‘The Chaotic Science Lab’: Supporting trainee science teachers – a cross departmental project

Abstract

This project supports science teachers in developing health and safety skills through the use of a virtual laboratory. In the laboratory they can carry out health and safety audits, develop their awareness of potential hazards and assess the possible risks involved. The students can visit the virtual world either individually or in groups, and then discuss the issues they have found to be a risk ‘in-world’ or later in the ‘real’ classroom. A web interface enables user registration and a user record for each session. Each session is recorded with time, date, location and scores for the user as they work through pre-programmed activities which enable the tracking and analysis of site usage.

Early findings suggest that this is an intriguing and unexpected addition to the science teacher training curriculum, and that students are keen to develop the scenarios further. There are clear benefits for staff and students alike.

Keywords

trainee science teacher, virtual world, health and safety

Debbie Holley (debbie.holley@anglia.ac.uk), Philip Howlett (philip.howlett@anglia.ac.uk),
Department of Education, Faculty of Health, Social Care and Education
Mike Hobbs (mike.hobbs@anglia.ac.uk), William Sawyerr (william.sawyerr@student.anglia.ac.uk)
Department of Computing and Technology, Faculty of Science and Technology

Introduction: Health and Safety in schools

Health and safety issues in laboratories are important aspects in the training of any type of scientist. For those becoming science teachers in schools, health and safety is essential not only in terms of the safety of themselves and their pupils, but also in terms of teaching the importance of the topic.

Health and safety in schools is governed by the *Health and Safety at Work Act 1974* which is a very wide ranging piece of legislation. The Health and Safety Executive (HSE) summarises the responsibilities of employees outlined in the Act as being:

> '1. Follow the training you have received when using any work items your employer has given you.
>
> 2. Take reasonable care of your own and other people's health and safety.
>
> 3. Co-operate with your employer on health and safety.
>
> 4. Tell someone (your employer, supervisor, or health and safety representative) if you think the work or inadequate precautions are putting anyone's health and safety at serious risk' (HSE, 2009).

These key points are applicable to all teachers in schools, but for teachers of science they are particularly important as science teaching by the very nature of the subject, is not without potential significant risk. Borrows (2006) highlights the fact that science teachers are anxious to avoid injury to students, colleagues or themselves. However, of all the accidents to students in schools reported to the HSE, only 2% occurred in science lessons (HSE, 2000). The Consortium of Local Education Authorities for the Provision of Science Services (CLEAPSS, 2008) report that a large number of these accidents involve new teachers in the first few months of their teaching, and consequently adequate health and safety training is essential for any science teacher training course.

CLEAPSS (2009) have produced guidance, including checklists, to help with ensuring that trainee science teachers (and new staff to a school) are fully aware of the health and safety issues. However, valuable preparatory work should be done during the teacher training course prior to beginning the placement. All science courses will include some aspects of health and safety preparation and planning, though this will be effectively a theoretical approach. This is complimented by the school-based practice which comprises 120 days in placement schools where most heads of science or school-science mentors will ensure that there is an appropriate induction to the health and safety policy of the science department.

Trainees have little time to develop their skills in health and safety in a pedagogy-based curriculum, and although there are numerous excellent resources available, it is the interactivity of practise in a safe environment that is missing. The difficulty with explaining health and safety issues to large numbers simultaneously is a common issue, and the use of web-based technologies is not new, for example Kennedy and Palmer (2011) describe the delivery of a web-based training and testing program to very large cohorts of students. The development of the Chaotic Laboratory project differs from this more traditional web based delivery by offering the affordances of interactions within a 3D immersive world. It offers trainees opportunities to develop virtual practical experience of the issues and the consequences of some key health and safety issues. The project outcomes encompass all four main aspects of the *Health and Safety at Work Act 1974* as outlined by the HSE (2009).

Our Project Aims

The project aims were:

1. To scope out the possibilities of developing a relevant and interactive space where trainee teachers could visit either individually or in groups.
2. To explore the affordances of a 3D virtual world (we selected Second Life).
3. To develop a prototype web interface enabling staff to track student interactions and activities 'in world' and export these; thus offering the potential to merge database information sets.

Integrating virtual worlds and e-learning resources into the curriculum

The New Media Consortium's (NMC) *Horizon Report 2012* describes technological trends that are currently affecting teaching, learning, and creative inquiry in higher education. Key results of the consortium's research indicate that increasingly, people expect to be able to work, learn, and study whenever and wherever they want to and that education paradigms are shifting to include online learning, hybrid learning and collaborative models (NMC, 2012). Similarly, Oblinger (2012) of EDUCAUSE argues that information technology can be a game changer in higher education, with the use of mobile devices, games, and social networks creating new learning experiences. The NMC also highlights several other emerging technologies which include mobile apps, tablet computing, game-based learning, personal learning environments, augmented reality and natural user interfaces that are likely to enter mainstream educational use over the next five years (NMC, 2012). However, much of the recent focus on the adoption of emerging technologies for educational purposes is not simply for using the latest and shiniest technologies. According to Glynn and Thorn (2011), these emerging technologies are intended to solve pedagogical problems in learning and teaching. In other words, they must integrate with the curriculum.

This project is located within this wider debate, in that integrating virtual worlds into the curriculum provides support for hybrid learning and collaborative models as well as creating new learning experiences. The term 'virtual world' describes an electronic environment that visually mimics complex physical spaces, where people can interact with each other and with virtual objects, and where people are represented by animated characters called avatars (Bainbridge, 2007). The use of virtual worlds within the curriculum maps on to game-based learning which, according to Royle (2008), shares many attributes with the pedagogy of problem-based learning. Virtual worlds within the curriculum also map on to the use of augmented reality as a way of outputting information from the perspective of the real world. Billinghurst and Dünser (2012) state that augmented reality supports the understanding of complex phenomena by providing unique visual and interactive experiences that combine real and virtual information and help communicate abstract problems to learners.

Second Life is an online virtual world that enables users to carry out a number of activities including exploring, socialising, and participating in individual or group activities using their avatars. Second Life allows content to be built and owned by its users. As such, it provides tools and guidance for manipulating the environment; allowing action scripting, object construction and two-way data communication with external databases and web servers.

Generally, virtual worlds provide a range of affordances which are useful for learning and teaching. The following is a summary of some of the affordances of virtual worlds (Wasko *et al.*, 2011):

- a blend of 'same-time same-place' fostering of participatory, collaborative learning in a safe and engaging environment;
- taking on different roles in simulated surroundings and to communicate and learn together as a group;
- conducting projects or task that might be impossible for the single learner;
- conducting projects or tasks that are impossible to conduct in the real world;
- confronting difficult problems, testing the outcome of certain decisions, and experiencing the consequences associated with those decisions;
- allowing users to progress at their own pace, offering different levels of changes and capabilities to endure a skill-ability balance for users.

Previous work at Anglia Ruskin University (Hobbs, Brown and Gordon, 2008; Anglia Ruskin Second Life Wiki, 2009) and elsewhere (Open University, 2008; JISC, 2009), demonstrate the importance of continuing development and evaluation of the pedagogic framework in virtual worlds. Developing the Chaotic Lab will enable original research into pedagogic practice in areas of usability, integration with teaching practice, communication and assessment of virtual world learning, student induction and support.

When complete the Chaotic Lab would be stocked with a series of individual and group activities. These would be selected and initiated from a web interface that controlled the placing and attributes of interactive objects (such as a chemical spill) within the virtual environment. The educator would need a reasonable knowledge of Second Life but would not need to be an expert developer in order to use the resource for their students. The system would track the locations and actions of student avatars within the environment

and allow annotations and responses to questions to be recorded. The key pedagogic outcome will be the application of correct health and safety process assessed by recording student decisions when reacting to the virtual world scenario. The abstraction of the communications and supporting data model from the virtual world allows flexibility in the application area, so that the same core resources can be used to support different application areas. This means that the funded research work will inform future mainstream curriculum development for blended and e-learning resources in a range of disciplinary contexts.

The Deliverables

Development decisions

The main deliverable is a virtual laboratory and associated learning materials, which pilots an implementation of the virtual world pedagogic process (JISC, 2009) and the use of the supporting infrastructure.

The project team chose to develop in the Second Life (SL) (Linden, 2012) as this is the most developed and commonly used virtual world for educational implementation (Sherblom *et al.*, 2009, HETL, 2011). This enabled the project to utilise the existing *Anglia Ruskin Island* (SLURL, 2012) resource and development experience within the team. Additionally this project facilitated Knowledge Transfer in areas of infrastructure development and deployment from an expert virtual world developer (Logan, 2012).

The technology used by SL provides tools for manipulating the environment, allowing action scripting, object construction and two-way data communication with external database and web servers. These features allow us to build scenarios, manage then and own the intellectual property of the resources.

Database and Communications

A recent project (The 3D warehouse, LMU *et al.,* 2011) developed an interactive scenario to help train warehouse staff on Health and Safety. The role of the virtual world was to reinforce learning from other sources and the data from the role play is only displayed to the user. For our project we wanted educators to be able to see results from student activities so that they could pinpoint areas of weakness and provide feedback to students.

SLOODLE (SLOODLE, 2011) is a popular, open source, tool-set that links the SL (and related virtual worlds) to the Moodle VLE via HTTP communication. Although SLOODLE successfully facilitates the integration of real and virtual learning the functionality is broader and less focused on scenario management than we need. So we developed our own, relatively simple, communication protocols to create a dedicated resource that would be easy for students to use and instructors to monitor.

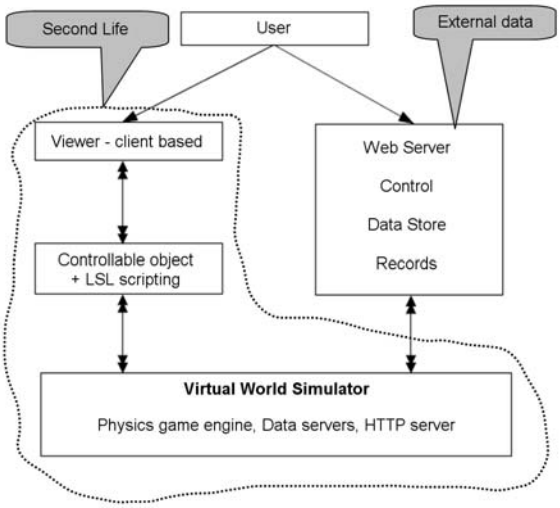

Figure 1: Overview of communication protocols

Objects within the virtual world were scripted with HTTP access protocols to enable them to pass information from the scenario, over the internet, to a supporting database implemented in PHP and MySQL. For example, when an object is moved from one location to another in the virtual scenario it reports the change to the remote database. Once the raw data has been recorded, which includes session

time and student ID, it can be assessed to see if the object is in the right or wrong place (according to the currently running scenario) and given marks accordingly.

When setting up a session for a student the database is also used to automatically select the objects and their locations for the scenario. This provides an element of variety in the role play activity.

System Operation

Currently the system allows for sessions that relate to preparing the class room for a teaching session by having a number of different items that need to be put into their correct places.

Figure 2: Virtual simulation modelled on real science laboratory

Figure 3: Connecting to the database via control panel with detail showing in-world dialogue

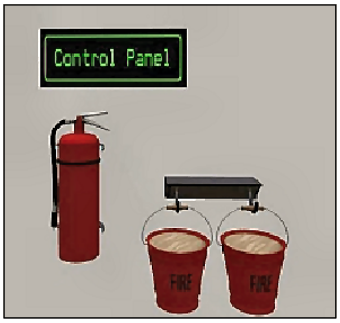

Figure 4: Chemical cupboard showing placement of bottles, and fire equipment located by control panel

Details for SessionID: 5
Date: 2012-05-08 20:19:37
World Name: Second Life
Session Duration: 5m 55s

Equipment Name	Start Position	End Position	Score
Beaker	<238.76420, 34.50322, 21.78943>	ZERO_VECTOR	0
Bottle Cupboard Door	Open	Closed	2
Cable Cover	<233.55000, 32.70139, 20.79501>	<247.65120, 31.64042, 20.79501>	1
Conical Flask	<243.15000, 24.60000, 22.07959>	ZERO_VECTOR	0
Glasses	<239.01350, 27.81187, 22.05302>	ZERO_VECTOR	0
Lab Stool	<240.55000, 24.10000, 21.24927>	ZERO_VECTOR	0
Mop Bucket	<240.06130, 14.66950, 21.04804>	<248.28910, 43.54284, 22.51451>	1

Figure 5: Session details showing location, timing and scores for the activities

A student can view all their sessions and a member of staff can view all student sessions; both can leave comments on each session. In addition to the scores an individual session may be partly or completely recorded through screen capture software (Hobbs 2012).

Conclusion

The project has developed a virtual laboratory where students are able to carry out health and safety audits, to develop their awareness of potential hazards and to assess the possible risks involved. This first prototype offers basic laboratory health and safety procedures, with the potential in future to offer a number of scenarios from the basic setup to a highly specialised laboratory with particular apparatus.

The students are able to evaluate the laboratory for safety individually or in groups, and then discuss the issues, and they can carry out a basic health and safety audit and develop their awareness of issues.

The web interface enables user registration and a user record for each session. Each session is recorded with time, date, locations and score for the user as they work through the pre-programmed activities.

The wider aspects of the project are the potential benefits for students on other science courses. A key aspect of the work is that the hazard and risk assessment can be re-visited without impinging on teaching time when students are working extremely hard both at university and at their placement schools. In the future we plan further applications to link to this technology that will support other scenarios useful for trainee teachers and other client groups.

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