Situated learning in virtual simulations: researching the authentic dimension in virtual worlds

Abstract

This paper describes and discusses a case study of postgraduate students undertaking accident investigation and risk assessment exercises in an online virtual world as part of their course curriculum. These exercises were constructed to overcome the ethical and practical barriers inherent in real-world exercises. In particular this paper focusses upon the potential of such exercises to facilitate the authentic dimension of situated learning and identifies some of the factors that affect the sense of authenticity in virtual world learning exercises. Thirteen such factors were identified. Nine of those were positive factors that enhanced the sense of authenticity; these were facilitation, presence and authority, visual realism, socialisation, comparative reality, engagement, active learning, generalizability and enabling learning from mistakes. The 4 negative factors which detracted from the sense of authenticity were the public image of virtual worlds, lack of naturalism, unrealistic graphics and lack of tactile sense.

Keywords: virtual worlds, situated learning, simulation, authentic learning.

1 Virtual worlds

Virtual worlds (VWs) are three-dimensional online environments in which users interact with the environment and other users through the activities of their avatars. Users can communicate through text (and usually voice) both synchronously and asynchronously, and in most virtual worlds they have the facility to create or significantly develop the environment around them and to personalise the look of their own avatars. VWs are also known as immersive online environments or immersive worlds, in recognition of the sense of involvement they can engender in some users.

The use of VWs generally, and specifically for education and training, has increased significantly during the past 6 - 10 years. Table 1 below summarises the growth in numbers and usage of VWs worldwide from 2009 - 2011 as an indication of their continued acceleration. It should be noted that in this table VWs are broadly defined, and include web-based social networking sites with some elements of 3D virtual world environments.

Age range	2009		2010				2011			
	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
5 to 10	152m	179m	190m	211m	219m	235m	272m	270m	296m	340m
10 to 15	367m	392m	413m	444m	468m	511m	561m	652m	694m	787m
15 to 25	117m	193m	237m	273m	288m	299m	313m	385m	456m	596m
25+	23m	25m	27m	30m	34m	36m	39m	42m	44m	49m
Total	659m	789m	867m	958m	1,009m	1,081m	1,185m	1,139m	1,490m	1,772m

Table 1: Growth in VW accounts 2009 – 2011 (Source: www.kzero.co.uk 2012)

Despite the caveats that the accounts summarised in Table 1 will not all be active at any one time, and that one person may hold a number of accounts in different VWs, the statistics are at least indicative of rapidly increasing interest and use. Of particular interest to higher education is the marked growth in usage in the 15 – 25 age range. The number of accounts held by users in that age range has undergone a three-fold increase in 2 years; by far the most quickly expanding group of users. The majority of accounts are currently held by users in the 10-15 age group (more than three-quarters of a billion) so it is at least likely that, as they age, some of those account holders will continue their use and further swell the numbers in the 15 – 25 range. Students entering higher education in the near future are likely to be very familiar with VWs.

Whilst it is difficult to accurately assess the total number of universities who have an active presence in VWs, regular snapshots of VW use in higher education in the UK have been undertaken by Eduserv (2012) since July 2007, and it is now evident that every UK university has members of staff who have developed, or are developing, something in a VW. Also, many international businesses (e.g. Kraft, Sony, IBM, Dell, Samsung, British Telecom and Unilever) and governmental organisations (e.g. NASA, US Immigration and Border Control, US Army) now use VWs for education and training (Second Life 2011). One hundred and fifty organisations worldwide have joined the Second Life Educators Directory and whilst the majority are higher education institutions, the list also includes organisations as diverse as the US Air Force and the Islands of Jokaydia Community in Australia (Second Life, 2012). VWs are therefore being widely trialled for educational purposes.

2 Situated learning

The term “situated learning” was first proposed by Lave and Wenger (1991). They developed the term to describe learning that takes place in the same context as that in which it is applied in practice. The notion of situated learning advances the idea that learning should not be viewed as simply the transmission of knowledge from a giver to a receiver. Learning is rather seen as a social process during which knowledge is co-constructed, and it takes place in physical and social environments which provide an authentic contextual framework. Situated learners learn through socialization, visualization and imitation, and this is particularly applicable to higher education as it is widely recognized that social context is a key element of adult learning (Merriam et al, 2006).

Although Lave and Wenger did not claim that situated learning is a pedagogical strategy as such, it has been applied successfully in many subject settings, including teacher training (Korthagen, 2008), organizational behaviour (Mezias & Lant, 2010), health care information systems (Tong et al, 2011) and adult computer education (Young & Merriam, 2010), for example. In particular, the importance of authenticity in learning contexts is stressed by many commentators and researchers [see, for example, Dede (2009), Webster-Wright (2009) and Park & Park (2012)] and questions of authenticity continue to be addressed in relation to situated learning in online and virtual environments [see, for example, De Freitas (2010); Tamai et al (2011); Cram et al (2011)]. Dede (2009) discusses how studies have shown that immersion in a virtual world can enhance education by enabling situated learning. He then goes on to argue that further studies are needed on the capabilities of immersive media for learning, on the instructional designs best suited to each type of immersive medium and on the learning strengths and preferences these media develop in users. However, there is little literature that identifies specific factors that may affect the situated learning authenticity of experiences in virtual worlds. This paper reports on and discusses a case study that sought to identify some of those factors in cohorts of postgraduate students undertaking accident investigation and risk assessment activities in the virtual world Second Life (SL).

3 The case study

Students of environmental health practice in the UK study a curriculum that includes public health, housing, food safety, occupational health and safety, and environmental protection. An underpinning principle of that curriculum is an understanding of risk management and accident causation, including the practice of accident investigation. It is ethically and practically awkward, at the very least, to organise realistic accident

investigations and risk assessments for students, and so these subjects have traditionally been taught theoretically in higher education. They are also sometimes supported by class-based role play and visits to industrial or commercial organisations. Simulations of accidents have been used to help students to learn about investigating accidents [e.g. Woodcock et al, (2005)], although these simulations have tended to be largely documentary in nature. Other approaches to teaching accident investigation and risk assessment have included computerised simulations of chemical or physical interactions [Brambilla et al, (2008) for example], but have still not enabled realistic participation in contextual scenarios. However, the advent of virtual worlds has now enabled simulations of accident investigations and risk assessments that include activities such as interviewing witnesses, inspecting premises and assessing risks in a realistic manner. This offers the opportunity for students to experience a form of situated learning previously unavailable to them, in which they can integrate and operationalize theory and practice in realistic settings. Carrying out these activities in virtual worlds can also inform advances in the development and deployment of curricula in risk and accident studies.

In this case study, students undertaking the Environmental Health Principles and Practice module in 2009/2010 and 2010/2011 (part of the MSc in Environmental Health at the University of XXX) undertook an accident investigation and a risk assessment in SL as an assessed part of the curriculum. Both exercises ran in a simulated light industrial park in SL; the accident investigation took place in a simulated warehouse (see Fig 1) and the risk assessment in a simulated boat hire shop (see Fig 2).

The simulations ran as follows. Four weeks before the exercises were due to begin the students were introduced to SL and created their free avatar accounts. They then took part in induction activities that included practising walking, text chatting, flying, pointing and clicking, taking photographs and teleporting. These were the only SL skills they would require to carry out the exercises. Accident witnesses were drawn from a mixture of students and teaching colleagues across the two cohorts; students who volunteered to be witnesses to the accident undertook the risk assessment once their input into the accident scenario was over. Accident witnesses were briefed on background to the company and then witnessed the accident in SL through the perspective of their avatars 1 to 7 days before the investigators began their exercise. The accident played out as a short animated sequence in SL controlled by the tutor, where the equipment and characters moved around the warehouse and the characters spoke to each other. The witnesses were in the same area as the accident scenario and so the sequence played out around their avatars, giving the witnesses the sense of being present when the accident took place.

Figure 1: Simulated warehouse

Figure 2: Simulated boat hire shop

Accident investigators received a copy of a realistic UK accident report form several days before they were due to begin the exercise. On the day of the witness interviews, which began their investigation activities, they attended class in a computer room and interviewed the witnesses to the accident, who were in a geographically different location in the real world. Those interviews took place in or near the simulated warehouse in SL and both investigators and witnesses interacted solely through their avatars. Investigators were also able to inspect the premises, interact with equipment and objects, take photographs, collect relevant documentation from the warehouse office and interview an automated non-player character (or “bot”) playing the part of one of the characters involved in the accident.

Once the accident witnesses had been interviewed by the investigators, they moved to the premises next door and undertook the risk assessment in the boat hire shop. Here they could make a visual check of the workplace, interact with machinery (including a pedestal drill and band saw) to check its safe operation, click on items for further information, interact with items (e.g. open doors to check storage areas), retrieve documentation such as the safety policy and accident book, take pictures and interview a non-player character playing the part of a member of the workforce.

Three weeks after the initial exercises the students had the opportunity to interview the manager of the warehouse or the boat hire shop, depending upon which exercise they had undertaken. One of the module tutors took on the role of manager in both premises using a previously unseen avatar. The students therefore did not know the identity of the person behind that avatar and this anonymity was further maintained through the use of text chat rather than voice for the interviews. Following these interviews the tutor returned annotated transcripts to provide formative feedback. When the students had collected all the data from the exercises, they were required to write a report, reflecting upon the way they had approached their exercise and what they had discovered. Accident witnesses were also asked to comment upon their experiences from a witness perspective.

All students were required to reflect upon what action they would take if their exercise arose in real life practice, and comment upon the law that would apply. All of this work formed part of their summatively assessed portfolio for the module.

4 Methods

Thirty-nine students participated in the VW exercises, of which 34 participated in the subsequent evaluation (i.e. an 87% sample, discounting the second attempts of 2 students who re-took the module in 2010/2011). Five students did not participate in the evaluation due to personal reasons not connected with the course. As the students neared the completion of their reflective portfolios, they were requested to complete an online questionnaire. This was undertaken during class time to maximise attendance and participation. Both cohorts also attended focus group sessions immediately after completing the questionnaire. Ethical clearance was obtained from the university research committee and each student was given a full description of the research, the use that would be made of their responses and the undertaking that all answers were unattributable to individuals. Participation in the evaluation was entirely voluntary.

The questionnaire collected data using both open and closed questions. The open questions encouraged varied and rich textual narratives from the participants and encouraged them to write narratives of both positive and negative experiences (Wisker, 2009), whilst the Likert scale items provided quantitative, homogeneous data. Gathering both these types of data helped to assure the reliability and validity of the study (Burns, 2000), although there will always be limitations to both requirements when data is being gathered from human participants. A Spearman-Brown split half reliability test was applied to the quantitative part of the questionnaire, which returned r_{sb}=0.94, demonstrating a high degree of reliability for that part. Construct validity was considered throughout the design of the study, particularly with regard to the consideration of methodology. The arguments that form the basis for the study and the methods employed to investigate those arguments had a sound literature and evidential base, although they were being applied in a somewhat novel area.

The questionnaire covered the following topics:

1. The students' sense of competence with information technology, online games and virtual worlds prior to commencing the simulation
2. Their overall experiences during the simulation
3. Their specific learning experiences during the simulation

4. Their expectations before the simulation and their views after it
5. An assessment of their immersive tendency [immersive tendencies questionnaire based upon Witmer & Singer (1998) as amended]
6. Personal data such as age and gender.

Respondents were asked to enter positive and negative narrative responses at 4 points in the questionnaire corresponding with categories 1-4 above. The focus group conversations took place over a one hour period, and the tutor facilitating the discussions asked starter questions corresponding to the same 4 categories above.

Quantitative data were analysed using Microsoft Excel for organisation, codification, parametric and non-parametric operations, and investigation of associations in the data. Qualitative data were analysed using Miles and Huberman's (1994) themed matrix technique; this technique involves initially grouping the main issues to emerge from the narratives in the questionnaires and the conversations during the focus groups and then developing a matrix that identifies the main themes to emerge and the position of the issues raised on that matrix. This technique was further applied to the individual themes, to reveal factors specific to those themes. This paper concentrates upon discussing and evaluating the theme that related to authenticity or "realness" of the learning experience, and the specific factors that affected that authenticity.

4.1 Limitations

As well as limitations regarding reliability and validity of data gathered from human participants, concatenating the results from two cohorts that studied the module at different times must also be justified. In order to minimise undue interference with the results, in both cohorts the variables relating to size, timing, material covered, staffing, scenarios and methods of evaluation were the same. The variation in responses between the cohorts for the summated scores for all learning experiences statements was 0.05. The similarities of the two cohorts' experiences, together with the similarity between the responses, strongly indicated that the experiences of both cohorts were sufficiently similar to justify concatenation of the results.

As this was a single case study its conclusions cannot be generalised beyond this particular case to situated learning in VWs as a whole. However, as Yin (2003) discusses, whilst the findings of case studies, particularly single case studies, are not directly generalizable into practice, they may form part of the knowledge base that informs developments in theory.

5 Findings

The quantitative findings relating to the students' experiences and learning outcomes are only briefly summarised in this paper. This is simply to aid with understanding the context of the more detailed discussion of the focus of this paper; the students' views of the authenticity of their learning experiences.

5.1 Summarised quantitative findings from case study

The evidence from this case study demonstrates generally good acceptance of VW technology as an environment for accident investigation and risk assessment exercises. There was a weak association between the students' sense of competence in the use of IT generally and how positive they felt their learning experiences to be ($r = 0.23$ {$0.53 \leq p \geq -0.12$; 95% confidence interval}). There was little appreciable association between sense of competence in the use of IT and gender (the sample contained 19 males and 15 females). Approximately one third of the students demonstrated some trepidation and uncertainty about using VWs prior to the start of the exercises, and this trepidation showed a strong association with their sense of competence in the use of IT (r=0.6 {$0.78 \leq p \geq 0.33$; 95% confidence interval}). But, this trepidation reduced significantly in most students as the exercises progressed. In 3 cases the unease did not reduce and was sufficient to interfere with their learning experiences. However, from the affected students' comments, it appears that the cause of this unease was unfamiliarity with the style of learning rather than a low sense of competence in IT use. Data analysis revealed no appreciable association between their unease and their sense of competence in the use of IT.

Overall, students did not demonstrate a strong identity with their avatars, but they did appear to feel a part of the VW when they were undertaking the exercises. They did not identify any major problems relating to the ease of use of the VW, and enjoyed taking photographs, chatting with their colleagues and moving around the VW. Those students who were more familiar with online or console gaming were a little more "at home" in the environment, but all of them coped well with the skills required to take an effective part in the exercise.

It would be meaningless to try to compare the summative assessment scores of the 2 cohorts taking part in this study with previous cohorts who did not undertake VW exercises. However, carrying out an internal comparison of the risk element scores with the rest of the module for these cohorts compares the performances of the same individuals, and is therefore at least indicative of variations between the topic elements in the module. These comparisons suggested that the scores for the risk element of the module, which were strongly influenced by the VW exercises, were 8% higher than for the rest of the module. Comments from the students and the course tutor also indicated that the learning outcomes were achieved effectively, particularly in relation to techniques of information gathering, understanding the interviewing process and analysis.

5.2 Authenticity and reality

Narratives were gathered from student comments in the evaluation questionnaire and the focus group conversations. Coding these data into themes, using the technique described above, identified the sense of authenticity and reality of the exercise as the most common theme. It was cited in 55% of the narratives in the evaluation questionnaire, and "real" was the most commonly occurring word in all questionnaire free text responses. Responses to the focus groups and narratives in the reflective portfolios also commented on the sense of reality of the exercise overall, despite the fact that it was being carried out in what they described as an 'artificial world'.

The discussions in the focus groups showed that it was the reality of the exercise as a whole, rather than the reality of the virtual world *per se*, that was the most influencing factor. The exercises required the students to inspect, interview, document and analyse in the same way they will have to when carrying out real life investigations and assessments. It was this set of activities, combined with the workplace context provided by the virtual world, which provided the sense of realism. It is important that research questions regarding the affordances of VWs in education take this point into account. Student experience is not solely an issue of the VW as such, but is strongly mediated by the nature of the activities that are carried out there, and also by how effectively learning can transfer between the real world and the virtual world. In this case, students learned about the theory of accident causation, risk analysis and methods of investigation in the real world. They then took what they had learned into the VW and applied that knowledge to the simulation. They learned from that simulation and then used that information in analysis exercises in the real world. They then took the results of that analysis back into the VW and applied it to the interviews they carried out with the site managers. The information they collected at those interviews was then analysed in the real world. This transference of learning between worlds is further discussed by Falconer (2011).

Figure 3: Word cloud of text responses to the questionnaire

Figure 3 shows a word cloud of the text responses to the questionnaire. The author recognizes that a word cloud is not a valid method of textual analysis for research purposes as it takes no account of syntax or the context in which the words were used. The word cloud here is shown for illustrative purposes only, as it does demonstrate how "real" was a dominant term in the textual responses. The full textual analysis showed that the phrase "like real life", which stands out in the word cloud, is a valid illustration of the students' narrative responses in the evaluation.

Further coding of the authenticity/realism theme revealed both positive factors that added to the sense of authenticity and negative factors that detracted from it. Nine of the 13 factors were positive, with the remaining 4 reflecting the anxieties and uncertainties some students experienced about the authenticity of using virtual worlds for these simulations. In each factor itemised below the students speak for themselves through their own narratives. The narrative extracts reproduced here are word for word extracts which are representative of the comments made by the cohort as a whole.

The nine positive factors that contributed to the sense of authenticity were as follows.

i. Facilitation

"Can see things that are impossible to see in real life ..."

"Gave an opportunity to investigate an accident that was unavailable to do under any other circumstance."

"When I was first introduced to the SL Accident Investigation I can honestly say that I was amazed by what a wonderful idea it is!!! I did not realise that something like this was possible... I know that SL is not real but it is

as close to real as we are going to get and I feel that whatever I learn from this will really benefit my future practice in this field."

"Enjoyed the virtual world, felt that it was almost like playing a game but at the same time allowed me to put into practice real skills that I will need to use in the real world."

"It was an opportunity to take part in an investigation otherwise not available to me at the time and so a good way of learning even though it was a bit wooden."

ii. Presence and authority

"It is visual and a more realistic way of learning as I felt like the actual person doing the investigation."

"It enabled me to lead an accident investigation like I could be required to in real life."

"I enjoyed putting my 'investigators hat' on and playing detective, I was eager to find out the facts!"

iii. Visual realism

"(At first) I was not particularly keen on taking part with the second life exercise was because I am not familiar with the virtual world, I thought that it is a fantasy land, sort of like playing with dolls on the computer. I am not sure how to explain but things such as this didn't excite me at all. (But the exercise) changed my initial outlook on the whole virtual world activities. I like that it simulated real life. I was a bit apprehensive at first because I do not particularly like 'video game' type things but I found it a very useful exercise. I like the visuals in second life and how real everything looked.

iv. Socialisation

I like that you could meet with friends and have a chat, as opposed to regular online chatting and it's just you and the screen. You sort of feel like you are real people in a fake world."

"I could interact in real time with real people."

v. Comparative reality

"It was more real than imagining an accident scenario."

"Alternative learning medium, nice change from sitting in the classroom and makes lessons more memorable."

"I liked the reality of the experience compared to the classroom."

vi. Engagement

“A good opportunity to try something more real than theory, and more engaging too. ”

“Practical, good experience for real life practice. Flexible with timings and could be accessed for free at home. Text chat is the most useful feature. I think this is better than voice chat as it allows you more time to think.”

“It was interactive, something different, was fun and interesting. Better than role play.”

vii. Active learning

“I am usually a "hands on" learner so I think that this helped in my understanding of real life scenarios even though it was fake.”

“I understand much more about what goes into an accident investigation and the kind of problems that you can be faced with, especially when talking to witnesses.”

“It is a new and novel way of learning, something I’m very open to than the normal read, read, read and regurgitate.”

“I was keen because I was looking forward to another system of learning, though I was quite sceptical about in the sense that I did not know what to expect initially.”

viii. Generalizability

“What has been good about every task after the Second Life scenario is that I have been able to relate it to real life easier in some way or another. So what I can take away from the scenario I can generalise to the application of EH practice.”

ix. Enables learning from mistakes

“(I liked …) that it didn't matter if I got things wrong, it was all about learning.”

“It was wonderful to be able to have a go at an accident investigation as you would in real life without actually having to be experienced in accident investigation. It is great to learn from your mistakes in Second Life rather than in the real world.”

“It provided an environment in which it is ok to ask questions to witnesses that you probably wouldn’t get away with in real life. You could fail safely.”

“(I liked) being able to investigate, make mistakes, without suffering any 'real' consequences!”

The four negative factors which detracted from the sense of authenticity were as follows.

i. Public image of virtual worlds

"Second life is a useful learning tool but I was sceptical about it, I think virtual worlds may have image problems as I associated them with gaming fanatics before the exercise and not as a learning tool."

ii. Lack of naturalism

"… it's a bit contrived ."

"I am not familiar with such learning before. It is totally something new and difficult for me to understand."

"I really found it something beyond my understanding."

iii. Unrealistic graphics

"Not that realistic, could have done with better graphics and be more interactive."

iv. Dislocation from tactile sense

"(Didn't like) limitations of virtual world. No ability to touch/feel."

6 Conclusions

One of the clearest signals to emerge from this research study was the sense of realism experienced by the students. They felt a strong sense of situation and liked being able to interact socially with their colleagues on the course. Social interaction and authenticity are key elements of situated learning and it appears that VW exercises can satisfy both these criteria effectively. More specifically, the evidence from this case study strongly indicates that VW exercises can offer effective opportunities for situated learning in accident investigation and risk assessment. In particular, they can facilitate the integration of theory and practice in environments that feel authentic to the students, and in which they can experience a sense of presence. Opinions on the realism of the graphics, and the overall visual sense, varied between students; some felt it was realistic whilst others reacted less positively. There was some suggestion that both expectation and previous experience of immersion in virtual environments (e.g. online gaming) may lead to some disappointment with the visual realism of the sets used in these exercises, but this was not very clear. It would be valuable for further research to investigate what aspects of the visual environment add to the sense of realism for some users, whilst detracting from it for others.

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