

Second Life: an overview of the potential of 3-D virtual worlds in medical and health education

Maged N. Kamel Boulos*, Lee Hetherington† & Steve Wheeler‡, *Faculty of Health and Social Work, †Institute of Digital Art and Technology and ‡Faculty of Education, University of Plymouth, Plymouth, UK

Abstract

This hybrid review-case study introduces three-dimensional (3-D) virtual worlds and their educational potential to medical/health librarians and educators. Second life (<http://secondlife.com/>) is perhaps the most popular virtual world platform in use today, with an emphasis on social interaction. We describe some medical and health education examples from Second Life, including Second Life Medical and Consumer Health Libraries (Healthinfo Island—funded by a grant from the US National Library of Medicine), and VNEC (Virtual Neurological Education Centre—developed at the University of Plymouth, UK), which we present as two detailed ‘case studies’. The pedagogical potentials of Second Life are then discussed, as well as some issues and challenges related to the use of virtual worlds. We have also compiled an up-to-date resource page (<http://healthcybermap.org/sl.htm>), with additional online material and pointers to support and extend this study.

Introduction

A virtual world is a computer-based, simulated multi-media environment, usually running over the Web, and designed so that users can ‘inhabit’ and interact via their own graphical self representations known as avatars. Linden Lab’s (<http://lindenlab.com/>) Second Life (<http://slife.com/>) is perhaps the most popular virtual world platform in use today, with an emphasis on social interaction (other platforms also exist, e.g. There—<http://www.there.com/> and Active Worlds—<http://activeworlds.com/>).

The population of Second Life has more than doubled since January 2007, and, as at 2 May 2007, has reached more than six million virtual citizens or ‘Lifers’, all with their own fully textured

high-resolution avatar that can be finely customized to the nth degree. Second Life also has a thriving economy that currently boasts millions of US dollars in monthly transactions via the in-world unit-of-trade, the Linden dollar, which can be converted to US dollars at a number of online Linden Dollar exchanges.^{1,2}

The popularity of Second Life is well deserved thanks to its host of advanced technologies (e.g. a unique in-world weather system, with realistic day–night cycle support)³ which, combined, place it well above all other virtual world platforms on the market today.

Three-dimensional (3-D) virtual worlds like Second Life can be considered as 3-D social networks, where people can collaboratively create and edit objects in the virtual world (like a collaborative 3-D wiki space), besides meeting each other and interacting with existing objects. (The reader is referred to Kamel Boulos & Wheeler⁴ for a detailed discussion of conventional social networks and wikis.)

Correspondence: Maged N. Kamel Boulos, Faculty of Health and Social Work, University of Plymouth, Drake Circus, Plymouth PL4 8AA, Devon, UK. E-mail: mnkamelboulos@plymouth.ac.uk

Compared with the conventional 2-D Web, 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);⁵
- browse information spaces/document collections in 3-D virtual libraries (see, for example, Second Life Medical and Consumer Health Libraries in Healthinfo Island⁶—described below);
- relax, visit new places, and sample new cultures (virtual tourism, e.g. visit Virtual Morocco in Second Life⁷ or Egypt's pyramids and Sphinx in There.com);
- play multi-player games in the virtual world, including educational, health related games;⁸
- 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;⁹
- develop social skills (and even clinical skills—see, for example, Second Life Heart Murmur Sim,¹⁰—described below)/socialize and interact with other people via customisable, 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.

The latest Second Life client also supports advanced, realistic voice chat (in addition to text chat and instant messaging), featuring 3-D-mapped voice with 'audio focusing' capabilities and speech gestures.¹¹ (As a user walks around someone who is speaking to them in Second Life, they will hear the voice move around in 3-D, based on where they are relative to that avatar. If the user turns toward someone who is speaking and moves closer, the voice will get louder. Also, as each speaker's volume is attenuated/boosted by their distance from the user's camera position in Second Life, the user can thus use the camera controls to create a momentary 'audio focus' on a given speaker. Speech gestures are customizable head, arm/hand and body movements that animate an avatar while speaking, and are triggered by different speech intensity levels.) A voice-changing Windows

software driver [like Screaming Bee (<http://www.screamingbee.com/>)] can be optionally used to hide the speaker's identity, or just for some added fun!

The potential of such a rich and engaging experience in education must be great. In fact, real and virtual world conferences have been (and are being) organized to explore and discuss the educational potentials of Second Life,^{12–14} while a recent project, Sloodle (for Second Life (SL) + Moodle—<http://sloodle.com/>), developed a mashup between Second Life and the popular learning/course management system, Moodle (<http://moodle.org/>).

Furthermore, in April 2007, the New Media Consortium (NMC—<http://www.nmc.org/>), an international, US-based not-for-profit consortium of nearly 250 learning-focused organizations dedicated to the exploration and use of new media and new technologies, advertised the availability of low-cost Second Life educational sims (land parcels with pre-built educational facilities) for rental to educational institutions.¹⁵ Indeed, in a virtual world, educational institutions and educators can create online communities that students can log into and interact in. Within these educational virtual worlds, students can, among other things, use their avatar to learn about new assignments and to create projects that are viewable within the virtual world.^{16,17}

In the next section, we describe some medical and health education examples from Second Life, including Second Life Medical and Consumer Health Libraries (Healthinfo Island), and VNEC (Virtual Neurological Education Centre). The pedagogical potentials of Second Life are then discussed, as well as some issues and challenges related to the use of virtual worlds. We have also compiled a companion resource page (<http://healthcybermap.org/sl.htm>), with additional up-to-date online material and pointers to support and extend this study.

Medical and health education examples from Second Life

Second Life currently features a good number of medical and health education projects (see the 'key presentation' entitled 'Second Life in Medical and

Health Education: A Quick Visual Tour' and the section entitled 'Top educational locations in Second Life', both at <http://healthcybermap.org/sl.htm>).

For example, at the Ohio University Sim in Second Life, visitors can play a 'Nutrition Game' to learn about the impact fast food has on health.⁸ This is achieved by allowing players to experiment with different eating styles in simulated fast-food restaurants to learn about the short- and long-term health impacts of their choices. The goal for an individual player is to make healthy choices that will result in a high score for the game and a positive effect on health.¹⁸

The Heart Murmur Sim in Second Life^{10,19} is another example. Conceived by Jeremy Kemp, an instructional designer at San José State University, CA, USA, it provides an educational virtual world for cardiac auscultation training that allows visitors (clinical students) to tour a virtual clinic and test their skills at identifying the sounds of different types of heart murmurs, based on sound files from McGill University's Virtual Stethoscope project (<http://sprojects.mmi.mcgill.ca/mvs/mvsteth.htm>).

Readers interested in genetics should visit the Gene Pool in Second Life.^{20,21} This is an interactive genetics lab/museum and learning area, featuring simulated lab experiments, tutorials and simple videos to enhance the learning experience. Visitors can learn about DNA and human chromosomes in great detail, explore a giant 3-D eukaryotic cell, and play the 'Mating Game' at a realistic mock-up of the Augustinian Abbey at Brno, where Mendel did his work about the laws of inheritance. The Gene Pool was conceived by Mary Anne Clark at Texas Wesleyan University in Fort Worth, USA.

At the University of California, Davis, USA, Peter Yellowlees and James Cook developed and evaluated a special place in Second Life to educate people about schizophrenic hallucinations²² and concluded in a paper they published in November 2006 that 'the use of Internet-connected graphics environments holds promise for public education about mental illness'.²³

The US Centers for Disease Control and Prevention (CDC—<http://www.cdc.gov/>) also have a pilot presence in Second Life, and are looking at

ways social media can be used to reach out to more audiences and promote public health.^{24,25} Two other Second Life examples, HealthInfo Island and VNEC, are discussed in some detail below.

HealthInfo Island—Second Life Medical and Consumer Health Libraries

HealthInfo Island (http://infoisland.org/health_info) and reference⁶ is entirely funded by a \$US40 000 grant from the US National Library of Medicine (NLM)/Greater Midwest Region of the National Network to provide consumer health information services in Second Life.²⁶ The NLM-funded project is officially entitled 'Providing Consumer Health Outreach and Library Programs to Virtual World Residents in Second Life' (2006–2008). Project partners include the Alliance Library System (ALS), the University of Illinois Library of the Health Sciences-Peoria, the Central Medical Library, the University Medical Center Groningen (UMCG) in the Netherlands, and TAP Information Services.

The following description of HealthInfo Island is derived with permission from a personal e-mail communication (by the first author) that took place on 1 May 2007 with Carol Perryman, the Project Coordinator, and Guus van den Brekel from UMCG. Perryman is a medical and consumer health librarian with years of experience, and also a PhD student at the University of North Carolina at Chapel Hill, USA, with research interests in evidence-based library and information practice, and consumer health information behaviours.²⁷ van den Brekel is Coordinator of Electronic Services at the Central Medical Library of the University Medical Center Groningen, the Netherlands.²⁸

Purpose and audience

The project is dedicated to health information in various forms. It aims at providing training programmes, outreach to virtual medical communities, important consumer health resources, and one-on-one support to Second Life residents. The target populations for HealthInfo Island include Second Life residents participating in identified in-world medical groups (e.g. groups dealing with stroke support, cerebral palsy, mental health and autism), or interested in learning more about



Figure 1 The NLM SIS 'Health Information Outreach Research Lab' building in Second Life

health and wellness, in addition to outside groups/professionals who might be interested in Second Life as a platform for providing services and outreach for health services.

Description and unique features

HealthInfo Island is run by a team of medical/consumer health librarians and information professionals, in collaboration with an epidemiologist, an internal medical physician, a retired pharmacist, an educator in nursing, 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. In its current incarnation at the time of writing (May 2007), the ground floor serves as a showcase of different ways to offer medical information as content in Second Life. Education and research on medically related subjects in Second Life will be displayed in the Medical Research Room, while another room houses a 'Breast Cancer Awareness' centre. The second floor is used by contractors employed by the US National Institutes of Health (NIH) to explore potential applications of the virtual environment. Plans for further development of the Medical Library include displays of historical medical images.

The second main building on HealthInfo Island, the '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'. The design of the library, 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, 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 centre intends to collaborate with non-profit groups and organizations, and to host special in-world meetings and events. The centre uses skyboxes, so that support groups or smaller consultations are ensured privacy.²⁹

Besides the three main building 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 US National Library of Medicine (Fig. 1). 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. Their building on HealthInfo Island currently hosts an interface to Tox Town (<http://toxtown.nlm.nih.gov/>), an environmental

health portal, as well as links to other well-known NLM information products. SIS is working to bring more health information products to Second Life, and to host a number of outreach activities in Second Life in the future.

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 gardens.

Other services piloted by the project include:

- Trial access to Ebsco's Consumer Health Database and to Reuters Consumer Health News, accompanied with workshops on the Consumer Health Database and the evaluation of health information on the Internet.
- Collecting and presenting quality consumer health resources about illness, drugs, allied/alternative and complementary medicine using US, European and other resources. This includes also presenting information about freely available scientific medical research (in e-books, e-journals, and online databases and repositories), as well as podcast modules for on-demand listening to themed audio sessions.
- Providing in-world medical and health related RSS (Really Simple Syndication) feeds.
- An in-world PubMed search has also been made available in the Medical Library building.
- Infostations: These offer an in-world search interface to PubMed and consumer health and patient information, trying to bridge the gap between the conventional Web and Second Life. Infostations can also be monitored from Internet web pages, and interaction with live avatars from the 'real world' is possible using chat.
- Automated tours of the island to give visitors information about specific services and events, especially at times when there is no in-world human librarian coverage.
- An artificial intelligence chat experiment dubbed 'Healthy' is being piloted that enables patrons to ask health related questions in Second Life, even when there is nobody around. Healthy

always has an answer—and sometimes, even a relevant one. Chatbots are able to provide information in the form of a web address or Second Life teleport link, results from a Google 'define' search, or even images on demand.

VNEC—virtual neurological education centre

Purpose and audience. The Virtual Neurological Education Centre (VNEC—<http://www.vnec.co.uk/>) was developed by Lee Hetherington at the University of Plymouth, Devon, UK.³⁰ 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. It also provides related information, events, and facilities through the virtual world of Second Life.

The VNEC offers an immersive, interactive experience with a unique feeling of 'presence'³¹ with synthetic sensations that make the user feel like they are in another reality. Through the VNEC building, users are able to select a range of neurological symptoms—motor, sensory, and balance—that animate their avatar, resulting in an effective method of limiting and restricting their independence, movement and coordination.

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 in Second Life aims to allow people with a neurological disability a second identity, without any reality restrictions, a place for socializing and to be involved with activities that may not be possible in the real world.

The VNEC has already attracted a wide range of audiences from around the world, but specifically would be appealing to neurological doctors, researchers, physiotherapists, occupation therapists, 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 (Fig. 2), with five main areas—reception, office, theatre, lecture and information point. All of the five areas have individual features, assisting



Figure 2 The VNEC building in Second Life



Figure 3 The VNEC medical theatre in Second Life

the user with information blocks describing the location they are in and the options that are available to them.

At the entrance to the VNEC, the user enters the 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 (cf. Yellowlees and Cook's Virtual Hallucinations project).²³ The office has three areas of interest and usage—conference, desk and seating for social interaction—where the possibility to talk to real-life

doctors 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 (Fig. 3). Within the theatre, users are able to navigate around and 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 primarily is an information area with detailed descriptions of equipment for people in the medical profession.

The VNEC also includes a fully functional lecture theatre for online lectures, meetings and conferences. The lecture theatre is situated outside, with views looking on to the VNEC. The area has potential to stream live video, presentations and images through a virtual plasma screen, which is set up prior to the event.

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 them in their individual cases.

The 'VNEC Member' group, found in Second Life, offers members regular newscasts about the VNEC, including events, new features and visitor experiences. The group has full access to the VNEC building, including all of its facilities, with frequent meetings to discuss future development plans and suggestions to improve the overall experience.

The future development of the 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. Furthermore, by making it possible to have a second, virtual life, the VNEC considers the prospect of people who possibly in reality have neurological restrictions; Second Life offers a new way of living in an extensive virtual environment.

Challenges and limitations. People suffering from a neurological disorder may present with individual forms of disabilities, which in some cases are felt as personal to the patient. Many people diagnosed with a neurological disability absorb it into part of their lifestyle, not seeing it as an impingement to their way of life. The VNEC only demonstrates a selection of symptoms of a neurological disorder, because of the wide variety of possible symptoms and the range of intensity, extent and effect variations that these symptoms may show at different disease stages.

On the technical side of things, the VNEC building has been built within Second Life, but also using additional 3-D software that has the capability of outputting and importing in to Second Life, at a cost. Objects imported or built into Second Life are made up of individual shapes called 'prims' (primitives).³² Prims can be manipulated in many ways to create objects of the designer's choice.

Individual islands in Second Life have limitations on the amount of prims that can be placed within the purchased land. In mid-design of the VNEC, the project encountered the issue of using all of the prims that were available. As a result of this, the purchase of another island in the same region was necessary that had the same amount of prims, which would be transferred and included in an overall amount, allowing further development to continue (another partial workaround could have been to use some prim-saving script to 'rez' or resolve objects on demand when an avatar enters the immediate area, thus allowing prims to be used only when needed).

Discussion

The pedagogical potential of Second Life

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. Teachers are also interested in widening access for geographically remote students—distance learners. The 2007 Horizon Report from NMC and Educause predicts that virtual learning spaces will be adopted on a wide-scale basis in education within the next 5 years.³³ This may be a conservative estimate. Students and teachers in many colleges and universities, particularly across the USA, 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.³⁴ 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 leveller, proving a very popular and equitable method of interaction. Second Life's game-based learning potential also holds great educational promise,³⁵ although the virtual world has much more to offer than a mere 3-D multiplayer game or collection of games.

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 list³⁶ 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 within Second Life, the purchase of land enables the creation of a secure area, i.e. with restricted access (if needed), for teachers and students.

Avatars

In Second Life, not only can students exchange messages in real time, they can actually see animated images of each other—digital 'alter egos'—on their screens. The students and teachers use 'avatars'—digital representations of themselves that they have created—that can take any number of forms, some bizarre, some comical. But the business of learning in Second Life is very serious and avatars may yet play a crucial role in the success or failure of education in such space. Baylor and Ryu³⁷ for example, report that students tend to gravitate toward pedagogical agents (automated tutors) with avatars that closely resemble their own real life appearances. Ethnic groups, for example, might be more comfortable studying with a tutor whose avatar represents a member of the same ethnic group, whilst younger students would be attracted to studying with a teacher who was represented digitally as being 'cool' or 'hip'. We should, however, accept such findings with caution, for the simple reason that learning is diverse and multi-faceted. What young medical student, for example, would not be at least curious to study at the feet of a teacher who uses the avatar of Alexander Fleming?

Navigation of learning space

Moving around in Second Life is both easier and more fanciful than moving around in a real classroom. Students can walk, but they can also manoeuvre around by flying, riding virtual vehicles, or even teleporting to different locations around their virtual space, making access to learning experiences more synchronous and rapid. Such spaces provide students 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 may therefore prove to be an ideal simulation resource where medical students can gain new skills without risk of harm to patients or themselves.

Student participation

Engagement in previous online collaborative learning environments has been observed to mirror engagement levels in traditional classrooms. Students are roughly divided into three groups. The first group tend to engage fully with the programme of study, contributing regularly to discussion groups and responding to the postings of their peers. The second group are more likely to engage sporadically, and post contributions irregularly, whilst the final group may never visit the website, and fail to take part at all. Second Life may hold a different set of outcomes in store, but research is yet too patchy to determine if levels of student engagement will change. However, it has been demonstrated that better participation in computer conferences can be encouraged through online activity which is purposeful, authentic and embedded deeply within the programme.³⁸

Reflective practice

The use of virtual learning environments has been shown to facilitate better reflection and the 'trading of stories' between online learners,³⁹ which can lead toward better building of communities of practice.⁴⁰ Reflective processes can be supported through the use of asynchronous discussion boards, but more likely, interaction (in Second Life) 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. Discussion about a ward round, previous conversations or tutorials with professors, or simply a reflection on a lesson learned, can all leave their digital trails in Second Life—proffering students with a means to revisit exchanges that have taken place.

There is the potential for students and teachers to enhance or change their professional identities through reflective use of virtual and online learning environments.⁴¹ Angela Thomas,⁴² for example,

reports about a student who, subsequent to spending time in her Second Life class, was noted by a colleague to have 'blossomed' offline (i.e. in real life).

Other issues and challenges ahead

Caveats and workarounds. From the examples we have presented in this paper and our discussion so far, 3-D virtual worlds then appear to have much creative collateral to offer to education as social spaces for learning, but, as with all media and applications, there are caveats.

The conventional Web/Web 2.0 and social networks like MySpace (<http://myspace.com/>) also share many of these caveats and issues,⁴ which include Internet addiction, gambling,⁴³ violence, pornography, trust, identity and privacy issues, copyright issues, health information quality and quackery issues, vandalism, and the need to master new skills depending on virtual-world user role (ordinary resident, learner, educator and developer/builder).⁴⁴

As in the conventional Web, guidelines for evidence-based content development should also be used in Second Life and further refined and adapted for the new medium to ensure that products built by those with little experience in health care or library practices will meet quality standards and criteria like information currency, non-biasedness and proper attribution. Residents should also be educated to carefully appraise content they come across in Second Life, and to always consider quackery a possibility in the virtual world, as it is in the conventional Web.

Also, as in conventional wikis where administrators have several options to protect content against vandalism,⁴⁵ landowners in Second Life can prohibit others from building or dropping objects on their lands (or editing existing objects). Users can also report abuse and harassment through the Second Life software client (under the Help menu). The Second Life Police Blotter page displays the most recent disciplinary actions taken by the Second Life Abuse Team.⁴⁶

In addition to the above issues, a high-specification machine, with a high-end graphics card (with software drivers supporting OpenGL—<http://www.opengl.org/>) and a fast broadband Internet connection, is also needed to smoothly run Second

Life and properly render the 3-D virtual world. (For a visual comparison of a low-end graphics card versus a high-end graphics card rendering of a scene in Second Life, the reader is referred to the figure entitled 'A tale of two graphics cards in Second Life', which can be found at the bottom of the companion resource page at <http://healthcybermap.org/sl.htm>.)

Second Life allows users to alter the preferences for in-world graphics, for example, avatar rendering, shading, lighting and terrain details can all be changed/tweaked,⁴⁷ but sometimes the graphics card software driver settings, for example, those controlling anti-aliasing to reduce the jaggedness of edges, also need to be adjusted separately outside the Second Life client for optimal visual/3-D experience.⁴⁸

Second Life for older people and people with physical disabilities

Second Life could be used to entertain older people and people with physical disabilities, and help them combat social isolation and loneliness. Indeed, a recent video interview by CBC.ca of a Second Life user with cerebral palsy, who runs a dance club in Second Life called Wheelies, proves this.⁴⁹

But 3-D virtual worlds may pose potential user interface, 3-D navigation/accessibility issues for older people and people with physical disabilities. Current virtual world navigation requires relatively good dexterity, so the methods of interacting with the virtual world may need to be reconsidered/redesigned to better suit these user groups; for example, using large screens, special joysticks, eye-tracking control and voice navigation (voice chatting has already been introduced in Second Life, and is a major improvement in this respect compared with typing text messages on the keyboard), motion-sensitive controllers that use multi-axial accelerometer-based sensors (like the Wiimote), etc.

It is noteworthy that Wii (<http://www.wii.com/>) and its motion-sensitive controller (Wiimote) are now popular among many older people⁵⁰ and Second Life and Wii are expected to very soon merge in different ways, offering many more exciting opportunities.⁵¹ It has also been reported that

Carol Perryman of the Second Life Consumer Health Library (described above) has approached members of IBM, which has a massive in-world presence in Second Life, to propose their involvement in assistive technology identification and adaptation for the virtual world.⁵²

However, the question that remains is that of the underpinning business model and affordability of these developments: who pays for these new technologies and their integration into Second Life? If it is only the older person or the disabled end user, then a 'digital divide' might soon appear between those who can afford the new 3-D technologies and those who cannot.

The 3-D Web: real or virtual?

The border between what belongs to the real world and what is virtual is getting more and more blurred and fuzzier, as 3-D virtual worlds like Second Life are rapidly becoming part of the everyday lives of millions of users around the world, who are relying on these worlds for communication and social networking, education, and even serious business. Many real-world big brand names and businesses (e.g. Adidas, Autodesk, BMW, Cisco, Dell, Fiat, Intel, Mazda, Mercedes Benz, Philips, Reebok, Reuters, Sony, Sun Microsystems, Toyota, and Vodafone, to name only some) have already established a strong presence in Second Life,⁹ a phenomenon reminiscent of the early days of the World Wide Web, when all major brands and companies were similarly eager to establish their own foothold and online corporate identity on what was then the new medium.

The 'Metaverse Roadmap—Pathways to the 3D Web' initiative (<http://metaverseroadmap.org/>) poses some very interesting and challenging questions on its homepage: 'What happens when video games meet Web 2.0? When virtual worlds meet geospatial maps of the planet? When simulations get real and life and business go virtual? When you use a virtual Earth to navigate the physical Earth, and your avatar becomes your online agent?' Indeed, all reality is rapidly becoming 'mixed or blended reality', as virtual and physical/real-world spaces, activities and applications are progressively converging and feeding back increasingly into one another. In the same vein, IBM's master inventor

Zygmunt Lozinski has recently demonstrated his vision, which involves using mobile phones as a true bridge between Second Life and the physical world, and not just for simple access to the virtual world.⁵³

The 3-D Web is born! But how much of the conventional (2-D) Web is going to converge with 3-D virtual worlds remains to be seen over the next months and few years. However, 3-D virtual worlds are more likely to continue as a (major) extension to, rather than a full replacement of, the conventional Web, at least for some time, until a mature and stable 3-D web browser client and corresponding server infrastructure are developed, that allow much tighter and seamless integration of 3-D virtual worlds with existing web resources and Web 2.0 content and applications. The recent move of Second Life toward Open Source (<http://www.opensource.org/>) is a very promising step in this direction.⁵⁴

Conclusions

Virtual worlds like Second Life are not mere 3-D multi-player games. The immersive, rich experience that such environments offer combines many of the features of Web 2.0, such as group instant messaging, voice chat, profiles and real-time social networking, and a unique form of online social interaction that involves sharing various objects and creative collaboration on building and running places and services in the virtual world (user-generated content).

Virtual worlds are thus a major part of the future of the Web. Virtual medical and health libraries, access to remote librarians, and other medical and health related educational applications through such worlds are not remote possibilities. Indeed, 3-D virtual worlds offer great potential to creative medical and health educators and librarians, but more research is needed into their use in medical and health education (also as the technology underpinning 3-D virtual worlds develops and matures over the coming months and years). Many of the associated educational and library-related possibilities still need to be fully identified, explored in various settings/scenarios, and carefully researched, refined and evaluated to document best practices, as well as the pitfalls that

are to be avoided, before they can be extensively used in daily teaching and learning activities.

Authors' contributions

MNKB conceived and drafted the manuscript. LH contributed the subsection about VNEC and provided Figs 2 and 3. SW wrote the Discussion subsection entitled 'The pedagogical potential of Second Life'. All authors revised and approved the final manuscript.

Key Messages

Implications for Policy

- Second Life represents a relatively new generation of 3-D virtual learning environments that has not been fully evaluated yet, and in which there is enormous potential for the development of creative and dynamic educational experiences.
- Second Life is part of the Web 2.0 movement and its future. Second Life is all about people, online communities, and 3-D social networks. It is a unique social experience, allowing people to meet and interact with each other and in groups, using a comprehensive and well integrated range of asynchronous and real time communication tools.
- Second Life is also about reusing, remixing, and mashing up user-created content and objects. As such, it can be seen as a vast collaborative 3-D wiki and an immersive audio-visual spatial experience that multiple users can experiment with together, edit, and see the changes in real time!
- The affordances of the 2-D Web and 3-D multi-user, immersive virtual worlds are different. They are not mutually exclusive or a substitute for one another, but rather very complementary and synergistic in many ways.
- 3-D virtual worlds are here to stay, mature, and eventually become one with, and tightly and seamlessly integrated into, the 2-D Web and the 'real world'/our daily lives over the coming months and years.

Implications for Practice

- Educators and their institutions need to 'think out of the box'. 3-D virtual worlds should enable educators and learners to be more creative and to develop new effective ways of teaching and learning, rather than to purely replicate real life and classrooms in Second Life!
- We need to especially identify and focus/capitalise on what 3-D virtual worlds are best at; those useful things and scenarios that can only be effectively carried out in virtual worlds and not via any other electronic medium (as effectively), and also determine and disseminate the optimal formulae for blended approaches that combine 2-D and 3-D media.
- Research is still needed to make 3-D virtual worlds more accessible and user friendly. Learners, educators, and developers in these virtual environments also need to acquire and master new sets of competencies and skills in order for them to make the most efficient and effective use of 3-D virtual worlds in learning and teaching.

References

- 1 Second Life. *Second Life—The Marketplace*. Available from: <http://secondlife.com/whatis/marketplace.php> (accessed 2 May 2007).
- 2 Second Life. Up-to-date Second Life economy statistics and graphs. Available from: http://secondlife.com/whatis/economy_stats.php (accessed 2 May 2007).
- 3 Second Life. *Second Life Technology*. Available from: <http://teen.secondlife.com/whatis/technology> (accessed 2 May 2007).
- 4 Kamel Boulos, M. N. & Wheeler, S. The emerging Web 2.0 social software: an enabling suite of sociable technologies in health and healthcare education. *Health Information and Libraries Journal* 2007, **24**, 2–23.
- 5 Second Life. *Second Life SONY BMG Music Entertainment on Media Island*. Available from: <http://slurl.m/secondlife/Media/166/80/46/> (accessed 2 May 2007).
- 6 Second Life. *Second Life Healthinfo Island*. Available from: <http://slurl.com/secondlife/Healthinfo%20Island/130/139/23/> (accessed 2 May 2007).
- 7 Second Life. *Second Life Virtual Morocco*. Available from: <http://slurl.com/secondlife/Casablanca/135/87/26/> (accessed 2 May 2007).
- 8 Second Life. *Second Life Nutrition Game (Ohio University Second Life Campus)*. Available from: <http://>

- vital.cs.ohiou.edu/index.php/Nutrition_Game (accessed 2 May 2007).
- 9 Second Life. *Second Life Brand Map*. Available from: http://www.kzero.co.uk/blog/?page_id=431 (accessed 2 May 2007).
 - 10 Second Life. *Second Life Heart Murmur Sim*. Available from: <http://slurl.com/secondlife/waterhead/124/56/32/> (accessed 2 May 2007).
 - 11 Second Life. *Bringing Voice to Second Life*. Available from: <http://blog.secondlife.com/2007/02/27/bringing-voice-to-second-life/> (accessed 2 May 2007).
 - 12 Livingstone, D. & Kemp, J., eds. *Proceedings of the Second Life Education Workshop at the Second Life Community Convention, San Francisco, 20 August 2006*. Available from: <http://www.simteach.com/SLCC06/slcc2006-proceedings.pdf> (accessed 2 May 2007).
 - 13 Second Life Community Convention. *2nd Second Life Education Workshop, 24–26 August 2007 at the Chicago Hilton, USA*. Available from: <http://slcc2007.wordpress.com/> (accessed 2 May 2007).
 - 14 Internet. *Second Life Best Practices in Education Conference 2007 (In Venues all over the Second Life World)*. Available from: <http://slbestpractices2007.wikispaces.com/> (accessed 2 May 2007).
 - 15 The New Media Consortium. *NMC Announces Parcel Leases in Three New Educational Communities in Second Life*. Available from: <http://virtualworlds.nmc.org/04/01/leases/> (accessed 2 May 2007).
 - 16 Antonacci, D. M. & Modaress, N. *Second Life: The Educational Possibilities of a Massively Multiplayer Virtual World (MMVW)*. 2005. Available from: <http://www2.kumc.edu/tlt/SLEUCAUSES2005/SLPresentationOutline.htm> (accessed 2 May 2007).
 - 17 Wikipedia. *Virtual World (In the Classroom)—Wikipedia*. Available from: http://en.wikipedia.org/wiki/Virtual_world#In_the_classroom (accessed 2 May 2007).
 - 18 Wiki. *Nutrition Game—the VITAL Laboratory at Ohio University*. Available from: http://vital.cs.ohiou.edu/index.php/Nutrition_Game (accessed 2 May 2007).
 - 19 Kemp, J. *Second Life Heart Murmur Sim video demonstration*. Available from: <http://youtube.com/watch?v=xJY2Iwbzop4> (accessed 2 May 2007).
 - 20 Second Life. *The Gene Pool in Second Life*. Available from: <http://slurl.com/secondlife/Immaculate/212/208/21> (accessed 2 May 2007).
 - 21 Clark, M. A. *The Gene Pool PPT Tour* (4 parts). Available from: http://department.txwes.edu/bio/Gene_Pool/Gene_Pool_I.ppt; http://department.txwes.edu/bio/Gene_Pool/Gene_Pool_II.ppt; http://department.txwes.edu/bio/Gene_Pool/Gene_Pool_III.ppt; http://department.txwes.edu/bio/Gene_Pool/Gene_Pool_IV.ppt (accessed 2 May 2007).
 - 22 Second Life. *Second Life Virtual Hallucinations (UC Davis)*. Available from: <http://slurl.com/secondlife/sedig/26/45/21/> (accessed 2 May 2007).
 - 23 Yellowlees, P. M. & Cook, J. N. Education about hallucinations using an Internet virtual reality system: a qualitative survey. *Academic Psychiatry* 2006, **30**, 534–9.
 - 24 Second Life. *The US Centers for Disease Control and Prevention (CDC) test site in Second Life*. Available from: <http://slurl.com/secondlife/Juwangsan/218/223> (accessed 2 May 2007).
 - 25 Weinreich, N. K. *The CDC's Second Life*. Available from: <http://www.social-marketing.com/blog/11/cdcs-second-life.html> (accessed 2 May 2007).
 - 26 Internet. *NLM Grant received for Consumer Health Library Services in Second Life*. Available from: <http://infoisland.org/2006/11/02/alliance-library-system-receives-grant-to-provide-consumer-health-information-services-in-virtual-world/> (accessed 2 May 2007).
 - 27 Perryman, Carole. Project Coordinator of 'Providing Consumer Health Outreach and Library Programs to Virtual World Residents in Second Life' (NLM grant). Available from: <http://www.unc.edu/~cperryma/Research/Research%20page.htm> (accessed 2 May 2007).
 - 28 van den Brekel, Guus. Blogger: user profile. Available from: <http://www.blogger.com/profile/05563838801421698112> (accessed 2 May 2007).
 - 29 Second Life. *Second Life Knowledge Base: How do I get some privacy in Second Life? Live in a Skybox*. Available from: <http://secondlife.com/knowledgebase/article.php?id=358> (accessed 2 May 2007).
 - 30 Second Life. *VNEC—Virtual Neurological Education Centre in Second Life*. Available from: <http://slurl.com/secondlife/Lost%20Islands%20NW/48/83/22> (accessed 2 May 2007).
 - 31 Sheridan, T. B. Telepresence and virtual presence. *Presence* 1992, **1**, 120–5.
 - 32 Wiki. *Primitive—Second Life Wiki*. Available from: <http://wiki.secondlife.com/wiki/Prim> (accessed 2 May 2007).
 - 33 2007 Horizon Project Advisory Board. *The Horizon Report—2007 Edition* (NMC and Educause). Available from: http://www.nmc.org/pdf/2007_Horizon_Report.pdf (accessed 2 May 2007).
 - 34 Lagorio, C. The ultimate distance learning. *New York Times*, 7 January 2007. Excerpt. Available from: <http://e-learning-teleformacion.blogspot.com/2007/01/ultimate-distance-learning-christine.html> (accessed 2 May 2007).
 - 35 Delwiche, A. Massively multiplayer online games (MMOs) in the new media classroom. *Educational Technology & Society* 2006, **9**, 160–72. Available from: http://www.ifets.info/journals/9_3/14.pdf (accessed 2 May 2007).
 - 36 Second Life. *Second Life Healthcare Support and Education mailing list*. Available from: <https://lists.secondlife.com/cgi-bin/mailman/listinfo/healthcare> (accessed 2 May 2007).
 - 37 Baylor, A. L. & Ryu, J. Does the presence of image and animation enhance pedagogical agent persona? *Journal of Educational Computing Research*, 2003, **28**, 373–95.
 - 38 Barker, S. Virtual learning environments for constructivist teaching in biosciences to promote sustainable development in higher education. *CAL-laborate Journal* 2002, **8**. Available from: <http://science.uniserve.edu.au/pubs/callab/vol8/barker.html> (accessed 2 May 2007).

- 39 Kirkup, G. Teacher or avatar? Identity issues in computer-mediated contexts. In: Burge, E. J. & Haughey, M. (eds). *Using Learning Technologies: International Perspectives on Practice*. London: Routledge Falmer, 2001.
- 40 Wenger, E. *Communities of Practice: Learning, Meaning and Identity*. Cambridge: Cambridge University Press, 1998.
- 41 Wheeler, S., Kelly, P. & Gale, K. The influence of online problem-based learning on teachers' professional practice styles. *ALT-J: Research in Learning Technology*, 2005, **13**, 125–37.
- 42 Thomas, A. My teaching semester in Second Life: pitfalls, challenges and joys. *SLATE Magazine*, 2006. Available from: http://www.slatenight.com/index.php?option=com_content&task=view&id=107&Itemid=40 (accessed 2 May 2007).
- 43 Internet. FBI checks out gambling in Second Life. *Reuters*, 3 April 2007. Available from: <http://secondlife.reuters.com/stories/2007/04/03/fbi-probes-second-life-gambling/> (accessed 2 May 2007).
- 44 Swaine, C. *Second Life Core Competency Framework (Education UK)*. Available from: <http://www.sleducationuk.net/?q=node/3> (accessed 2 May 2007).
- 45 Kamel Boulos, M. N., Maramba, I. & Wheeler, S. Wikis, blogs and podcasts: a new generation of web-based tools for virtual collaborative clinical practice and education. *BMC Medical Education* 2006, **6**, 41. Available from: <http://dx.doi.org/10.1186/1472-6920-6-41> (accessed 2 May 2007).
- 46 Second Life. *Second Life Police blotter*. Available from: <http://secondlife.com/community/blotter.php> (accessed 2 May 2007).
- 47 Second Life. *Second Life Preferences Guide*. Available from: <http://secondlife.com/knowledgebase/article.php?id=335> (accessed 2 May 2007).
- 48 Internet. *TweakGuides.com—Nvidia Forceware Tweak Guide*. Available from: http://www.tweakguides.com/NVFORCE_6.html (accessed 2 May 2007).
- 49 Internet. *Second Life: Excellent Review from CBC*. Available from: <http://www.dlc-solutions.com/blogs/jeremylundberg/2006/11/second-life-excellent-review-from-cbc.html> (accessed 2 May 2007).
- 50 Internet. *Wii Invades Retirement Home*. Available from: <http://www.dailyTechnical.com/Wii+Invades+Retirement+Home/article6191.htm> (accessed 2 May 2007).
- 51 Wallace, M. *Wii Interface for SL?* Available from: <http://www.3pointd.com> (accessed 2 May 2007).
- 52 Peters, T. & Bell, L. MUVEing toward accessibility—soaring beyond physical challenges in virtual worlds. *Computers in Libraries* 2007, **27**, 34–7. Available from: <http://www.technewsworld.com/story/56880.html> (accessed 2 May 2007).
- 53 Kelly, S. Mobile talk moves to Web 2.0. *BBC News, Click Programme*, 23 February 2007. Available from: http://news.bbc.co.uk/2/hi/programmes/click_online/6389469.stm (accessed 2 May 2007).
- 54 Internet. Second Life goes open source. *vnunet.com*, 9 January 2007. Available from: <http://www.vnunet.com/vnunet/news/2172099/second-life-goes-open-source> (accessed 2 May 2007).

Received 3 May 2007; Accepted 28 June 2007

Copyright of Health Information & Libraries Journal is the property of Blackwell Publishing Limited and its content may not be copied or emailed to multiple sites or posted to a listserv without the copyright holder's express written permission. However, users may print, download, or email articles for individual use.