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Using VR in Learning and Teaching

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Introduction:

This paper investigates the use of a Virtual Reality (VR) simulation (The Underground Station Evacuation Simulator- USES) that was initially developed to explore mass emergency behaviour experimentally (see Drury & Cocking, 2007). However, since January 2009, I have been using the USES to teach Research Methods to 1st year Undergraduate Psychology Students, and realised that it can also be useful in teaching students about theories relating to the psychology of crowd behaviour. Therefore, I investigated the effectiveness of the USES as a teaching tool to explore its potential educational benefits.

Conceptual background to VR:

VR has developed from relatively simple beginnings in University or military computing laboratories in the 1960s into a global phenomenon, now available to anyone with Internet access and PCs with sufficient processing speeds. For instance, applications such as *Second Life* (where people interact globally with other users via avatars) had nearly 20 million registered user accounts in 2011[1]. Its use in education has also attracted interest, and this is investigated in the following report; how VR technology has changed not only the methods of teaching and learning, but perhaps even some of the philosophical underpinnings of how we view education itself.

The development of Immersive Virtual Reality (IVR):

Loomis, Blascovich & Beall, (1999) suggest that the first IVR system was created in 1965, with later applications used to train fighter-pilots in the US military (Winn, 1993). The aim of these early applications was to place users in a three-dimensional (3D) environment that enabled them to interact in a similar ways as they would have done in reality. Bell & Fogler (1995) believed Virtual Learning Environments (VLEs) were "characterised by high degrees of immersion, believability and interaction, with the goal

[1] http://en.wikipedia.org/wiki/Second_Life

of making the user believe, as much as possible, that s/he is actually *within* the computer generated environment.... In an ideal virtual world, a user would be completely unable to determine whether they were experiencing a computer simulation or the 'real thing'" (p.2).

More recently, Dalgarno & Lee (2010) suggested that 3D environments could enhance knowledge if it was based on direct rather than abstract experience. Current evidence from teaching interventions also suggests that use of VLEs in education can be beneficial. For instance, Walker (2009) found that students on a mental health course reported significantly higher learning benefits from using a VR simulation (where they interacted with clients in the forms of avatars) compared to those who used more traditional forms of learning.

In order for VLEs to create an effective sense of immersion or cognitive presence, (Bricken, 1990), some (e.g. Winn, 1993) have argued that certain technological requirements are necessary, such as the use of head-mounted devices (HMDs). However, such requirements are often beyond the technological and/or financial resources of most academic teaching departments without specially designed immersion laboratories or external funding. This led Lavroff, (c.f. Winn, 1993) to argue that 'desktop VR' is less effective, because it does not meet the necessary requirements for IVR. However, Dalgarno & Lee (2010) believed there is a difference between presence – "the subjective sense of being in a place" and immersion – "the objective and measurable properties of the system or environment that leads to a sense of presence" (p.13). Therefore, while they considered immersion and presence to be important factors, neither were unique in creating effective VLEs; suggesting that technology is not the only factor in creating a sense of realism in virtual environments.

Recent research (e.g. Drury et al., 2009) has found that a sense of psychological immersion can be generated without the specialised technology necessary for perceptual immersion. This is done through getting participants to engage in role-play beforehand or providing scenarios that give context to the environment in which they will be immersed. Use of such techniques can create a sense of psychological immersion that helps overcome any deficits from a lack of perceptual immersion. This has been supported by recent theoretical developments arguing that role-play strategies can help learners 'lose themselves' (Dalgarno and Lee, 2010, p.22) more easily within VLEs and to adopt the opportunities for different perspectives that controlling avatars will allow. As an important aspect of constructivist learning theory, these ideas will now be explored in more detail.

VLEs and Constructivist Learning:

Some argue that VLEs can have pedagogic benefits beyond the topic being taught. For instance, Winn (1993) felt that immersive VLEs can break down boundaries between the first and third persons, thus reducing the need for abstract symbol systems and

increasing students' capacity for learning as they experience more direct forms of education: "IVR allows first-person experiences by removing the...boundary between the participant and the computer... VR technology... allows a synthetic experience to capture the essence of what it really means for a person to come to know the world. Immersion in a virtual world allows us to construct knowledge from direct experience" (p.8).

This relates to a tenet of constructivist learning theory, for example, Duffy & Jonassen, 1993), that knowledge and learning are better facilitated by direct experience of the world. Jackson & Fagan (2000) point out that constructivism has a long history in educational theory, believing that learning is an active process of construction, and that teaching should support such construction rather than communicating knowledge. Therefore, the processes involved in VLEs, where users control avatars in simulations, support the principles of constructivist learning and offer an exciting way for learners to construct knowledge from their direct experience of an alternate reality. However, a word of caution should be offered before declaring VLEs the future of teaching. De Byl & Taylor (cf Lefever & Currant, 2010) argue that one should go beyond re-creating the classroom via 3D environments and VR and explore approaches that facilitate learner-centred collaborative experiences. Slevin (cf Lefever & Currant, 2010) also felt that VLEs can merely reflect the traditional classroom or just be used to store information, and argued that new technology should instead "offer different forms of action and interaction" (p.31-32).

Theoretical justification:

Dalgarno & Lee (2010) review the learning opportunities of 3D VLEs and argue that while there is evidence to support educational outcomes from their use, it was unclear whether it was simply because of their 3D aspects, and there was there sufficient data supporting the cognitive benefits of desktop VR. They argue against assuming that the increased technological capacity of VLEs will necessarily result in an increased sense of immersion and consequently improved learning experiences. Thus, there appears to be a need to combine technological advances and increased psychological identification with VLEs for any learning benefit.

Method:

VLEs are often used to research topics that are impractical and/or unethical to re-create in the real world (e.g. Bell & Fogler, 1995), especially in the realm of Social Psychology. For instance, Slater et al. (2006) used VLEs to re-create the classic Milgram (1963) obedience experiments, as the original research methodology where participants are instructed to deliver what they believe are potentially fatal electric shocks to a confederatewould fail current university ethical guidelines. Indeed, Drury et al (2009) argued that VLEs provide an opportunity for experimental research into mass emergency behaviour, an area that has been neglected since the imposition of increased

ethical constraints on recreating such events in real-life. While these VLEs are analogue situations (participants know it is not a real emergency), they do seem to reproduce some aspects of life-like behaviour if participants become psychologically immersed within the simulation, and so appear to be useful for such research.

Procedure:

This study involved 120 students running the USES simulation in the Psychology Department's Computer laboratories. They logged in to individual PCs and read instructions for one of two experimental conditions to which they were allocated, which set the scenario in which they were immersed; that is, a crowd of people escaping a fire from an Underground station. Participants were cast either as being with others with whom they shared a sense of collective identity (e.g., fellow students coming back from a protest march), or alone in a crowd of strangers. Once the simulation began they had to control the actions of a character, namely whether to help other passengers or to push past them. On completion of the simulation, all students were debriefed. The theories behind the VR simulation were explained in more detail. Students were then expected to write up the practical as a piece of assessed coursework. Finally, students were asked to complete a questionnaire assessing their perceptions of the intervention and related learning experiences (see Appendix 1)

Results:

120 students participated in the practical workshop, 110 submitted their write-up, and of these, 86 % passed, with over 2/3 of them (73) gaining a mark of 50% or above, and 7 achieving a first (70% and above). Figure 1 illustrates the mark spread.

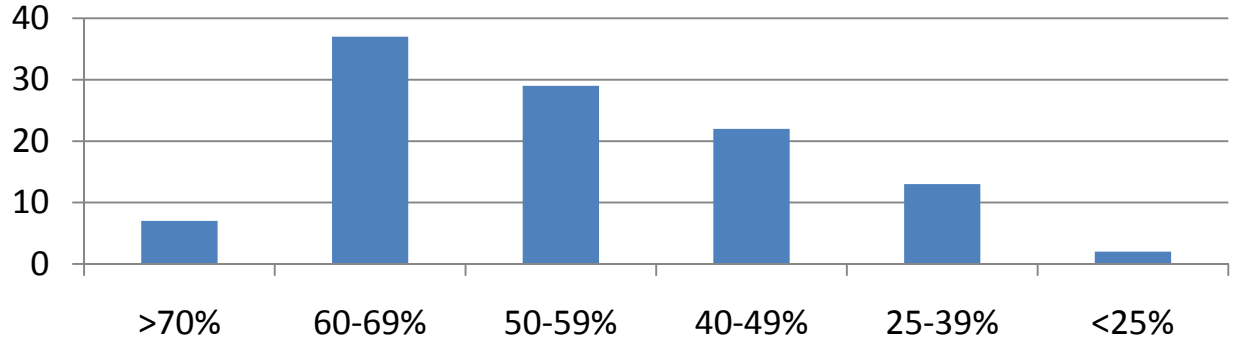

Figure 1: Coursework mark spread

The questionnaire distributed at the revision session attracted less respondents (34 in total), as it was held later in the term and attendance at such optional classes was lower than the compulsory element of the course. Responses to measures were recorded on a five point Likert scale, and items re-coded so that a higher score meant a positive response. The following figure represents sample responses relating to the students' perception of the effectiveness of the VR simulation itself (see appendix 2 for questionnaire results in full).

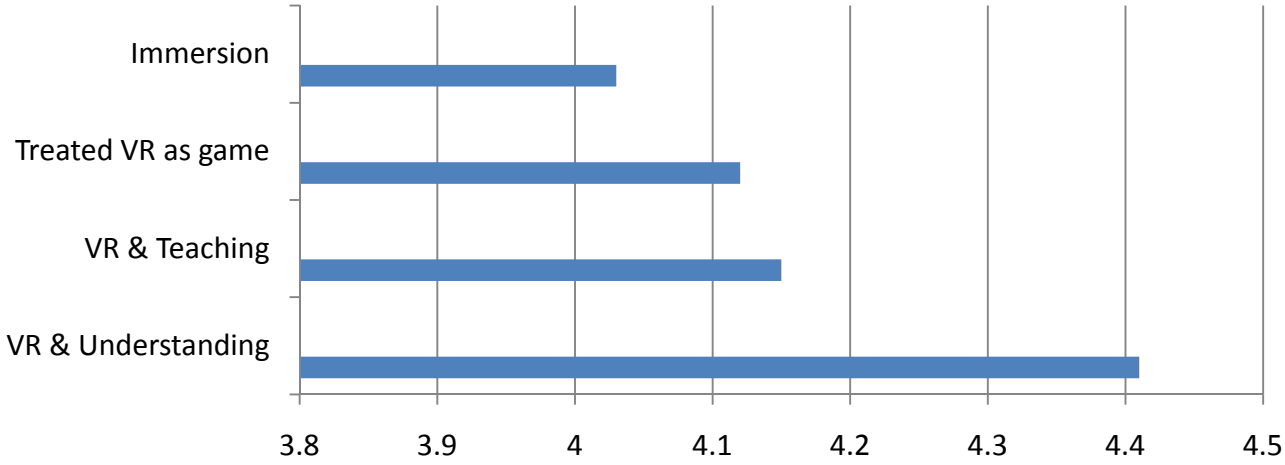

Figure 2: Sample questionnaire responses:

Participants, felt a strong sense of immersion (in response to question 8) and believed that they did not treat the simulation as if it were a game[2], with both measures scoring over 4 on the 5 point-scale. Students also believed strongly that using the simulation helped improve their understanding, not only of the specific topic, but also felt that VR improved learning in general. For instance, the questions relating to this (19, 21, & 22) scored a mean of 4.23 on the 5 point scale, with q.19 'Do you think doing the VR simulation helped improve your understanding of the topic?' scoring the highest overall (4.42).

Discussion:

Overall, the USES simulation appears to have been successful in engaging students, and their learning outcomes appear to have benefitted as well. However, there are possible limitations with this study that need to be discussed before considering the wider implications of this intervention. First of all, there are some methodological weaknesses within the simulation that may have affected participants' sense of realism and hence immersion. Participants knew that the simulation was not a real emergency and however well immersed they are, people do not know how they would truly behave in *real* emergencies (unless they have actually experienced one themselves) and so to some extent participants' actions can only be their predictions of how they might behave.

There are also limitations regarding learning outcomes that should be considered. While participants reported a strong belief that using the VR helped improve their understanding and consequently their mark, I was not able to gather evidence to support this, as I could not match up individual participants' performance in the simulation and their mark with their later questionnaire data. Future interventions could collect more information that will make it possible to match up participants' data, although this generates potential ethical issues as such data may compromise participant anonymity.

[2] this item was re-coded, so that a high score meant they did not treat it like a game

Finally, a further limitation was noted that may suggest a possible future direction in which to take this VR simulation. There are no consequences to participants' actions in the simulation, as the other characters do not respond to them, something that would almost certainly happen in a real-life emergency if someone was pushing other people to escape. Therefore, as computer processing speeds improve, future interventions could have multiple participants controlling the actions of characters within the same simulation, creating a multi-user interactive VLE. Jackson & Fagan (2000) argued that multi-user VLEs are becoming increasingly possible with current advances in technology, and so use of such interventions will undoubtedly increase over time. They also suggest that using VLEs may create a sense of camaraderie amongst users that could encourage conceptual change in the face of real world problems. This could perhaps be similar to the common identity that develops in the face of adversity in mass emergencies (Drury & Cocking, 2007) and using such technology could perhaps foster a climate of increased co-operation to cope with future global problems.

Implications:

Increased interactivity in the use of VR can also have interesting theoretical implications for education, because Multi-user Virtual Environments (MUVEs) could inspire more 'connectionism'- where those involved in learning networks can improve learning using Vygotskian style Zone of Proximal Development (ZPD) principles (c.f. Siemens & Titteneberger; 2009). Dalgarno & Lee (2010) termed this concept as 'co-presence', where MUVE users feel a sense of 'being there together' with other on-line users around the world, despite being geographically distant (p.14). This has interesting parallels with the psychological principles upon which the USES is based, as Turner's Self Categorisation (1987) theory argues that common social identities develop as a result of normal social processes, encouraging people to identify and act collectively with others that they may not even personally know.

Conclusion:

The use of VLEs in education is increasing exponentially and this is opening up exciting new opportunities, as learners interact with each other more and more in virtual worlds. This may even result in changing the very way in which we view education itself- something that is illustrated in the following quote from De Freitas & Veletsianos (2010): "The definition of learning as information re-gurgitation is giving way to a notion of learning as centring upon immersive learning experiences that are inherently social and collaborative" (p.5).

However, a word of caution is advised, as technology should never be considered as a substitute for solid educational practice, and Dalgarno & Lee (2010) suggested that it may not necessarily be the technological capabilities of VLEs that encourage effective learning. What is more important is whether or not they are grounded in sound pedagogic principles. Nevertheless, the use of VLEs appears to be here to stay and so

educators would do well to embrace such technology, while at the same time never fetishizing the technology per se, but exploring how particular interventions can build upon existing educational knowledge and practice.

References:

Bell, J.T & Fogler, S.F. (1995) The Investigation and application of Virtual Reality as an educational tool. *Proceedings of the American Society for Engineering Education 1995 Annual Conference.* Session Number 2513, June 1995, Anaheim, CA.

Bricken M. (1993) *Virtual Reality Learning Environments: Potentials and Challenges.* HITL, Washington. Available via; http://www.hitl.washington.edu/publications/m-90-4/m-90-4.html

Dalgarno, B. & Lee, M. (2010) What are the learning affordances of 3-D Virtual Environments? *British Journal of Educational Technology,41.* (1), 10-32

De Freitas, S. & Veletsianos, G. (2010) Editorial: Crossing boundaries: Learning and teaching in virtual worlds. *British Journal of Educational Technology, 41.* (1) 3-9.

Drury, J. & Cocking, C. (2007). *The mass psychology of disasters and emergency evacuations: A research report and implications for practice*. Unpublished manuscript. University of Sussex, Brighton. Available at; http://www.sussex.ac.uk/affiliates/panic/applications.html

Drury, J., Cocking, C., Reicher, S., Burton, A., Schofield, D., Hardwick, A., Graham, D., & Langston, P. (2009). Co-operation versus competition in a mass emergency evacuation: A new laboratory simulation and a new theoretical model. *Behavior Research Methods 41* (3), 957-970

Duffy, T.M. & Jonassen, D. H. (1992) *Constructivism and the technology of instruction: a conversation.* Lawrence Erlbaum: Hillsdale. NJ, US.

Jackson, R. & Fagan, E (2000) Collaboration and Learning within Immersive Virtual Reality *Proceedings of the third international conference on Collaborative virtual environments.* ACM: California, US.

Lefever, R & Currant, B. (2010) *How can technology be used to improve the learner experience at points of transition? Review of peer-reviewed academic literature, national and international resources within Higher Education Institutions Literature.* University of Bradford, UK. Feb 2010.

Loomis, J., Blascovich, J., & Beall, A. (1999) Immersive virtual environment technology as a basic research tool in psychology. *Behavior Research Methods, Instruments & Computers, 31.* (4) 557-564.

Milgram, S. (1963) Behavioral study of obedience. *Journal of Abnormal & Social Psychology,***67,** 371-378

Siemens, G.& Tittenberger, P. (2009) *Handbook of Emerging Technologies for Learning.* March 2009. Available via; http://weblearn.londonmet.ac.uk/webct/RelativeResourceManager/Template/HETL.pdf

Slater, M., Antley, A., Davison, A.,Swapp, D., Guger, C., Barker C., et al. (2006) A virtual reprise of the Stanley Milgram obedience experiments. *PLos ONE,* **1**, e39. Doi:10.1371/journal.pone.0000039

Turner, J.C., Hogg, M.A., Oakes, P.J., Reicher, S.D.& Weatherall, M.S. (1987) *Rediscovering the social group: a social categorisation theory*. Blackwell: Oxford

Walker, V. (2009) *Traditional and 3D Virtual Learning Activities: Evaluating Cognitive, Affective & Psychomotor Learning.* Paper presented at the Learning Technologies Conference, Queensland, Australia. Nov 2009.

Winn, W. (1993) *A conceptual basis for Educational Applications of Virtual Reality.* HITL, University of Washington: Washington, US.

Biographical note:

Dr Chris Cocking is a Senior Lecturer in Social Psychology at London Metropolitan University. His research interests include social identity, collective action and inter-group conflict. His particular area of expertise is crowd behaviour in conflict and emergencies such as riots and terrorist attacks. His published work has contributed to revising current models of emergency planning. **E-mail:** c.cocking@londonmet.ac.uk

Appendix 1

VR questionnaire PY 1006 May 2010

The following questionnaire has been designed by me to assess your opinions of the Virtual Reality evacuation programme that you did as part of your teaching in week 5. I am currently taking a course in Applying Learning Technologies to teaching, and I would like to find out how effective this VR programme has been in your learning. If you attended the practical session that used my VR simulation, then I would be very grateful if you could fill in the following questionnaire. Please answer questions as truthfully as possible- you will not be assessed on this, and all answers are completely confidential. If you have any questions, please contact me on c.cocking@londonmet.ac.uk
Many thanks
Chris Cocking

Age: Female: Male:

For the following questions please circle the appropriate response

1) How clear were the verbal instructions you were given before the practical began?

Not clear at all	A little	Somewhat	Quite	Very clear
1	2	3	4	5

2) How clear were the instructions in the PowerPoint slideshow you read before the simulation began?

Not clear at all	A little	Somewhat	Quite	Very clear
1	2	3	4	5

3) Did you find the scenario in the PowerPoint slideshow believable?

Not believable at all	A little	Somewhat	Quite	Very believable
1	2	3	4	5

4) Which Identity condition were you placed in?

Personal ID condition (separated from companions in crowd)	Social ID condition (with companions in crowd & other characters in red)	Can't remember

5) How realistic did you find the VR evacuation simulation?

Not at all realistic	A little	Somewhat	Quite	Very realistic
1	2	3	4	5

6) How great a sense of urgency to evacuate did you feel?

No urgency	A little	Somewhat	Quite	Very urgent
1	2	3	4	5

7) How easy did you find it to imagine that you were in a real evacuation?

Not at all easy	A little	Somewhat	Quite	Very easy
1	2	3	4	5

8) Do you think that the use of VR technology made it easier or more difficult to imagine that you were in a real evacuation?

Very easy	A little easier	Neither	Slightly difficult	Very difficult
1	2	3	4	5

9) Do you think that you behaved in the simulation the same way that you would behave in a real emergency?

Very much so	Somewhat	A bit	Not much	Not at all
1	2	3	4	5

10) Do you think you treated the simulation like a video game?

Very much so	Somewhat	A bit	Not much	Not at all
1	2	3	4	5

12) Did you feel emotionally engaged during the simulation?

Not at all	A little	Somewhat	Quite	Very much so
1	2	3	4	5

13) Did you care about the other characters in the simulation around you?

Very much so	Somewhat	A bit	Not much	Not at all
1	2	3	4	5

14) Did you feel guilty if you pushed other characters?

Very much so	Somewhat	Maybe	A little	Not at all (or didn't push)
1	2	3	4	5

15) Did you feel good if you helped other characters?

Very much so	Somewhat	Maybe	A little	Not at all (or didn't help)
1	2	3	4	5

16) How stressful did you find doing the simulation?

Not stressful at all	A little	Somewhat	Quite	Very stressful
1	2	3	4	5

17) Were you relieved when you reached safety and the simulation ended?

Very much so	Somewhat	A bit	Not much	Not at all
1	2	3	4	5

18) How useful was the debrief session in explaining the relevant theories covered in the practical?

Very useful	Somewhat	A bit	Not much	Not at all
1	2	3	4	5

19) Do you think doing the VR simulation helped improve your understanding of the topic?

Very much so	Somewhat	A bit	Not much	Not at all
1	2	3	4	5

20) Do you think doing the VR simulation helped improve the mark you were given for the write-up of the practical?

Very much so	Somewhat	A bit	Not much	Not at all
1	2	3	4	5

21) How useful do you think VR technology is in teaching in general?

Very useful	Somewhat	A bit	Not much	Not at all
1	2	3	4	5

22) How useful do you think this particular VR simulation was in teaching you about theories relating to crowd behaviour in emergencies?

Very useful	Somewhat	A bit	Not much	Not at all
1	2	3	4	5

23) What mark did you get for the write-up of this practical?

Less than 40%	40-50%	50-60%	60-70%	Over 70%	Did not submit

24) Was there anything about the practical/simulation that could be improved, and if so, what would make it better?

If you have any other comments, please leave them here

Thank you for doing this questionnaire, I am hoping that it will contribute to greater understanding of the processes involved in using different kinds of technology in teaching. Current theories of VR argue that it enables participants to effectively immerse themselves in situations that may be too ethically problematic to recreate in other ways. Therefore, it can have a role in teaching potentially risky topics in safer experimental conditions that reduce the risks involved. If you think that doing this questionnaire has raised any issues for you, please talk to me afterwards, or contact the University Counselling Service on; https://intranet.londonmet.ac.uk/studentservices/counselling/
Once again, thanks for your time, and if you would like to see a copy of the final report when it's published, please leave your contact details here.

Appendix 2:

Questionnaire descriptive data

	N	Mean	Std. Deviation
1) How clear were verbal instructions	34	4.2941	1.00089
2) How clear were instructions in PPt	34	4.3235	.80606
3) Was PPT scenario believable	34	3.3235	1.17346
4) Which ID condition were you in	34	.8235	.75761
5) How realistic was VR	33	2.9091	1.04174
6) How great a sense of urgency to evacuate	33	3.0606	1.02894
7) How easy to imagine in real evacuation	33	3.0303	1.01504
8) use of VR easier to imagine in real evacuation	33	4.0303	.76994
9) Did you behave same way you would in real evacuation	33	3.0909	1.35471
10) Did you treated VR like game	33	4.1212	.92728
12) Were you emotionally engaged during simulation	33	2.8485	1.09320
13) Did you care about other characters	34	3.2941	1.05971
14) Did you feel guilty pushing other characters	34	2.8235	1.56613
15) Did you feel good helping other characters	34	3.5000	1.44075
16) How stressful was the VR simulation	34	1.9118	1.19005
17) Were you relieved when VR ended	34	3.7353	1.08177
18) How useful was the debrief	34	4.0882	1.16431
19) Did using VR improve your understanding of topic	34	4.4118	.98835
20) Did using VR improve your mark	34	3.7941	1.36580
21) How useful is VR in teaching in general	34	4.1471	.95766
22) How useful is VR teaching crowd behaviour theories	34	4.1176	.94595