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3D MODEL OF THE HIV VIRUS CREATED BY SL:MADCOW COSMOS (KARUNA ISLAND) - HTTP://SLURL.COM/SECONDLIFE/KARUNA/84/212/22

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Editors' Corner

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Keywords: future Internet; standards; frameworks; game-based learning; OpenSim; Second Life ®; health and medicine; virtual patients.

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"*Much like the (original) Internet, virtual worlds will allow us to do "older" things more effectively, and do other things anew*" -- Yesha Sivan

A ubiquitous, immersive and engaging online platform for future generations

Despite their current "teething" problems, which are in many ways similar to the problems that faced the World Wide Web during its early days (Kamel Boulos et al., 2008), 3-D virtual worlds are poised to become a major online communication, learning, business and entertainment platform for our future generations. Today's kids are being taught school lessons in 3-D virtual worlds (http://news.bbc.co.uk/newsbeat/hi/technology/newsid_7869000/7869303.stm) and are increasingly becoming used to the 3-D medium. A recent article in the British magazine Computer Shopper (http://www.computershopper.co.uk/columns/243207/raves-virtual-real-ale-it.html) discussed how today's children are very heavily involved in virtual worlds, perhaps much more than youths and older adults, which gives some clue about where the (3-D) Internet is heading when these kids grow up:

"*We've already seen the birth of the first generation of children who will always inhabit virtual worlds and pre-packaged experiences. In fact, the highest growth area in virtual worlds is those aimed at children between the ages of five and eight. Have you ever heard of Wales? Of course you have. It has a population of just over three million souls. Have you ever heard of Neopets? No? It's a bit bigger than Wales. In fact, it's a virtual world with a population of 45 million registered users, and all of them are children. How about Habbo Hotel? One hundred million children regularly inhabit this artificial existence. As for the likes of Cyworld in South Korea and Hipihi in China, there are probably more citizens of these virtual worlds than were living on the entire planet when The Machine Stops (written by EM Forster and published in 1909) was originally written.*"

While some of the above mentioned virtual worlds are 2.5-D (e.g., Habbo Hotel) and much more basic and less immersive compared to Second Life®, Hipihi (China - http://www.hipihi.com/index_en.html) is a direct match to Second Life®. It seems the virtual worlds "empire" is now moving to Asia, with offerings from Hipihi, Nurien (South Korea - http://www.nurien.com/ —Nurien is far more superior than Second Life® in terms of graphics and immersiveness), Cyworld Mini Life (South Korea - http://us.cyworld.com/), and others from this part of the world.

We have also begun to see 3-D virtual worlds that offer a 3-D mirror world experience like Near London from Near Global (http://www.nearglobal.com/About.aspx) and GeoSim Cities (http://www.geosim.co.il/). This is a very welcome trend that will definitely continue and contribute to shaping the ultimate 3-D Internet over the second decade of the twenty-first century.

Also, and in a way similar to the early Web and how its interface was gradually integrated into mainstream desktop computing (like Microsoft Windows Desktop, starting in Windows 9x and Internet Explorer 4), 3-D virtual worlds might one day shape the graphical user interfaces of mainstream operating systems and even of cloud computing on small Internet devices. Apple is already exploring 3-D desktop and application interfaces (see patent application at: http://appft1.uspto.gov/netacgi/nph-Parser?Sect1=PTO2&Sect2=HITOFF&p=1&u=%2Fnetahtml%2FPTO%2Fsearch-bool.html&r=1&f=G&l=50&co1=AND&d=PG01&s1=20080307360&OS=20080307360&RS=20080307360 and figures at: http://www.macrumors.com/2008/12/11/apple-exploring-3d-desktop-and-application-interfaces/), while AMD and others are developing systems to compute a game's (or 3-D virtual world's) graphics, compress them, and send them out over the Internet, so that online users can run the results on platforms, such as cellphones, that are too computationally underpowered to render the graphics on their own (Ross, 2009; see also OnLive's cloud gaming service: http://www.spectrum.ieee.org/apr09/8548).

Multi-touch user interfaces, augmented reality and other technologies already available today will also contribute to realising the future 3-D Internet of ubiquitous real-virtual worlds, where the boundaries will increasingly get fuzzier between 'real' and 'virtual' and between 'humans' and 'user interfaces'. A recent video-montage by Microsoft illustrates the company's vision for 2019, where one can see examples of the above boundaries getting blurred (see: http://www.istartedsomething.com/20090228/microsoft-office-labs-vision-2019-video/ or on YouTube at: http://www.youtube.com/watch?v=RvtxupQmRSA&feature=PlayList&p=DC88D59DC711D462&index=0&playnext=1), while General Electric has an inspiring mini-example of augmented reality that anyone can try online (see: http://www.youtube.com/watch?v=00FGtH5nkxM and http://ge.ecomagination.com/smartgrid/#/augmented_reality). SixthSense, developed at Massachusetts Institute of Technology's Media Lab, is a wearable, gesture-driven computing platform that can continually augment the physical world with digital interactive information (http://news.bbc.co.uk/1/hi/technology/7997961.stm).

New forms of human—3-D virtual space interaction are also being developed that could, in the next few years, transform the way we use and inhabit 3-D virtual worlds. For example, Microsoft is currently working on a fully hands-free control system that will use face and voice recognition, as well as motion sensors to allow users to customise their avatars and interact in 3-D virtual spaces (see: http://www.neowin.net/news/gamers/09/06/01/microsoft-introduces-controller-free-gaming-project-natal).

Towards an integrative vision of a novel 3-D virtual worlds platform —moving beyond today's Second Life®

As the main component of the next-generation 3-D Internet, and much like the flat (2-D) Web, 3-D virtual worlds are, and need to be, generic (i.e., application-neutral) by design for maximum flexibility. Then purpose-built applications can be developed on top of this generic foundation to serve specific purposes (*cf.* Moodle (http://moodle.org/), the well-known Web-based Virtual Learning Environment, which runs as a specialised application or platform over the generic flat Web, and SLoodle (http://www.sloodle.org/), Moodle's Second Life® extension).

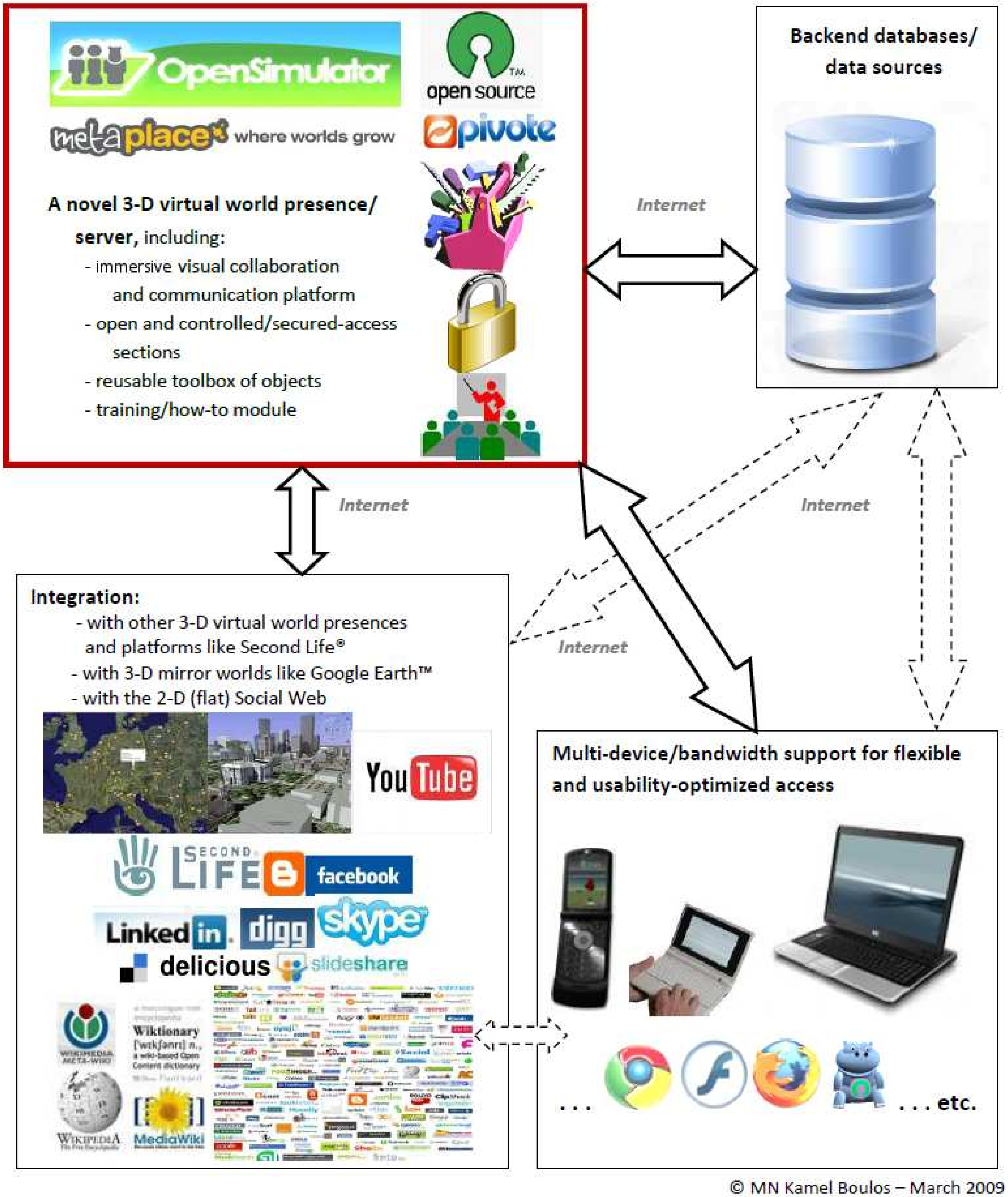

Figure 1. An integrative vision of a novel 3-D virtual worlds platform. Content development and storage (content syntax and storage location) should ideally be separate from, and independent of, the presentation platform, allowing presentation to take place in different 3-D virtual worlds, on the flat Web, on mobile phones, etc., following the spirit of, and building on, the new Open Source PIVOTE toolkit (http://code.google.com/p/pivote/) that adopts this approach.

Figure 1 illustrates an integrative vision of a novel 3-D virtual worlds platform that seamlessly weaves into, and harnesses, existing and emerging Social Web services and data sources, and also gracefully adapts to different Internet devices that have different input and output affordances, to provide the ultimate 'immersive visual collaboration and communication hub' for our different daily (online) activities and interests.

Metaplace (shown in Figure 1 – http://www.metaplace.com/) is a successful example of an emerging 3-D virtual world platform that, albeit not very immersive as Second Life®, manages to integrate very well with existing flat Web content and even runs in standard Web browsers (with the Adobe Flash Player plugin) without the need for a special software client viewer, all while being extremely easy to learn and develop presences in (see comments about Metaplace at https://www.jiscmail.ac.uk/cgi-bin/webadmin?A2=VIRTUALWORLDS;QyPIQA;20090322220248%2B0000).

The quest for 3-D Internet standards

Standards will play a key role in realising the integrative vision shown in Figure 1 and to ensure smooth interoperability among various 3-D virtual worlds and between those worlds and other online services and data sources.

Today (in March 2009), the Open Source OpenSim platform (http://opensimulator.org/) and the largely proprietary/closed-source Second Life® are sporting some very welcome inter-compatibility between them. For example, the same software client (Second Life® viewer or Hippo viewer - http://mjm-labs.com/viewer/) can be used to visit both OpenSim-based and Second Life® grids. Second Inventory (http://www.secondinventory.com/) allows most (full-permission) objects to be ported (with any associated textures and internal scripts) from Second Life® to any OpenSim grid.

Figure 2. The University of Plymouth Sexual Health SIM on the OpenSim-based New World Grid. Most of the interactive objects that appear in this snapshot were successfully ported unmodified from our primary presence in Second Life® and are fully functional under OpenSim, thanks to the Second Inventory application (http://www.secondinventory.com/files/products.php).

Kamel Boulos, with help from the administrators of the French OpenSim-based New World Grid (http://www.newworldgrid.com/), have successfully ported many of the interactive objects at the University of Plymouth Sexual Health SIM in Second Life® (see: Kamel Boulos and Toth-Cohen, 2009) to a new, mirror presence on the New World Grid (http://osurl.org/grid.newworldgrid.com:8002/Eleniel/58/45/33 and Figure 2).

Using the same Second Inventory software, we have also ported the free Open Source PIVOTE scripted objects (part of the PREVIEW Immersive Virtual Training Environment—see http://www.pivote.info/) from Second Life® (where they can be collected at: http://slurl.com/secondlife/St%20Georges%20University/123/16/21) to our place on the New World Grid.

OSurls (OpenSim URLs - http://osurl.org/, similar to Second Life® SLurls) have made access to OpenSim presences very user-friendly, while recent developments like OpenSim Made Easy (http://lab.newworldgrid.com/index.php/OpenSim_Made_Easy) are opening 3-D virtual world region hosting to the masses and significantly reducing its costs. Viewers like RealXtend (http://www.maxping.org/technology/viewers/intergrid-teleportation-with-rex.aspx) and the Hypergrid concept of OpenSim (http://opensimulator.org/wiki/Hypergrid) are promising to make intergrid teleportation as simple as clicking a link to move to another site on today's flat Web. However, OpenSim, much like Second Life®, is still a "closed" platform in some ways. Yesha Sivan beautifully expresses the current situation in a recent online post at http://www.dryesha.com/:

"*Currently the virtual worlds industry operates more like the Computer Gaming Industry than like the Internet industry. Each developer, be it private (e.g., Linden, Forterra) or an Open Source (e.g., Sun Darkstar,* ***OpenSim)*** *is developing its own server, client, and rules of engagement. The inherent rationale of these efforts is a combination of "we know best" and "we will conquer the world." While this may be the case (see Microsoft Windows, Apple iPod, or Google search), the common public good calls for a connected system like the internet, where different forces can innovate in particular spots of the value chain.*"

Linden Lab (the creator of Second Life®) and IBM are currently mulling together their new 'MMOX[i] standards' via the official IETF (Internet Engineering Task Force) channels. The proposed MMOX standards and Open Grid Protocol suite will offer an application-layer wire protocol for virtual worlds to enable inter-application interoperability; provide for access and exchange with other systems on the Internet such as Web services, e-mail and other information storage systems; and allow network layers to recognize virtual worlds traffic and make routing decisions based on its characteristics (see: http://trac.tools.ietf.org/bof/trac/wiki/MmoxCharter).

On the other hand, the Metaverse1 EU Project Consortium led by Philips Research in the Netherlands is working on a new International Organization for Standardization (ISO) MPEG-V standard to be ready by October 2010 to fill in a similar standards gap (see: http://www.chiariglione.org/mpeg/working_documents/mpeg-v/mpeg-v_Reqs.zip).

The two standards sets are not necessarily mutually exclusive or competing with one another at this early stage (despite the clear overlap in their objectives). As MMOX and MPEG-V both evolve over the next few years, we will see which one of them will ultimately win the support of the industry or dominate the virtual worlds scene, or perhaps there will be some "merger" of the two sets at some point or a failure of one of them to deliver or even some new standards sets and players joining in. In fact, Mozilla, the developer of the Firefox Web browser (http://www.mozilla.com/firefox/), has just announced (as this article was being finalised) that it has joined forces with the graphics consortium Khronos (http://www.khronos.org/), who manage COLLADA (the COLLAborative Design Activity for establishing an interchange file format for interactive 3D applications - http://www.khronos.org/collada/), in setting up a working group to create a standard for what they call 'accelerated 3D graphics on the Web', the first version of which is expected in 2010 (see: http://news.bbc.co.uk/1/hi/technology/7963302.stm). It remains to be seen how this Mozilla-Khronos development will affect (or become affected by) the recently launched 3Di OpenViewer for OpenSim, an in-Web-browser 3D virtual world viewer (see: http://www.youtube.com/watch?v=4otd5c1U0iY and http://3di-opensim.com/en/).

Years ago, SGML (Standard Generalized Markup Language, an ISO-ratified standard) lost the Web "battle" to XML (eXtensible Markup Language, a W3C specification). SGML, while powerful and comprehensive, is very complicated, and the industry eventually dropped it in favour of XML, a much simpler language that still offers most of the power of SGML but without its complexity. We might witness the same in 3-D virtual worlds over the coming years, with the simpler and agile specifications gradually gaining wide acceptance and any emerging cumbersome "dinosaur-like" standards rapidly disappearing.

Moving on from these application-neutral reflections on emerging and future developments in 3-D virtual worlds, the remaining part of this article will explore in some detail one current real-world application example of these new media, focusing on how 3-D virtual worlds can support game-based learning and presenting a case study of the Respiratory Ward, a 'virtual patients' game-based learning module in Second Life® developed at the Faculty of Medicine at Imperial College London.

Are Multi-User Virtual Environments (MUVEs) ready to support game-based learning?

Multi-User Virtual Environments (MUVEs) such as Second Life®, OpenSim and Active Worlds (http://www.activeworlds.com/) offer new collaboration and immersed teaching and learning opportunities. A large number of educational institutions are already exploring ways of making use of these new virtual environments. According to the Eduserv Spring 2009 Snapshot of Virtual World use in UK Higher and Further Education, many universities in the UK are studying the use of virtual worlds – mainly Second Life®- in education. A range of different uses of virtual worlds in UK higher and further education were identified with learning and teaching activities predominating, as well as simulations, the visualisation of complex structures and safety role-play.

According to Livingston et al. (2008) very few MUVEs have been designed specially to support educational objectives. MUVEs generally are not purposely built to effectively support educational activities. In order to take advantage of the potential of MUVEs and to produce effective immersive and engaging learning environments, a large number of developers and designers are required.

Games provide a meaningful and relevant context in which learning activities can be delivered. Good games have clear goals and "explicit information both on-demand and just in time when the learner needs it" (Gee, 2003). The term game-based learning has emerged as a generic name for the use of games for learning or educational purposes. It has also been termed 'serious games', and includes fully immersive environments (or 'metaverses'), in which learners can take on virtual presence in virtual worlds (Joint Information Systems Committee 2007).

Game-based learning implementations in MUVEs may provide the means to deliver guided and engaging teaching and learning experiences more suited to the 'digital natives' generation. It could be said that some MUVEs already provide ready-made games engines and some authors recognise Second Life® as a game-based application providing a space in which games can be created, allowing highly structured linear experiences as well as more open-ended ones. However, some do not classify it as a game, because of its lack of predefined goals (Livingstone 2007). MUVEs lack of effective built-in authoring tools which may guide educators and learning technologists in the design of effective game-based learning implementations.

Designing game-based learning activities in MUVEs

The Faculty of Medicine at Imperial College London has developed a Respiratory Ward in Second Life® with a series of virtual patients activities following a game-based learning model (Figure 3). The game-based learning activities aim to drive experiential, diagnostic and role-play learning activities within the 3-D world, aiming to support patients' diagnoses, investigations and treatment. The Respiratory Ward was developed with five virtual patients covering (medical history, differential diagnosis, investigations, working diagnosis and management plan). Different narratives and modes of representation were developed within the areas described above (introductions, scaffolding information, diagnostic capabilities, assessment and triggers) (Toro-Troconis et al, 2008b).

Figure 3. Virtual Patient at the Respiratory Ward – Imperial College London region in Second Life® (http://slurl.com/secondlife/Imperial%20College%20London/150/86/27/).

The game-based learning process covers a wide range of activities and phases which should be followed in order to ensure a pedagogically sound game-based learning implementation. The following phases where followed for the design of game-based learning for virtual patients in Second Life®. It is worth highlighting these phases may apply to the development of game-based learning activities in any other MUVE and any other health or healthcare area.

Concept Development Phase

This phase started when the idea of game-based learning for virtual patients was conceived. The main learning outcomes of the activities were determined. The framework for evaluating games and simulation-based education developed by De Freitas and Martin (2006) were also adapted for this research (Toro-Troconis et al, 2008b).

Draft paper prototypes were created and a *Concept Document* was produced covering the following:

- High Concept. This looks at what makes the game-based learning experience different from other similar activities.
- Player Motivation. This section identifies the key motivational factors across the target population.
- Game Play. This looks at what the learner will do while playing the game.
- Story. The story identifies the main events, characters and setting in which the learning experience takes place.
- Target Audience.
- Game Genre.
- Target Platform and hardware requirements.
- Competitive analysis.
- Game Goals.

Another document produced at this stage is referred as 'Pitch Document'. The pitch document discussed the same topics highlighted in the Concept Document but in an abbreviated form. Learning technologists, instructional designers, educators and technical developers play a key role in formulating ideas and preparing concise and persuasive concept and pitch documents. The role of a game designer or learning technologist with a strong background in instructional design is crucial at this stage. They all have to work together to come out with a clear idea about: a) learning outcomes, b) learner characteristics, c) important contextual factors, and d) a desired instructional approach which will guide the nature of interactions to be designed to facilitate game-based learning (Hirumi and Stapleton, 2008).

The game should be identified within a specific instructional strategy or theory addressing the right instructional design model to be applied. For example, Case-Based Reasoning (Aamodt and Plaza, 1994), Learning by Doing (Schank, Berman & Macpherson, 1999) or Problem-Based Learning (Barrows, 1985). The selection and application of an instructional design principle will determine the nature of the learning environment guiding the sequencing of critical learning interactions and game activity which will influence the way learners achieve the game learning outcomes.

The instructional strategy selected for the design of game-based learning activities for the delivery of virtual patients was a constructivist approach. In this case the "story" presents the learners with a virtual patient scenario and the "game play" requires the learners to interact with different tools and dialogue messages to access content information and construct their own knowledge on how to work their way through the virtual patient cases.

Pre-Production Phase

Once the game concept has been produced after completion of the concept design phase, the development team starts planning the pre-production phase. This phase aims to identify the following:

- Story (nature of characters, activities and events the learners will interact with when playing the game-based learning activity).
- Game play (rules, tools and goals).
- User controls.
- User interface.
- Game levels.
- Media assets (audio, video, art design and technical issues).
- Production details.

During the pre-production phase for the Respiratory Ward the main activity of the virtual patient characters were identified as well as the levels of interaction within the environment. It was decided to keep the game-based learning experience to a single-player, although multiple players can communicate in a Problem-Based Learning approach when accessing the virtual patients. The rules were established and the virtual patient components implemented following the MedBiquitous Virtual Patients Model (http://groups.medbiq.org/medbiq/display/VPWG/MedBiquitous+Virtual+Patient+Architecture - also used in the above mentioned PIVOTE project) helped to establish the different rules, media assets and tools required at each stage (Toro-Troconis et al., 2008a).

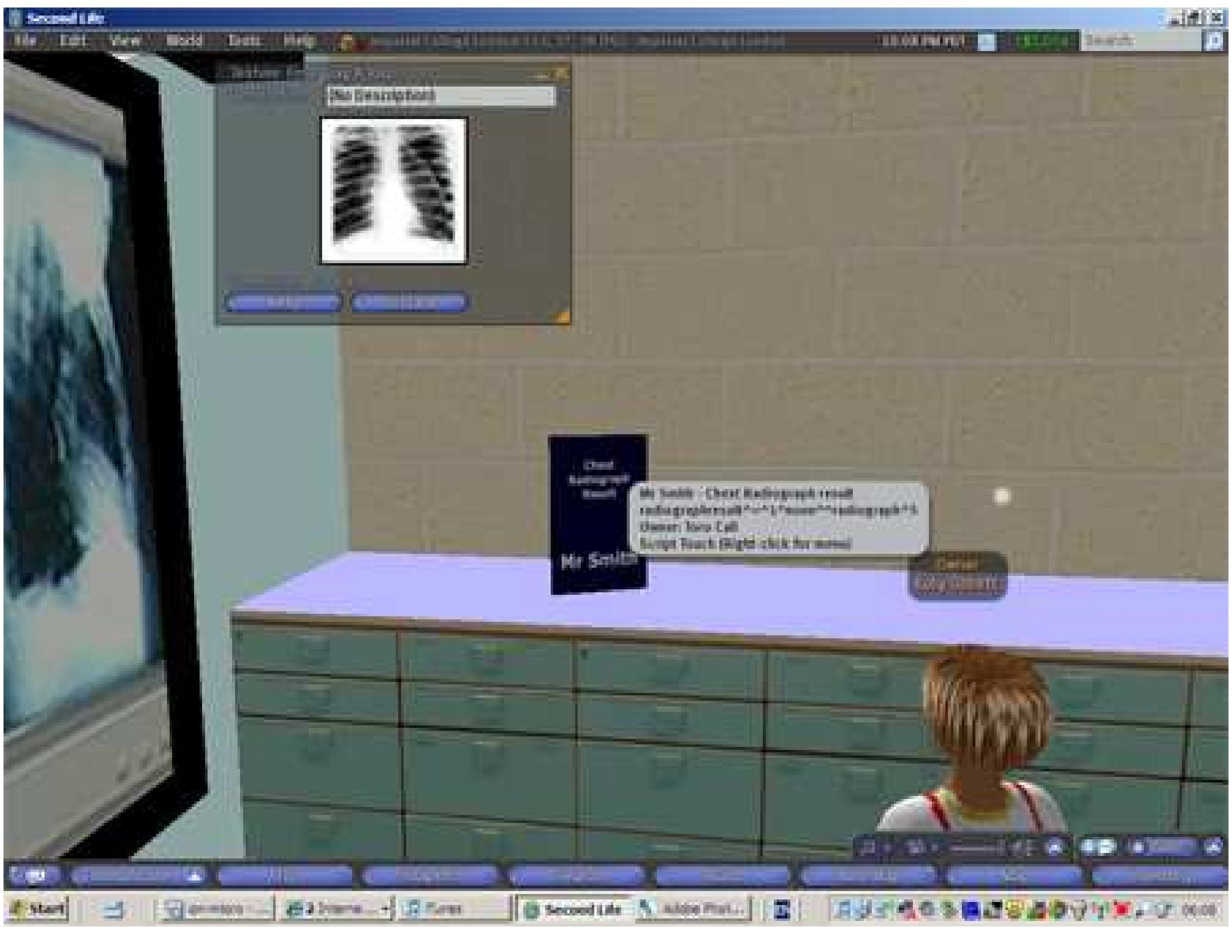

Figure 4. Virtual patient user controls and interface**.**

User controls and interfaces were designed to accommodate to the Second Life® capabilities. The use of notecards and on-screen text messages were used as the main user communication interface (Figure

4). The design of a Heads-up display (HUD) was originally planned to keep the learner informed of his/her performance. HUD elements indicate player/learner status showing which direction the player/learner is going or where the player/learner ranks in the game.

Production Phase

The production phase began once the prototype was approved. The production phase was broken down into Alpha and Beta versions and the final "Gold" version was delivered once the Alpha and Beta versions were fully tested. Each section of the game-based learning activity was tested and any bugs were documented in a testing document. Production of the Beta version concentrates in fixing all the bugs and incorporating all the code, art work, audio, user-interface, navigation and media assets required. Once the game-based learning activity passed satisfactorily Beta testing, the final Gold version was delivered.

The HUD is a very good method for conveying information to the player/learner during the game. However, it was decided not to design a HUD at this stage in order to keep the development simpler and more economical. This will be re-assessed for the next development phase.

Final notes

The game-based learning design and development process described above shows the need of a large team and key team members to ensure an effective implementation of game-based learning activities. It is believed that the process of designing and authoring game-based learning activities not only in Second Life® but in any other MUVE may be made more accessible if design guidelines and built-in game authoring tools were available.

It is very unlikely e-learning teams in further and higher education institutions will have learning technologists with expertise in game design, which makes the process of designing game-based learning activities in MUVEs more challenging and expensive. Game designers may be brought into the team from external providers. However, this may increase development costs as well as making the development process longer until the game designers become acquainted with the culture of the educational institution and the learning outcomes of the game-based learning activity to be produced.

At the same time, the development of generic game authoring environments across MUVEs may lead into interoperable game-based learning activities, which means that one game-based learning activity authored in one MUVE, such as Second Life®, could be exported and re-used in another MUVE, such as Active Worlds. The IMS[ii] Learning Design specification is worth looking at in this respect. The implementation of the IMS Learning design specification allows different game implementations authored in different game engines to be played in different IMS conformant game engines (Moreno-Ger et al., 2007).

A successful story not focused on game-based learning but in the educational context is the aforementioned Sloodle project, which aims to bring flexible support for teaching and learning to 3-D virtual worlds via integration with a VLE[iii] – specifically Second Life® and the open-source Moodle VLE (Livingstone et al., 2008).

The Implementation of game-based learning within MUVEs is potentially very interesting and very challenging for formal educational settings. The development of game-based learning guidelines and easy to use authoring environments may result in a greater proportion of game-based learning being developed and delivered via MUVEs, which are based on higher order principles of education and learning.

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[i] NE: MMOX – concept related to Massive Multiplayer Online.

ii NE: IMS – Internet protocol Multimedia Subsystem.

[iii] NE: VLE – Virtual Learning Environment.