

Virtual Worlds in Computing Education

Jonathan Crellin, Emma Duke-Williams, Jane Chandler,
School of Computing, University of Portsmouth

Timothy Collinson,
University Library, University of Portsmouth

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Contact Details:

Dr. J. Crellin,
School of Computing,
University of Portsmouth,
Buckingham Building
Lion Terrace
Portsmouth
PO1 3HE
jonathan.crellin@port.ac.uk
02392 846421

Abstract

This paper reports on the use of a virtual world (Second Life) in computing education, and identifies the precursors of current virtual world systems. The paper reviews the potential for virtual worlds as tools in computing education. It describes three areas where Second Life has been used in computing education: as a development environment; as a collaboration tool, and to provide a environment for simulation. The benefits of virtual worlds for computing education (with a particular emphasis on Second Life) is discussed. Qualitative feedback from students is reported which, although not definitive, illustrates many of the benefits and disadvantages of using virtual worlds in computing education.

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Overview of Virtual Worlds

Although it is comparatively recent that 'virtual worlds' such as Second Life have received attention, the concept of a simulation of a virtual world used as a way of interacting with a computer or data has a long history. Virtual worlds were used in role playing games from the earliest days of interactive computing, for example text based adventure games such as Will Crowther's *Adventure*. Role Playing Games were originally developed (and still exist) as complex rule based, paper board games, for example Gygax's *Dungeons and Dragons* from 1974, but the complex rule sets associated with these games lent themselves to computerisation. By 1976, computerised versions of these games appeared (Burka, 1995), such as *Advent* (developed in 1975), first implemented as a

text based virtual world. Adventure games played over a network became known as Multi User Dungeons or MUDs. These allowed different individuals (sometimes far apart) to interact with each other in a virtual environment (albeit a limited text described virtual environment). Trubshaw developed the first MUD in 1978 (Bartle, 1990). Although the first MUDs were focussed on competitive game play, by the end of the 1980s 'social' MUDs started to appear, for example TinyMUD, written by Jim Aspnes in 1989. In that game players could spend virtual money, and create objects and places (Roberts, 2000). Alongside the development of text based computer games a growing range of fiction described 3-dimensional, computer based worlds, for example books such as William Gibson's *Neuromancer* (Gibson, 1984) which introduced the idea of cyberspace and Neil Stephenson's *Snow Crash* (Stephenson, 1992) a book commonly described as the inspiration for *Second Life*, together with films and television shows such as *Tron* (Disney, 1982), *Star Trek* (which introduced simulated environments within a Holodeck in 1987) and *The Matrix* (1999).

Other predecessors of the current virtual worlds include three dimensional simulators. Simple flight simulators have been in use since the first world war (for example in training the skills necessary for aerial combat). The Link simulators were a successful series of electro mechanical simulators used from 1929 to 1955 (L-3 Communications, 2009), but the increase in power of computers meant that computer based simulators, as the basis for games, and for basic training, started to appear around 1979. Microsoft's Flight Simulator was first released for Apple II computers around 1980 (Gruppig, 2008). These very early games represented one of the first attempts to create simulated 3D worlds through which a user could travel freely, albeit very crudely within a world of wire frame based graphics.

Flight simulation represents a fairly limited and constrained domain, but more complete virtual realities were also attempted. It was not until 1987 that the term 'virtual reality' was first used by Jaron Lanier (Lanier, 2007), but forms of 'virtual reality' existed much earlier. Pre-computer electro mechanical analogue simulations such as Morton Heilig's *Sensorama* in 1962, provided a sensory accompaniment (vibration, wind effects, and odour) to a wide angle stereoscopic movie with stereo sound, through a form of immersive console (Rheingold, 1992). Virtual reality has always focussed on immersing the user in the virtual environment, often through use of motion sensitive head mounted displays (HMDs), and data gloves. These devices work, but mostly remain intrusive and do not provide a particularly high resolution experience. Virtual reality has continued to be used for training and education (Collier, Stevens, Hand, Smith, Farrell, & Watts, 2006; Collier, Stevens, & Hand, 2006), as well as in entertainment. Role playing using physical simulation (such as artificial patients) is increasingly used in education in safety critical domains such as medicine, the focus of the University of Portsmouth *EXPERT* Centre (Reynolds, 2007).

In the twenty first century a number of three dimensional simulations of real and imaginary environments have been developed, which have come to be known as virtual worlds. One requirement of virtual worlds is an online persistent world, active and available 24 hours a day and seven days a week. In some ways virtual worlds provide access to applications and communications tools in much the same way as a conventional operating system. A virtual world metaphor might even eventually replace the desktop metaphor as a way of providing easy access to computing facilities. There have been a number of projects that have simulated real physical environments to support learning, for example (Collinson & Williams, 2004; Pablo, 2005).

The following three examples of virtual world systems provide an overview of the way in which virtual worlds have developed.

The World of Warcraft (WoW) (Blizzard Entertainment, 2009) is reputed to have the largest number of active users. It was originally created in 1994, and as gone through a series of enhancements. It presents a 3d virtual world based around a dungeons and dragons like role playing game. Although involving a good deal of virtual violence it does require users to co-operate with other online players to form teams, in order to progress. Its massive number of players (over 11.5 million subscribers) lead it to be described as a massively multiplayer online role-playing game (MMORG).

Linden Labs (founded in 1999) created Second Life in 2003 (Linden Inc., 2009). This interactive and extendible virtual world can be used over the Internet, with players (or users) who interact with each other online. It does not have a 'goal' as such, although creating and selling goods and services has become one of several main activities in Second Life. Second Life is described as a world made by its netizens, as most of the environment and the objects in it are created by users. This is distinctly different to World of Warcraft and other rule-based virtual worlds where the environment, rules and the majority of objects are initially created by the developers. Second Life contains a 3D primitive editor, and a reasonable intuitive (but proprietary) object oriented scripting language (LSL or Linden Scripting Language). The virtual world of Second Life is sufficiently open that third party development of world 'viewers' is possible, and thematic viewers for Second Life exist. CBS (an American television network) built a simplified Second Life viewer for episodes of a television series called CSI:NY (Nino, 2007). The existence of an exchange rate market (<http://secondlife.com/statistics/economy-market.php>) between Second Life's virtual currency and real currencies is reputed to have led to real world millionaires (Au, 2009). A youth version of Second Life (the Teen Grid for ages 13-17) is also available, explicitly designed to support secondary education, the only adult users are teaching staff, who have satisfied criminal records checks, and who are confined to clearly identified locations (such as virtual school classrooms). Activities relating to aspects of programming, 3D design, e-commerce, interactive system design, game development, internet communications, artificial intelligence, and others are all possible in Second Life. This coupled with the availability of parts of the Second Life system and in-world editors that are relatively intuitive for programmers makes the Second Life virtual world a suitable environment for computing students.

Project Wonderland (Sun Microsystems Laboratories, 2009) is another 'virtual world' that has received some attention in the world of education. It uses Project DarkStar technology (a 3D Java system), and has been adopted by Sun Microsystems and renamed Sun Game Server in 2003. Project Wonderland is described as 'experimental technology' rather than a project. In some respects Project Wonderland does not quite meet the definition of a virtual world, since it is often run locally, and therefore may or may not be as persistent as Second Life or World of Warcraft. However this limited and local approach does have some benefits for educational uses, and can limit the distractions of a large virtual world. Project Wonderland is Java based, and can be integrated with standard Internet tools (for example VNC), so in some respects provides a better virtual world for computing students, with more opportunities to develop transferable skills. The knowledge and skills involved are not proprietary and limited to one product (as in the case of Second Life's scripting language).

The remainder of the paper will focus on Second Life since "*Second Life remains, by far, the 'virtual world of choice' for academics in UK universities and colleges. Though OpenSim is mentioned by a minority of vocal academics, the number of non-SL uses and investigations across UK academia is still a small fraction of the SL uses*" (Kirriemuir, 2009). However much of what follows identifies the issues associated with any virtual world system.

Overview of Second Life

There are several features of Second Life that have made it particularly attractive to educators. Perhaps one of the most important is that unlike most computer 'games' (like World of Warcraft) there is no explicit goal in Second Life. The goals in Second Life (as in real life) are those one identifies for oneself, and so frequently reflect real world goals. Shopping and marketing are certainly common activities in Second Life. Many locations feature large shopping malls, which lead to a considerable amount of interest from large retail companies and brands, interested in promoting real world products through the sale of virtual equivalents. Vice (online sex and gambling) were also common in Second Life (although recently Linden Labs has restricted online gambling in Second Life and confined "adult" activities to well marked locations). Lurid tales of Second Life depravity often appear in the popular press (Rawstone, 2008). Second Life has

relatively few restrictions as it only has adult users; Teen Second Life (ages 13-17, or faculty members restricted to a specific location) has much tighter controls.

Second Life is a system that fits into the current 'web2.0' philosophy of Internet systems. Although Linden Labs provide a framework (referred to as "land"), most of the objects in Second Life have been created by users of Second Life. Linden Labs has described it as a "*world made by its own netizens*". The main reasons people use Second Life are to visit places created by other users and to meet other people. Hence an important aspect of Second Life are its suites of built in development, communication and collaboration tools. Second Life is fairly easy to use as much of the interaction uses a real world metaphor, but note the comments from some users, below, about ease of use. Some of the places one visits in Second Life are modelled on real world locations, for example 'Knightsbridge' and 'Trinity College Dublin', others are completely unrealistic, exploiting the features of the virtual world (for example the ability to fly and suspend platforms in the air creates different architectural imperatives).(illustrations)



Second Life avatars also range from near perfect clones of the real user, to bizarrely different and enhanced appearances. Issues such as identity are more easily explored in a world where gender changes (or even weight loss and gain) are trivial. Identity and disability have also been explored in Second Life. (illustrations)



Many education locations use some form of simulation. This might be simulation of a real world event, or simulation of something that is otherwise difficult to observe (for example entering a cell at the Genome project). The immortality of avatars also lends itself to simulation of things that would otherwise be difficult or dangerous to observe (for example observing a tsunami simulation from the 'inside' at NOAA). (illustrations)



Finally, Second Life can take inputs from other Internet systems, so its possible to drive Second Life objects by events in the real world, for example the weather map at NOAA. (Noaa weather map).



Second Life in Teaching

As Second Life is an interactive system, so subjects that involve developing interactive systems can use it as a teaching environment. This paper describes three areas where it has been used in computing education at the University of Portsmouth:

- Developing interactive systems as part of a unit in Human Computer Interaction (HCI);
- Developing educational environments as part of an education computing unit;
- Larger scale development of systems as part of computer engineering projects.

Additionally this paper briefly describes a nascent University of Portsmouth project involving simulating a 'seizure scenario' as part of a computing forensics course as Second Life is also an environment that allows the simulation of real world environments.

Second Life is also a real world internet communication tool. It contains text/chat tools and voice over internet protocol (VOIP) tools which enable users to make and receive calls from phones in the 'real' world. It allows users to exchange and display documents, text, pictures and other media. It can be used as a form of very specific shared whiteboard. These seem to be similar to many of the collaboration features found in a virtual learning environments (VLEs). Even the areas where Second Life lacks features of a VLE, these can be added with in-world tools of which many free and commercial ones exist within the world (Chandler, 2008). Its also possible to link Second Life with VLEs, although this currently works well only with ones which are open source. For example Moodle has been combined with Second Life as part of the SLOODLE project which provides mechanisms for tracking a students progress through in-world learning activities, and for assessment submission, grading etc. (Livingstone & Kemp, 2008). Work is however being undertaken to integrate commercial VLEs (such as Blackboard) with Second Life (IDIA, 2009). In terms of support for education the use of virtual worlds in libraries (particularly University Libraries) is fairly common, for example Southampton Solent University has used the library as the hub of their Second Life presence.

Second Life has a large number of users, and one area of activity in Second Life has been eCommerce. Although we sometimes hear people say "*I don't have time for a second life, my real life is already so full*", the people who use Second Life are real people (despite having odd avatar names), who earn real world money, which they spend on consumer products, virtual and real. This means that it is possible to set up real businesses in Second Life, so there are many real commercial ventures with a presence in Second Life (Siklos, 2006). Such businesses require fewer resources than are involved in creating a real world business, and so are ideal for technically focused student enterprise projects.

Face to face and distance teaching

Face to Face (FTF) teaching and Distance Learning (DL) teaching can both use virtual worlds, for the former the use of the virtual for development and simulation is probably most important, with a limited role for online collaboration. But for DL teaching the collaboration and communication aspects of a virtual world become much more important.

Technical issues

Second Life is not without its technical limitations. It does require a broadband Internet connection, (though not necessarily a particularly broad one) and this can be a problem for use with distance learning students. However, it is fairly reliable with intermittent connections, which is useful when using Second Life with people in other countries, and when using mobile broadband. It has viewers available for the three main operating systems, Linux, Mac and Windows, and some limited interaction/communication tools that will run on mobile devices, such as mobile phones. Much of the work in displaying the three dimensional environment falls on the graphics card in the client computer. Because most of the hard work is done by the graphics card, Second Life will run on low end computers, such as netbooks. (SecondLife.com, 2008). In order to allow cross platform portability, OpenGL is used, but as this is not supported by all graphics cards Second Life will not run on some apparently powerful computers due to graphics cards incompatibilities.

Second Life uses several Internet ports, which must be open in any institution's firewall. VOIP tools in Second Life use additional Internet ports (SecondLife.com, 2008). Second Life is currently free to use, so it is possible for students to register and use it. There are also paid for accounts which have some benefits (principally providing a continuous in-world income and an enhanced level of technical support). In order to use Second Life for teaching it is useful to own or rent some land (effectively 'land' is hosted on Linden Labs server space), and this also incurs a charge. Second Life is a system that is located outside an institution, operating from servers located in the western United States. The reliability of the system is therefore not directly controlled by a single educational institution. During periods of maintenance the system may not be available, although these are usually notified in advance.

Second Life viewers are normally installed on a computer (which requires administration rights for use on Windows PCs). However a 'portable' version of the viewer can be run from a USB stick, and this approach makes Second Life usable in a range of teaching labs, without necessarily requiring prior installation, or easy for ad hoc use off campus. (Chandler, Crellin, & Duke-Williams, 2008).

Overview of virtual worlds in Computing education

A large number of UK Universities have some presence in Second Life, and Second Life is quite often used as a support framework for students (often distance learning students). However the number of UK Universities using this in teaching computing subjects appears to be quite small. Reviewing the Virtual Worlds Watch snapshot for 2009 (Kirriemuir, 2009) reveals some specific examples:

- Computer games: Loughborough University, University of Teeside, Bromley College
- Project Management: University of Bedfordshire
- Health Informatics: University of Plymouth
- 3D design: University of Sunderland, University of Hertfordshire, University of Strathclyde
- General topics in Computer Science: University of Greenwich, Heriot-Watt University, The Open University.

The following section describes several examples of how teaching using Second Life can be conducted, and describes teaching at the University of Portsmouth. In each case some limited, qualitative evaluation took place, mainly in the form of comments from students. Although not definitive this does help to indicate the strengths and weaknesses of using this type of tool.

Example 1: Human Computer Interaction Unit

The 20 credit, level 3 Human Computer Interaction (HCI) unit at the University has made use of available Internet technologies in its delivery since it began more than ten years ago. The use of these technologies has enabled the amount of time spent on the subject to be optimised and the amount of time spent on administration to be decreased. Some of the technologies used have been reported before (Crellin & Rosbottom, 2001, 2005), and use of Internet technologies of one sort or another has a long tradition in HCI (Chalk, 2002). Currently students are encouraged to use a range of collaborative tools including third party systems such as Google Documents.

How the unit / assessment runs

The unit is assessed using a coursework (involving a group of students, usually four) and an exam. For each presentation of the unit a number of interactive tasks are used, with each group undertaking one of (usually) three tasks. The tasks are allocated at random by the tutor, however if a group expressed considerable distaste with their allocation, or a strong preference for an alternative then generally staff will exchange it for another. Table 1 shows the number of students in each delivery of the unit who undertook a task in Second Life for their unit assessment.

Table 1: Number of students in different modes of the HCI unit

Period	Mode	N students/unit	Students developing in SL	Addit. students using SL
2007-8 Sem1	FTF	86	32	32
2007-8 Sem2	FTF	29	13	12
2007-8 Sem1	DL	12	4	-
2007-8 Sem1	Collaborative	17	4	4
2008-9 Sem1	FTF	108	33	30
2008-9 Sem1	DL	8	8	-
TOTALS		260	94	78

Face To Face mode

The HCI unit is taught over one semester, in face to face (FTF) mode to undergraduate students. The class size is usually around 100 students. Students doing another 'task' were used as subjects for the evaluation of each task. In the Second Life task students were asked to design a classroom, in Second Life, to teach a subject of their own choosing. Students were asked to register with Second Life, and had access to it inside the University (using a version of Second Life which could be run without install). Students could also use Second Life from outside the University, if they had access to a suitable computer and Internet connection (which the vast majority of computing students do have) and chose to install it.

Distance Learning mode

The unit was taught through the University VLE (webct-campus in 0708 and webct-vista in 0809), at about the same time as the FTF mode. The size of this cohort is quite small, usually around 10 students. Chat sessions are scheduled for roughly every second week. Students are allocated to groups and tasks, but it became apparent during the 0708 delivery of the unit that the Second Life task promoted more engagement and much more intra-group interaction (a positive benefit for distance learning). As a result in 2008-9 DL all students were allowed to work on the Second Life area, so the group of students doing this topic and working together was 8.

Second Life also proved useful as a supplement to the VLE chat system, particularly in 2008-9 where the VLE based chat system proved to be extremely unreliable. A mode adopted with the DL students was to 'meet' on one night in the VLE chat system for a 'formal' session, and the following night in Second Life for a more informal session, discussing HCI issues in general, the assessment as it developed, to do some visits to interesting places in Second Life, and to do some activities (for example shopping).

Second Life was accessed by students in Azerbaijan, Iran, southern and central Africa, and various parts of the UK. A variety of Internet connections were used, including in one case a dial up modem (mainly only allowing text-chat interaction), and 3G wireless dongles, as well as conventional wired and wireless broadband connections. When intermittent internet connections were used Second Life proved to be substantially more reliable than the University's VLE chat system, which was quite surprising. Students also 'met' each other outside formal contact time in Second Life.

Collaborative Mode

The unit was taught face to face by local staff at a campus in Malaysia, to part time students with some contact and unit management taking place from Portsmouth. Tasks were allocated to groups of four in the same way as in the FTF mode. One group of students worked on a Second Life task, and these were met with regularly in Second Life whereas interaction with other groups was via website tools. The unit ran in 2007-2008 but not 2008-2009.

An example of student work

The task was to 'build an online classroom' in Second Life, where classroom was loosely defined as an environment to support an educational activity. One group of students (distance learning students) built an environment to support a balloon debate. In a traditional balloon debate a number of well known characters must defend their worth, through debate, in a balloon that is gradually falling to earth. After each round the least worthy participant is ejected from the balloon. In the Second Life version the balloon debate featured a 'real' balloon, and after each round the loser was thrown from the balloon. The characters that were defended were super heroes from popular fiction, and included Batman, Wonder Woman and Darth Vader. The user interface involved a preparation room (including telephone boxes for changing into the required costume, and instructions for the participants). Students observed users engaging in the balloon debate, and identified features of the interactive system that were less usable. For example the labelling and instructions, the choice of graphic representation of objects, the sequence of actions associated with tasks were reviewed. There were three observers, and each one provided a user. Each observer and user were geographically separated from each other, collecting information about the interaction using videoed verbal protocols. This data was later shared between the students and used as the basis for an evaluation of the usability of this 'system'. The 'classroom' was mostly built from found resources, with some modifications. Although this was not a conventional interactive system, it provided an experience in observing users interacting with an interactive system design, and usability problems that one might find in many interactive systems, such as labelling errors, poor choice of metaphor, and task sequence problems.

Balloon Debate Illustration



Feedback from HCI students

Using questionnaires a range of qualitative feedback has been obtained from the HCI cohorts of students (see Table 1 for relative numbers). These have shown a range of reactions from the students, both positive and negative with the students overall falling into three fairly similarly sized groups: those who liked Second Life, those who disliked it, and those who were indifferent to it. The breadth of views is typified by the following comments:

Student A: "For distance learners it offers a sense of participation that [the VLE] doesn't e.g. you can see if an avatar is typing or resting and it feels like being part of a real meeting. It is also fun! There is potential for students to work together building and learning scripting. There is scope for students to attend presentations from experts based in other countries. SL could also be used to explain topics issues to students e.g. show how computer network works or ask students to work on a task together. I do think that time would need to be spent preparing students to use SL and explaining issues relating to security, how the interface works etc."

Student B: "best thing about Second Life? Hmm knowing to stay well away from it. I really didn't enjoy using it. It was maybe slightly more interesting for [the HCI unit] as its more novel than typical interface applications. Although any 'game' or science app could have been used instead I suppose"

The students who most liked Second Life identified the facility to communicate and work together when apart as its most appealing features. This was seen as a particularly positive benefit in using Second Life by the distance learning students. In addition the unit co-ordinator noticed that it seemed to result in a much higher level of group cohesion than is usual with distance learning students who do not normally see each other. Second Life also seemed to support collaboration much more effectively. Distance learning sessions held in Second Life typically went on long after they were supposed to finish. The ability to build things and share them directly, to see things as they were being built by other members of the group seemed very direct, and much more 'natural' than the more formal methods of collaborating online. The students frequently compared the affordances of Second Life to those of the University VLE. In terms of online socialisation the way students chose to present themselves in their avatar became a source of fascination for the group, and many discussed new things that individuals had found, bought or built. One student (named cat in Chinese) chose to represent himself as a cat, another adopted super hero costumes, and this became an element in the project his group developed (see the example of student work outlined above).

Those students who did not like Second Life often described their difficulties with the interface. Although some of these difficulties were caused by technical problems in getting the software working, many more complex issues also arose. For example, many students found the incessant game like atmosphere annoying and insufficiently serious, whilst for students with a lot of experience of gaming environments (often on consoles) the relatively primitive graphics of Second Life were seen as a distraction. Students usually accepted the relevance of using this type of tool as part of an HCI course, but realised that they did not find the virtual world metaphor personally appealing. Finally some students found that the virtual world distracted from their conception of a learning environment.

Example 2: Educational Computing Unit

In contrast to the HCI unit described above the level 3 unit Educational Computing (EDCOM) has also used Second Life but with much less success despite a small overlap in students. Educational Computing, is an on campus final year option which tends to attract students with an interest in

working in computing education and training, rather than students expecting to become programmers. Part of the coursework for EDCOM involves the design and development of an interactive artefact to train or assess a learner. During 0708 and 0809, students taking the EDCOM unit had the option of using Second Life as the delivery tool for their artefact (the alternatives being Flash or HTML). Across both years only two student chose to use Second Life, the others all chose to develop their artefact in HTML or Flash.

Part of the coursework involves students in evaluating existing learning resources; comments often include such things as "boring, just things to read". Most students (2007-08) selected Flash, as they felt that both SL and Flash were new, so they wanted to learn the tool they thought would be of more use in the future. However, those students who selected Flash as a building tool found learning the interactions difficult, and as a consequence tended to use just text and images. The two students who selected Second Life minimised the amount of text they used - and focussed on interactions (as required) - one had the highest mark for the software development, and the other scored in the top 20%.

Example 3: Second Life and Computing Dissertations

The School of Computing at the University of Portsmouth runs several major engineering project units, at undergraduate and postgraduate level. These are usually studied by students during the final two semesters of their course (undergraduate) or during the summer (postgraduate). Each project is individual, and on an agreed topic. Projects/dissertations typically involve constructing a system to solve a computing problem and require students to show their ability to design, implement and test a substantial artefact together with a literature review and a critical evaluation of their work. Project students are each assigned a supervisor who they meet regularly and who advises them during the running of the project. During the academic years 2007-2008 and 2008-2009 a number of students undertook Second Life related projects. It was sometimes difficult to judge the relative complexity of the project topics, however most projects were completed successfully. The range of topics completed were varied, and illustrate some of the possible approaches that can be used in projects.

- A Heads Up Display (HUD) providing information on University of Portsmouth events - this required a combination of scripting in LSL, development of a text based interface using prims and the integration of the HUD with a website which contained the information to be displayed by the Second Life HUD. The student who undertook this project went on to work on a Higher Education Academy ICS funded project on developing a multi-tool, worn by an avatar, containing a range of education resources for teaching in Second Life. This tool required the development and integration of prim based education tools scripted in LSL combined with handling various types of inputs both textual and menu/button based.
- Linking real world events to Second Life events. One part of the project involved using a webcam as the primary input device, with the light level and predominant colour detected by the camera used to manipulate lighting in a location in Second Life.
- A Students' Union in Second Life. This eCommerce project looked at how goods and services could be delivered in Second Life and built a prototype of a virtual Students' Union selling t-shirts. This project required consideration of HCI elements together with the development of clothing textures using an external graphics image editing package.
- Modelling parts of the University of Portsmouth campus in Second Life. These projects take two forms - those that involve building accurate representations of parts of the campus (to aid in the familiarisation of new students) and those modelling the resources available in a particular part of the University. Some projects have combined both these elements. The projects building representations of the campus require architectural simulation, the use of external graphics packages and complex use of prims, whilst those modelling resources need

to develop visual metaphors and link their Second Life objects with external information systems such as the University Library.

- Simulated PC hardware (in effect a large computer an avatar can walk into) providing information about each part to support a unit an introductory unit on computer architecture.

Evaluation

Some students were attracted to undertaking a project in Second Life by the idea of acquiring marketable skills or by the thought of undertaking their project in a 'game' environment, but found the actual practice of developing in Second Life unappealing. Interestingly one student having chosen to do a project in Second Life to enhance their CVs reported that they wished they hadn't *"as they had never enjoyed using computer games"*.

The students undertaking projects in Second Life were included in the end of year questionnaires detailed below, but additional, qualitative, evaluation was provided by many students both in their supervision meetings and as part of their project report/dissertation. Much of these evaluations were linked to managing the project life cycle and the attributes of their artefact but some evaluation of Second Life as a tool was provided by all the students undertaking projects in Second Life.

The problems experienced by the project students broadly fell into two groups: lack of experience with LSL (Linden Scripting Language) and difficulties with 3D modelling. Lack of experience with and the need to learn unfamiliar software is a frequently reported problem in final year projects as students often chose to undertake project using novel (to them) software tools. The range of difficulties with 3D modelling encompassed: the cost of uploading textures to Second Life (students were however given a bursary in linden dollars to help with this); the limited range of 3D manipulation tools within Second Life and the need to learn how to use additional, external, 3D modelling software.

The positive aspects of undertaking projects in Second Life identified by students were predominantly concerned with its ease of use and the scope it gave to their imagination, typified by the student who reported *"creating this artefact has made me more imaginative when I create models, so this will aid me hopefully in my chosen career"*.

Feedback questionnaires

All 2007/8 and 2008/9 students who used Second Life as part of a final year unit or for their final year dissertation were asked to complete a, predominantly qualitative, short questionnaire about their experiences of using Second Life. The questionnaire was administered at the end of the academic year (so some weeks after their academic use of Second Life had ended). In 2007/8 the questionnaire was delivered via email and in 2008/9 via Survey Monkey. In both cases response rates were low and so the responses cannot be taken as conclusively representative, however a marked difference in attitude to Second Life was evident between the two cohorts and some interesting anecdotal feedback was obtained. No students in either year had Second Life accounts before they needed them for their University work and at the completion of their university work in Second Life the majority had ceased to use Second Life

The students were asked about how easy they found Second Life to install, run and use. This was given as an open-ended question in 2007/08 and as a Likert Scale in 2008/09. In 2008/09 students found these activities 'very easy' or 'easy' to do except for using their avatars where they were initially evenly balance between 'very easy' 'easy' 'ok' and 'hard' but after some months of use all found their avatars 'very easy' or 'easy' to use. The responses in 2007/08 were all at least partially negative, for example *"Not as easy as I would expect, I did not find the SL interface very intuitive"* and *"after the In-World tutorial it wasn't too bad although the user interface isn't the best"*. The technical problems the students encountered included:

- "The Lag, even at the uni it was very laggy, at home sometimes unusable (I only tried it once or twice at home however)..."

- "Server crashes, server downtimes, "lands" too busy to enter or too many "prims" in land."
- "Using the interface for the first time was hard."
- "Picking up items, sometimes the display is very cluttered."
- "Avatar alterations initially a long winded process until I became familiar with the process."
- "Because it loads everything dynamically it was/can be very slow and the graphics etc are questionable."
- "Playability was not very good in comparison to other computer games."
- "It's complex for a first time user."
- "Hardware and Internet bandwidth demand"

It is notably that while problems with lag and server crashes were reported by the 07/08 students these were not issues for the 08/09 students. This concurs with the authors' subjective assessment that over the last 18 months Second Life has become increasingly stable and links to increased advice to students on how to manipulate the graphics settings to improve performance. Tutors' familiarity with the Second Life environment seems to be a significant factor in successful student interactions with Second Life, for example one student reported: *"One thing that really helped me to feel more confident was that I met with my tutor in SL and she showed me around the University island. It was useful to have someone there to "speak" to and show me things e.g. how to teleport. At that stage I was a complete beginner. It was also useful to be able to ask questions to my tutor if I didn't know how to do something or needed advice"*.

The students also reported many positive benefits to using Second Life such as:

- Interactivity to explore, relative freedom of expression and overall thoroughly enjoyable.
- It gave a user total control of his environment
- The opportunities for learning, developing skills, collaborating and being creative.
- Interacting with other users
- "...a new world that contains everything in real world is amazing..."

Further Work

Other units in the School of Computing, University of Portsmouth are looking at making use of a virtual world based approach. At the University of Portsmouth there are a several forensic units and courses available within the School of Computing. Digital forensics is studied at undergraduate and postgraduate levels. One aspect of digital forensics is seizure simulation. Seizures involve visiting a suspect's premises and seizing data devices and media for examination. Although this sounds straightforward there is a continual risk that data will be lost or compromised (for example access dates modified) so the process of digital evidence seizure is quite complicated. The Association of Chief Police Officers (ACPO) have a set of guidelines for the seizure of digital evidence. Applying these can be difficult in practice. Digital forensics specialists may not be directly involved in seizures in criminal cases, (although may be on hand to advise police officers), however they may be directly involved in commercial seizures (for example confiscating a suspect's work computer at his place of work). Information from the environment may reveal things about the suspect that aid the investigation of files and passwords.

Creating scenarios in the real world can be difficult. Ideally they need to be 'dressed' like a stage set, which means the range of possible scenarios is quite limited. A lot of time can be spent setting one up. In Universities space is often 'charged for' which makes finding suitable available rooms quite difficult, and permanent space is often impossible. In the University of Portsmouth a permanent 'forensics house' has been set up, this provides quite a vivid simulation of seizure of data devices from the scene of a violent crime, in order to justify the costs of this resource it is used on many different kinds of forensic course and so there are issues with availability and with students practising the necessary skills outside of time tabled sessions. Even using a real location (such as an academic's office) has flaws. As a result student exposure to seizure simulation is quite limited.

A range of virtual seizure scenarios are therefore being developed in Second Life. Students will be asked to perform a seizure task, collecting information from the environment, and compiling this into a report. Disk images of the data devices collected will be provided. In Second Life a number of locations can be stored, and brought into the world as required, using a tool called a holosuite. Large rooms (such as an open plan cubicled office) can be used with this sort of tool. Initially role playing will be used, with students and tutors taking on roles. In some cases simple 'bots' (avatars animated by scripts) can be used. In world image capture can be used. Students may replay the same scenario taking on different roles (Crellin & Karatzouni, 2009).

Discussion

Our experience of using Second Life in Computing Education has had many positive aspects. It is clear from the comments from students that widely different responses to it are possible, and support from tutors is important in overcoming student anxiety. Students studying computing are more likely to have a wider experience of computer systems than students in other domains, and are less likely to be intimidated by Second Life (or any other computing environment or tool). However wider experience of computer entertainment can make Second Life seem rather crude compared to (for example) the rich 3D simulation available in a console game. Our students reported using the following MMORGS: Kaneva, Moove, Diablo II, World of Warcraft (WoW), Final Fantasy XIII. Although Second Life makes it easier for students to develop interactive systems (at least as prototypes) by using the large number of existing components available, and the relatively simple editing/programming tools, it can still be quite complex for less technically skilled students to acquire the necessary skills to build things. The tools built into Second Life are quite limited, and this may be frustrating to students who have used more powerful tools in programming or three dimensional modelling. Final year students do understandably tend to be risk adverse, and are more likely to use familiar tools when assessment is involved. However, for some subjects (for example HCI) it can allow students to explore very different types of interaction, and challenge their assumptions about what interaction 'is supposed to be like'. In particular as a prototyping tool, where full functionality is not necessary, complex 'systems' can simulated in Second Life quite easily. Where a longer period of work is involved, as in final year projects, the outcome can also be quite positive with students building richly configured artefacts blending programming/scripting skills with those from HCI and other subjects.

A number of factors have been seen to detract from the use of Second Life. It can be quite intimidating to some users (and some academics). One academic was very disturbed by the flaming skull appearance adopted by one student for his avatar. This was in fact a 'super hero' costume, (Marvel Comic's 'Ghost Rider'), which related the topic area that the student was developing however it was seen by the academic as threatening and inappropriate. Second Life exposes students to many distractions, which might get in the way of their studies, this is however a commonly perceived threat with any internet/web based software. Also students sometimes find the unerring game-ness of the environment means they cannot take academic activity in it seriously. Establishing appropriate behaviour in a virtual world can difficult, as some of the following incidents highlight:

- The student who on first entering Second Life removed all his 'clothes' and ran off to find the avatar of a female lecturer to show off his appearance.
- The student who after it was suggested he might like to attend a third party class in Second Life, to see how Second Life classrooms worked, came back and asked what a class on being a 'trainee submissive' would cover.
- A pair of students who bought some Second Life cars, and left them crashed and overturned on the 'lawn' of another college's campus.

These examples show that students may have difficulty defining appropriate behaviour in a virtual world. Standards of behaviour in the real world are not always extended to the more anonymous

and less real virtual world. Managing these different levels and standards can be quite difficult for both staff and students and leads to consideration of the extent to which events in a virtual world should have consequences in the real world and what allowances should be made for novices (e.g. accidental 'nudity' when changing clothes may occur in the early days in a virtual world but not in the bricks and mortar world).

Virtual worlds like Second Life do seem to have benefits for distance learning students. They appear to be less austere than the stark interfaces in many VLEs, and give students who cannot meet each other or their tutors face to face an opportunity to interact on a more human level. The rich, three dimensional environment can be more appealing to visual learners than a text based VLE. There is also more opportunity for 'fun' and socialising in a virtual world than there is a traditional VLE.

Second Life is not the only virtual world. Like most Internet products it is likely to decline in popularity, Ofcom's report on the Communication's Report for 2009 shows the hours per month spent by consumers since 2008, with Second Life use declining by 67%, to about 9 hours a month in world, this contrasts with about 6 hours a month for Facebook users (Ofcom, 2009). Virtual worlds (which ever system is used) do have some benefits in education and the following features are often beneficial:

- Easy to build in
- Many 'real' users
- Informal and formal meeting areas
- Persistent
- A virtual economy
- Lots of existing content/objects
- Integration with open source VLEs
- Low cost
- Reasonably reliable
- Communication/collaboration tools

Conclusion

The use of Second Life has helped engage some students (particularly distance learning students). However many computing students find Second Life unappealing, and difficult to use. Whilst virtual worlds have their benefits, it is best to use them as an optional addition in teaching. Its most successful where tutors can confidently interact with students in world. Second Life has some, but not all, of the features of a VLE. It can be used in a number of ways in computing education, as a development environment, as a simulation environment and to provide an opportunity for student enterprise. Proposed work to develop forensics scenarios will make use of a number of benefits of Second Life for teaching computing such as the ability to quickly and cheaply build simulations from found and customised parts; its persistence; its immersive features and its communication/collaboration tools.

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Second Life Locations of Interest

- Genome <http://slurl.com/secondlife/Genome/128/128/48>
- HEA ICS Depot <http://slurl.com/secondlife/UoP%20Island/235/24/53>
- IBM <http://slurl.com/secondlife/IBM/106/6/23>
- Knightsbridge <http://slurl.com/secondlife/Knightsbridge/211/25/22>
- NOAA <http://slurl.com/secondlife/Meteora/177/161/27>
- University of Portsmouth <http://slurl.com/secondlife/UoP%20Island/43/40/41>
- Southampton Solent University <http://slurl.com/secondlife/Solent%20Life%202/204/95/22>
- Trinity College, Dublin <http://slurl.com/secondlife/Dublin/155/110/25>