaping" learning, communications, social interactions, and perceptions. Furthermore, Sibbet presents interesting questions surrounding themes, such as cross-generational communications, identity exploration, cross-cultural exchange, problem solving, deep dialogue, and ceremony. All of these questions have implications for healthcare professional development and education, and even healthcare delivery.

Accessibility

Online virtual worlds are available 24/7 and there is an anytime/anywhere benefit for distance education learners with a high-speed Internet connection. Other advantages include virtual training approaches that yield results invaluable for healthcare professionals, and, for the healthcare consumer, there is an advantage of logging on and learning from events happening in Second Life. The medium is excellent for improving students' access to places otherwise difficult to reach. The technology makes spatial representation useful for hands-on learning and heightened student engagement because the real-time social interaction and gaming aspect spurs chances for 'discovery-based and goal-oriented learning' (New Media Consortium, 2008).

Team-Oriented Collaborative Learning

Using an online virtual world can overcome the barriers involved with traditional stand-alone computer-based simulation and provide simulated team-oriented clinical training. Virtual worlds are computer-based entities that can simulate a real-world environment, offering active learning experiences that are authentic yet safe. Virtual worlds give users a digital presence that offers a unique and comprehensive environment for online team-based collaborative learning. It provides a means by which training and collaborative team-building simulations can occur regardless of the location or the exercise being practiced removing the barriers involved with a traditional clinical simulation.

In the past, computer-based simulations have rarely been anything more than disconnected people passively viewing information or playing games. The virtual clinical simulation (VCS) model uses a team-oriented model where:

a) The team is faced with a clinical problem which requires action;
b) Group discussion is encouraged as no action can be taken in the simulation with a unanimous decision;
c) From the group discussion, a solution is formulated;
d) Each team member must carry out the solution decided upon by the team for the action to take place and for the simulation to continue; and
e) Once the problem is solved, each team member reflects (written) on the individual and team processes of the action carried out (Rogers, 2008).

Research has shown learning obtained from simulations is very similar to the learning gained from traditional classrooms (Bruce, Bridges, & Holcomb, 2003; Engum & Jeffries, 2003; Jeffries, 2006). The research study conducted by Engum and Jeffries (2003) compares

the effectiveness of an interactive, multimedia, virtual reality computer IV catheter simulator with a traditional laboratory experience of teaching IV venipuncture skills to both nursing and medical students. A randomized, pretest-posttest experimental design was employed with a total of 163 participants: 70 baccalaureate nursing students and 93 third-year medical students beginning their fundamental skills training. The pretest scores were similar between the computer and the traditional laboratory group. There was a significant improvement in cognitive gains, student satisfaction, and documentation of the procedure with the traditional laboratory group compared with the computer catheter simulator group, and both groups were similar in their ability to demonstrate the skill correctly. This evaluation and assessment was an initial effort to assess new teaching methodologies related to intravenous catheter placement, and their effects on student learning outcomes and behaviors. While a traditional learning method was preferred by students, the combination of these two methods of education may further enhance the trainee's satisfaction and skill acquisition level.

Similarly, research conducted by Bruce, Bridges, and Holcomb (2003) regarding injuries related to the events of September 11, 2001, and continuing military actions associated with Operation Enduring Freedom, underscore the accurate focus of the Joint Trauma Training Center and the Warskills Simulation Laboratory. The research describes how these two programs ensure that nurses are prepared to respond to diverse medical situations worldwide. Outcome measures from both initiatives attest to the effectiveness of an integrated program that facilitates both simulated and traditional learning of critical thinking skills and clinical judgment to increase the nurses' ability to provide trauma care to severely injured military personnel. On average, students retain 50% of a group interaction and 90% of what they act on (Petty, 2004). VCS provides a means by which virtual training

and collaborative team-building exercise can be conducted.

Constructing Meaningful Experience

Hanson and Sinclair (2008) support the constructivist theory suggesting students learn more effectively by engaging in collaborative problem-solving activities. The authors propose that the purpose of a learning activity is not so much the problem being solved, but the learning experience, which helps students develop a cognitive understanding "that may be generalized beyond the specific problem" (p.3). This make an important point in relation to computer-based clinical simulations (CBCS), in that it implies a simulation should provide experience of, and appreciation for, problem-based learning in a social environment (Rogers, 2011).

For simulation in virtual worlds to be effective, it involves more than just learners practicing protocols and skills; it also requires human dimension where non-technical skills such as teamwork, communication, or leadership are applied (Alinier, 2007). Although virtual worlds can provide learners with an interactive environment, currently in Second Life, healthcare learners are now co-constructing knowledge in a collaborative context, providing learners with a meaningful clinical experience, and allowing them to practice and understand skills and characteristics critical to their development as healthcare professionals. Activities should have a clear purpose that acknowledges the realities of the educational setting, and allows learners to work on their own issues and engage with problems and challenges (Sharpe & Oliver, 2007).

Safety and Navigation of Learning Space

Moving around in virtual worlds is both easier and more fanciful than moving around a traditional classroom. Learners can walk, but they can also fly, ride virtual vehicles, or even

teleport to different locations around their virtual space, making access to learning experiences more synchronous and rapid. Such spaces provide learners with a psychologically-safe environment within which they can participate in experiential learning, practice skills, try out 'what if' hypothetical scenarios, and make mistakes without serious repercussions. Second Life and other virtual worlds may therefore prove to be an ideal simulation resource where medical students and healthcare professionals can gain new skills without risk of harm to patients or themselves (Boulos, Hetherington, & Wheeler, 2007). Unlike traditional teaching methods, simulation encourages learners to take an active role in management of an emergency situation.

Using virtual worlds extends the ability of educators to provide a controlled clinical experience that does not disrupt workflow at a clinical agency. Educators can use competency-based assessment and evaluation to ensure all participants attain learning outcomes. From the patient perspective, having a virtual experience may give patients an increased sense of control over health experiences, and should improve both knowledge and confidence, since the patient can navigate the healthcare system from the comfort of their own home. Patients can literally practice being patients or making healthy choices: they can formulate and ask questions in a simulated experience and receive reinforcement from a variety of virtual experiences (Beard, Wilson, Morra, & Keelan, 2009).

Reflective Practice

The use of virtual learning environments has been shown to facilitate better reflections and the 'trading of stories' between online learners (Kirkup, 2001), which can lead toward better building of communities of practice. Reflective processes can be supported through the use of asynchronous discussion boards; but, more likely, interaction

(in virtual worlds) will be synchronous in real time, and within visual range of all other contributors, providing users with a sense of immediacy and engagement that has an equivalency to a telephone conference call.

Need for Effective Virtual Medical and Health Education

Pedagogical Potential

Educational research involving the use and effectiveness of virtual worlds and MMOGs is in its infancy. Nonetheless, there are reported advantages to having students and healthcare professionals engage in these emerging technologies (Miller, 2008). Learners actively interact with content and role play skills associated with their profession. By allowing learners time to interact with other avatars (e.g., patients, staff members, and other healthcare professionals) in a safe, simulated environment, a decrease in student anxiety, an increase in competency in learning a new skill, and encouragement to cooperate and collaborate, as well as resolve conflicts, is possible. Active learning takes place due to other participants being in the same virtual world and constructing objects to represent ideas that may enhance self-reflection and knowledge (Miller, 2008).

Virtual worlds, like Second Life, offer unique didactic experiences to users seeking health information, skill building, and healthcare training, group support, and individual consultation. Second Life venues for training can remove the travel and overhead costs that traditional healthcare training requires, and 3-D simulations can increase the utility of online training in areas where one-on-one interpersonal communication is an issue, as in the classic physical exam.

Communication is an aspect of effective teamwork. Another important aspect of teamwork that is essential in healthcare and education is "how" members interact with each

other or develop connections that form a community of practice. The transfer of Second Life to real-life behaviors has implications for healthcare. The experiential qualities of Second Life can be leveraged to promote the transfer of behaviors in Second Life to real-life. Edgerton describes that people practicing health behaviors in a virtual world are more likely to perform them in the real world (AIS Health, 2008).

Hobbs, Brown, and Gordon (Aune, 2008) state the benefits associated with developing communities of practice within virtual world environment in order to transfer skills that will enhance collaborative work within the work environment. Moreover, there exists a commonly held belief students will feel more satisfied with their course work if they are involved, and continue to develop relationships with their peers in learning environments. It has been argued that the element of social inclusiveness is "much more important in web-based instruction than in distance-education courses for learners to feel or perceive that they are a socially integrated part of a virtual community and that they have a sense of contact in the network: (Jung, 2001, p. 531)." Virtual world environments allow for the transfer of skills from virtual worlds to the workplace and perhaps the development of lifelong skills. Disseminating health information in virtual reality could, thus, offer more effective health communication, reach a substantial number of people at once, and, in turn, produce real-life health results at low cost and with high impact.

Second Life hosts a dedicated education page at http://slife.com/education containing a number of resources for educators to use. It also runs a dedicated 'Healthcare Support and Education' mailing list (Second Life, 2007) and even provides free temporary 'land grants' for those interested in testing out the pedagogical potential of the virtual space. For those educators who decide to set up professional practice in Second Life, the purchase of land

enables creation of a secure area with restricted access for teachers and students.

Educational Communities

The educational communities within Second Life and other virtual worlds are growing quickly as teachers begin to see the potential 3-D virtual environments have to enhance the learning experiences of their students (Boulos, Hetherington, & Wheeler, 2007). Educators are also interested in widening access for geographically remote learners – distance learners. Students and teachers in many college and universities, particularly across the United States, have already been gathering virtually on 'islands', for discussions, seminar ('3-D webinar') presentations, and other learning activities where digital materials are created, stored, and used (Lagorio, 2007). Second Life is proving to be ideal for those studying at a distance from their parent institution, and entry into the virtual world seems to be a great leveler, proving a very popular and equitable method of interaction. Second Life's game-based learning potential also holds great educational promise (Delwiche, 2006) although the virtual world has much more to offer than a mere 3-D multi-player game or collection of games.

While virtual worlds provide varied educational environments, it is unlikely to entirely replace other forms of delivery and it is best seen as an adjunct to both face-to-face teaching and other online applications. As such, learning in virtual worlds needs to be informed by the established best practice recommendations and theoretical underpinnings of both forms of delivery. Situated learning requires meaningful, realistic activities (e.g. the learning has to be understood as useful outside the virtual environment). It also requires significant opportunities for discussion and time, with perceived learning from online courses directly related to the amount of discussion actually taking place in them. Educators need to

plan for the time and activities required to get learners to a stage where they are comfortable enough in virtual worlds to start constructing meaningful knowledge relevant to the course they are studying (Salt, Atkins, & Blackall, 2008).

Virtual World Medical and Health Education Applications

Second Life Applications

Virtual worlds are rapidly becoming part of the educational technology landscape. Forterra's OLIVE, The Croquet Consortium, ProtonMedia's Protosphere, and Linden Lab's Second Life are all examples of virtual world environments. Platforms like these are potential environments for providing medical and health education (Forterra Systems, 2009, Croquet, 2009, Sun Microsystems, 2009, Proton Media, 2009, & Linden Labs, 2009).

Second Life is one of the best known and highly successful of these virtual worlds. Educators in the medical and healthcare areas appear to have been keen to explore the potential of Second Life particularly in relation to acquiring and practicing some of the "softer" skills required. Role play and simulations both seem to be used fairly widely.

Beard, Wilson, Morra, and Keelan (2009) found a considerable number of Second Life sites (34) whose primary purpose were to disseminate health information with their sample indicating sites in the Support category and Education & Awareness category as being notably popular. The interactivity, online accessibility, dynamic visual displays, and communication capabilities are key components in many of the successful health sites surveyed (Beard, Wilson, Morra, & Keelan, 2009). The following is a summary of successful Second Life medical and health education applications consistently found to be compelling and particularly innovative by taking full advantage of experiential features.

Virtual Hallucinations Project

Virtual Hallucinations, a project originally launched by Peter Yellowlees and collaborators at the School of Medicine at the University of California at Davis (Second Life, 2007), aims to educate people about the perceptual abnormalities experienced by schizophrenics by simulating common hallucination experiences. On entering the building the avatar experiences audio and visual distortions based on the reported experiences of specific people undergoing a schizophrenic episode. There are several interactive components within the simulation that aim to educate the user about this illness and the challenges faced by people with schizophrenia.

Women's Health Center at The Ann Myers Medical Center

The Ann Myers Medical Center, founded by Dr. Ann Buchanan in honor of her mother, Ann Myers, is run entirely by real-life nurses and physicians who donate their time. Much of the site is off limits to non-members. For its members, the site offers education through classrooms, resources, and simulations and is noted as being the first Second Life community to have adopted medical simulations in 2007 (Rosen, 2008).

A few areas are open to non-members, including the Women's Health Center (WHC), where information is provided explaining the importance of self-breast examinations. A room in the WHC shows female users how to perform their own breast exam and another area shows what a mammogram machine looks like. The tour guide then urges visitors to take these lessons from Second Life into real-life.

Heart Murmur Sim

The Heart Murmur Sim in Second Life is another example. Conceived by Jeremy Kemp, an instructional designer at San Jose State University, CA, it provides an educational

virtual world for cardiac auscultation training that allows visitors (clinical students/healthcare professionals) to tour a virtual clinic and test their skills at identifying the sounds of different types of heart murmurs, based on sounds files from McGill University's Virtual Stethoscope project (http://sprojects.mmi.mcgill.ca/mvs/mvsteth.htm) (Kemp, 2007).

Sexual Health Sim

The Sexual Health Sim, run by the University of Plymouth (UK), contains public health information about sexually transmitted diseases. The site was made possible by a land grant from Education UK in July 2007 (Boulos, 2009) and contains several interactive features, such as photographs of symptoms of various sexually transmitted diseases and a 3-D tour of the testes. Users can read about condoms and safe sex practices, and receive a virtual condom for their avatars to use. Avatars can also simulate the experience of illness by literally donning a "skin" (similar to clothing but acts like a second skin) that, in this case, visually displays the lesions of AIDS-related Kaposi Sarcoma on the avatar. The Sexual Health Sim employs unique features of Second Life in order to communicate health information to users.

CDC Island

CDC Island is a 3-D virtual representation of the U.S. Centers for Disease Control and Prevention (CDC – http://www.cdc.gov/), which is looking at ways social media can be used to reach out to more audiences, and promote public health (Second Life, 2007 & Weinreich, 2007). The island contains many displays that link users to different websites and, at times, allows them to participate in discussion and focus groups. The site includes several outreach activities, including CDC robots that ask for comments and site suggestions; a bracelet for avatars that automatically informs users of health awareness initiatives; live RSS

feeds of health stories; and, occasionally, a live CDC representative is available in-world.

The National Institutes of Health (NIH) Second Life White Paper noted the benefit of anonymity for users in seeking health information and the opportunity to speak directly with a CDC representative (National Institutes of Health, 2007).

HealthInfo Island – Second Life Medical and Consumer Health Libraries

HealthInfo Island (http://infoisland.org/health_info) is funded by a $40,000 U.S. grant from the U.S. National Library of Medicine (NLM)/Greater Midwest Region of the National Networks to provide consumer health information services in Second Life (Internet, 2007). The project is dedicated to health information in various forms. It aims at providing training programs, outreach to virtual medical communities, important consumer health resources, and one-on-one support to Second Life residents.

Description and unique features. HealthInfo Island is run by a team of medical/consumer health librarians and information professionals, in collaboration with an epidemiologist, internal medicine physician, retired pharmacist, nursing educator, some library para-professionals, and many others, to accomplish the grant objectives.

The 'Medical Library' is one of three main buildings on HealthInfo Island. It has three floors intended to highlight health displays both inside and on the roof. With multiple rooms on each of the three floors, the rooms focus on various areas that include, but are not limited to, the following: education and research on medically related subjects, breast cancer awareness, historical medical images, and contractor employed by the US National Institutes of Health (NIH) to explore potential applications of the virtual environment.

The second main building, 'Consumer Health Library,' looks like a home. This design choice was made on purpose to encourage comfort and create a warm environment

where Second Life residents can feel 'at home.' Its design, the landscaping, and all displays are intended to be accessible, interactive, and to encourage a collaborative, friendly atmosphere. Like the Medical Library, the Consumer Health Library showcases innovative information objects whose primary intent is to engage the viewer interactively. Some of these objects lead the participant through a decision tree by using questions, and eventually providing a tailored response in the form of a Flash tutorial, a PDF document, links to in-depth information, or even teleport links to other landmarks within Second Life.

The third building, the 'Health and Wellness Center,' was developed to bring patient advocacy to Second Life. To achieve its objectives, the center intends to collaborate with non-profit groups and organizations, and to host special in-world meetings and events. The center uses skyboxes so that support groups or smaller consultations are ensured privacy (Second Life, 2007).

Besides the three main buildings described above, a 'Health Information Outreach Research Lab' building was created by the Specialized Information Services (SIS – http://sis.nlm.nih.gov) Division of the U.S. National Library of Medicine. SIS is exploring Second life as a venue to provide health information to special populations, and as a platform for testing new information delivery technologies.

A focal feature of the new HealthInfo Island is the landscaping. The 'Gardens and Mountains' of HealthInfo Island provide excellent meeting spaces for large and small groups, and for collaborative events and activities. For example, the island hosted a Second Life Diabetes Support Group event, in which an internal medicine physician with a strong interest in patient education participated in a casual question-and-answer session that was held in the beautiful mountain garden (Boulos, Hetherington, & Wheeler, 2007).

VNEC – Virtual Neurological Education Center

The Virtual Neurological Education Center (VNEC – http://www.vnec.co.uk/) was developed by Lee Hetherington at the University of Plymouth at Devon (Second Life, 2007). It demonstrates a virtual simulated online experience where people are able to actively expose themselves to the most common symptoms that a person suffering from a neurological disability may encounter. VNEC offers an immersive, interactive experience with a unique feeling of 'presence' (Sheridan, 1992) with synthetic sensations that make the user feel like they are in another reality.

The purpose of the project is to make more people aware of neurological disabilities; and allow people suffering from a disability a place to further their knowledge and understanding, offering them support, information, and rehabilitation training. The VNEC has already attracted a wide range of audiences from around the world -specifically appealing to neurological physicians, researchers, physiotherapists, occupational therapist, caregivers and patients-, and can provide educational material for family members and friends.

Description and unique features. The VNEC has been built in the form of an L-Shape, two-story building, with five main areas: reception, office, theatre, lecture, and information point. All five areas have individual features assisting the user with information blocks describing their location and options available.

At the entrance to the VNEC, the user enters a 'reception' area that holds information regarding a range of neurological disabilities in three formats: web-based (URLs), uploaded podcasts, and viewable videos about neurological disabilities, rehabilitation techniques, and comments from people who have visited the VNEC.

The 'office' area entices the user to experience neurological symptoms. By selecting a chosen disability, the user is presented with information about the disability, and a wearable badge that, once worn, will affect the performance of their avatar. The office has three areas of interest and usage – conference, desk, and seating for social interaction – where the possibility to talk with real-life physicians or other sufferers of a neurological disability in a safe and non-restricting environment could occur.

The upstairs of the VNEC represents the design of a reality 'theatre' and users are able to navigate around to explore machines and operating equipment that can be found in the neurological department of a hospital. The theatre can be used for medical training and staff awareness. This is primarily an information area with detailed descriptions of equipment for people in the medical profession.

The 'lecture' theatre is situated outside with views looking onto the VNEC that offer online lectures, meetings, and conferences. The area has potential to stream live video, presentations, and images through a virtual plasma screen.

The final, and perhaps most important area, of the VNEC is the 'information point.' The information point advertises companies that offer support, help, and advice for people suffering from a neurological disorder. The advertisement links the user directly through to the chosen company's website, which the user can then use to contact the company personally, or to find out more about what the company can offer to their individual cases.

The future development of VNEC will allow the opportunity for medical professionals in reality a chance to enter the digital world, and be involved in online consultations, advice, and medical care in individual private rooms within Second Life (Boulos, Hetherington, & Wheeler, 2007). Furthermore, by making it possible to have a

second, virtual life, the VNEC considers the prospect of people who, in reality, possibly have neurological restrictions; Second life offers a new way of living in an extensive virtual environment (Boulos, Hetherington, & Wheeler, 2007).

Virtual Medical Schools

Several universities are training medical students in Second Life (Stott, 2007). Stott noted that some universities have found that having a unique Second Life presence can affect the brand of the school and attract future students.

Informational technology, simulation, and virtual reality, already an integral part of medicine and medical education, will continue to advance medical practice in the 21st century (Harden, 2006). Information and digital technology has also facilitated the realization of what some may have considered revolutionary a decade ago – a virtual medical school. Resource development for a virtual medical school involves collaboration of 30+ medical schools representing more than a dozen countries. Not only does this virtual 'medical school' offer tailored 'just for me' and 'just in time' learning opportunities for students across the globe, but it also provides an international flavor to online learning (Mclean, Cillers, & Van Wyk, 2008) – truly a global community.

Second Health

Second Health showcases recent efforts to implement the polyclinic model, a single point of access for both insured hospital and clinic medical service by simulating a London polyclinic (Beard, Wilson, Morra, & Keelan, 2009). The region is created as a town with several different areas to which users can teleport, such as a training area, a hospital, a polyclinic, and the Second Health Auditorium which hosted the first meeting for the international Virtual Association of Surgeons (iVAS) in April 2008. iVAS was attended by

forty-seven avatars from five different countries (Leong, Kinross, Taylor, & Purkayastha, 2008).

Another component of current research includes YouTube videos that display scenarios of Second Life simulations for those individuals who are not current Second Life members. Second Health has an extensive website which states that "The future of healthcare communication" (Second Health, 2009).

Discussion

These Second Life virtual world medical and health education applications have proven success and demonstrate significant potential to improve health communication and patient experiences in the real world. Second Life is being used to educate users about important public health issues, train healthcare providers, market and promote health services, allow individuals to seek out individual or group support for diverse health issues, and to facilitate research. The steady rise in Internet use for seeking health information has converged with increased popularity of a range of Web 2.0 applications (Beard, Wilson, Morra, & Keelan, 2009).

Virtual worlds are part of our present existence and offer online users of all ages opportunity to explore, create, imagine, collaborate, role play, interact, socialize, learn, and experience learning in a safe and vivid manner. The educator is in a position to look at who the learners are and what the learner really wants from their learning experiences. What motivates generation Y to X to learn? What are they accustomed to doing on a daily basis? Why not research, investigate, and try this social networking and virtual reality tool in medical and health education to create learning moments in today's world?

CONCLUSIONS AND RECOMMENDATIONS

There is great optimism about future use of virtual worlds applied to all phases of medical and health education including continuing medical education. The enriched environment, convenience, and possibilities for constructivist approaches all add up to tremendous potential. What's more, it is expected that virtual worlds will become more ubiquitous in other types of computing. Some speculate that these virtual 3-D learning environments will soon replace our Internet browsers (Toro-Troconis & Boulos, 2009). Virtual worlds are thus a major part of the future of the Web.

Effective Medical and Health Education Attributes

Virtual 3-D learning environments encourage active learning while learners create and explore activities similar to those of a "field trip," versus the two-dimensional experience of a classroom setting. This reaching-out and meeting new avatars and practicing communication skills in an aesthetic environment help to maintain interest in learning, and provide valuable experiences that may enhance student engagement, promote participation, and motivate self-directed learning. Educators who see "on-the-horizon technologies" in medical and healthcare education present an opportunity for today's learners to explore exciting worlds beyond the traditional classroom, and are showing understanding of current use of technology. Participating in virtual worlds is enjoyable for the learner, encourages creative expression, broadens socialization skills, promotes independent problem-solving, provides opportunity for self-teaching, and sets the stage for collaboration. Future empirical research findings will help determine if learning objectives are met by offering virtual 3-D learning tools.

Educators and their institutions must 'think outside the box.' Three-dimensional virtual worlds will enable educators and learners to be more creative, and to develop effective ways of teaching and learning rather than to purely replicate real-life and classrooms in virtual worlds. The design attributes of successful virtual world medical and health education applications suggest that both anonymity and interactivity are paramount. Guidelines for evidence-based content-development should also be used in virtual worlds, and further refined and adapted for the new medium to ensure that products built by those with little experience in healthcare will meet quality standards, non-biasedness, and proper attrition (Boulos, Hetherington, & Wheeler, 2007).

Need for Effective Virtual Medical and Health Education

Educational research regarding virtual 3-D learning environments and the effects on learning outcomes in medical and healthcare education is lacking. However, Bainbridge (2007) states scientists and scholars are moving forward in conducting research about virtual worlds. He encourages research to be completed in a timely manner because the current transformation of the virtual worlds is time sensitive, and future retrieval may be challenging.

The medical and health education opportunity in virtual worlds may not be a replacement for the doctor- or nurse-patient interaction or relationship, but virtual worlds may serve as an adjunct to pre- or post-learning tools. Virtual worlds are part of our present existence, and offer online learners opportunities to explore, create, collaborate, role play, socialize, interact, and experience learning in a safe and controlled manner. Moreover, virtual worlds are an ideal learning environment for proactively engaging students in constructing knowledge which relates to realistic problems, and assisting in the development of problem-solving skills in a collaborative environment without inflicting harm to patients and other

staff members.

Virtual World Medical and Health Education Applications

Virtual medical and health libraries, access to remote librarians, and other medical and health-related educational applications through such worlds are not remote possibilities. The realism and social interaction within 3-D virtual worlds make it a viable venue for developing and testing new medical technologies that have implications in the real world.

There are many instructional design possibilities to consider that may further leverage the unique advantages of virtual world medical and health education applications. One may consider incorporating and expanding a mock patient element so medical teams could interview their own mock patients and compare findings. This would enhance the psychosocial learning of patient care allowing medical providers to interact with other avatars (including patients, staff, and experts) in a safe, simulated, environment and reflect on their learning. This could also be used more specifically to boost engagement and information transfer.

Conclusion

Like healthcare, medical education is fast becoming a business. Commercialization and internationalization of medical education have been supported by the online, virtual world, and distance learning opportunities. I predict that virtual 3-D learning environments and medical schools will continue to proliferate over the next decade providing continuous and flexible learning and simulation opportunities to meet many of the needs of a global community of students. To be able to ask questions and pursue health information and educational experiences in an interactive 3-D setting, with interpersonal but anonymous contact, is singular to virtual worlds, and opens a range of exciting new possibilities for both

patients and healthcare professionals. The findings of this review suggest that virtual worlds offer tremendous opportunity to provide a space for constructivist learning at its best, and to enhance learning outcomes beyond that provided by traditionally designed medical and health education.

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