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Research Group

Immersive technologies for learning:
A multi-disciplinary approach

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Editor

Stewart Martin

iVERG 2010 Proceedings - International Conference on Immersive Technologies for Learning: A multi-disciplinary approach

iVERG

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Preface

It gives me great pleasure to welcome you to this inaugural issue of the conference proceedings of the International Virtual Environments Research Group. This issue is dedicated to the publication of selected papers written by researchers in Europe, Japan, Singapore from the *International Conference on Immersive Technologies for Learning: A multi-disciplinary approach*. Delegates to the conference came from institutions across the world and created a relaxed, enjoyable atmosphere within which a wide range of exciting and innovative papers were presented on topics from across the educational, training and theoretical spectrum. We were delighted to welcome colleagues from:

Academy 360, Hull, UK
Future University, Hakodate, Japan
Leeds College of Art, UK
Nanyang Technological University, Singapore
National Institute of Education, Singapore
Newman University College, Birmingham, UK
Nisai Academy, Durham, UK
Oxford University, UK
South Shields Community School, UK
SupaReal, UK
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Teesside University, Middlesbrough, UK
The London Institute, UK
Tufts University, Massachusetts, USA
University of Derby, UK
University of Hull, UK
University of Leeds, UK
University of Leicester, UK
University of Twente, The Netherlands

The iVERG 2010 conference would not have been possible without the work of the local organizing committee, session chairs and editorial review team including Michael Vallance, Paul van Schaik and Noola Griffiths, to whom especial thanks are due for their dedication and hard work.

March 2011

Stewart Martin
Chair, iVERG

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The skeleton in the seminar: Teaching and learning in virtual worlds

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Abstract. How do virtual worlds and MMORPGs function as learning spaces? What kinds of mentoring, pedagogy, collaborative learning are emerging from early experiments with these spaces? And what is the relation between these processes and their real world counterparts? This paper presents examples of teaching and learning in *Second Life* and *World of Warcraft* from recent research projects. It explores performative and discursive aspects of teaching and learning in avatar-based environments. It argues that these are ambiguous spaces in new ways which can be confusing for learners, but which can be ultimately productive if the available resources are managed in the interests of the learner.

Keywords: virtual worlds, teaching and learning, drama, new media

Virtual worlds, dramatic spaces, game worlds

What are virtual worlds? This question has been hotly-debated, not just in our net-inflected world and the virtual worlds of the 3-D web, but since ancient times. *Second Life* anthropologist Tom Boellstorff (2008) cites Plato's cave, earthly life represented as shadows thrown on the wall by the firelight, as a kind of virtual world – though he points out too that the perceived relation of 'real' to 'virtual' has been inverted in our times: for Plato, our 'real' world is the shadow.

A more contemporary philosophical imagining of virtual worlds, again cited by Boellstorff, is Foucault's heterotopia (Foucault, 1984). Unlike utopias, which Foucault defines as unreal ideal places, heterotopias are liminal, transgressive real spaces in every culture, places of ritual and taboo. Foucault's examples are places such as cemeteries, brothels, colonies, ships. In many ways, these are appealing analogies for the spaces to be found in virtual worlds and online games, which do seem to have a predilection for such liminal territory. However, what makes Foucault's image more appropriate to the virtual nature of such worlds (itself a contested term, of course), is his image of the Mirror, an interstitial space between utopia and heterotopia, a standpoint which both clarifies and confuses his presence in either:

> *From the standpoint of the mirror I discover my absence from the place where I am since I see myself over there. Starting from this gaze that is, as it were, directed toward me, from the ground of this virtual space that is on the other side of the glass, I come back toward myself; I begin again to direct my eyes toward myself and to reconstitute myself there where I am.* (Foucault, 1984, pp. 47).

This image is appealingly similar to the figure of the inhabitant of a virtual world, their 'real' corporal self crouched over the computer screen, their 'reflection' active in a world which might be unreal (utopic) or real (heterotopic). In the end, Foucault's meditation serves to flesh out the ontological ambiguities of presence and absence, virtuality and reality, in this context.

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Our challenge is to accept that such ambiguities are not resolvable; or to make a possibly rash decision. My decision, for what it's worth, goes like this. There is a difference in the ontological status of myself and my avatar. My efforts to construct my own identity rely heavily on contexts and forms of representation: speech, costume, gesture, facial expression, belongings, residences, accoutrements. In the virtual world, these are not simply representations, however (of cultural affiliation, wealth, taste, and so on) – they are representations of representations – they are doubly-articulated signs. By contrast, such representations in real life are singly articulated. A shirt may represent a Goth sensibility, but it is a shirt, not a representation of one. Secondly, and perhaps more importantly, these representations in real life (RL) are what I'll call dependent – dependent on and anchored in embodied identity (not in a representation of embodied identity). From a phenomenological point of view, this selfhood articulates the psycho-social apparatus of identity with the sense-perception apparatus. At the same time, the communicative apparatus of the body can be fully deployed in the social expression and construction of identity. In the avatar, only sight and sound are engaged directly of the array of sense-perception; the rest are represented. In terms of expressive potential, only speech can be directly employed; elsewhere, limited representations of communicative processes are employed. To summarise: there is a qualitative difference between identity inhering in the embodied presence of the Real World and the less durable, ontologically removed, modally more restricted, projected identity of the virtual world. This is not to say, however, that the forms of self-exploration, extension and expression made possible by avatar-embodied projections are not valuable; and in the context of this article, valuable in the context of teaching and learning.

In considering the nature of the social performances of virtual worlds, I have a particular analogy in mind. For me as a former teacher of English, Drama and Media in secondary schools, virtual worlds have an educational ancestor. This is drama and simulation. For example, when I was an English teacher I conducted an improvised drama based on the Old English epic tale *Beowulf,* in which my Year 8 class were the warriors in Hrothgar's mead-hall, awaiting the arrival of the monster Grendel. Another example was an extended improvisation based around Longfellow's *Hiawatha*, in which the four classes of Year 8 became tribes of the Iroquois nation, enacting elements of the story of Hiawatha, and inter-acting through simulations of trade and combat between lessons.

These activities were typical of the kinds of educational drama, or process drama, pioneered by figures like Dorothy Heathcote and Gavin Bolton. They also incorporate elements of the drama 'conventions' adapted for educational drama by Jonothan Neelands from the work of Brazilian theatre practitioner Augusto Boal. Perhaps the most emblematic convention developed by Boal was 'forum theatre', radical in terms of textual authority because it handed the power to create the drama to the actor/spectators; and equally radical in its political implications for the often dispossessed people with whom he worked (Boal, 1992).

But what has all this to do with virtual worlds? There are three important similarities, I want to suggest. Firstly, the working-out of a drama in process is core to both. The building and maintenance of an imaginary world, and the rituals, encounters, adventures, and humdrum activities we engage in within it, are common to both. The semiotic tools are different, but perhaps only superficially. Whether a configuration of computer graphics represents a tool, or the rulers and paper tokens that represented Iroquois coup-sticks and wampum bead currency in our Hiawatha drama, the principle is the same. An act of symbolic substitution is going on of the kind the Russian developmental psychologist Lev Vygotsky had in mind when he offered a child using a broomstick as a horse by way of illustrating the imaginative work of play (Vygotsky, 1962). Physical objects, then, have a different ontological status from their

status in non-dramatic life, and closer to their status in virtual worlds. They are representations of something other, something belonging to what Heathcote called the 'as-if' of drama (e.g., In Heathcote & Bolton, 1996). They belong inside Huizinga's famous 'magic circle', where the rules of play and not the real world apply; and the consequences of actions in the real world do not apply (Huizinga, 1949, pp. 10). However, there is much debate about the magic circle's impermeability. Edward Castronova argues, for example, that its impermeability is compromised by the political economies of virtual worlds like Second Life, where money and certain aspects of legal and regulatory activity cross the boundary between the virtual and 'real' worlds (Castronova, 2005). But other kinds of leakiness can be argued. There are times in the 'real world' where an 'as-if' ontology seems to apply – when we dress up for an interview, playing the role of the professional worker we hope to be if appointed; where we pretend to be cross with a child to emphasise the seriousness of a situation; where the child pretends to be upset to win sympathy. By the same token, there are many situations in games and play where the 'as-if' ontology gives way to real world pressures and consequences: where we might have 'really' offended someone in the virtual world; where our representation of ourself as avatar causes reactions similar to those our physical selves cause in the real world (baldness in my case); where our communicative practices are closely related to those we possess in real life – a fluency in certain kinds of language, perhaps; or a sense of humour; or alternatively a facility counterposed to a disability in real life – walking and running for wheel-chair users; or 'hearing' text-based dialogue for deaf people (c.f. Carr, 2010).

Secondly, and more specifically, both involve role-play. In fact, as Goffman reminded us, it's a core process in life itself, in the construction and performance of selfhood (Goffman, 1959). The process of improvisatory performance, whether of social selves or imagined selves (perhaps all our identities are a combination of these types) is at the root of this kind of drama. Again, it's possible to distinguish between dramatised bodies within the magic circle of a drama and its 'as-if' imaginary world, and dramatised bodies outside a dramatic context; and how both relate to the body of the avatar. The body outside a dramatic context represents itself – it might dramatise the role of doctor of waiter, as Goffman describes – but it really is doctor or waiter; just as its surgical gown or waiter's apron are really those things, rather than representations of something else. Inside the drama – and in the virtual world – everything is a representation of something else. In RL drama, it's a child's body pretending to be the body of an Iroquois warrior; his shirt pretending to be the buckskin, his voice, gestures, face, all pretending to be those of the warrior. In the virtual world, it's a programming or scripting language, wire-frames and pixels pretending to be those things.

Thirdly, both drama and virtual world possess the possibility of crossing the boundary of the magic circle. This is the essence of Boal's forum theatre – an ability to step in and out of the drama to plan, observe, critique. Process drama routinely does this as part of its improvisatory work, its composition-in-performance. In virtual worlds, we oscillate between an immersion in the world and the avatar and a sense of ourselves sitting in the chair in front of the computer. We have a range of functions to allow for avatars to be out of character in a Massively Multiplayer Online Role Playing Game (MMORPG), or away temporarily in *Second Life*. A commonsense understanding of role is that actors are as deeply immersed as possible: but in fact drama educators make the point that engagement in role is gradated, and that degrees of role distance are possible and desirable (Carroll & Cameron, 2005).

There are, for the purposes of my argument here, two implications of these debates about the nature of virtual worlds. The first is that no simple assumptions can be made about our virtual selves and our virtual worlds, no easy reading-off of analogies between the two. We oscillate between them, in something like Foucault's mirror, and if we are to consider their

educational potential, we must take account of this space of imperfect reflections, inversions, tenuous relationships. The second implication is that virtual worlds are dramatised spaces; firstly in the same way that our performance of selfhood (and identities as teachers and learners) is always dramatised in RL; but also because of the possibility afforded to experiment with different representations of ourselves, for students to direct the trajectory of the drama, for teachers to be dramaturge as well as pedagogue.

First steps in a virtual world: leaky boundaries

My first experience of a virtual world was in a research project looking at role-playing games (AHRB 'Textuality in Videogames', 2001-3 – see Carr et al., 2006, for a full account of this research). As part of this project, my colleague Diane Carr and I spent a good deal of time in the MMORPG *Anarchy Online*, a sci-fi-styled world offering a range of roles, locations, and other resources.

This has served us since as an example of learning – in this, case, learning how to exist in a virtual world. My lessons particularly involved, for example, learning how to work with a team of people, how to fight and shop, and how to manage social encounters of various kinds, when these social encounters were mediated by avatars. Online collaborative endeavour has sometimes been seen from the point of view of communities of practice (Wenger, 1998). The structures of communities of practice do seem to apply to groups in virtual words; though the rhetoric of busy, pro-social communities does not necessarily fit. Figure 1 shows my avatar, Nirvano, discussing with a newly formed group how to go about a mission together. It seemed a negative lesson to learn: the partners were suspicious of each other, there was no clear sense of the levels of commitment which communities of practice expect, and I was not the only 'legitimate peripheral participant'. I mention this here as a counterbalance to the celebratory rhetoric that sometimes accompanies accounts of either communities of practice or online structures (or both). While Henry Jenkins has illuminated this field in many ways, his vision of collective intelligence by no means describes all that takes place (Jenkins, 2002).

Figure 1. My avatar in Anarchy Online, *Nirvano*, attempting to join a team

Another apparently negative lesson was learned in an encounter with an avatar who made an offensive remark about my avatar's physique, which I had chosen to be a little stocky, in acknowledgment of my actual physical build. His opening remark was "When's the baby due?", at which I took offence (Figure 2). There were two lessons to be learnt here. The first was the oddness of this apparent suspension of normal social rules of etiquette; and the equal oddness of my offence at rudeness directed at a graphic representation. These oddities relate to the ontological status of the avatar, and the extent to which such events are seen as protected by the rules of drama, game or play. If the 'psychosocial moratorium' often claimed for game and play-spaces, or the role protection claimed for process drama, really applied for me, I would not have taken offence. So this is either the misconstrual of a virtual world encounter by a newbie, or these rules and circles are more leaky than is sometimes supposed. Looking back ten years later, I think it's a little of both. The implication is, of course, that some kind of mentoring is required in virtual worlds (we cannot simply assume that everyone intuitively understands what's happening); and that the boundary between RL embodied identity and Virtual World projected identity is insecure: we should routinely expect leaks, and unexpected consequences; and we should take specific steps to specify the rules of a situation to our (specified) community if we want to minimise this.

Figure 2. My avatar, *Nirvano*, and Diane Carr's avatar *Grayse*, meet a challenging stranger in Anarchy Online

Teaching and learning in *Second Life*

A second project some years later looked at teaching and learning in *Second Life* (Learning from Online Worlds: Teaching in *Second Life*, funded by the Eduserv Foundation). Part of the project involved conducting a series of seminars with MA students on two programmes at the London Knowledge Lab: MA Media, Culture and Communication, and MA ICT in Education. In the first programme, students following a module in computer games opted into three seminars: a getting-to-know-you seminar; a seminar with a visiting animator; and a seminar with a visiting lecturer from the University of Cape Town. Six students participated. In the case of the second programme, all students following the relevant module attended a series of seminars in *Second Life*.

What did we find?

Firstly, that embodiment as an avatar could change students' learning behaviour, or classroom identity. The most dramatic example of this was a student who was normally quiet, studious and deferential to authority. He appeared at the first seminar held in *Second Life* (an introductory session for students to get used to SL) in a surprising guise. We thought he had not appeared until we noticed knives flying past us, and looked up to see him sitting on top of a large lampshade (Figure 3). He was wearing a Mexican 'Day of the Dead' skull, and had adopted the name Cheapo Umaga. In a second seminar, which was set up by Marion Walton, an academic at the University of Cape Town, he appeared again in this guise, and we noted a propensity for asking challenging questions, in this case about the actions of a guild in *World of Warcraft*, the topic of the seminar.

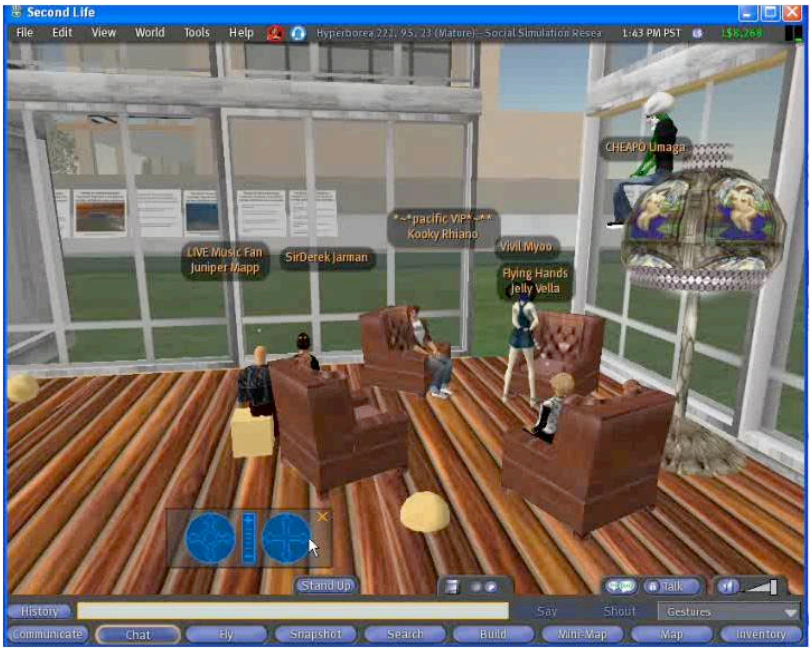

Figure 3. Our first MA visit to Second Life

What enabled him, then, to move from his customary quiet, deferential mode of learning to this challenging class clown? One possible explanation was that he was an experienced player of *Counterstrike*. It transpired that Cheapo was his nickname from *Counterstrike* days, gained when he fired on his own allies (a cheap shot). The elements of *Second Life* which evoke the environment of a game, then, seemed to have given him permission, as it were, to enact a playful, even aggressive, in-world identity, even though he knew the situation was an educational one. The confusion of semiotic domains – in effect, the confusion of the seminar room and the game-world – gave him licence to behave quite differently.

Another possible explanation was that playing the role of Cheapo had the kind of ontological transience that I have suggested above. Although the situation was not make-believe, there was enough 'as-if' about it to permit a kind of irresponsibility in the performance of this role, the freedom from real-life consequences that drama theorists call 'role protection', and game theorists call the 'psychosocial moratorium'. Playing his real life student role under his actual name implied consequences, long-term commitment, ontological substance and durability. In this case, the escape from these provided more room to learn, to question, to challenge, to refuse conventional hierarchies.

A second finding of this project was that, as might be expected, students had mixed feelings about the quality of the *Second Life* experience. One obvious but important point to make here is that their perception of the virtual world depended at least partly on what they were comparing it with. In this case, there were two points of comparison. On the one hand, it was being measured against face-to-face seminars, the typical experience of fulltime students on this MA programme. On the other hand, it was being compared with the VLE through which part-time students accessed the course (in this case, Blackboard). The following extracts from interview transcripts represent the polarised views of two students from the MA Media Culture and Communication, the first full-time, the second part-time:

> REAL LIFE GIRL …
>
> *The interface is easier I think, in the VLE. I'm not a big fan of them either. It's fine for uploading and to write something and get feedback, that's alright, but if somebody needs to work, for me it's hard. I even have problems doing that over Skype – I find it really hard and sometimes people don't understand either and they need a bit more time to see what people mean. I find it very complicated.*
>
> … AND VIRTUAL WORLD BOY …
>
> *though i am still quite amazed - even now - that we are 3,000 miles away and sitting next to one another on a bench having a conversation. …i think it is great particulalrly with me being so far away. i would have liked to have done more Second Life classes. helps me to feel engaged …the fact that you can fill a classroom with students and lecturers who are in avrious far flung corners of the world is huge …and being in Second Life you feel more a part of the proceedings than you would in an actual classroom … Better than the VLE this is like being there … the VLE is like sticking an essay on a wall and then waiting for a response.*

The first student clearly has no time for the virtual world, and sees no advantage of it over the VLE; and both of them seem to her inferior to the face-to-face experience. She made the point elsewhere that *Second Life* (and by extension any virtual world where text-based chat is the norm) just felt like a lot of writing. This is an interesting example of how the multimodal nature of virtual worlds can be apprehended differently by different people. What for one is a natural-feeling form of conversation, taking its place in proportion within the 3-D representation of environment and social action, for another can completely dominate the multimodal mix, feeling like a burdensome obligation to read and write, made more oppressive by the real time synchronous exchange which for others provides dramatic presence, a sense of social contact, and immediacy of feedback.

The students on the MA ICT in Education programme were generally enthusiastic, but some also had reservations. This selection of comments from reports made on the experience gives a sense of some of their reactions:

> *In all honesty, I felt I learnt more from the single 'lecture' in Second Life than I have done through the weekly discussions on Blackboard. That's not to say Blackboard is of little use or Second Life is a revelation in terms of teaching and learning: the fact it was face-to-face and as close to a real lecture as we have had on this module made a great deal of difference.*
>
> (G's report)
>
> *When I got there were a few people already there so I spent a bit of time talking to them. It was good to bump into other people who were in the same boat as me. […] It was good to see avatars helping each other to learn new tricks by giving each other instructions using the chat facility and also showing each other how to actually do something.*
>
> (Student report, I.)

> *The Second Life was a good experience but at times I found it to be very confusing when everyone started to say things at the same time. It was also difficult to know who you are talking to as many people gave their avatar a different name to their own.*
>
> (If's module debrief)

The following year, the experiment was repeated with the MA Media group, and included a session in *Second Life* in which the nature of *Second Life* as a learning environment was the explicit topic of discussion. This was a revealing and wide-ranging conversation, raising a number of new points. For example, one student raised the idea that the text-based chat produced orderly dialogue, since the texts were automatically ordered, and identified by the name of the avatar. There was, then, no possibility for people to talk over each other or interrupt; or for anyone to be confused about who said what. However, such an optimistic view contrasts with the perception of the last student represented above, who felt everyone was speaking at once (even though this is literally impossible with text-based chat). Other points were made for and against chat: positively, that it favoured certain kinds of disability, such as deafness, since it displaced the physical process of hearing in its provision for conversation; and negatively, that it erased some of the social and cultural markers of spoken voice, such as regional accent.

Another point raised by students related to the social space we used in *Second Life*. We chose to use ordinary social spaces (in this case, Education UK Island) rather than virtual seminar rooms. At least one of our students felt this was a more authentic social space than the bare seminar rooms where we would normally meet in RL. Here, then, is a tension: different judgments about perceived realities. For some students, seminar rooms may seem arid, artificial, cut off from the world outside, while the spectacular social spaces of virtual worlds, peopled with exotic avatars, dressed in bizarre furnishings and lit by picture-postcard weather may seem much more 'real', both socially and in terms of a visual modality. For others, the reverse may be true: the seminar room may be an authentic representation of academic seriousness, what they came on the course to find, a familiar, appropriate home for the academic genres of lecture, seminar discussion, research presentation they expect to find. By contrast, the spaces of *Second Life* may seem distracting, trivial, irrelevant to academic endeavour. In social semiotic terms, modality, or a claim to truth, credibility and authenticity, cannot be established by a text or authorial intention alone – it is a process of negotiation with readers, audiences, users. The same seems to hold for virtual worlds, seminar rooms and VLEs. In any case, if our choice of space in a virtual world is to use social spaces (rather than virtual academies and lecture theatres), then those spaces and their inhabitants will always be ambiguous (see Carr et al., 2010). Are the events going on there educational, playful, gatherings of hobbyists? Are they school trips, or time out, or extra-curricular? Are they ethnographies of online life, seminars, explorations of new media? The function is determined by the use, of course; but inflected by the cultural setting, and the loosening of the conventional topographic and other markers of academic life. However, we also found that ambiguity was reduced by clarity of planning, of session content and of structure, and by students' familiarity with each other, each others' avatars, and the location.

Finally, one student raised the question of the role of the teacher. He characterised it as a kind of orchestration in *Second Life*, observing the shift from the traditional 'stand-and-deliver' mode to a more conversational one, and from formal hierarchies to more vertical, informal structures. This kind of shift was also observed in the previous year by a tutor on the ICT in Education programme, who argued that *Second Life* provides a social space for students to meet in ways which go beyond the boundaries of the seminar or the course sessions:

> TUTOR: *It's the synchronicity [of Second Life], but also the kind of interactions. I was quite 'jokey' with the students in SL. It changes your relation with them. I'm not entirely convinced by Blackboard. There's meant to be space for students to socialise but this isn't really used. People post, and a handful post a lot and engage in dialogue. When I was teaching the MA module last year, I got the impression that part of the reason students stayed the course was because they met other people. It seems to me that people do the course not because it will advance their career necessarily, but because they are at a stage where they need some intellectual stimulation. Part of the pleasure / meaning of the course is meeting others and sharing interests, sharing life dramas, and so on. But what is missing from blackboard, I think, is the sense of a class as a social entity.*

Virtual doctorates: supervising in *Second Life*

For a year now, I have been supervising a PhD student in *Second Life*. It is an appropriate environment for him in many ways: his research project concerns boys' computer game-play and culture; he followed the MA game module and *Second Life* seminars (although he is not a user of *Second Life* himself); and he works at some distance from London. In respect of this last consideration *Second Life* is functioning here, just as for some aspects of the MA module, as a 3-D, avatar-based VLE. In this respect, the comparisons to be made are with other forms of communication we use: phone, Skype video, or Moodle. The advantages seem to be, for this student, threefold. Firstly, it's synchronous, like Skype, but unlike the conventional VLEs. Secondly, it offers a sense of embodied presence which makes the conversation somehow more replete, more of an encounter, embellished with bodies, costumes, furniture, different locations (we have met at four different locations) (Figure 4). Thirdly, the text-based chat offers certain advantages. This last point is worth further consideration. It has practical implications: we can both save the chat-log, and have a verbatim transcript of the supervision session for future reference. It has certain affordances for the conversation. It is slower than speech in two respects: the typing is slower than speech; but also the conventions of this kind of exchange are more tolerant of pauses than spoken exchanges. There is, then, more room for reflection, digestion of the last point or question.

Finally, an interesting outcome, if only anecdotal, is that it seems easier to spend longer in *Second Life*. Telephone or Skype supervisions in my experience tend to last between 30 minutes and an hour. These *Second Life* sessions are lasting from an hour to 90 minutes, suggesting that the kind of immersion commonly attributed to online worlds and games may also be a feature of these sessions. This contrasts with the experience of the tutors in the *Second Life* MA sessions we documented, who found the experience intensive, even draining. What made those sessions difficult was the effort of group management, quite different from managing a group in a seminar room (Carr, et al., 2010). Immersion alone, however, may be an inadequate concept to describe the supervision sessions. Carr (in Carr, et al., 2006), in an essay on the RPG *Baldur's Gate*, distinguishes between *immersion* - a perceptual and imaginative investment in the game producing a pleasurable, trance-like absorption – and *engagement*, involving grappling with more challenging ideas and changing schemas. These supervisions would be best characterised by a combination, then, of immersion and engagement, with an emphasis on the latter, requiring attention to the content of the research discussion, the needs of the student, the coverage of the agenda, the planning for future work and sessions.

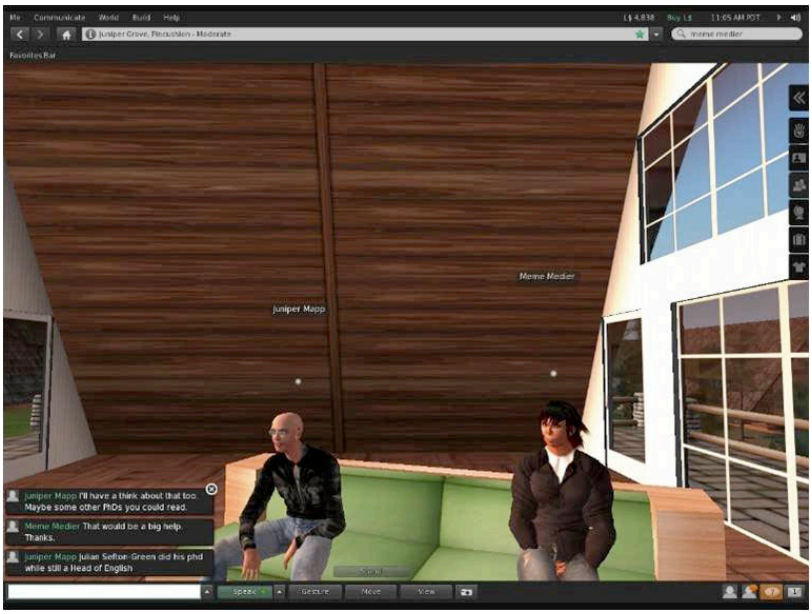

Figure 4. Doctoral supervision in *Second Life*

What seems much less of an issue is the question of role-play here. It is difficult to tell how our roles as teacher and learner are affected by avatar mediation or by the environment. Certainly something is different: meeting him in particular spaces, for example, even when these are my house in SL, makes a difference of a kind hard to specify. But there is nothing spectacular about the role-play; indeed, this feels much more like the kind of routinization of role proposed by Goffman (1959).

Conclusion: Shuttling Between Worlds

Our experience of teaching in *Second Life* allowed for instantaneous shuttling between worlds: we took our students on an instant 'trip' to an animation studio, for example, where they could hear a commercial animator operating in *Second Life* describe her company and its work. But more importantly, it seems clear that the real shuttling happening here is between the online and offline worlds. Some of the questions that seem to be necessary are:

- How does the avatar-based role play of teacher and student relate to their offline performance of these roles?
- How do the spaces in online learning relate to and differ from the conventional seminar rooms we use?
- How do the communicative practices of virtual worlds relate to those of 'meat space' and conventional VLEs such as Blackboard and Moodle? And to the spatial continuities and discontinuities of student attendance, both face-to-face and at a distance?
- How do the temporal structures of virtual worlds complement, or replicate, or disrupt those of other learning settings and situations?
- What does the multimodal ensemble of virtual worlds provide that the more impoverished modalities of conventional VLEs don't?
- How does a virtual world like *Second Life* contribute to the longer perspectives and trajectories of learning – the planning, assignment writing, development of student roles, identities and social lives, the construction of knowledge, the legitimation of learning?

My experience of virtual worlds as learning environments has been generally positive. But it has also on occasion been disorganised, chaotic and frustrating. The worlds themselves seem to offer valuable possibilities: new ways to provide synchronous exchanges, to overcome discontinuities of time and space, to explore and extend the dramatic performance of teacher and learner roles, to construct varied social spaces to complement the inevitably constrained environments of university buildings. However, the key to productive learning and teaching in many ways seems to be an old story. The critical factors are effective planning and pedagogy; active learning; time for reflection; and pitching of new challenges in the way both good game designers and Vygotsky (1962) suggest – to be both accessible and challenging.

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Learning Science via a science-in-the-making process: The design of a game-based learning curriculum

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Abstract. We present the design of the *Legends of Alkhimia* game and game-based learning curriculum as a model of 21st century science education. The 21st century knowledge economy demands knowledge producers and innovators. However, current public educational systems are generally designed for content mastery instead of knowledge production. Science is often learned as a product, failing to incorporate the process that makes science and helps students think scientifically. In this paper, we present the theoretical constructs underlying the design of the *Legends of Alkhimia* game and learning program. We frame science learning as a science-in-the-making process similar to that of the ancient Alchemists. We also depict the products of our design: a 6-level computer game and an 8-session role-playing curriculum.

Key words: Scientific inquiry, role-playing, design research, chemistry game, game-based learning

Introduction

Learning in the 21st Century

It remains a fact that learning science in school is often framed as mastering a body of expert-generated factual information, though alternative approaches of science learning have been advocated decades ago (e.g., Driver et al., 1994). This belief about science learning is manifested in how instructional materials are designed and used in the mainstream educational settings. The use of textbooks is an important barometer that unfolds how teaching and learning sciences is conceptualized by the mainstream educational system. Most textbooks are "designed" as well-structured packages of expert-generated contents. For the efficiency of content delivery, they are written in a "prescribed and encyclopedic style of presentation" (Bierman et al., 2006). In other words, science is repackaged as an anthology of important scientific findings reported with texts, diagrams, and tables in textbooks. What, then, have students learned of/about science when they learn science with science textbooks? It is common that students describe science as an unbiased body of knowledge discovered only by great scientists (Kelley & Crawford, 1997). Students are positioned as followers of science authorities while the major responsibility of teachers is to facilitate content mastery. Students' experience of science in schools seldom goes beyond comprehending and memorizing expert-generated factual information.

The content mastery model of science learning was an effective and sufficient educational

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model when being able to read and write is a social and economic advantage. Mastering scientific facts was seen as a higher-level skill that would bring job security and economic success. However, as the world economy shifts to knowledge economy (Drucker, 1993; Friedman, 2005), knowledge production and innovation become the new motto for social and economic success. Being able to read, write, and apply scientific facts for work - traditionally defined literacy skills - is no longer sufficient. The upheaval in social and economic life in the information age pushes back onto the public educational systems, challenging policy makers, researchers, administrators and educators to redefine success and education in the new, ever-changing global village.

How might we, then, reform science education that address the 21st century knowledge demand? In this paper, we propose a model of science learning suitable for the 21st century global economy. To this end, we examine (1) the nature of innovation and knowledge production in science, (2) instructional tools that may be designed to facilitate knowledge production and innovation, and (3) curricular activities built around our discussion of 21st century science learning and tool-mediate learning environment. As a closure to our argument about design, we articulate the role and functions of design in educational reform and situate this design in the ecology of education.

Theoretical Framework/Design Framework

Rethinking science education for the 21st century

What is the nature of scientific study? While ethnographic studies of school science identify that most students believe that scientific knowledge is "discovered" by great scientists such as Newton and Einstein, science researchers (e.g., Driver et al., 1994; Taylor, 1996; Sandoval & Millwood, 2005) argue that scientific knowledge is "constructed." In the process of knowledge construction, scientific theories are validated via explanation, dispute and arguments among the science communities before they are legitimized as scientific facts. Sandoval and Millwood (2005) succinctly synthesize the nature of scientific study. They argue that there is no inherent value of truth in scientific theories. Scientific knowledge is a human construction. Since scientific knowledge is constructed, the validity of science lies in the degree of persuasion.

The mainstream science curricula are mainly built upon the assumption that scientific knowledge is discovered and can be transmitted to students via didactic instruction and content delivery. Viewing scientific knowledge as constructed knowledge not only suggests a different view about science, but also points to a potentially productive path to revamp science education for the 21st century knowledge demand. The approaches and methods scientists are trained to construct scientific knowledge show them to be knowledge producers and innovators. Since scientists develop their skills, knowledge, identity, values and epistemology (Shaffer, 2006) through scientific inquiries, teaching students to inquire science may be a productive way to enculturate students as intelligent novices (Brown et al., 1993) who learn to be knowledge producers and innovators.

Scientific inquiry as a 21st century knowledge production skill

In constructing scientific knowledge, scientists develop specific cognitive tools as well as physical instruments to facilitate knowledge construction process. In terms of the cognitive tools, inquiry skill is essential and shared by scientists. Facing problematic situations,

scientists take actions to "convert the elements of the original situation into a unified whole" (Dewey, 1938 p. 108). The actions taken by scientists to solve problems share common characteristics—asking questions regarding unsettled situations, proposing hypotheses based on existed knowledge, conducting investigation, collecting and interpreting data, and developing theories about the questions they raised. Though there are different ways to characterize this knowledge construction process, it is typically identified as scientific inquiry (Chinn & Malhorta, 2002; White & Frederiksen, 1998). As a central tool for constructing scientific knowledge, scientific inquiry is not only a tool that scientists utilize to construct scientific theories, but also a tool that may help young people to become a knowledge producer demanded by the 21st century economy.

Challenges of fostering scientific inquiry in the classroom

Though educational researchers (e.g., Driver et al 1994, White & Frederiksen, 1998; Kuhn, 2005) commonly agree that learning scientific inquiry is essential for science education, conducting scientific inquiry in the classroom is challenging, especially in terms of keeping scientific inquiry authentic. Authentic scientific inquiry, defined as inquiry carried out by practicing scientists (Schwartz & Crawford, 2007), emerges in the communities of practicing scientists in which domain-specific skills, knowledge, identity, values and epistemology all contribute to its authenticity (Shaffer, 2006). Therefore, the authenticity relies on a community of science practitioners to take place.

To implement authentic scientific inquiry, schools face various challenges. Public educations are generally not conceptualized to foster science practices. Therefore they may not sustain such a heterogeneous infrastructure and culture that science practitioners experience in their everyday work experience. Teachers, the ones in charge of steering classroom practices, are usually not trained as scientists. Seldom do they have experience working with science practitioners. When some teachers do have the experience to foster authentic science practices in the classroom, they may find science textbooks not fully compatible with their experience working as science practitioners. Textbooks guide its practitioners to trust whatever printed in black and white while scientific journals invite critique and re-evaluation from their viewers. Therefore, Chinn and Malhorta (2002) maintain that most scientific inquiry tasks in schools are simple inquiry tasks, inquires adapted to fit in school's science curricula.

Since it is impractical to implement authentic scientific inquiry within current educational setting, simplified inquiry tasks offer a feasible solution in helping students learn inquiry. The simplified inquiries are often designed to capture core components of scientific inquiry, such as experiments, observations and illustrations. However, it is questionable if the simplified version of inquiry really helps student capture the essence of inquiry. Chinn and Malhorta (2002) argue that most simple inquiry tasks are called into question with two major drawbacks.

The first setback originates from failing to engage students in asking inquiry questions, a hallmark for inquiries. To engage a student in an inquiry, it requires the student herself to perceive a situation as unsettled or disturbed to initiate an inquiry process (Dewey, 1938; Postman & Weingartner, 1969). It is the inquiry question that motivates a person, making her an inquirer. A situation that is viewed as problematic for a chemist, such as the increase of carbon dioxide on earth, may not be viewed as problematic for a teenager student whose goals for learning about green house effect is to get good grades in chemistry tests. For the

chemist, his inquiry question may lead him into tracing Carbone dioxide footprint inside the ice at the North Pole. He may have some ideas, or even hypotheses, about what the increase of carbon dioxide might lead to. And these ideas or hypotheses are just the very beginning of an inquiry process. For most simple inquiry tasks conducted in schools, teachers often post the inquiry questions. And the answers can be Googled, if not found directly from their textbooks. Students then will conduct experiments and collect data to prove the theories they should have developed themselves. To engage students in a simplified, and yet authentic inquiry, the design of inquiry must somehow situate students in problematic situations that motivate them to be inquirers, those who ask questions and are motivated to answer them.

Another major setback for many simplified inquiries is the failure to engage students as evaluators, which is also a hallmark for practicing scientists. Once an inquiry question is raised, a practicing scientist is in constant interrogation of existing theories, data, research questions and interpretations of data. The inquiry, with or without answers already defined by others, is an open-ended challenge that demands constant evaluation in the entire inquiry process. In other words, the underlying epistemology of an inquirer is an evaluative epistemology (Kuhn et al., 2000; Chinn & Malhorta, 2002). An evaluative epistemology is deeply rooted in the belief that human knowledge is value-laden, socio-culturally relevant and constructed. Simplified inquiries not only did not facilitate evaluative epistemology; it actually facilitates false epistemology (Chinn & Malhorta, 2002). Therefore, how simplified inquiries can be designed to facilitate evaluative epistemology is a major concern for implementing inquiry tasks in schools.

Designing scientific inquiry with computer games

In the past decade video games have been proposed as a medium with rich potential to realize situated learning (Gee, 2003; Squire, 2006). Game researchers (e.g., Prensky, 2001; Gee 2003; Squire, 2006) maintain that computer and video games provide great examples of how learning experience may be designed using game designs principles. Squire (2006) points out that good video games design players' experience by situating players in contexts where learning is more contextualized and embodied than many traditional learning media. These arguments suggest that video games afford design of learning experiences coherent to the situated perspective of learning (Brown et al., 1989; Gee, 2004) and may have the potential to foster scientific inquiries that engage students in asking genuine inquiry questions as well as in fostering evaluative epistemology.

In *Mad City Mystery*, a handheld role-playing game designed to foster argument skills, Squire and Jan (2007) maintain that two major game design features, role-playing and open-ended challenges, engage players in collaborating dialogically in order to develop evidence-based arguments, a critical skill that practicing scientists employ in conducting scientific inquiry. In the *Saving Lake Wingra* game-based learning curriculum, Jan (2009) utilizes role-playing, non-player characters, and game challenges to facilitate question-asking and evaluative epistemology in middle schools. In our design, we leverage role-playing in the design of a 6-level computer game and an eight 2-hour sessions curriculum to compensate the two major disadvantages in employing simplified scientific inquiry in schools.

Design of the *Legends of Alkhimia* Learning Program

In the first part of the paper, we articulate how we may reform school science curricula to help young people innovate and produce knowledge via conducting scientific inquiries. Drawing from research literature, we also highlight two major challenges in helping students learn scientific inquiry in schools via simplified inquiries. Game-based learning approaches afford unique opportunities to engage learning styles that differ from the content mastery paradigm of learning.

In the following discussion, we present the design of the *Legends of Alkhimia* game and curriculum. The *Legends of Alkhimia* curriculum is an eight-session chemistry curriculum designed to engage students in scientific inquiry. The *Legends of Alkhimia* game replaces chemistry textbook as the major learning material in the classroom. Drawing on the theoretical discussions, we orient and align our design based on the following design guidelines:

1. Situating science learning in science-in-the-making
2. Situating science learning in scientific inquiry
3. Situating learners in problematic situations
4. Fostering evaluative epistemology in the process of learning

Situating science learning in science-in-the-making

Since the goal of our curricular design is to situate students in a science-in-the-making process, it requires a major revamp in the design and use of educational media and activities, which are designed to teach ready-made scientific conclusions. Our effort in transforming the ready-made-science curricula into a science-in-the-making curriculum is inspired by the inquiry process of ancient alchemists. Many of them posted an open-ended inquiry question—how base metals might be turned into gold—and it initiated inquiry processes still inspiring to science practitioners today. To investigate how base metals may turn into gold, alchemists proposed hypotheses, designed and conducted experiments to test their hypotheses, interpret their data and constructed knowledge regarding the properties of substances and the relationship between different substances. Though the major assumptions underlying the Alchemy concept are misleading based on today's perspective, Alchemy is a science-in-the-making process that became a precursor of modern chemistry.

Alchemy provides a model through which a simplified, and yet epistemologically authentic science-in-the-making process may be replicated in the classroom. To replicate the science-in-the-making process, we leverage the affordances of 3D role-playing computer games to engage students in similar challenges and inquiry processes. We design The *Legends of Alkhimia* game and curriculum to structure students' scientific inquiry experience. The following delineates how we design science-in-the-making in the classroom with The *Legends of Alkhimia* game and curriculum.

Designed for secondary (middle school) science education in Singapore, the *Legends of Alkhimia* curriculum is an eight-session chemistry curriculum (See Table 1) composed of the following activities: briefing, gaming, small group discussion, whole class discussion and debriefing. The *Legends of Alkhimia* game is the cornerstone based on which all curricular activities are structured. The game consists of six levels of game challenges and inquiry cycles. Each level will be played in a session for about thirty minutes. Typically, students will discuss their prior knowledge and experience at the beginning of a session, followed by playing a level of the *Legends of Alkhimia* game as a team of four players, and then

collaborate to interpret their findings in the game in order to propose and evaluate their theories about the nature and relationship of substances that emerge in the game world.

Table 1. The *Legends of Alkhimia* game-based learning curriculum

Session (Time)	Topic/ Learning Outcome/ Activity	Game Play
0 (120 min)	• Intro to project and admin matters • Pre-Survey • Overview of learning scenario and final project • Prepare personal profile (e.g. in the form of curriculum vitae, draw how they see themselves as a chemist) and group profile to be uploaded on wiki:	NA
1 (120min)	*In-session:* • Scientific inquiry *Out-of-session online discussion/ research:* • Classes of substances (elements, mixtures, compounds, metals and non-metals) • Classes of behaviours of substances (chemical reactions and non-chemical changes) • Separation of mixture (solid-liquid)	*Level 1* • Separate solid-liquid mixtures • Destroy metal monsters
2 (120min)	*In-session:* • Scientific inquiry *Out-of-session online discussion/ research:* • Classes of substances (solute, solvent and solution) • Common reactions of metals • Factors of rate of reaction (particle size, concentration)	*Level 2* • Separate mixtures (solid-liquid, solutions) • Destroy acid monsters
3 (120min)	*In-session:* • Scientific inquiry *Out-of-session online discussion/ research:* • Common reactions of acids • Limiting and excess reagents • Properties of gases (hydrogen and carbon dioxide)	*Level 3* • Neutralize samples of acids and bases in the lab • Neutralize contaminated cabbages in the farm
4 (120min)	*In-session:* • Scientific inquiry *Out-of-session online discussion/ research:* • Classes of metals (according to reactivity) • Factors of rate of reactions (reactivity of metal, temperature)	*Level 4* • Test effect of temperature on rate of reactions in lab • Destroy acid monsters in both cold (mountain-top) and hot (underground) conditions
5 (60min)	• Re-visit self and group profile • Re-visit and getting started on final assignment	

6 (120min)	*In-session:* • Scientific inquiry *Out-of-session online discussion/ research:* • Mixtures of liquids (solutions, miscible, immiscible liquids) • Separation of substances based on different densities	*Level 5* • Separate solutions, miscible and immiscible liquids • Use liquids to destroy door made of metal of very low reactivity
7 (120min)	*In-session:* • Inquiry into self and identity *Out-of-session online discussion/ research:* • Consolidation of previous sessions' discussion topics	*Level 6* • Synthesize notes taken of substances and reactions from previous levels • Select best metals for ammunition and armour • Decorate armour • Destroy super monster
8 (120min)	• Group presentation of final project task (a proposal) • Evaluation of proposals • Update CV and group profile • Post-survey	NA

The Legends of Alkhimia game

In the game, students role-play as apprentices of a master chemist to tackle six levels of game challenges (see Table 2). Typically, a player will tackle a challenge in cycles of three steps. First, a player encounters a problematic situation that can be overcome only by conducting appropriate experiments. He must identify the sources of the problems and hypothesize how the issues may be solved through experiments. Second, the player conducts virtual experiments in the in-game virtual lab in order to produce substances that may solve the problems. Third, the player uses the lab-generated substances to test how they work. The last step is where players test their hypotheses. These three steps are designed to be an in-game inquiry cycle—raising questions, proposing hypotheses, conducting studies, testing their hypotheses and developing theories. In the game, players are designed to fail in their initial trial. They then gain critical information and experience out of the failure. A successful player must learn from his failure in game and modify his hypotheses accordingly in order to tackle the game challenges.

Table 2. Six levels of game challenges in the *Legends of Alkhimia* game

Level	In-Game Challenges		Related ideas/concepts in the design
1	Lab	Separate mixtures (solid-liquid, solutions)	• Strong and weak acids dissociate in water to different extents • Separation of substances can be based on size of particles and boiling points • Kinetic Theory
	Field	Destroy metallic monsters	
2	Lab	Separate mixtures (solid-liquid, solutions)	• Depending on the substances to be recovered and the properties of the substances, different separating techniques are used • Collision theory
	Field	Destroy acid monsters	
3	Lab	Neutralize samples of acids and bases in the lab	• Metals can be classified according to their reactivity • Reactivity of metals affect the rate of reaction of metals with acids • Properties of material affect uses of the material: Insoluble bases are used instead of soluble bases to neutralize acids.
	Field	Neutralize contaminated cabbages in the farm	
4	Lab	Test effect of temperature on rate of reactions in lab	• Substances may or may not react with other substances depending on whether heat is applied • Properties of material affect uses of the material: Carbon dioxide is used in fire extinguishers; hydrogen is used in airships and as rocket fuel
	Field	Destroy acid monsters in both cold (mountain-top) and hot (underground) conditions	
5	Lab	Separate solutions, miscible and immiscible liquids	• Depending on the substances to be recovered and the properties of the substances, different separating techniques are used • Big ideas/ concepts as level 1 and 2
	Field	Use liquids to destroy door made of metal of very low reactivity	
6	Lab	Synthesize notes taken of substances and reactions from previous levels	• Big ideas/ concepts as level 1-6
	Field	Select best metals for ammunition and armour Destroy super monster	

For example, in level one of the *Legends of Alkhimia* game, the players were attacked by three moderately reactive metallic monsters, which can be destroyed using acid in the battlefield. Facing this problematic situation, players have a gun and two cartridges, A and B, which could be used as weapons against the metallic monsters. Cartridge A, a mixture of sand and strong acid (which is unknown to the players), is more effective against the monster, but is also a rare substance and in a smaller amount. Cartridge B, composed of sand and weak acid, is less effective against the monsters but in a greater amount. The players may use both cartridges to defeat the monsters, but their weapons will jam initially because of the sand in the cartridges. Defeated by the monsters, players manage to retreat to

the virtual lab where several lab functional units and apparatus are available for conducting certain experiments. If a player hypothesizes that their cartridges were jammed because of impurity in the cartridges, he may conduct experiments that may enhance the purity of the cartridges, such as using coarse and fine filters, separating funnels, or the combination of a few lab functional units, to purify the cartridges. The player can then bring the produced cartridges back to the battlefield to see if his hypothesis and experiments work as predicted.

A key design decision across all levels is that the substances being used to create the monsters and cartridges are concealed to the players. It situates players in a world similar to that of the ancient alchemists. Like ancient alchemists, players may not know what these substances are and are unclear about their relationship with other substances, such as the substances in their weapons. They must construct knowledge about these substances by collecting and identifying suitable data from multiple resources. For example, they may examine the procedure through which a specific substance was produced using specific lab equipments and its effectiveness against the monsters to interpret and construct knowledge about the substances in game. The design of this scientific-knowledge-in-the-making process is coherent with John Dewey's (1993) argument about scientific induction:

Scientific induction means, in short, all the processes by which the observing and amassing of data are regulated with a view to facilitating the formation of explanatory conceptions and theories (pp. 86)

The *Legends of Alkhimia* Curriculum

While the *Legends of Alkhimia* game is designed as the backbone of this learning program, the game does not provide a complete package for scientific inquiry for a few reasons. First of all, the inquiry in the game is more of an individual quest than of a collaborative effort critical to the knowledge production in professional scientific communities. It is essential to extend their inquiry experience in the game into activities that support reflection and evaluation of their performance in game. This brings the second issue, which is also critical in shaping players' inquiry experience. Though the *Legends of Alkhimia* game aims at designing players' experience as science-in-the-making through scientific inquiry, not all players will play in the ways intended by the game designers—as a scientific inquiry experience. This is an issue common to the design of instructional media whether the chosen medium is a traditional textbook or a new digital medium. A textbook can be read and interpreted differently by readers who bring in different experiences, desire, and prior knowledge into their reading of the textbook, thus generating different meanings to the readers. Activities after game play are mainly designed to facilitate players' interpretation of the game toward scientific inquiry. The out-of-game activities are designed to support individual, group and whole class reflection and evaluation on scientific inquiry. The following describes a typical activity structure shared by six of the eight sessions of the entire learning program:

Pre-game prior knowledge sharing

Each student brings in unique experience and knowledge into the designed chemistry inquiry. Before playing each level of the *Legends of Alkhimia* game, students will share their experience of previous experience and playing session. This may not only help students reconnect to prior knowledge, but also keep the chemistry theories they are developing in check. In addition, students will also bringing to the fore their selves as agents in a shared learning experience. Through the pre-game activities, students will collectively establish a

social presence and social context based on prior experience to be over-layed or connected with the present to situate learning activities in the current session.

After-game group reflection and whole class discussion

Following game-play, students will organize themselves in their game-play groups. They will share their own in-game scientific inquiry notebook with the group members and select what and why they think is the best one to release to the class. We see that in the process, the students will have to collaboratively negotiate what counts as good scientific inquiry and bring these criteria into evaluating and selecting the best set of in-game notes. Students will also negotiate how the substances are classified and what names to be given to them like ancient Alchemists.

A whole-class discussion and reflection is designed to present, challenge or consolidate theories proposed by each small group. The whole class activity will take two forms. First, each group will take turns to report on their in-game inquiry as well as classification and naming of substances. Thereafter, the teacher will facilitate the whole-class discussion to reflect on the students' scientific inquiry. The discourse will revolve around two big questions: What are the properties of the substances? What evidences can be used to argue for or against the proposed theories of the substances? The themes of the questions are aligned to the main learning goals, and the questions are recurrent and revisited through the program. As closure to the session, students will vote, as a class, the best names for the substances and the best inquiry. The teacher will also recap the knowledge constructed by the class.

Role-playing in the Legends of Alkhimia Curriculum

In science classrooms that highlight content delivery, teachers often act as content authorities. They deliver contents and explain key ideas to students who are often considered passive receivers. As content authorities, teachers evaluate and judge if students have contributed to the intended answers when there are discussions. The underlying assumption about learning and role-playing often creates an initiate-response-evaluate (IRE) discourse structure that inhibits students from expressing their own voices and judgments (Cadzen, 2001). In many cases, it eventually mystifies the nature of scientific knowledge and affects students' confidence to perform like scientists (Lemke, 1990). We aim to change this widely accepted notion about role-playing in the classroom through design. In the *Legends of Alkhimia* curriculum, the teacher recedes from being a content authority to be a process director in order to help students to take a more central stage in learning. Role-playing as science apprentices, students are seen by the teacher as leading actors and actresses in the *Legends of Alkhimia* role-playing curriculum.

As a process director, the teacher envisions the inquiry process her students needs. The students are the leading actors and actresses who take the central stage in performing inquiry. The teacher director guides them, but he or she does not perform for them. For example, the teacher-facilitated discussion during the group reflection and whole class discussion are designed and facilitated by the teacher, but it is the students who are making arguments and interpretations about properties of different in-game substances. The teacher interprets (and invites other students to interpret) students' performance (e.g. classification and naming of substances) and speech acts in order to understand what guidance might be needed. He or she will also mediate students' discussions as a more or less equal voice. At

times, the teacher questions students as a curious co-participant. At times, he or she assumes more control in order to carry the discussions in depth. A useful strategy is to "re-voice" (O'Connor & Michaels, 1996) students to frame discourse towards learning goals and position students as members of a community of practice.

There are two major goals for designing the teacher-facilitated discussions. On the one hand, guided by the more experienced teacher, students will construct evidence-based knowledge with respect to the two over-arching questions and learn to see themselves as sources of scientific knowledge. On the other hand, through participating in teacher modelled scientific discourse in the earlier sessions, students will be acculturated into initiating and engaging in scientific discourse on their own. Therefore, in the latter sessions, the teacher will distribute more control over the class discourse to the students and allow more time for student initiated discourse. In other words, the teacher director fades into the background accordingly when student actors are capable of talking and performing inquiry on their own (Vygotsky, 1978).

Conclusion: Designing for 21st Century Science Education

In this paper, we initiate our argument by maintaining that literacy is dynamic, contingent upon the status of the world. The literacy skills defined by the industrial society are no longer sufficient in a globalized knowledge economy. One of the essential new literacy skills for the emerging new global society is the ability to produce knowledge and innovate. In science education, learning to inquire scientifically is a skill that may helps one to be a knowledge producer.

Though the world that we live today has advanced technologically and economically, schools lag behind in social transformation (Tyack & Cuban, 1995). Transforming science learning from the current content mastery paradigm to incorporate inquiry-oriented learning model has been proposed and conducted by many science education researchers (e.g., White & Frederiksen, 1998; Chinn & Malhorta, 2002). Since authentic scientific inquiries are hard to reproduce in schools, scientific inquires are usually simplified. As a result, many scientific inquiries are not only epistemologically inauthentic, but also fail to engage students in asking inquiry questions on their own. To tackle the challenge, we design a learning program, The *Legends of Alkhimia* game and curriculum, to help students inquire with epistemological authenticity. The science-in-the-making processes and practices from ancient Alchemists inspire our design of the Chemistry learning program for secondary school students in Singapore.

The Centrality of Design in Developing Educational Theories

We highlight the centrality of theory-informed design not only as a way to advance the design aspect of theory development in education, but also as a productive approach to transform educational practices. Today's school system is conceptualized and designed mainly on common sense rather than on science (Tyack, 1974; Sawyer, 2006). Hence the learning practices in schools often lack of theoretical clarity. Designs of learning programs drawing on rigorous educational research may help to transform schools toward a more research-based practice.

In this conceptual paper, we articulate how we may transform current educational practices. We draw on past studies to understand typical classroom practices and the design

philosophy underlying these practices. Without tackling the major design assumptions, our re-conceptualization may be scratching the surface only. To transform the educational practices scientifically, the design should be informed by the knowledge base available to researchers. In other words, the researchers present a design framework that is guided by theoretical constructs (diSessa & Cobb, 2004). In our case, we present a design case informed by social constructivism, scientific inquiry, game-based learning and classroom discourse. Furthermore, when a design leverages specific technologies to engineer a learning environment, it is essential to consider the affordances and constraints of the technologies (Norman, 1993; Pea, 1993) and how the affordances may be leveraged to align with the intended pedagogy in design. In this regard, we believe that a book might be written in a style or genre that supports scientific inquiry similar to our design with a 3D role-playing game.

Limitation of Design

As schools are stabilized communities that practice learning, they have established certain cultural models over years of practices. The curricula, assessments, pedagogies and school logistics are all aligned to formulate a stable structure that not only enhances the efficiency of the system, but also keeps the system in check. This creates a catch-22 situation for educational reform. On the one hand, we wish to create a steady system in order for it to perform consistently and effectively. On the other hand, we wish to transform the system accordingly so it can better adapt to global changes that are often hard to predict. Our design is situated in this larger educational ecology. Mainly focusing on designing for local classroom change, this design does not reflect on the ecological issues arising at the level of educational administration and policy. However, as a basic functional unit of the entire educational system, classroom practices will bring out both local and ecological issues. We believe that the enactment of this design-based research (Brown, 1992; Collins, 1992; Barab & Squire, 2004) study will inform us not only students' inquiry experience in the *Legends of Alkhimia* learning program, but also insights into how their learning experiences are structured by the current classroom culture, schools or even the educational system.

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The (inconvenient) realities of the virtual

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Abstract: With the widely reported benefits of using virtual worlds in education, the 'Media Futures' module at Newman University College explores the future applications of these environments. This requires students to immerse themselves within Second Life to reflectively explore core themes of the module which includes identity, ontology, educational futures, produsage and convergence. Many writers have taken forwards Prensky's (2010) concept of 'digital natives' and it is assumed that a certain amount of re-configuration is needed within education to effectively engage the youth of today. Will this hold for students at Newman University College who typically come from a widening participation context? Over the past 2 years of running the 'Media Futures' module, qualitative information has been gathered regarding the experience of students within virtual and gaming worlds, which gives an insight on the effect this intervention has had with participating students. Students seem to lack the instinctive 'digital native' ability within sessions and it would seem that this lack of ability can be linked to the widening participation context of our institution. This leads us to question the degree of cultural capital (Bourdieu, 2004) that students possess in relation to digital media available to them. This review concludes with a list of factors that our own institution needs to carefully consider for this type of learning intervention, which will help to improve the experience of future cohorts at Newman University College.

Keywords: Virtual Worlds, Second Life, Digital Native, Cultural Capital, Identity, Ontology

Digital Natives, Virtual Worlds and Cultural Capital

Marc Prensky (2010) first coined the term 'Digital Natives' in order to refer to a new generation of students who are at a disjuncture with education. He argues that this new generation are disconnected with the current educational system, which speaks the language of the older generation. Prensky has profiled what is familiar to this new generation of students; immediacy and non-linear access of information; multitasking; networking with others and use of recreational entertainment technology. This profile has been cemented and expanded upon, with subsequent writers also attributing further features; the expectation of being able to customise experience (Roberts, 2005); being able to seamlessly move between online and face-to-face interactions, which has been attributed to gaming (Oblinger, 2005); learning by doing; interacting rather than passively consuming; and an increased awareness of multiculturalism within a globally connected world (Raines, 2010). Prensky has highlighted that the future of education for these 'digital natives' lies within digital and technological solutions and Oblinger (2005) highlights that these solutions need the capacity to satisfy their social nature and their desire experiential learning.

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Students are reported to spend much more time playing video games than reading, and this is seen as a potential area for development in teaching and learning.

When considering the discourse above alongside virtual worlds, there are a number of parallels that can be drawn between what native students expect from education and what a digital technology such as this has the potential to enable. Virtual Worlds can provide a globally networked platform, with the opportunity for the rules of the educational game to be re-imagined within a new environment. Such worlds allow for a high level of personal and world customisation and can be considered as having a close relationship with online gaming 'lifeworld' technology that digital natives are familiar with.

Virtual Worlds have been subject to a great deal of academic interest in recent years and Kirriemuir (2009) provides a useful snapshot of virtual world use within higher education. Many of these uses have a close association with problem based learning activities, as recognised by the recent JISC report on serious virtual worlds (de Freitas, 2008, pp.2). It is also important to note in the current economic climate, virtual worlds have the potential to deliver learning interventions that traditional education cannot resource or cannot reproduce in the real world. The aforementioned JISC report also makes reference to the concept of a metaverse that was first coined by Neal Stephenson (1992). This has been used to describe the emergence of an immersive 3D internet and the potential for this to provide a 'wrapper' (de Freitas, 2008, pp.5) for educational technologies. It is worth considering that educationalists, students and business could all be active within an integrated 3D Web, which has the potential to provide increased collaboration opportunities between sectors. In addition, if online gaming and virtual education occupy the same metaverse space, we may find that the foundations are in place for reconciling the informal cognitive benefits of gaming within an educational structure – a scenario that Johnson (2005) passionately projects. This ties in with the predicted socio-technical developments within the Futurelab (2009) report, with the weakening of sector boundaries and the need to provide lifelong learning opportunities. This same report highlights the importance of highly valued creative areas within an increasingly polarized job market, which is described as one of the key challenges for education in the future. Skills learnt by students within virtual worlds that could apply to new and exciting career opportunities, would seem to fit well with this.

When giving further consideration to research into virtual worlds and using the recent special issue of the *British Journal of Educational Technology* (BJET, 40(3)) as an example, we can identify the following dominant discursive themes that appear in several of the concluding statements that are intended to inform further virtual world research; student collaboration and reflection; social constructivist pedagogy; institutional and design barriers for teachers; learning through / in play; open, daring and 'risky' pedagogy; the interplay of learning and education (or edutainment); experiential pedagogies and 'learning by becoming'. We concur with these findings in terms of the abundance of affordances Second Life mobilises for constructivist education. However, within all of these studies there would seem to be an absence of student voices, and although we do not suggest that these authors are guilty of assuming that students are always-already 'digital natives', there is a need to further research within this area.

At the same time, our research is informed by Foucault's theory of discourse and the exercising of power – the conditions of possibility for forms of social practice, including education – and of Bourdieu's 'cultural capital'. Foucault's contribution to theory is to conceive of the relations between forces and how these relations exercise power in

discourse. The conditions of possibility for discursive arrangements to exercise power, then, are such relations – things 'coming together' in such a way to delimit ways of thinking about social practice (and the physical manifestations of such discourses). As Deleuze paraphrases:

> *Power-relations are the differential relations which determine particular features (affects). The actualization which stabilizes and stratifies them is an integration: an operation which consists of tracing a 'line of general force', linking, aligning and homogenizing particular features, placing them in a series and making them converge.* (Deleuze, 2006, pp.63)

We wonder, then, whether the migration to the virtual realm for education is sufficient, in itself, to be emancipatory for students who are alienated by the convergence of features in the more orthodox curriculum or whether the rules of the game will transfer intact to a Second Life context. If the latter is the case, then the affordances for social constructivist pedadogy will need a further shift in power relations to come to fruition – the use of a virtual world in itself will do little to reconfigure the relations between forces.

Bourdieu's theory of cultural capital (2004) is, broadly speaking, a sociological extension of Marxist social class analysis. By distinguishing between – and inter-relating - two forms of capital - economic and cultural, this model is able to account for the accumulation of 'distinction' (from others) in the form of such commodities as qualifications and other symbols of status. Education serves to provide people with more or less cultural capital and it is, we argue, essential to view the affordances of virtual worlds from this perspective, whereas some commentators have been guilty of assuming an always-already transgressive and emancipatory context for virtual world education, in which 'digital natives' acquire cultural capital by virtue of being immersed in certain technicities (see Buckingham, 2007). We are concerned here precisely with the degree of translation between more orthodox forms of cultural capital and academic literacy and the capacity to proceed with comfort and confidence in virtual environments when the experience is still framed by those orthodox drivers of success - learning outcomes constructed in the idioms of the long-standing academic language game. In other words, we are sceptical about the distinction between cultural capital and the ability to operate as a digital native, and thus the notion of digital nativehood (as innate and discrete from culture, from acquisition or inheritance) itself.

This theory of cultural capital does not square neatly with Foucault –being an arguably more 'straightforward' conception of how forms of capital exercise power which is previously held by elite groups – as opposed to Foucault's theory of power existing only in its practices, most notably in discourse. Thus discourse is no *carrier* of power. Nonetheless, we want to consider the ways in which cultural capital and discourse are related in the set of assumptions that are made about virtual world reflective learning:

> *The more the official transmission of capital is prevented or hindered, the more the effects of the clandestine circulation of capital in the form of cultural capital become determinant in the reproduction of the social structure.* (Bourdieu, 2004, pp.26).

Thereby the widening participation agenda might be seen to have disrupted the hierarchical transmission of capital (tuition fee constraints notwithstanding) but at the same time reinforced them in the realm of the cultural – the rules of the game of undergraduate studentship are left, for the most part, intact. Will then, the integration of virtual world learning contexts serve to transgress the orthodox relations between forces that legitimize certain forms of learning and marginalize others (and in so doing attribute capital to the one kind and not to the other)?

In tracing the relative degrees of comfort our students experienced in their Second Life learning encounter, we wanted to understand the relationship between 'virtual world aptitude' and more orthodox forms of cultural capital. In short, would the competences required for academic 'book learning' transfer more or less intact to the virtual space? And what would the findings tell us about the space between these discursive moments of consensus (risk, empowerment, empathy) and their reception in social practice on the part of learners – especially those entering higher education within a 'widening participation' context?

Crucially, the fact that our students are engaging with Second Life within a Media degree, makes the risk of assumption even greater. When bringing together experiences from the past 2 years, our most important findings relate precisely to the fact that we experienced levels of discomfort and concern amongst these students who were far from 'native' when inducted to 'avatar-learning'. We also experienced more behaviour management requirements in Second Life than ever in the seminar room. If the conditions of possibility for Media undergraduates to learn reflectively when the object of study is the ontological exploration of the virtual, then perhaps we should tread even more carefully with students for whom the virtual world encounter is more of a shift in relation to their learning outcomes?

Virtual Worlds at Newman University College

For students studying Media as part of an undergraduate course, we have completed a second year of running the 'Media Futures' module. This provides a framework for students to research virtual and gaming worlds and relate this to core module content that includes virtual world education, edutainment, ways of 'being', using media concepts for virtual and gaming worlds, convergence, identity, and 'produsage'. For a module such as this, and the ontological questions that it covers around reality and identity, it makes actual experience a necessity for students. Listening to a lecture within the virtual may be little more than a novelty for many subject areas, but within the context of this module, the residue of 'real' features of a lecture provides an interesting topic for discussion. In addition, tools that exist within gaming and virtual worlds for consumers to produce content gives immersed students the opportunity to reflect upon first hand experiences of 'produsage' and relate this to possible future developments within this field.

Second Life was selected as a virtual world for the students to engage with during the module. Millions of people use this world, but it is difficult to pin down exactly how many active user accounts second life currently has. De Freitas (2008, pp.19) states that there were just under 15 million registered user accounts in August 2008 and looking at recent economic statistics published by Linden Labs (2010) in May, this shows that almost 1.5 million residents logged in within a 60 day period. Although usage is not totally clear, it is obvious that this virtual world has a large active user base and subsequently provides potential for rich interaction with resident communities. The included production toolset also provides students with an ideal opportunity to create content within this virtual world.

In the first year of running, the experience for students was limited to two remote sessions, both of which used lecture and seminar based teaching techniques. As Carr has highlighted within her 'Learning to Teach in Second Life' report (2008), a traditional setup provides a familiar environment within the virtual, and can help reduce disorientation for

students. These learning experiences and their own exploration of the virtual, provided students with the opportunity to form lines of enquiry to inform their end of module assessed presentation.

In academic year 09-10, the second year of operating this module, a number of changes in delivery were introduced, the most significant being the remote delivery of the module. Students were required to attend 2 introductory face-to-face sessions that prepared them for virtual world distance learning. Distance learning activities included auditorium lectures, virtual tours, discussions and content production. With the help if the JISC's Regional Support Centre, we were also able to establish an island for our students interact with and in order to simplify the signup and induction process, we were able to create a Newman University College signup page to Second Life using the 'RegAPI' service (Provided by Linden Labs; full information on using the Registration API can be found at http://wiki.secondlife.com/wiki/Regapi). Assessment for the module was also adjusted so that students were now required to deliver an online presentation, either using Second Life or a Slideshare.net Slidecast, which was felt to be more in keeping with online delivery. Finally, an additional assessed element was introduced, where students were required to complete a research journal based upon their experiences within virtual and gaming worlds. To provide scaffolding in the creation of this, students were given specific instructions on how to complete each journal entry.

For the 2 cohorts who have now taken this, they would seem to fit the 'widening participation' profile of Newman and exhibit a 'disconnect' with assessment. Out of the 29 students who have now taken this module, 72% have required at least one resit to progress on their course and 48% have required 2 or more to progress. For this early venture within the virtual, we have concentrated on gathering qualitative data to find indications of what effect Second Life has on learning. Due to the exploratory nature of this intervention, we felt that open ended discourse would be most productive to meet our needs. The table below describes the qualitative information gathered, as well as summarising entries that students are required to make within the online research journal.

Table 1. Summary of Qualitative Information Gathered

Type	Description	Cohort 1 year 08-09 (n=14)	Cohort 2 year 09-10 (n=15)
Questionnaire	Series of closed questions relating to ability to access second life at home. Open ended questions relating to technical difficulties, comparing experience to traditional lectures, identity creation, evaluating learning opportunities and opinions on extended use of Second Life. An additional question was introduced for cohort 2 relating to how often they play video games and what genres they are familiar with.	Yes (n=10)	Yes (n=8)
Discourse within Sessions	Discourse within Second Life Sessions Chat logs for each of the second life sessions were saved and reviewed. Discourse within Face-to-Face Focus Group For cohort 1, students were invited to take part in a focus group after experiencing the 2 remote sessions within Second Life. Opinions were recorded from this focus group.	Yes (n=14)	Yes (n=15)
Assessed Journal	As part of the assessment for the second cohort, students are required to complete 7 assessed reflective journal entries relating to the core themes of the module. These journal entries provide students with structured guidance on how each of the entries should be completed. • Entry 1:- Description of gaming worlds available to students for ethnographic research. • Entry 2:- Response to questions relating to initial identity creation within Second Life and experiences within game selected for research. Students are required to post a follow up entry on their opinions around identity towards the end of the module • Entry 3:- Further investigation of identity created in second life in relation to selected module readings • Entry 4:- Further investigation of chosen game for research in relation to core module readings. • Entry 5:- Comparing identity within Second Life to identity within chosen game (in relation to core module readings) • Entry 6:- Reflection around production of content within virtual and gaming worlds based on firsthand experience and core module reading. • Entry 7:- Preparation for presentation by investigating a selection of themes that are supported by core module readings related to produsage, virtual world education, identity, game effects and convergence.	N/A	Yes (n=15)

Student Experiences

When looking at the responses within the questionnaire relating to students' ability to access Second Life, we found that home access was not in place for all students. The table below summarises these results, along with the type of internet connection used and any significant technical difficulties encountered.

Table 2. Summary of Students Ability to Access Second Life, Internet Connectivity and Technical Difficulties Encountered

	Cohort 1 (08-09) (n=10*)	Cohort 2 (09-10) (n=8*)
Where Accessing?		
access from home	8	5
access using college facilities	2	3
Internet Connectivity?		
dial up modem	0	0
broadband (3G, ADSL or cable)	8	8
college internet connection	2	0
Technical Issues?		
significant issues encountered	8	7
no significant issues encountered	2	1

* = number of questionnaire responses

From the questionnaire respondents in both cohorts, it is evident that the majority of students had IT capability at home to access Second Life and all students had broadband connectivity. As we had anticipated an inequality of access, an ICT room had been set up on campus for Second Life for cohort 1. Due to our own technical difficulties, we moved to providing students with Macbooks and pre-paid 3G modems for cohort 2 (although this introduced a different set of technical difficulties relating to setup and configuration of 3G modems). The main difficulties reported within the questionnaire include; unable to hear spoken audio; unexplained Second Life client failures; loss of internet connectivity; and unable to watch videos shown within the virtual world (cohort 2 only). For students within the first cohort who had a limited experience within Second Life, these technical issues remained unresolved. For the second cohort, the majority of issues were resolved by the 5th virtual session. For our students, technical issues at home would seem to be a likely, and a detailed investigation in future cohorts is needed to establish the full extent.

When turning our attention to the qualitative discourse gathered for these 2 cohorts, students' prior knowledge of Second Life and 'serious gaming' was extremely limited, with only 2 students across both cohorts ever having a brief experimentation with using it. With initial identity creation in cohort 2, it quickly became apparent that there were differences between the students in their approaches to this. Students who have had more experience with commercial game environments perceived Second Life as a game and constructed identities that were more abstract in nature.

> *I found a complete outfit that is given to you from the start. It's to look like a cardboard box man. Your whole outfit gives the look of being comprised of*

cardboard tubes and boxes. I chose this because it was a fun and comical look and provided entertainment quickly… …I think this shows I don't really take the game as a 'Second me' but just another character in an online world to mess around with.

Student 4, Cohort 09-10 (Source: Assessed Journal)

Students with less gaming experience were more likely to create something that was similar to their real life identity. It is not totally clear what this was due to, but one possible reason could relate to these students not being exposed to the same level of identity play as gamers.

Students, whether they played games regularly or not, found identity construction within Second Life uncomfortable and potentially dangerous, due to its perceived relationship to reality. This would seem to go against the trend that young people expect to be able to personalise and customise their self representation (Futurelab, 2009, pp.98)

I have chosen to represent my avatar as I have because, firstly, it looks nothing like me and so therefore it hides my identity. You can never be sure of Internet users these days and it cannot be policed.

Student 8, Cohort 09-10 (Source: Assessed Journal)

In Second Life you can act like someone you're not or someone you aspire to be which could ruin relationships and your social life in the real world.

Student 11, Cohort 09-10 (Source: Assessed Journal)

The game was a bit strange because you meet people on there who consider Second Life reality and it is then no longer an enjoyable game.

Student 11, Cohort 09-10 (Source: Questionnaire)

Most online worlds I have ever been in don't really play to be a 'second life' but instead other a completely different universe which isn't similar to our own. I feel Second life has too many similarities to our real world.

Student 4, Cohort 09-10 (Source: Assessed Journal)

Students who were familiar with playing games have found skills learnt in navigating and exploring a gaming environment translated to Second Life. Students with less gaming experience took significantly longer to find their feet.

Second Life gives you good opportunities to learn, however it can be quite awkward as if you have never used it before you have to learn about it as well as what is taught as it goes along.

Student 9, Cohort 09-10 (Source: Questionnaire)

When providing teaching within Second Life, it became immediately apparent that students were more comfortable with virtual interaction, with frequent informal text communications during sessions. Students highlighted this as a potential positive benefit to using Second Life

I can see myself practicing the art of 'small-talk' through regular exchanges with other avatars on a daily basis perhaps - something I'm not very good at in the real world.

Student 13, Cohort 09-10 (Source: Assessed Journal)

I'm not very talkative in the real world but I felt comfortable and talkative in SL.

Student anonymous, Cohort 08-09 (Source: Questionnaire)

> *Students feel more free to type their responses rather than being in a lecture and not wanting to feel stupid.*
>
> Student anonymous, Cohort 08-09 (Source: Questionnaire)

Certain students found the environment so similar to gaming worlds, they treated the experience as a time for play rather than study. This introduced a disruptive element to teaching and interaction with other residents, which needed to be addressed by applying real world ideologies around how learning should take place within the virtual. For those less experienced with gaming, it seemed more natural for them to apply real world ideologies to the experience.

> *When reflecting on my own identity in Second Life, I believe that I am cautious and influenced by the 'double awareness' of my behaviour and attitudes as it is a multiplayer world where you are, similar to reality, being judged and perceived a certain way; where a lot of the normal conventions from the real world, also apply to the virtual world.*
>
> Student 10, Cohort 09-10 (Source: Assessed Journal)

Gamers who had an easier time getting used to the environment also found it easier to get to grips with the provided production tools.

> *The process itself is fairly straightforward once the user is familiar with the interface for modeling, and this can be aided by many online guides and tutorials that can be found within Second Life itself.*
>
> Student 2, Cohort 09-10 (Source: Assessed Journal)

These same students were also more likely to recognise the limitations of the Second Life production toolset and the need for 3rd party modelling and development tools.

> *Creating environments within Second Life in comparison with those developed using Unity differ greatly in terms of appearance; the quality of the graphics and detail in the environments of Unity appear much more advanced and complex to those of Second Life. However, both tools are relatively simple to operate under guidance, suggesting that advancements in the power of web 2.0 may well lead to online environments combining the MMORPG ability of Second Life with the visual qualities and accuracy of tools such as Unity to create spaces much more visually representative of real-life.*
>
> Student 2, Cohort 09-10 (Source: Assessed Journal)

In contrast, students who were not so familiar with gaming environments, needed an increased level of support in getting used to the production tools. By the end of the module, these students had mastered using them, but were less likely to recognise the limitations of these

> *I have created a flag with a pole and also, had the opportunity to make small items such as, a box and a ball. This shows how we can instantly make an item and produce an item creatively and use them in the virtual world.*
>
> Student 14, Cohort 09-10 (Source: Assessed Journal)

Whatever the background of the student, this firsthand experience of production within the virtual increased the quality of reflection around 'produsage' and their engagement with academic writing on the subject.

When students talked about whether they would use Second Life beyond the life of the Media Futures module, it became apparent that gamers had little interest in using the environment any further. The perception that Second Life was a substandard game without rules, seemed to be the deciding factor for this decision. It

is quite interesting that these views still bubbled to the surface, even though students were aware that this was being used within an educational context and Second Life had some important fundamental differences to gaming worlds.

> *It's useful to highlight aesthetically pleasing environments because I think this is one of the things that I enjoyed so much about WoW, and why I would chose it over Second life ... I think I just don't want to invest any more time than I have to into it as the general world of Second Life fails to meet a majority of my personal gamer needs.*
>
> Student 4, Cohort 09-10 (Source: Assessed Journal)

> *Within Second Life it is exactly as it says – a second life; I would prefer to escape real life playing a game, than actually escaping real life to start another life (even if it is virtual) where you just play yourself, just wandering and exploring as you would do in reality.*
>
> Student 8, Cohort 09-10 (Source: Assessed Journal)

> *I personally wouldn't spend any more time on Second Life because I find it quite boring. There is no purpose to the game and there is nothing to achieve.*
>
> Student 11, Cohort 09-10 (Source: Assessed Journal)

The above views relate closely to recent findings by Diane Carr (2008), where she has highlighted that we should not assume that gamers will appreciate the use of Second Life more than their peers and comments are generally more 'scathing' when relating Second Life to their gaming experiences. The comments above are a stark contrast to discourse provided by other students not as heavily involved with gaming, as the following shows.

> *I believe I will continue to use Second Life as a leisure activity and for educational purposes as I feel it has it's place in the not so distant future.*
>
> Student 3, Cohort 09-10 (Source: Assessed Journal)

> *As I mentioned in my previous journal entry, if there are creative ways in which I can integrate my real world activities in a constructive and beneficial way (which I'm sure there are) I would consider investing more of my time to such an open platform.*
>
> Student 13, Cohort 09-10 (Source: Assessed Journal)

For most, the context of study integrated into the use of a virtual world, it became apparent that this provided profoundly unfamiliar territory. With the second cohort, the difficulty of relating academic work to the use of virtual worlds was more apparent due to the slow development of ethnographic research journal entries. It was also apparent that technical difficulties for both cohorts produced further feelings of anxiety for the affected students, resulting in an expression of preference for traditional teaching over the virtual for some.

> *I don't think it can benefit as much as going to a traditional lecture.*
>
> Student anonymous, Cohort 08-09 (Source: Questionnaire)

> *In a traditional lecture, it is easier to pay attention and its easier for everyone and myself to stay on the subject.*
>
> Student anonymous, Cohort 08-09 (Source: Questionnaire)

> *I feel as though I learn more face-to-face.*
>
> Student anonymous, Cohort 08-09 (Source: Discourse within Sessions)

Positive viewpoints of teaching and learning within the virtual were much more apparent in the second cohort towards the end of the module. These students have

benefited from a greater exposure to the virtual, which resulted in an increased familiarity within the teaching and learning context after all technical issues had been resolved.

> *It was more interactive and more interesting than a normal lecture as you are more involved than a traditional lecture or seminar.*
>
> Student 9, Cohort 09-10 (Source: Questionnaire)

> *...it is only beneficial to those that have overcome all technical issues – Only then is it highly enjoyable!*
>
> Student anonymous, Cohort 09-10 (Source: Questionnaire)

> *Second Life is good for exploring new media and the values around it. It also taught me how to use a piece of software to be creative and think outside of the box.*
>
> Student anonymous, Cohort 09-10 (Source: Questionnaire)

Among other positives highlighted by the students, was a belief that attendance at lectures would increase within Second Life. This was certainly true with the first cohort of students who had a limited experience. However, towards the end of the module for the second cohort, it was apparent that attendance had dropped to levels that were directly comparable to face-to-face teaching. Across the two cohorts, it is striking that most of the positive aspects attributed to Second Life could be considered as being basic issues around making it easier to attend lectures and being in an environment of increased comfort. This takes on greater significance when you consider the creative and imaginative processes that are going on during the process of feeling comfortable with your own identity and establishment of relationships within the virtual.

All students, including sceptical individuals, were willing to discuss their retrospective feeling that they had 'been to' the lectures and were not sitting in their house at home or in front of a computer. This has fostered a significant depth of interaction around the ontological questions that the module raises. While interacting with experiences from a richly developed environment and artefacts of your own creation, coupled with the requirement to represent your identity though an avatar of your own creation, it provided a unique opportunity for students to reflect on their own 'hyper-reality'.

From the research conducted, it is clear that the degrees of cultural capital required to 'self-present' and to theorise on this practice were in keeping with those required for more traditional forms of academic practice – to articulate, to reflect, and to be 'self-knowing'. Students' with the ability to achieve through traditional forms of learning where clearly better placed to benefit from this learning opportunity. For those within this group lacking the cultural capital of the traditional; the benefits of the experience fell below expectations, and this was particularly apparent for those that can be considered as gamers. These students found it difficult to get past the idea that Second Life was an inferior version of a pastime they feel passionately about, which provided a layer of prejudice that had to be surmounted before any potential benefit could be achieved.

Factors to be Considered for Our Context

Based on this initial exploration in the virtual, we have formulated a number of factors for consideration in relation to learning and teaching within virtual spaces at Newman University College. We hope that these will be of use to academics working with students who are equipped with varying degrees of cultural capital and that these factors pay due sensitivity to the starting points of students engaged in avatar based learning. Many academics have high expectations for student achievement in this mode of delivery for a variety of reasons, but we believe that the data presented here shows that care and attention is needed with regards to your own circumstances for this to come to fruition.

Acquisition of Participation Skills

Although some of our students could be classed as more native to the environment, the majority have limited experience of gaming or virtual worlds. These students encountered a steep learning curve of being able to interact with the environment while also trying to meet the requirement of engaging with academic discourse around module themes. Careful planning is required so the less digitally confident student is not overloaded and this skills acquisition should successfully translate into the language game of orthodox learning outcomes and QAA benchmarks.

Watch Out for the 'Native' Gamer

Some of our students fitted the profile of a 'native' to the environment, and this was due to their extensive experiences of games playing either on PC or consoles. Controlling avatars / characters within gaming worlds generally has enough similarities to make controlling an avatar within Second Life easy for this type of student. When completing an induction programme, you need to make sure that their needs are catered for so that they do not become disengaged when others are learning the control basics. It is also worth noting that these students will make unhelpful comparisons between virtual and gaming worlds and they need to be fully aware of the differences between them to ensure that unhelpful comparisons do not persist.

Honesty in relation to academic discourse

This is vital if students are to develop online research skills for deep learning rather than surface browsing. From our evidence, this would appear to be a large gap in 'information literacy' but it is tempting for academics to assume that these conditions of possibility are somehow differently constructed in online contexts. The acquisition of cultural capital, in our experience, directly transfers across from library research to the internet, from homes full of books to 'digital literacy'.

Avatar Distance Learning is not Easy

Mistakes have been made in the past around other forms of online learning and it is important to note that previous school experience is still pretty detached from any form of distance learning, even before virtual worlds are thrown into the mix. Not all

students will be able to access from home due to technical difficulties, socio-economic status and unsuitable conditions at for remote study. If education is not careful, 'new inequalities will arise' (Futurelab, 2009, pp.60) for students who do not have the ability to cope with these new demands.

Reflexive Critical Literacy

This must be the desired outcome of avatar-based learning for students to move beyond 'unreading' (Gee, 2003) to critical reading. This is to say that the success of the Media Futures example above rests on the compulsion for students to take risks, to negotiate identities and as such, to deconstruct the 'idea' of Second Life at the same time as learning within it. Just as we would ask our students to question the traditional curriculum (what is knowledge, what 'counts' as legitimate, how is power exercised in education?) so we must afford them time and space for such genuine enquiry in the digital world. Conclusions within the final report of the Open Habitat project include the assertion that virtual worlds 'work best when knowledge ownership and transfer hierarchies are flattened out' (White, 2009, pp.19) and this would seem to be a key in encouraging a critical approach by students. Identity play also has a role in facilitating the agency of the individual (Futurelab, 2009, pp.73) and there is a potential to allow students to negotiate ideologies and rules to learning in virtual worlds, rather than having a top-down systemworld ideology imposed upon them.

When looking back at the literature at the start of this paper and comparing this to our own student experiences, it seems clear that the 'know how' - whatever form of capital that is - that students need in contemporary higher education if they are to see their investment return in terms of academic success is remarkably consistent across time and space and across the various (postmodern) thresholds of experience and knowledge. Put most bluntly, there is little evidence of the transgressive nature of virtual world contexts for learning leading to any transgression in the nature of learning or in the 'ways of being' for studentship in Newman University College. We hope that this is merely a result of our review capturing a 'snapshot' from a relatively early foray and that the further development of our research on this module will reap rewards.

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Investigating positioning within the dialectics of real and virtual worlds

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Abstract. Recent attention to processual paradigms of thought within the ontology of social phenomena has rendered theories of *positioning* (Harré & Langenhove, 1999) dynamic alternatives to otherwise static concepts of role. In this paper, we investigate *positioning* as the discursive and performative negotiation of identity so as to better understand the dialectical interplay between living in the real and the digitally-mediated virtual worlds in terms of how youth construct their identity and sense of self, negotiate meaning, and make sense of their social experiences online. Situating our study within the immensely popular MMORPG, World of Warcraft (WoW), we found that youth frequently engaged in repositioning of initial positions, coupled with performative and accountative positioning intentionality. Through performative-social acts, youth's self-positioning reflected the agentive affordance of online lived worlds through the construction of key interaction frames for the negotiation of new positions of online identity that is more strongly coupled with their offline identity.

Keywords: identity, positioning, virtual worlds, youth

Introduction

In recent times, earlier conceptions of identity and the nature of self as a stable relationship between linguistic and social variables have been challenged by new approaches to the relational understanding between language, narrative, and the impact of cultural tools on the development of the human person (Bruner, 1990; Valsiner, 1998). From this perspective, the concept of identity has been variously described as 'multiple' (Rosenberg, 1997), 'narrated' (Sarbin, 1986) and the self as 'dialogical' (Hermans, 1996; 2001; Hermans & Kempen, 1993). In this regard, identities are always in a process of *becoming*. Adapting Bakhtin's (1929/1973) theory of dialogism and heteroglossia, it may be argued that the self is decentralized and consists of multiple 'I' positions in constant dialogue with each other and with a similarly decentralized cultural universe of *other* selves. This concept of 'positioning' in positioning theory resonates with Mead's (1934) idea that consciousness involves the acquired ability to take the role of the *other*.

Contemporary youth culture involving active engagement in new media activities (e.g. online role playing games, social networking) reflects use of technologies within popular culture that is profoundly affecting the development and expression of human lives (Levinson, 1998) and broadly engaging the multiple 'I's that are in dialogue with *other* selves in the cultural world. Recent studies on new media phenomena have shown en masse *digital migrations* to virtual worlds that are emerging as one of the most influential technologies impacting youth culture (Meadows, 2008). Subsequently, this has lead to an information age

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(Castells, 2004) where not only are today's youth fluent and playful with digital technologies but they are also developing alternative, sophisticated, reflective literacies amidst new cultural norms and social practices (Hsi, 2006). The increasingly pervasive influence of digital media culture on youth today has spawned a new phenomenon of youth's 'life online' as real life gets increasingly intermingled with virtual life/lives. We posit that through a dialectical interplay between living in the real and the digitally-mediated worlds, the self that emerges from the dialectics of offline and online activities resonates closely with concepts of *positioning* of the dialogical self as it interacts within its own personal and sociocultural worlds (Harré & Langenhove, 1999; Herman, 2001; de Fina, Schiffrin, & Bamberg, 2006). This concept of positioning grounds the theoretical thrust of our paper as we investigate the ontology of youth's *life online* phenomena through the discursive and performative negotiation of identity so as to better understand the dialectical interplay between living in the real and the digitally-mediated worlds, through various modes of identity *positioning*.

Theoretical Background

The theoretical notion of positioning was first introduced by Hollway (1984), who described women's and men's subjectivities as "the product of their history of positioning in discourses" (p. 228). As dynamic alternatives to otherwise static concepts of role, analyses of positioning build on the premise that identity is socially constructed at several levels: through relationships between the speaker and articulated words; through relationships between self and other; and through relationships to the dominant ideologies, widespread social practices, and underlying power structures drawn together as Discourse (Gee, 1996). Given this perspective, one of the goals of positioning theory is to more clearly identify the mechanism through which linguistic and social processes become reified as observable products that may be glossed by others as "identities" (de Fina, Schiffrin, & Bamberg, 2006, p. 7). Drawing on Vygotsky's ideas about the cultural embeddedness of thought and language, and on Wittgenstein's concept of 'language games' (Howie & Peters, 1996), the concept of positioning builds on underlying theories of social constructionism, and assumes among other things that human behaviour is goal-directed and constrained by group norms, and that human subjectivity is historically dependent of each individual's interactions with other people (Harré & Langenhove, 1999).

According to Langenhove & Harré (1999), speakers and interlocutors, during discursive interactions, invoke narratives or 'storylines' to make their discourse and performance meaningful to themselves and others. They can be thought of as presenting themselves as actors within a performative act, with varying "positions" assigned to the various "actors", whereby the storylines "can be taken from a cultural repertoire or can be invented" (Langenhove & Harré, 1999, p. 30). These positions that Langenhove & Harré refer to are not fixed *apriori*, but instead are fluid, and may change from moment to moment, depending on the storylines through which the various actors make meaning of the interaction. Within this conceptualization, positioning is thus interpreted in terms of a tripolar of interrelated concepts: storyline, positions, and performative-social acts.

Against this backdrop, positioning theory provides a central theoretical construct within our study for tracing youth identity trajectories, affording relational and interactional analyses, based on the tripartite concepts of storyline, positions, and performative-social acts. Thus far, very few studies (e.g. Cook-Sather & Young, 2007; Linehan & McCarthy, 2000) have used positioning theory as an approach in understanding the process of *becoming*, especially within

the context of online worlds. In this paper we consider the value of positioning theory within a dialogical-performative space as opposed to its common interpretive application to the study of pure conversational acts. We posit that tracing identity trajectories as a process of positioning would allow us to discover the means that youth adopt to enact various positions within storylines that lead to utterances and actions that are given meaning and recognized as *social* acts (Langenhove & Harré, 1999).

Within a social context like the online virtual space World of Warcraft, meaningful interactions between participants require joint construction of utterances and gestures, along co-constructed storylines and speech acts. This need for a joint construction means that positioning theory can help to illuminate youth identity negotiation processes, ranging from "the proclamation and open assignment of membership into social categories to the enactment of different kinds of selves, to indirect conveying of alignments and misalignments to the implicit placement of social agents into pre-assigned roles" (de Fina, Schiffrin, & Bamberg, 2006, p. 8). Of particular interest to us is how youth engage in self-positioning within the WoW gaming environment as part of their identity construction and negotiation process. Thus, the research questions that motivated our study were:

1. What positions do youth gamers naturally adhere to within the dialogical and performative spaces of WoW?
2. How do these positions impact upon their selves and identity, both online and in the offline world?

Additionally, this study provides an example of how positioning theory may be operationalized as an analytical framework for tracing identity trajectories within the interstices of offline and online worlds.

Contextual space of analysis – *World of Warcraft*

Given the currency of the phenomenon of online role-playing games, our research was situated within the context of the extremely popular immersive multiplayer game space, *World of Warcraft* (WoW), which takes the form of an extravagantly re-imagined version of J.R.R. Tolkien's Middle-earth, akin to a medieval *Matrix*. The game's narrative and structure revolve around a Western European fantasy tradition that parallels the dungeons and dragons game genre of the 1970s. There are two main factions within the game – horde and alliance. Each faction has four races: the alliance is comprised of dwarves, gnomes, humans, and night elves, while the horde consists of orcs, tauren, trolls, and undead. Each race has a unique set of characteristics and its own list of available class choices. There are nine classes (druid, hunter, mage, paladin, priest, rogue, shaman, warrior, and warlock) in the game, and each has its own unique set of abilities and powers. Each player controls an avatar with a chosen race and class within a game-world that they can affect by interacting with it. The game rewards success with equipment and experience, which allow players to improve their skills and power (Blizzard Entertainment, 2009). In addition, players may opt to take part in battles, more commonly known as 'raids', with and against other players, including both duels and fights against characters allied with an enemy faction. Players usually form guilds and raid communities to collaborate and fight against the enemies. In this regard, 'inhabitants' of WoW do not simply interact with the game environment; instead the vibrancy of these games lies in the interactions they necessitate between players.

Within the WoW gaming system, realism and identity take on a deep significance. The virtual identity of a user (look, gender, and race as represented by their choice of avatar, name, skills, and characteristics, the way that they interact and speak, the language they use etc.) are not limited by biological or social forces as they are in the offline world, but they are subject to the player's choice. Gamers are able to explore different subject positions and experience identities that are different from their own real world identity facilitated by the creation of virtual characters (Gee, 2005). These very aspects of WoW afford youth gamers varying degrees of personal agency in how they position themselves in interactions that are interlaced with the expectations and history of the WoW community, a sense of 'oughtness' (Linehan & McCarthy, 2000, p. 442) on how to engage in discourse, and enact their performed actions within the gaming environment. In this regard, if the practices in which youth routinely engage in within WoW are viewed as central to the process of identity formation, what kind of personal agency is inscribed in these practices? We are particularly interested in the agentive role of youth in interactions as being able to counter dominant practices, discourses, and master narratives. Hence, by investigating how youth gamers engage in self positioning driven by the sense of 'oughtness' within the dialogical and performative spaces of WoW, we seek to explore the efficacy of this construct in addressing the ontology of youth *life online* phenomena and theoretic notions of youth's negotiation of the dialectics of offline and online identities.

Methodology

This paper draws on an ethnographic study within WoW in which data were gathered from participant-observation sessions, interview responses, in-game chat transcripts, web-based messaging transcripts, and players' experiences and narratives in the form of blog or online forum postings. In-game interviews were conducted either within the public or private 'chat' mechanism of the game. Semi-structured offline interviews were also conducted to further corroborate the online data. The period of ethnography commenced in July 08 to Dec 09, for a duration of 1.5 years. The researcher logged on for four hours each day. As a participant-observer, the researcher focused on experiencing the game world first hand. This experience was integral to the study because it directly impacted on the researcher's ability to understand the phenomenological game experience of a relatively new WoW player. The researcher declared a research identity whilst at other times operated as co-participants or participant-observers as data were collected. We recognize that there is a long history of covert or semi-covert research in ethnography and that non-disclosure of research identity in computer-mediated-communication research remains an unresolved issue (Hillis, 1999).

Various literature (Markham, 1998; Hine, 2005; Taylor, 2006) were reviewed to identify concerns that may arise from the anthropological stance of our study. According to Boellstorff (2006), the use of anthropological methods among game researchers is well known because of the notion of play (in this context, game play in WoW) as a 'master metaphor' in relating to a range of social and cultural dynamics. Scholars from this field approve the nuanced insights that ethnographic methods uncover, especially within the context of many new and challenging research settings within the 'information age.' Hine (2000, 2005), author of two critical references in the domain of virtual ethnography, expounds that researchers need a context for conducting online ethnographic work. The first stems from the notion of the Internet as "a place, cyberspace, where culture is formed and reformed," while the second "sees the Internet as a product of culture" (Hine, 2005, p. 9). Similarly, Wilson and Peterson (2002) posit that online communities are unique social spaces that need to be studied as true

communities in their own right. These issues reflect wider questions of whether online spaces are in any sense 'real': indeed, whether they are 'spaces' at all. We posit that online spaces such as WoW offer a context for agency and participatory action that constitute a player's sense of *being* in the world (Hillis, 1999). In this regard, any analytic methodological tension between offline vis-à-vis online and real vis-à-vis virtual should be cast aside. As Hine (2000) reiterates, if data collection is rigorous, then the process and validity of ethnography in virtual spaces should be duly recognized as with any other forms of ethnography.

Description of informants

Our first informant (Youth A) is male, in his mid-twenties, and working in the game industry as a game analyst. He is also a part-time degree student on a distance study program. He is an early adopter of many online games, having started playing from the age of 10. He has even travelled to Japan to meet top game players. He was recruited as a member of a very elite American WoW guild. He has also started his own local guild where there are at least thirty players under his purview.

Our second informant (Youth B) is a male Computer Engineering student at a local university, in his mid-twenties, who started playing WoW when it was first released in 2004. He has an elder sibling who is also a game enthusiast. He believes that his sibling's gaming habits may have had a significant influence on him. Originally none of his offline friends played the game, but he says he has "made numerous friends online." He spends an average of six hours daily playing WoW. He shared that his objective, after he graduates from college, would be to find a job that will allow him to continue his gaming activities.

Our third informant (Youth C) is a female student, in her early twenties, pursuing a diploma in Computer Networking at a local polytechnic. She has been playing WoW for the past one year, since the game was introduced to her by her elder sibling. Apart from MMORPGs such as WoW, she is also an avid enthusiast of mobile computer games afforded by Nintendo DS and Sony PSP devices.

Our fourth informant (Youth D) is a female student, in her early twenties, who is also pursuing a diploma at a local polytechnic. She spends up to six hours daily online. Her online activities include playing WoW, social networking and instant messaging with friends. Her engagement in WoW is largely fuelled by her interest in role-playing games of the dungeon and dragons genre.

Given the in-depth qualitative nature of our study, we focused on collecting 'thick descriptions' (Geertz, 1973) from youth's specific cases of 'life online', as opposed to distilling results from a large sample size for inferential statistics purposes. Identified through chain sampling, our informants represent the average age of WoW players (Yee, 2005). In the Daedalus Project, Yee (ibid) reported that the bulk of WoW players have an average age of 28.3 (SD=8.4). On average, players spend 22.7 (SD = 14.1) hours per week playing WoW, with no gender differences reported in the number of hours played per week.

Data analysis

Based on the premise that the position one takes may serve as a determinant of how one can contribute to the mutually determining triad of 'position—storyline—performative-social acts', conveying a variety of attributes, such as power, composure, confidence, and authority (Harré & Langenhove 1999), and orienting major changes in participation structure, our objective was to use positioning to capture salient performed social identities within WoW. To identify

positioning, it is therefore necessary for us to look at the detail of each interaction, at what is said and done, and how others respond, and make inferences about the rights and duties that are being presumed by youth gamers within WoW.

Based on a coding scheme by Harré & Langenhove (1999), we used the key dimensions of position order, position intentionality, and positioner as determinants of one's performed identity. Position order refers to the instance in which a position is stated, whether it be an initial position, a reposition, or a position carried over from another storyline or context. Position intentionality is related to how deliberately a position is assumed, and whether it is done as a performance to influence others or as an accounting to others' expectations. Positioner refers to self or other. Within a dialogical interaction, each of the participants always positions the other while simultaneously positioning him or herself. In this sense, positioning constitutes the initiator and the *others* in certain ways. At the same time it is a resource through which all persons involved can negotiate new positions (Harré & Langenhove, 1999, pp.22). Table 1 summarizes the coding schema applied during data analysis.

To investigate how youth gamers engage in the various modes of positioning within the immersive game space, we focused on coding informants' in-game chat transcripts according to the key dimensions of positioning outlined in Table 1. Extending beyond capturing the various modes of self-positioning, data from semi-structured offline interviews were also analyzed as a means of triangulation and to uncover the complex interactions within the interstices of informants' offline and online worlds. Each message line within the chat transcript was analyzed as a unit of analysis, coded iteratively according to the critical dimensions of position order, position intentionality, and positioner. Within the transcripts, each line of message could either be text typed by the informants or performative gestures enacted by the informants, captured within the chat (using a function supplied in the game). Each message was considered in the context of the overall flow of the 'storyline' or the discussion thread in which it appeared.

Table 1. Key dimensions of positioning (Langenhove & Harré, 1999)

Dimension	**Modes of positioning**		
	First Order	**Second Order**	**Third Order**
Position Order	An initial positioning statement	A repositioning of an initial positioning	A positioning statement carried over to a new storyline
	Tacit	**Intentional-performative**	**Intentional-accountative**
Intentionality	A positioning statement that occurs naturally and implicitly within a storyline	A deliberate positioning statement	A forced positioning in response to someone else
	Self	**Other**	**-**
Positioner	A positioning statement about oneself	A positioning statement about another person	

A total of 48 chat transcripts consisting of 563 lines of messages were analyzed. Inter-rater reliability was calculated by determining the Cohen Kappa statistic, and it was at an acceptable value of .87 (Cohen, 1960).

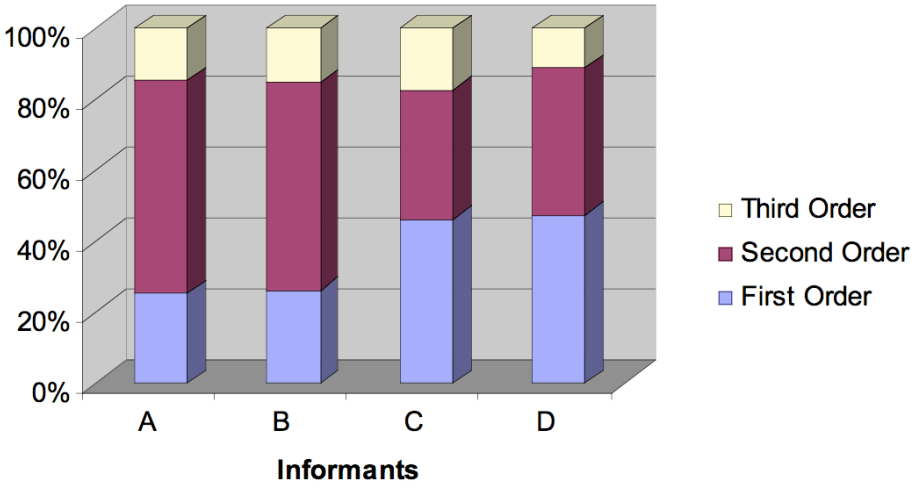

Figure 1. Order of positioning in which informants locate themselves within WoW

Findings and Discussion

In positioning, selves are located within interactions as "observably and subjectively coherent participants in jointly produced story-lines" (Davies & Harré, 1990), within the tripartite structure of position-storyline-performative-social act. Co-construction of identity is negotiated between 'storyteller' and 'audience' through adoption or resistance of 'subject positions' that are afforded by the social-interactional, social-relational structures of the lived world (in this case, WoW). Our first research question was focused on investigating the positions our informants adhered to within the dialogical and performative spaces of WoW. We found that second order positioning was the highest mode of positioning in which informants locate themselves and others within an essentially socially-structured lived world (see Figure 1).

Initial positioning stance appeared to be readily countered within an existing storyline while positioning statements carried over to new storylines were less common, indicating more focused interactions within the game space. Interestingly, our female informants engaged in more frequent first order positioning compared to the male informants. This was traced to the patterns of socialization that they engaged in within the game space: they tend to initiate conversations (e.g. introducing themselves) or enact certain performative gestures (e.g. waving or bowing) indicative of their intention to start an interaction with another avatar within the game space. In doing so, they naturally engaged in more first order positioning stances as compared to the male informants, who were observed to be more focused on levelling up. This observation was contrasted with their semi-structured offline interview data.

> *…back in school, my classmates used to make fun of me. I didn't have that many friends there. I didn't attempt to make friends with them too because I was too shy* – Youth C

> *…no I don't think I will chat guys up offline. Too shy and scared of rejection I guess. In WoW I'm not so scared because I think my avatar is pretty attractive! And I've made quite a few friends- both guys and girls. In fact, I meet some of them for coffee too. Actually it's not so scary after all, now I'm more open to talking to people, especially if it's about gaming because I'm quite good in that* – Youth D

When asked if they frequently initiated interaction with others offline, we observed that informants C and D used terms such as 'shy', 'scared', and 'rejection' in such a way as to

suggest that their patterns of socialization within the offline world are inconsistent with their online performative-social acts. In the case of Youth D, the fantasy constructions of identity in WoW offer an exploration of alternative representations of self that bear upon her identity trajectory. From one who appeared cautious in initiating interactions, she claimed to be less apprehensive as a result of her online interaction experiences. We observed, through the in-game interactions, that Youth D's sense of confidence in engaging in first and second order positioning coupled with feelings of empowerment through mastery of skills in online gaming enabled her to imbibe a more agentive position that pervades the boundaries of her offline and online worlds. In a heterotopic world of online game culture, female gamers seem to have found a context which enables them to enunciate their identity, declare their existence, and find others of their kind (Kennedy, 2002). We posit that this is of particular significance to players who may feel isolated offline, be it as a female or as an individual.

In terms of positioning intentionality, both performative and accountative positioning intentionality occurred in more than 70% of messages analyzed (see Figure 2). Informants engaged in performative positioning that were related to the boundaries of the class characters they chose within the game space. For example, as priests, players focused on being potent healers while as mages, they focused on being powerful offensive casters. The following transcript excerpt indicates the positional intentionality within a particular storyline between Youth C (Hikari) and her interaction partner.

1 To Hikari: hunting you down!
2 Hikari : I need to get to Tiragarde Keep, get those Kul Tiras Sailors and Marines
3 To Hikari: right! but why?
4 Hikari : leveling up, in a good way!
5 Hikari : and get that Benedict and the key!
6 Hikari : you're the expert
7 To Hikari: actually I didn't get benedict's key too
8 Hikari : the last time I thought u did?
9 Hikari : its not an option
10 To Hikari: traded it off some alt :P
11 To Hikari: u gotta do it yourself man
12 Hikari : i've done this for weeks
13 Hikari : and you are kind of off the back now, makes me mad
14 Hikari : I thought u are supposed to guide
15 Hikari: should do it the correct way, no?
16 Hikari : anyway, I'm not gonna spare the time for this man
17 To Hikari: hold it right there, we'll do it together no need to get mad all for nothing

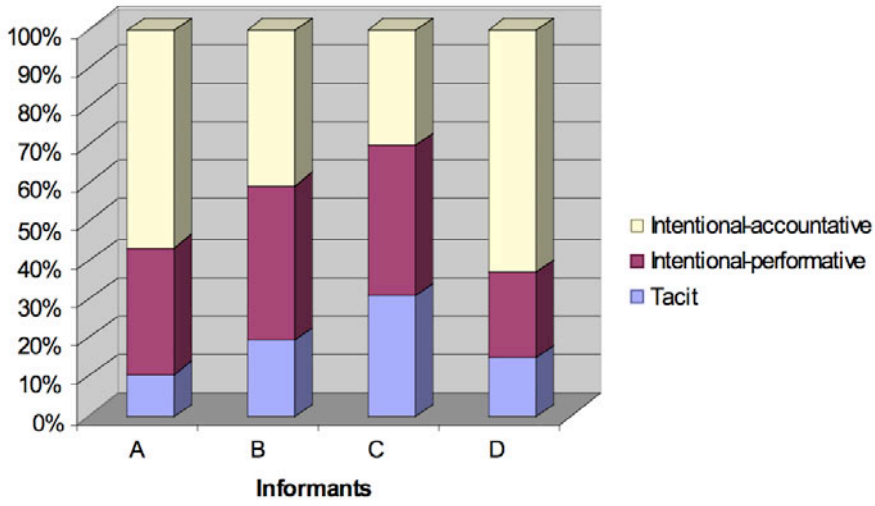

Figure 2. Positioning intentionality within WoW

Analyzing this excerpt, we see that Youth C initially positions her interaction partner as "the expert" (first order). However this was repositioned by her interlocutor's response "actually I didn't get Benedict's key too" (second order). Linking this response to another storyline, "the last time I thought u did?" (third order), Youth C's interaction partner deliberately puts her in an intentional-accountative position (line 12). Accountative positioning occurred in response to *other* positioning of oneself, exemplifying how informants negotiated the conflict between his or her position in relation to how others position them. In doing so, key interaction frames, in terms of participant's alignment and stance of projected self (Goffman, 1981), are constructed for the negotiation of new identity positions. In the case of Youth C, her alignment of her projected self through intentional-accountative positioning (line 14) becomes more strongly coupled with her offline self (elaborated below).

Self and other positioning occurred in more than 70% of messages analyzed, reflecting how informants position themselves within sets of interrelated rights, duties and obligations in WoW (see Figure 3).

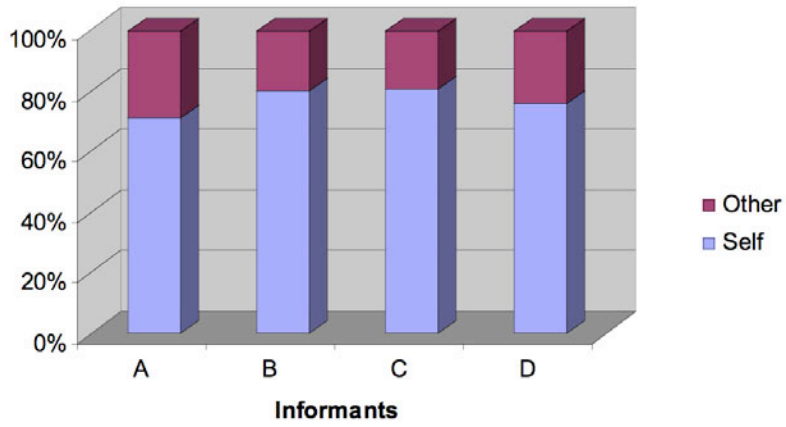

Figure 3. Self-other positioning within WoW

In the aforementioned transcript, we see Youth C engaging in self-positioning (line 4) portraying herself as a gamer who levels up within the normative guidelines of quest completion. We observed higher occurrence of self-positioning within social interactions that give others an insight into the identity of the informant as a game player. For example, Youth C manifests the disposition of a game player who keeps within the narrative structures of

WoW as opposed to leveling up through other means that flout the game's rules. We connected this observation with Youth C's offline interview data.

> *I was a prefect in school, got nominated by the teachers. I guess I've never been the defiant kind. But my classmates, they were all making of fun of me as the teacher's pet, like I was the class nerd or something they used to call me. So I didn't really get along with them…I just let them do what they want…in fact didn't bother too much to even make friends with my classmates. Most of the time I came home and started playing games. Nobody calls me nerd in there…I'm pretty good so don't feel so lousy I guess. It feels so much better talking to even NPCs than my horrible classmates you know.* – Youth C

Clearly, to be nominated as a prefect indicated that Youth C possessed qualities of a person who could assist the school in managing order, ensuring students kept to the school rules. These prefectorial qualities and her disposition toward keeping to normative guidelines and rules in school were recognized by the teachers, and they continue to be manifested even in the online spaces, a reflection of how one's offline and online identities interrelate in myriad ways. As Youth C positions herself within the game space through intentional-performative statements, it reflects her apprehension of her social position within a lived world that constitute relations, or perhaps stable affiliations with her offline identity. The high occurrence of second order positioning and self positioning coupled with performative and accountative intentionality also reflects the agentive affordance within online lived worlds. As opposed to Youth C's nonchalant attitude toward her classmates, within the offline world ("*I just let them do what they want…in fact didn't bother too much to even make friends with my classmates*"), she is very much engaged in repositioning of initial positions (line 8) and forced positioning in response to others (lines 12 - 15) within the online space. The agency manifested reflects how she brings her own experience as well as her own perspective within a particular storyline. Following Davis and Harré (1999), agency implies choice in that the person has the capacity to reflect upon positions taken, can reinterpret their personal experiences, and take up new positions as they become apparent. The ability to position shift or, in other words, to use *position* to fluidly negotiate and renegotiate one's relative status in an interaction require some degree of intentionality, with the realization that as positions shift around, the type of contributions that each participant may make to the interaction will also change (Harré, 2005). We observed that within WoW, it often becomes the responsibility of the person who starts with the more central and powerful position, by merits of contextual expectations and by virtue of being recognized as the "better game player", to initiate game-based position shifts.

Another key aspect of positioning theory concerns the rights and duties associated with a position. Being positioned in a certain way carries obligations or expectations about how one should behave, or constraints on what one may meaningfully say or do. These expectations are frequently the anchor points from which positioning may begin (Davies & Harré, 1999). However deviation from expected duties may occur when repositioning either by self or others is enacted. For example, Youth C's interaction partner had a duty as a guide to assist others in completing quest challenges. However by admitting that he did not get Benedict's key via conventional quest completion, but instead "traded it off someone" resulted in a repositioning in terms of his performance as a guide within WoW. What is important to note is that negotiation of position via self and other interactions has an accumulated impact on one's identity trajectory, a phenomenon that can be seen through the positioning intentionality of players within WoW. When one take a strong performative stance, whatever it may be, that stance will shape the expectations of others, particularly when the relative social position of those others (i.e. new players who look up to higher-leveled or more experienced players)

suggests their ready acceptance. The following transcript excerpt provides another example of Youth A's (Scarab) interaction with a new game player.

1 To Scarab: thanks Lord
2 Scarab : We are going to do some traveling, flight path gathering combined with some questing at this point.
3 To Scarab: I'm right with you
4 Scarab : This will allow us to speed things up
5 Scarab : you with me?
6 To Scarab: yes totally
7 Scarab : Before we leave, go south and zone into Tanaris.
8 Scarab: Go to Gadgetzan and talk to the Gryphon master on the other side of the town to get the new flight path.
9 Scarab : its not an option
10 To Scarab: following me?
11 To Scarab: cords not reflecting…..
12 Scarab : don't bother abt the cords, follow me
13 Scarab : keep close or…
14 To Scarab: yeah yeah not gonna lose sight
15 To Scarab: need to get this through
16 To Scarab: you're like my saviour

From the excerpt, we see Youth A demonstrating in-depth knowledge of the game, through detailed guiding processes using discourse specific to the game, the objective of which was to assist his interaction partner in speeding up his/her leveling up process. There is a sense of recognition and positioning of Youth A as an expert (line 16) that intertwines with his identity development within, and without, WoW. The recognition of Lord Scarab as a skilful and high-regarded game player is carried through to the offline world. As shown in the following interview excerpt, Youth A shared how feelings of animosity and jealousy toward him, brewed within the online lived world, were carried forth into the offline world through threats of physical violence.

> *I was the guild leader in WoW, was recruited, I didn't seek any guild out …I guess they saw my stuff. With my guild members, we spent a lot of time together. When we are not raiding, we would meet up for coffee or just hang out…I remembered there was this group who was not happy with me…I don't know why, I never offended them .I think they were jealous that our guild was rising so fast. They threatened to beat me up if they saw me. That was weird, I don't even know these people but yeah I was kinda scared that I may bump into them in town or something…* – Youth A

The intimately enmeshed online and offline experience demonstrated from the excerpt above reveal "real" engagements between players, with no clear distinctions made between their offline and online realities. To these players, life in WoW is not necessarily any different from offline lives such that delineation of identities occurs. Through strong performative stances within WoW, one's sense of accumulated positioning that bears upon one's identity trajectory may be extrapolated through a dialectically coupled experience of youths' online and offline worlds. This implies that player positioning within social and culturally lived worlds has the ability to not only shape interactions within each storyline, but also to construct and negotiate one's identity over time, underpinned by the tripartite concepts of storyline, positions, and performative-social acts.

Implications

In positioning, selves are located within meaningful social acts as observably and subjectively coherent participants in jointly produced story-lines (Davies & Harré, 1990). Our investigation into the construct of positioning, reified through performative social acts offers a tractable analysis of youth's meaning-making and identity construction processes. We observed how the various modes of positioning in terms of position order, intentionality, and self-other characterized one's projected selves in terms of prominent stances in interaction, selves that one would clearly be identified with or would use to identify the other. Our findings illuminate youth's construction of self with reference to the multiple discursive and performative practices and the interpretations of those practices that can be brought into being as they engage in dialogical interactions within offline and online worlds.

We have seen in this paper that youth's participation in an online social space such as WoW exists as an intimately enmeshed offline and online experience. What players do when engaging in their online activities are largely perceived as *real* engagements with *real* fellow gamers, with no clear distinctions made between their offline and online realities. For these players, life in WoW exists as an enunciation of their relational identities in a changing context influenced by social and cultural practices. This relational perspective bears implications on how we may further understand the ways online activities interplay with youths' offline identities and their sense of self. In moving from static concepts of role to dynamic constructs of positioning, the underpinning relational construct provides an ontology of the phenomena of youth's 'life online'. Recognizing that social and material practices are inextricably linked within youth's offline and online worlds, we are in a more informed position to respond to the demands of youth's increasingly sophisticated literacies, through leveraging gaming and new media technologies toward educational ends.

Our study has shown that youth's engagement in online worlds is far from cognitively trivial. Learning new skills, strategies, and knowledge of the game is seeded by psychodynamic dimensions of motivation and emotions, and social dimension of communication and collaboration—all of which are embedded in the socially situated context of WoW.

Issues of boundary crossings, across contemporary online environments and offline spaces of formal curricular learning, are likely to become increasingly pertinent to educational researchers and technology designers in terms of how youth may negotiate and mediate their meaning-making processes in self-regulatory ways. To this end, we suggest a focus on maximizing the relational interactivity and processes across contexts to enhance performance and learning efficacy in the design of learning tasks. These synergies are with the view to fostering learners' critical and emerging identities. In this regard, a more robust understanding of educationally-valued meaning making and learning processes arising through youth's 'life online' phenomena would only serve to strengthen the bridge between literacy practices in informal online environments such as WoW and in offline spaces of formal curricular learning.

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Engaging career and personal development within immersive environments for students with learning difficulties: Case study paper

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Abstract. Despite the large UK investment in career development services, encouraging young people to engage with these services has often been challenging. Furthermore, providing access to these services for those with severe disabilities and learning difficulties can also be prohibitive due to the physical barriers involved in accruing appropriate resources and connecting with specialist personnel. Whilst the traditional 2D Internet assists in removing many of these obstacles, end-user experiences are far from engaging and can often be frustrating due to the solitary nature of the medium. 'Westlands School Campus' is a functionally and visually rich virtual 3D landscape designed to enable accelerated learning experiences in the educational, careers, financial, sexual health and additional support sectors for young adults with a wide range of physical and cognitive abilities. The highly interactive, immersive and multi-modal virtual environment exploits the potential for personal experiential interactions and stimulating learning experiences within the digital realm. This paper presents, in the form of a case study, the key stages of development and associated methodology, the challenges of adapting new 3D internet technology to education and reflections on the response of teaching professionals and students.

Keywords: Virtual Worlds, Immersive Environments, 3D, Career Development, Education, Learning difficulties.

Introduction

Students at Westlands School have a range of disabilities ranging from mild learning difficulties (MLD) and emotional and behavioural difficulties (EBD) to varying degrees of autism. Protracted definitions of EBD conditions according to the revised SEN (special educational needs) Code of Practice (DfES, 2001) section 7:60 include the terms withdrawn, isolated, disruptive, disturbing, hyperactive, lacking in concentration and presenting challenging behaviour. In the majority of cases individuals with EBD have an emotional difficulty or disturbance resulting in either the refusal or inability to make full use of proper educational opportunities available culminating in pupils becoming difficult or challenging to manage. One of the critical points in the Special Educational Needs and Disabilities Act (SENDA) 2001 states that: "If a disabled person is at a 'substantial disadvantage', responsible bodies are required to take reasonable steps to prevent the disadvantage" (Special Educational Needs and Disability Act, 2001).

In light of the above, it is noted that the role of educational providers to investigate innovative new teaching methodologies in order to provide a more satisfactory learning experience has been recognised as essential (Cobb et al., 2009). To this end, Westlands School have joined over one hundred other colleges, universities and other learning institutions which have established a presence inside 3D Virtual World. These specialist environments

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have the potential to link students who are isolated by disability, geographical location or social circumstances through the establishment of virtual communities and can enable pupils to transcend the limitations of physical life in a virtual space (Wood et al., 2009). Given the collaborative nature of the medium and the development potential to accommodate a wide range of preferences and accessibility options depending on the needs of each individual user (Wood et al., 2009), Virtual Worlds can provide significant opportunities for learners with disabilities. This is especially applicable to children and young people with autism as these individuals tend to relate to computer programs more than they do to tutors or instructors within a traditional learning environment. As a result of this, their learning potential can actually increase when using computer aided instruction programs (Moore & Culvert, 2000). Virtual World technologies allow environments to be designed to meet the specific and highly demanding needs of autism sufferers by concentrating on developing core skills such as speech or eye contact. It is ultimately hoped that the further development and refinement of computer aided learning applications (including Virtual Worlds) for children with autism could lead to breakthroughs in overcoming the social, emotional and communicational difficulties associated with Autistic Spectrum Disorder and with MLD, whilst simultaneously easing the burden of those caring for these individuals (Emmons, 2008).

Support for people with learning disabilities has moved away from the medical model to a social model based on inclusion and integration (British Institute of Learning Disabilities, 2010). In addition to the collaboration and engagement opportunities of Virtual Worlds technology as a delivery tool, a more direct ICT policy can prove highly beneficial to students with learning difficulties in a variety of ways. Levels and paces of learning can be tailored to suit individual needs inside non-threatening environments with the graphical and audible elements offering immediate rewards. An adaptive learning environment, tailored to the needs of the user assists in providing greater levels of autonomy for students. A Virtual World environment may encourage students to make independent decisions to effectively complete and manage tasks in their own time. This is especially important as it has been noted that many students with MLD often suffer from lack of confidence and a general "switch-off" to education after experiencing failure and frustration in education (National Centre for Technology in Education, 2010). This is further re-enforced with the development of practical exercises and role playing which may help students to overcome worries of 'getting it wrong' in real life situations (Broadribb & Carter, 2009). Whilst the use of Virtual Worlds in educational contexts is widespread, it is still very much an emerging technology which meets with some scepticism from tutors. Numerous studies, however, have shown that the use of computer aided teaching does not reduce the learn gain seen by following traditional teaching methodologies (e.g. Tvedten et al., 1993; Xakellis & Gjerde, 1990), indeed it is expected that students with certain disabilities including social interaction deficits such as Asperger's Syndrome may benefit greatly from computer aided learning (Emmons, 2008).

The aim of the Westlands project was to develop an online, engaging learning tool for students with mild learning difficulties using 3D web technology. This was achieved by creating an online 3D learning environment which serves both staff and pupils as a next generation delivery platform for relevant curricular material.

Virtual Worlds

The Virtual Worlds of the 3D Web are persistent online environments which provide rich, experiential experiences through their ability to replicate the salient aspects of human

behaviour and the physical world. Whilst the 2D Internet offers many benefits to the end user and plays an ever increasing role within the educational curriculum, the experiences on offer to both students and academics are very much individualistic and solitary in nature. In comparison, Virtual Worlds allow access for multiple users (~30-1,000+ depending on platform) to be co-present within the same space, and share the same experiences as they occur within the environment. Virtual Worlds enable communication and global collaboration inside media rich spaces, aesthetically constructed to meet the needs and requirements of the activities being performed within.

There are numerous corporate and academic applications for Virtual World technology across a wide range of fields and disciplines which benefit from the ability to simulate tasks that may have financial, geographical or temporal constraints impacting on the feasibility of a physical world event taking place. Gartner, Inc (2007) estimates that by 2011, 80 percent of active Internet users including Fortune 500 enterprises will have a 'second life' in some form of Virtual World environment. In an educational context, Virtual World technology presents new opportunities for personalised teaching and learning scenarios, in turn enabling greater levels of student participation, tailored lesson plans and higher learner autonomy (de Freitas & Yapp, 2005; West-Burnham, 2005; Field, 2007).

There have been many studies documenting the use of Virtual World technologies as educational tools. Examples include movement analysis in sports education to allow coaches to assume the role of the athlete (Lopes et al., 2009), whilst a study undertaken at the Hong Kong Polytechnic University investigating the feasibility and desirability of learning and teaching university-level Media Studies subjects inside a Virtual World was highly praised for allowing experiential and independent learning (Herold, 2009). The technology has also met with success in delivering learning objectives as part of an MBA Operations Management course and in presenting entrepreneurship education modules to primary (Pereira et al., 2009) and secondary school students (McClenaghan, 2009). Whilst Virtual Worlds do not claim to be a substitute for real-world communication and engagement, they nevertheless provide significant opportunities in academic fields, with such institutions as Harvard Law School (US) and The Open University (UK) utilising Virtual Worlds as a platform for curriculum refinement and delivery. Indeed it is proposed that Virtual Worlds in whatever form will be a widely used technology embedded into the social-technical system used for teaching and learning in the foreseeable future (Jarmon, Lim, & Carpenter, 2009).

Westlands Virtual Campus

The principle purpose of this project was to support and assist the curricular education of students with mild learning disabilities (including spectrums of autism) and/or emotional or behavioural difficulties. This was achieved through the development of an online three-dimensional virtual learning environment (3DVLE) for Westlands School based in Stockton-on-Tees, England, in conjunction with Connexions, a service run by the UK Government Department for Children, Schools and Families.

Prior to development of the Virtual World, a series of discussions, meetings and visits were arranged with Westland's tutors and members of Connexions staff to determine the objectives and outcomes of the project and to establish the learning needs and educational requirements of the students. It was ascertained during these meetings that a virtual Westlands campus should be created, with emphasis put on development of an environment which was entertaining, engaging and appealing to the pupils, in order to support a stimulating learning

experience. The Westlands 3DVLE was thus designed to replicate or augment salient real-world facilities inside a familiar and recognisable environment with tasks, information and support delivery with thought-provoking role play exercises attached to each building within the environment. Core elements of the Westlands 3DVLE included a bank, a dedicated Connexions building, a conference centre and an art gallery as well as dynamic street furniture dispersed around the island (Figure 1).

The Westlands 3DVLE was developed using the platform OpenSim, an open-source version of the Second Life application. As one of the most popular Virtual Worlds (with nineteen million registered accounts to date - KZERO, 2009.), Second Life is primarily a social networking platform with "residents" partaking in a diverse range of activities including socialising, shopping, and teaching inside of dedicated environments. The platform is also widely used for conducting corporate and academic research and development as the technology gains traction as a serious tool to aid global collaboration across a variety of sectors. Using the open-source version of the Second Life platform as the delivery vehicle as opposed to Second Life itself, or indeed one of the other 30+ 3D Virtual World platforms (Meta-mole, 2010) available allowed complete control over the build. Construction, functionality integration, server hosting and maintenance could be undertaken without any additional factors such as input, constraints or platform downtime impacting on the project which often occurs as a by-product of licensing a particular platform from an external organisation.

Figure 1. Westlands Virtual Campus environment

WVC Environment and Activities

Each of the buildings and assets contained within the dedicated Westlands 3DVLE environment offer a range of tasks and activities designed to educate, inform and support pupils. The integration into structured lesson plans, role-play scenarios and other group exercises in the environment acts as an accelerant to learning and teaching platforms for tutors. Connexions staff are also able to operate within these spaces and provide dedicated information and support services on a one-to-one basis as required.

Connexions Building

The Connexions building (Figure 2) contains five information points and a dedicated meeting room for Connexions staff to provide help and advice. Students are able to book a timeslot and arrange a private one-to-one consultation with a Connexions advisor. Meeting

Connexions staff in-world, in the first instance may be an appealing scenario to students as the liaison occurs in a familiar and safe environment.

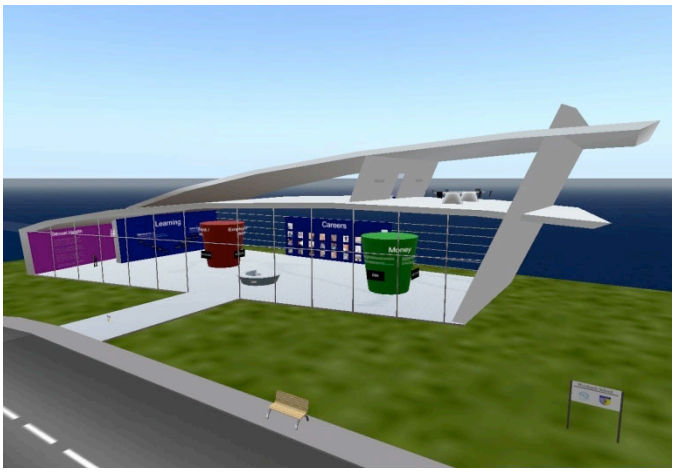


Figure 2. Connexions Building

The information points act as a reference for the students and provide information via text, live web links and note-cards which can be retained by the pupil for future reference as required. Students are able to interact with these resources at will to obtain information relating to money, careers, employment/work, learning options and sexual health. Key information is displayed for each topic with further details available inside a note-card.

Bank

The bank building (Figure 3) houses a main reception, a cashier counter, a service desk, a bureau de change counter, private meeting rooms and an information desk. The virtual bank also contains several ATM machines allowing students to access their virtual account details and view their transactions in real-time.

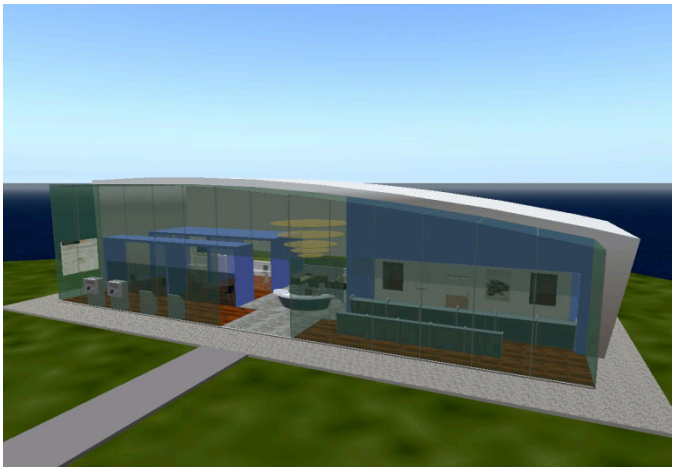


Figure 3. Bank

Students are able to apply for and open a virtual bank account by completing a web based application form available from the service desk. Upon opening the account each student is gifted a set amount of fictional money (initially £200) and a budget planner which they can use to monitor and track their finances, in turn enabling each pupil to analyse their earning, spending and saving activities, in real-time. Insight into the various roles and responsibilities

present inside a banking environment can also be obtained though role-playing exercises with students assuming the position of bank manager, cashier, customer service advisor and customer. Participation in such exercises enables familiarisation of encounters in a comfortable and safe environment, preparing pupils for similar encounters in the physical world.

Car Showroom

The car showroom presents the student with information and considerations involved when looking to purchase an expensive item; in this case a motor vehicle. Cars are presented with relevant specifications including the make and model, price, insurance group, respective MPG and fuel type. With these details students are able to gain insights into the additional running costs which are supplementary to the vehicle purchase price in turn gaining practical experience in dealing with finances and the consequence of choice.

Fuel Station

The fuelling station (Figure 4) further encourages students to consider the implications of purchase decisions by exposing them to the expenses incurred in operating a vehicle. To this end, petrol and diesel costs were replicated to enable calculation of the fuel economy for their particular vehicle.

The fuelling station also provides examples of ecological technologies such as environmentally sustainable fuel (LPG and electricity) and energy (wind and solar) solutions to facilitate learning and discussion regarding the use of fossil fuels. The environmental agenda can be further discussed with the inclusion of ecological areas to introduce biodiversity topics exploring the methods of CO^2 reduction and highlighting the importance of such behaviour. Core benefits to the student in this scenario extend the financial experiences available elsewhere in the environment and also introduce elements of environmental awareness.

Figure 4. Fuel Station

Conference Centre/Art Gallery

The conference centre and art gallery (Figure 5) are both contained inside one building. Located on the ground floor are a series of picture frames enabling the display of up to ten pieces of student art. Students are able to submit images to a tutor which can be uploaded to one of the frames inside of the gallery. The second floor houses a large auditorium with

seating and integrated media option whereby tutors are able to upload video media to run in-world as part of a lesson plan or other curricular activity. All images and videos are referenced from the server they are held on via database queries which update and refresh the link every five minutes.

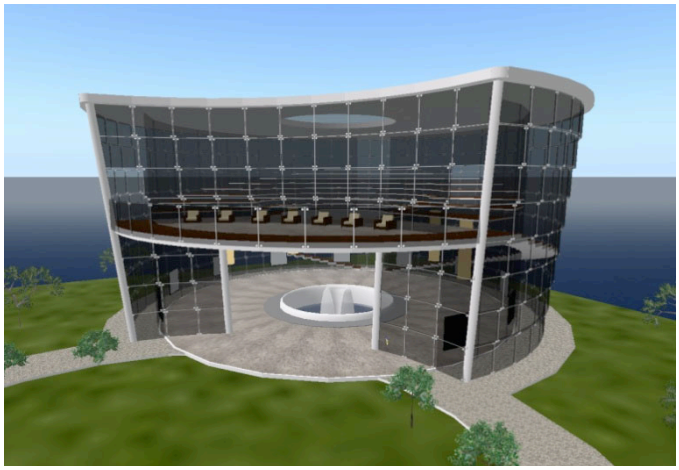


Figure 5. Conference Centre/Art Gallery

Gymnasium

The gymnasium has been recreated as a scale model replica of the facilities available to students attending Westlands School. In the physical world this space is used as a common area for students to socialise and gain insights into fitness, nutrition and other aspects of health and wellbeing. Students are able to partake in discussions and activities centred on aspects of health and fitness, whilst also using the space to engage in social and collaborative communication within a familiar environment. This not only encourages a positive play ethic but also helps pupils familiarise themselves with the Westlands 3DVLE.

Street Furniture

In order that the students feel comfortable within the environment, efforts were made to populate the space with familiar items to create a space that is easily recognisable and comparable to the physical world. The assets used to populate the Westlands 3DVLE assisted greatly in the immersion of individuals into the Virtual World, and in turn, the tasks which they were performing inside of the space.

Static Information

Static objects present inside the Westlands 3DVLE include standardised street furniture such as lamp-posts, benches, bus-stops, fencing and billboards. Whilst selections of these elements operate purely in the context outlined above, several also provide opportunities for further curricular exercises.

With bus travel often being used by the students, exercises were developed to assist students in determining the most cost effective types of fares available. Three types of fare were presented to pupils detailing cost scenarios for daily, weekly and monthly travel tickets. This enables not only the calculation of savings between the three ticket types, but also a comparison between the cost of public transport as opposed to purchasing and maintaining a motor vehicle. Additional billboards located around the island highlight other services such as

TV licence fees and road tax charges in order to inform students about additional expenditure which is often overlooked.

Dynamic Displays

The inclusion of dynamic objects provides tutors with the ability to alter six notice-boards spread over the environment. This in turn assists in providing a stimulating environment for the students whilst keeping them informed of any changes or updates to the Westlands 3DVLE. With the activities and topics taking place inside of the environment differing from lesson to lesson, the ability to modify content on displays allows tutors to cycle the required resources, providing additional information as is necessary. Changes to the billboards are performed through the 2D Staff Web-Portal, part of the Westlands Virtual Campus Management System.

Westlands Virtual Campus Management Systems

Whilst the development and use of the Virtual World to aid in collaborative learning was the core aim of this project, it was also necessary to create and integrate 2D Virtual Campus Management System for staff and students to manage their accounts and control the learning environment from both a technical and educational standpoint.

ICT and teaching staff at Westlands School need overall technical control of the environment as the Virtual World is held behind their own firewall. In addition to network security issues, this meant that account creation, management and alterations to in-world content required the development of a dedicated and secure system. This system was held on the school servers as an Intranet, and acted as a control and amendment mechanism for the Virtual World. In addition to this, a second system was required for pupils to manage their accounts and for integration of components accessed both through the student portal and the Virtual World.

Staff Portal

The staff portal provides tutors with the tools required to manage and control various aspects of the Virtual World. The system also includes a direct link to the student portal via a comprehensive messaging and notice board system, enabling staff to communicate with students individually or as a group. Sources of information and guidance are also available should they be required.

Home Page

Upon successfully logging in, members of staff are directed to the Home page where they can access instructions on navigating the portal and controlling their avatar inside the Virtual World. The Home page also provides facilities for tutors to change their password using a simple web-form and provides complete and comprehensive details regarding the ICT policy operating within Westlands School to ensure that all staff are aware of the codes of conduct regarding the use of the network and the Internet.

Users

Depending on the access rights available to a particular member of staff, tutors are able to create and manage multiple types of user accounts inside the Users page by navigating to one

of five different sub-pages. This area of the system has been developed to allow relevant staff to control access to the environment at all times.

Create an Account

In order to grant a user access to the staff or student portal and provide them with an avatar for use inside the Westlands 3DVLE, a tutor or ICT technician with administrator privileges must create an account for them, achieved via the use of a web form. Administrators first select the type of account to create, a selection which varies depending on the respective function of the individual requesting the account. Options are available for four user types; Connexions Staff, Westlands Tutors, Students and Avatar Only. The two former account types provide access to the staff portal whilst student accounts are tied to the student portal. Avatar only accounts are unique in that they do not grant access to either of the management systems, but do allow access to the Westlands 3DVLE.

Usernames are then entered which automatically generate a dedicated email address ([username]@westlands.stockton.sch.uk) tied into the messaging system of the staff and student portals. In order to generate an avatar for the user, the administrator selects a model from available options; male or female and staff or student. These four options are displayed graphically in order to make the avatar generation process as intuitive as possible for the end user.

Account Management

A complete list of all accounts separated into the four user categories can be accessed through this area of the portal. With full administrator privileges tutors or ICT technicians are able to modify each of these accounts. Connexions, Westlands staff and student accounts can be deleted, have passwords reset or messages sent to their email accounts as required. The Avatar Only users do not have access to a management system and thus the Send a Message option is not available.

Messages

A completely integrated messaging system is built into the Staff Portal for the direct management of all activity related to the Westlands 3DVLE. Comprising of Inbox, Sent Message and Compose modules, tutors are able to manage messages and create an email which can be sent to all students or directly to individuals.

Noticeboards

As with the media elements contained inside of the Art Gallery/Conference Centre the Notice boards element of the Staff Portal is tied into the Virtual World. Tutors are able to view the current messages on display and edit these as necessary. In-world notice boards will update within 5 minutes of any changes.

Logout

Tutors are instructed to logout after using the Staff Portal as a best practice exercise to ensure the security of the account and the Westlands 3DVLE is not compromised.

Student Portal

The student portal gives pupils the tools to interact with the 3D environment. A comprehensive messaging system is in place to enable communication between tutors and

peers as applicable. Sources of information and guidance both from the school and the Connexions service are also available for reference.

Login System

As with the staff, all students are required to log-in with their unique Username and Password to access the Student Portal. Pupils receive these details via an automated email sent to their personal email addresses upon creation of their Westlands account. These login details are identical to those required to access the Westland 3DVLE, creating a unified login system for access to both the Student Portal and the Virtual World.

Home Page

After logging in, Students are directed to the home page which acts as a central location for data access and management of their accounts. Instantly accessible is the messaging system, enabling students to view their email through the user specific mail client embedded on the page. From here students are able to view their inboxes, sent mail or compose a message to be sent to a tutor. Announcements for students sent by staff through their own portal appear prominently inside the Inbox of the messaging system. The home page also provides sections for information regarding navigation of the portal and the environment and the ICT policy to ensure students are aware of the rules and regulations regarding the use of the network and the Internet. A dedicated reporting system to report misuse and bullying is also accessible from this page as are facilities for students to change their password using a simple web-form. Should these passwords be forgotten, they can be reset by an administrator through the student account management system within the Staff Portal.

Information

The Westlands Virtual Campus has been created in partnership with Connexions, a service offering help and advice to young people. The Information Page enables students to access different materials and services offered by the Connexions team:

Ask-SAM

Ask-SAM is a personal advisory service operated by Connexions providing students with the opportunity to ask questions about jobs, qualifications, relationships, drugs, health or anything else that affects their lives. Contact details and web-links to other Connexions services are also provided.

Connexions

Offering a brief summary of the Connexions service, information on their confidentiality and Zero tolerance policies, students are able to familiarise themselves with the types of support on offer.

Meet with Connexions Staff

Integrated into the Westlands 3DVLE, students are able to complete a simple web-form and request a timeslot to meet with a Connexions advisor. Students will then be granted access to the meeting room within the Connexions building located in the 3D environment. Students are only able to gain entry to this space during the timeframe selected on the date of the meeting, with access restricted at all other times.

Expenditure

When students open up a bank account inside the Virtual World, they gain access to their budget planner. Used as part of curricular education, this component enables students to manage and track their finances in real-time. Students are able to access their balance from inside the environment by using the ATM machines within the bank.

Progress

Students are able to complete a personal statement to form part of their overall progress file as dictated by the curriculum. This page consists of nine questions with attached text boxes for pupils to input their responses which can be amended and updated at any time by the student.

Curriculum Vitae

Similar in functional to the Progress page, students are invited to complete a comprehensive form in order to generate a curriculum vitae. Required fields are presented to the pupil with text boxes and forms used to populate details which are again captured via the integration of a save button.

Upload Artwork

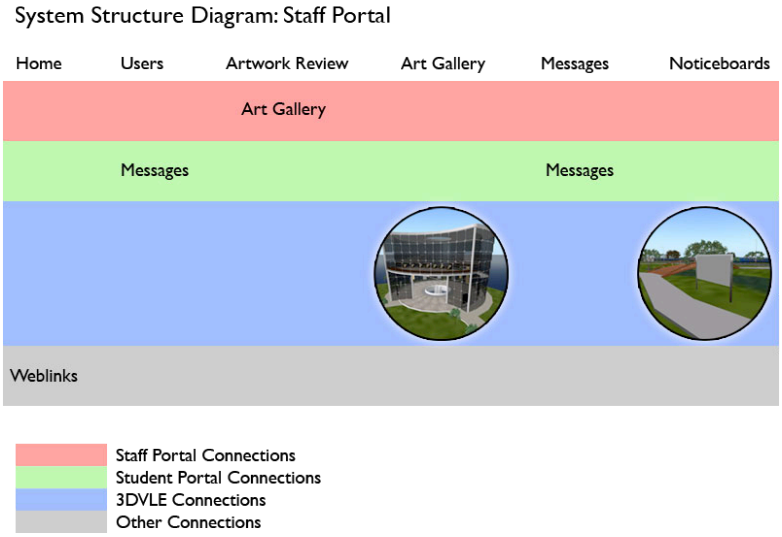
This is the first stage in uploading artwork for display in the Art Gallery inside the Westlands 3DVLE. Students are able to upload an image for review with an attached title by following a logical and simple upload process. This image is then held on the server awaiting approval from a tutor at which point the image can then be assigned to an in-world canvas.

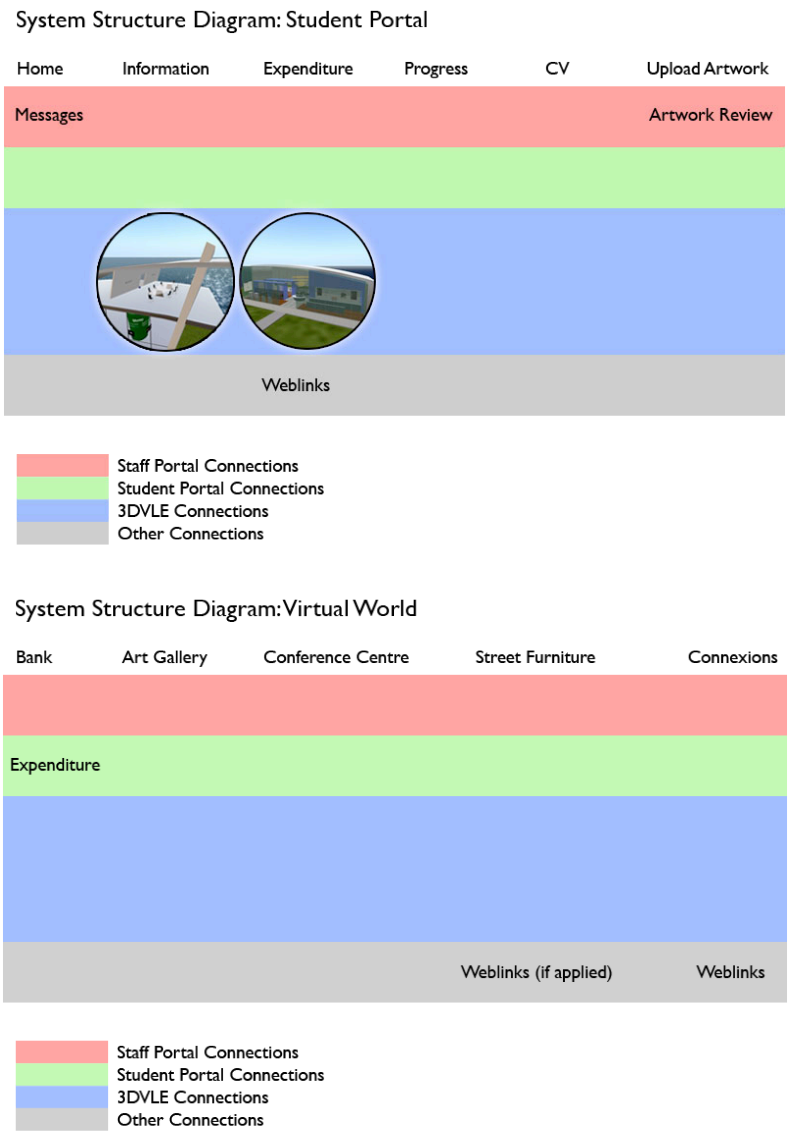
Logout

As with tutors, all students are instructed to logout after using the Student Portal as a best practice exercise to ensure the security of their account and the Westlands 3DVLE is not compromised.

System Structure Diagram

Graphics for the system structure, links for the Staff Portal, Student Portal and Westlands 3DVLE are below.





Feedback from Schools

When presented with the opportunity to utilise a Virtual World environment to support the learning of ICT, careers, PSHCE, English and Maths subjects, the students were reported to be amazed and excited to begin lessons, despite the perceived 'dry' nature of certain topics. Once lessons began, students were described as being immediately engaged with customising their avatars, exploring the environment and making notes on various careers. Feedback gathered from students was overwhelmingly positive with one student using knowledge gained from the environment to complete an application form for a real bank account. It was noted that a large proportion of this effectiveness could be attributed to the informal and fun aspects of engaging with a Virtual World, juxtaposed with the cognitive recall experienced by the students which stemmed from the familiar negotiation of digitally constructed environments present in recreational computer games.

It can often be difficult to hold the attention of students when teaching certain topics in a classroom, even more so when these students are disaffected or have a short attention span. The use of a Virtual World as a delivery tool was reported as having a positive effect at engaging Westlands pupils, the majority of whom are visual and/or kinaesthetic learners.

Tutors were documented as noticing a substantial difference in the motivation to learn as students interacted with the perceptual stimuli inside of the Virtual World, with the replicated Gymnasium and Car Showroom proving very popular. Such was the impact that students were noted as wanting to access the environment from home and continue exercises there.
The effectiveness of the Westlands 3DVLE has been so profound that a cross referenced and certified course in chroma-key video production is in development which will see students upload their own videos to the Conference Facility. Tutors are also documented as discussing options relating to additional environments to offer 'days out' to children with severe learning difficulties who are unable to travel and are already planning extensions to the Virtual World with other schools, with reference to potential global links once the remote networking issues have been addressed.

Conclusion

Providing access to appropriate learning materials to engage career and personal development for those with learning difficulties is a global problem, particularly amongst young people. As discussed in this paper, many of the needs of the users include development of fundamental skills including communication, independence, collaboration and engagement, therefore effective targeting and education at an early age can have extremely positive implications for the future.

The elements contained inside of the Westlands 3DVLE and associated portals can be used to introduce and re-enforce these skills at the level required by the student with a view to preparing pupils for life outside of an educational context whilst also providing a significant positive contribution to the national curriculum.

Designed to replicate salient physical world facilities with stimulating tasks and thought provoking role-playing exercises attached to each sector of the environment, the Virtual World features various assets such as a Bank, a Car Showroom, an Art Gallery and a Conference Centre. Learning sessions for students comprised of a combination of tutor delivery, paper and virtual based exercises, peer discussion and tutor feedback.

Results and feedback received has been extremely positive with students reported to have displayed increased levels of concentration, memory recall and knowledge retention. Tutors were also documented as positively assessing the Virtual World in terms of both effectiveness of delivery and scope for future development.

The positive impact on the student motivation and willingness to learn, even wanting to extend lessons into their free-time from home, was interpreted as a successful outcome and has further highlighted the potential of Virtual World technology in education.

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Promoting emotional health and wellbeing through online solution-focused psychological group work: An account of work in progress

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Abstract. Nisai Virtual Academy (NVA) provides educational programmes to over 350 young people across the UK and overseas. The NVA Connect virtual learning environment (VLE) combines synchronous and asynchronous communication, a virtual classroom, media, chat rooms, blogs and wikis to allow students to study a range of courses, such as GCSEs and A levels, entirely online and participate in a safe and vibrant learning community. NVA examination results suggest their model is effective: learners achieve results that stand up to comparison with the national average results in mainstream schools. NVA are developing an online Wellbeing Centre to promote emotional health and wellbeing. It will be available to those who attend NVA and also as a service to schools. The first programme that is being developed is the Nisai Personal Challenge, a ten week online solution-focused group work intervention aimed at supporting early intervention and prevention work around social, emotional and behaviour difficulties in young people. This paper considers how evidence-based interventions from the face-to-face world might be re-constructed for the online context. The paper clarifies the language of emotional health and wellbeing and offers a picture of the current needs of young people in the UK. A summary of what we know about what works in schools to support emotional health and wellbeing is presented. A solution-focused approach is put forward as a psychological basis to the Nisai Personal Challenge and consideration is given to the evidence and theory basis for this way of working. Examples of the psychological resources that are intended for use are presented and there is a discussion of how these may be re-constructed to take advantage of the NVA VLE.

Keywords: online, coaching, solution-focused, Nisai Virtual Academy

Introduction

Every Child Matters: Change for Children is a new approach to the wellbeing of children and young people from birth to age 19 in England and Wales. The aim is for every child to have the support they need to be healthy, stay safe, enjoy and achieve, make a positive contribution and achieve economic well being. Within this agenda schools have been increasingly positioned to play an active role in enhancing the emotional health and wellbeing in children and young people. This is to be achieved through early intervention and prevention and also through more targeted and specialized work within the context of school.

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The advent of live, immersive, virtual online schooling brings both opportunities and challenges in terms of working to support student emotional health and wellbeing. There is an opportunity to reconstruct, for the online context, what we know supports emotional health and wellbeing when working face-to-face in schools, and also the challenge to develop entirely new ways of working using the digital medium.

Young people, through their use of social networking websites, demonstrate that a generation of young people are readily engaging with the digital world to talk about their most personal issues. One potent element of the Internet is an unlimited potential for identity management within the medium (David Giles, 2006). What is clear is that there has been a digital turn in the social reality of young people. This appears not to be class related. In an analysis commissioned by the USA Department for Innovation, Universities and Skills, entitled "How are young people using social media" (DIUS, 2008), it was found that nearly half of 16-19 year olds went online several times a day and that such behaviour was not income dependent. Going online appears to be a ubiquitous social phenomenon.

Whilst psychological and educational communities ponder how best to embrace this digital era, young people are already engaged in a very real dynamic of immersive participation. The language used on the Internet demonstrates an evolution of discourse (Crystal, 2001), and adolescents are in the midst of that language evolution (Greenfield & Subrahmanyam, 2003). In short, young people are already talking through the web about how think, feel and act, their life and worries and their goals and hopes for the future.

Given the way the internet and social media has transformed the social world of young people, it is perhaps surprising to find little evidence that such technologies have changed the approach taken by those working to positively affect children and young people's emotional health and wellbeing. In fact it is the authors' observation that it seems that the gap between young people's worlds and the world of professionals working with them has widened exponentially in recent years.

If children's professionals are to engage with the digital turn, two issues need consideration: firstly, an evidence-base for developments in this area, and, secondly, how to develop approaches that intervene early in order to be preventative and break the cycle of crisis-response to young people's difficulties.

These issues will be addressed in this paper through a consideration of: the evidence base relating to emotional health and wellbeing in schools; how the NVA Wellbeing Centre will act as a space for information and resources for students; and, the development of an early intervention programme - the Nisai Personal Challenge.

We are, undoubtedly, surrounded by a wealth of needs, illustrated through estimates that show that 10% or 1:10 of children and young people have a diagnosable mental health issue in the UK (Office of National Statistics, 2004). The digital turn in the social world of young people presents the opportunity to create new forms of relatedness, new interventions, and new spaces (through entirely digital or blended approaches) that support emotional health and wellbeing. As well as a re-construction of traditional approaches to embrace the digital turn, there is also a need for an extension of the canon of interventions, approaches and resources and ways of supporting more children and young people than we do currently. In doing all of this, entire new ways of working need to emerge and this requires innovative and groundbreaking work.

The Nisai Virtual Academy Wellbeing Centre

This paper reports upon the practical response to the challenges detailed above made by Nisai Virtual Academy (NVA). NVA are a virtual school provision, achieving better than national average examination results and working with nearly 350 children from all over the UK and beyond who are not in mainstream school, for a range of reasons, or who have some additional needs, including:

- Young people unable to access mainstream education for medical reasons (such as ME)
- Students excluded from school or those at risk of exclusion
- Young people exhibiting emotional or behavioural issues
- Students requiring focused exam preparation
- Students requiring additional academic support within a mainstream setting
- Students living overseas

NVA is a learning community that combines timetabled live teaching sessions and mentoring and support, a VLE, and social networking spaces. NVA have embarked on the construction of a Wellbeing Centre that will provide synchronous and asynchronous group and individual emotional health and wellbeing programmes, using the VLE and live classroom technology, including synchronous communication through text and audio chat, a web-based whiteboard, investigative assignments, chat rooms, discussion threads, wikis and other media content. The centre will also be a space for information and resources on emotional health and wellbeing.

The first programme in development is a 10-week group work intervention aimed at prevention of social, emotional and behaviour difficulties in school. This programme has been given the working title Nisai Personal Challenge and will adopt a proactive stance to develop students' meta-cognitive awareness, in order to:

- Enable personal reflection upon their behaviour,
- Develop their understanding of how this affects what they get out of school and their effect on others
- Work on their goals about what needs to change to improve things and
- Initiate some positive observable change.

The programme is being developed as part of a blended online learning and mentoring service to a group of schools in Cambridgeshire, England and is aimed at pupils who appear to be at risk of escalating difficulties in terms of their behaviour and engagement with school. An experienced educational and coaching psychologist and a teacher with highly specialised expertise in challenging behaviour, educational inclusion and student re-engagement are designing the programme and will also supervise and train the NVA staff who will deliver it. It is hoped this model will allow this specialist work to be delivered to larger numbers of young people with additional needs than currently access early intervention, preventative services.

The development of the Wellbeing Centre requires synergy between the NVA approach, modern evidence-based educational and coaching psychology and many years of experience teaching young people with emotional and behavioural difficulties. To support the creative

process an iterative cycle has been adopted and is outlined below (Figure 1). The planning of the programme draws on an evidence base to inform its development.

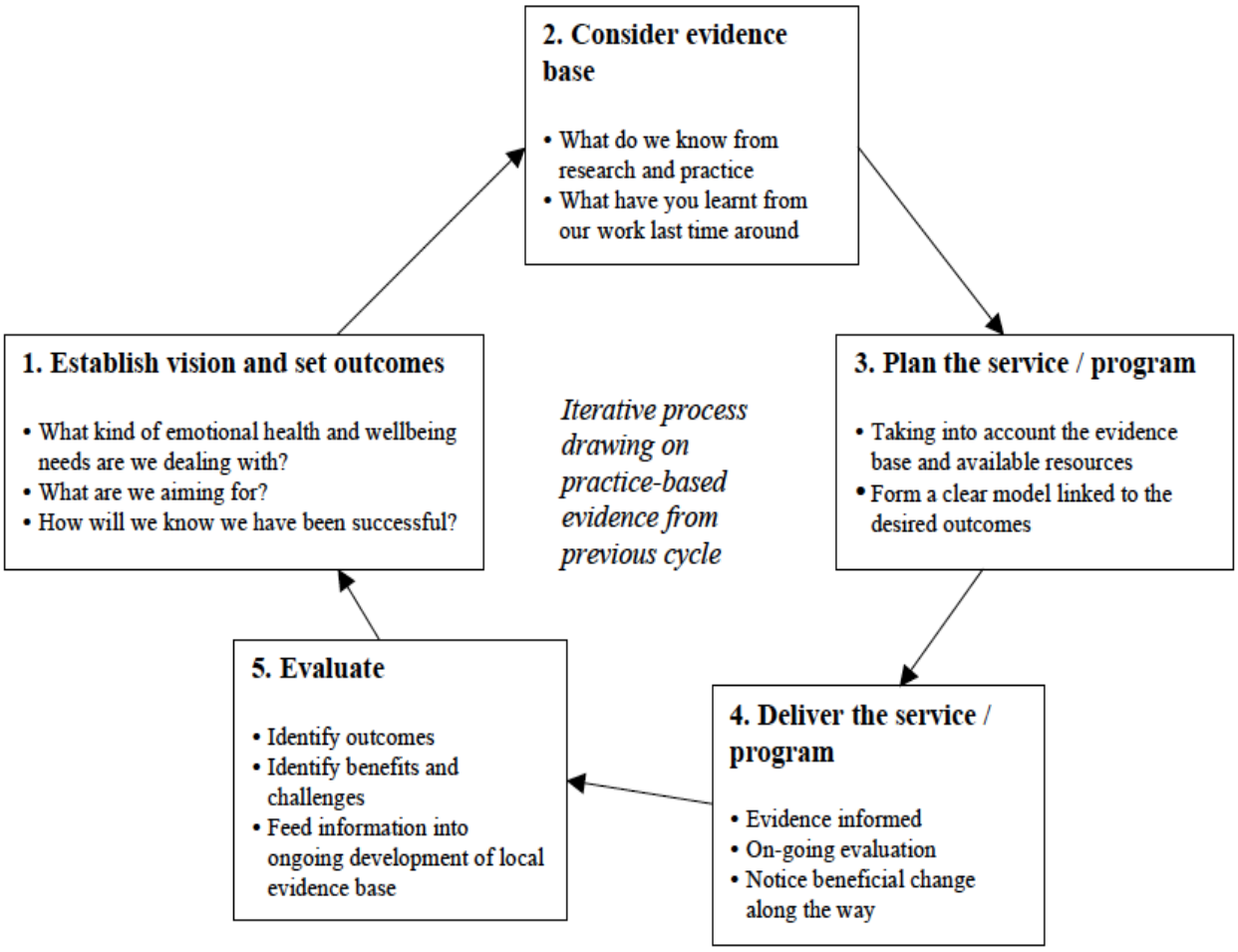

Figure 1. Nisai Wellbeing Centre Iterative Development Process

The context of the development of the NVA Wellbeing Centre requires an understanding of the language of emotional health and wellbeing and the current needs of young people in the UK. It is also important to understand what we know about what works in schools to support emotional health and wellbeing. This evidence base, that has informed the development of NVA Wellbeing Centre, is considered. A solution-focused approach is put forward as a psychological basis to the Nisai Personal Challenge, and consideration is given to the evidence and theory basis for this way of working with reference to the therapeutic outcomes literature. Together these serve to underpin the Nisai Personal Challenge. Some examples of the psychological resources from the programme are presented with discussion about how these may be re-constructed to take advantage of the NVA VLE and social media.

The Language of Emotional Health and Wellbeing

Terms such as emotional literacy, emotional intelligence, mental health and emotional and behavioural difficulties are often used with regard to the emotional health and wellbeing of children and young people. This depends on whether the text in question is written by an

author from an education or health background and as to whether the author is working in the US, UK or Australia. These terms are unpacked below to explain what is meant by the challenge given to schools to enhance children and young peoples' emotional health and wellbeing.

Table 1. Constructs relating to Emotional Health and Wellbeing

Emotional Intelligence	The term Emotional Intelligence became well known in the mid 1990s when the American psychologist Daniel Goleman wrote Emotional Intelligence (Goleman, 1996), which highlighted five areas that can be developed at any stage in life. These developmental areas are self-awareness, empathy and reading emotions, managing emotions, harnessing emotions productively and handling relationships.
Mental Health	In the past mental health has often been used as a euphemism for mental illness but modern definitions of mental health include the ability to develop emotionally, intellectually and spiritually, to make relationships with others, to participate fully in education and social activities and to have positive self-esteem (DfES, 2001; Weare, 2000; Hartley & Brewer, 2001). The term Mental Health is often associated with more medical definitions that traditionally focussed on the presence or absence of mental illness and/or emotional and behavioural problems that are considered outside of the normal range for the age of the child (DfES, 2001).
Emotional Literacy	The clinical psychologist Claude Steiner first used the term Emotional Literacy in 1979. He broke the term down into five parts: knowing your feelings; having a sense of empathy; learning to manage emotions; repairing emotional damage and putting it all together. Steiner places the emphasis on using the emotions in relationships to know how to listen and respond to others (Matthews, 2002). The National Emotional Literacy Interest Group (NELIG, www.nelig.com) says: "In the same way that we talk about ourselves being literate (able to read or write) or computer literate (able to use computers) so too we have degrees of emotional literacy. The degree to which we are emotionally literate, therefore, reflects the degree to which we are able to recognise, understand, handle and appropriately express our emotions. Just like computer literacy and traditional literacy, some of us are better at it than others" (Osbourne, 2004, pp. 20).

There is a strong correlation between all of these terms and a broad consensus that they are all trying to define the same concept in order to promote shared discussions (Weare, 2004). In the UK emotional literacy is the preferred educational term, in contrast to the US where the term Emotional Intelligence seems prevalent. Schools and local authorities in the UK are increasingly using the term 'emotional health and wellbeing' in relation to both the care they take of pupils and the curriculum they provide (OFSTED, 2005). NVA have adopted this term as a way of encompassing the threads of work that will reside within the Wellbeing Centre. The UK Healthy Schools Programme provides a useful definition of the term (DfES, 2004c):

> *a holistic, subjective state which is present when a range of feelings, among them energy, confidence, openness, enjoyment, happiness, calm and caring are combined and balanced…*

(Weare & Gray, 2003, pp. 7).

This terminology invites a positive-discourse about children and young people and a process of growth, rather than a problem-discourse, offering a less stigmatized way for young people and adults alike to talk about strengths and needs in this important area of personal development.

A national picture of Emotional Health and Wellbeing

The statistics regarding emotional health and wellbeing illustrate the need for schools to approach the emotional health and wellbeing of their students in a cohesive and planned way. In 2000 Meltzer carried out a study into the mental health of 10,438 children and their families in Great Britain. The study showed that 10% of children and young people aged between 5 and 15 have a diagnosable mental health issue. The Office of National Statistics (2004) study into the mental health of children and young people in Britain confirms that there has not been any change to this trend over the following five-year period from 1999 to 2004. In 2004, 1 in 10 children and young people aged from 5 to 16 years also had a clinically diagnosed mental disorder.

For vulnerable groups the statistics make for stark reading. Meltzer (2003) identifies that 45% of children who are looked after by local authorities (children in public care) have a mental disorder and some of them experience more than one kind of disorder. 37% have significant conduct disorders, 12% have emotional disorders and 7% were rated as hyperactive. Further to this, studies by Woodcock (2003) into refugee and asylum seeking children, and Aldridge & Becker (2003) into children of parents who experience mental illness show that there is a higher than average prevalence of mental disorders in these groups of children and young people. The studies also provide evidence that there is the need for greater awareness of children's emotional health and wellbeing.

What Works to Support Emotional Health and Wellbeing

With 10 per cent of children and young people experiencing significant difficulties in their emotional health and wellbeing, clearly all schools should consider what they can do to support and enhance student wellbeing (OFSTED, 2005). According to Weare (2001) the very same strategies that prevent mental health problems promote positive emotional health and wellbeing. In other words, recognising what works well on a preventative level is exactly what needs to be put in place for those who are experiencing difficulties.

As early as 1992 in the US (Weare, 2001) and 1998 in the UK, (Rutter et al., 1992) interventions that were most effective in helping at-risk young people have been reviewed. Weare (2001) summarised that both these studies concluded that effective interventions begin early, work on self-esteem, provide personal support, teach life skills, involve peers and parents in the process and create a positive ethos.

Many of these ideas extend into work to address the emotional health and wellbeing needs of all children and young people in schools. Research from Green et al., (2005), Rutter et al., (1998) and Weare (2004) has established that the following characteristics determine greater effectiveness:

- The adoption of a whole school approach within a cycle of continuous improvement with long term plans lasting more than a year

- A greater emphasis placed on emotional health promotion rather than the prevention of mental health problems
- Closer partnership working with specialist professionals offering consultation, training and advice
- When strategies go beyond the classroom in the way that they engage the physical environment of the learners life, link with the family and community, and influence the curriculum and teaching
- Targeting high risk groups to enhance coping with negative feelings, develop better social skills and improve peer relations through specific group and individual wellbeing programmes, underpinned by a clear evidence-base, as well as individual learner level collaborative-consultation and coaching / training for staff working with the learners
- A focus on improving self-esteem that is evident as a core value of the educational context

Through the Wellbeing Centre development NVA are considering the implications of these characteristics and are developing targeting interventions (see point five above), such as the Nisai Personal Challenge programme. To underpin the work an evidence base has been established by turning towards a number of innovative areas of psychological practice.

A Potential Contribution from Psychology

Given the emotional health and wellbeing needs in children and young people, and society in general, it is hardly surprising there have been long standing calls for psychology to broaden its relevance to society in ways that would help the general public in a positive manner in their day to day lives. This call goes back to the late 1960s, (Miller, 1969) however, as Laungani (1999) suggested at the turn of the millennium, traditional psychology as a research discipline and an applied profession had not risen to the challenge of meeting the needs of the broad population.

Things are now changing. The field of positive psychology (Seligman & Csikszentmihalyi, 2000; Snyder & McCullough, 2000) invites the psychologist to disentangle their work from pathology-laden terminology and a clinical approach that can be seen as alienating (Drewery & Winslade, 1997) and may, as Walter & Peller (2000) assert, even contribute to the creation and maintenance of problem behaviour. Instead the psychologist is invited to step out from the deficit-discourse (Gergen, 2004) of traditional practice into a dynamic that is strengths-based and solution-focused. It is from this area of psychology that the Nisai Personal Challenge draws on an evidence base that provides a warrant for the approach being taken- a solution-focused approach.

Solution-focused Approaches

The solution-focused approach is a constructivist, humanistic approach to therapy, coaching or change that concentrates on the strengths that people bring, and emphasizes the importance of solution construction rather than problem analysis (Grant, 2003). Solution-focused approaches grew from a groundbreaking approach called Solution-Focused Brief Therapy (SFBT) developed in Milwaukee in 1980 and given its name in 1982 (De Shazer, 1985). De Shazer and colleagues (Weiner-Davis, de Shazer & Gingerich, 1987; Berg, 1991; de

Shazer, 1988, 1991; de Shazer et al., 1986; O'Hanlon & Weiner Davis, 1989) discovered that clients achieved their goals quicker by talking more about their hopes for the future and their strengths, rather than describing their problem-peppered past. De Shazer also observed that small changes have a ripple effect and lead to larger changes in the environment of the client. As Murphy (1996) went on to emphasize, big problems do not need big solutions.

De Shazer (1985) suggests that for the finding of a solution, it is useful to develop a 'vision' of a future or 'one of a set of futures', that is perceived as being more satisfactory and fulfilling, and the task is to assist the client in developing 'an expectation of change and solution' and the use of the unlocking 'skeleton' key that triggers the first small changes. Furthermore, they discovered that by amplifying the solution behaviour and reinforcing it by giving compliments, the client began to do more of it, thus outweighing the 'problem' patterns. Gingerich & Eisengart (2000), in their review, note that:

> *The solution-focus assumes clients want to change, have the capacity to envision change, and are doing their best to make change happen. Further, solution-focus assumes that the solution, or at least part of it, is probably already happening…* (p. 478).

The crucial assumption made by SFBT- and by extension any process taking a solution-focused approach- is that it is more of an epistemological activity than a medical/therapeutic one (Walter & Peller, 2000) and that: *We live in a world of meaning and language that is creational, social, and active…* (Walter & Peller, 1992, pp. 11).

The evidence basis for this way of working

A solution-focused approach provides the theoretical orientation and practical discursive resources to the Nisai Personal Challenge programme and the frameworks it uses during the 10 weeks course. There is an encouraging evidence base for this way of working that can provide a warrant for this approach. Gingerich & Eisengart (2000) published a systematic review of outcome research relating to solution-focused approaches. The authors identified 15 controlled studies of the outcomes from solution-focused brief therapy, with four of the studies involving children/young persons as participants (Geil, 1998; LaFountain & Garner, 1996; Littrell, Malia & Vanderwood, 1995; Seagram, 1997). These studies provide an indication of the power of the approach, showing a consistent trend towards positive outcomes. They are summarised in the appendix (Appendix 1). Further evidence is set around a series of guiding statements below:

Utilize client's resources and work through a positive alliance

Hubble, Duncan and Miller's (1999) review of outcome studies found that client's utilizing their resources, and experiencing a positive alliance with the worker, accounted for the majority of the variance in treatment outcome. An explicit acknowledgement of strengths is also attractive because it brings:

> *a competency-based view of people as resourceful and capable of fostering a co-operative relationship between school staff…and students with whom they work…*
>
> (Murphy, 1996, pp. 199).

This is important as the client and the client's resources have been found to be critical to a successful outcome, with relationship factors following thereafter, with practitioner expertise, including models and techniques, at a distant third place (Hubble & Miller, 2004).

Given all of this, approaches that harness the client's inner strengths and resources are likely to be most effective, in a similar fashion to recent distinctions drawn in the therapy literature (Linley & Harrington, 2006).

Ask about goals for change

Evidence includes that from the Multi-dimensional Family Prevention programme in the US, which found that families reluctant to engage in services were more likely to do so when practitioners asked about their goals for change (Becker, Hogue & Little, 2002).

Acknowledge strengths

In another study O'Neil & McCashen (1991) found that when they acknowledged family strengths, services users reported that they felt they were viewed more holistically.

Active involvement

Brown (1996), and McKinnon (1992), both found that when service users felt they had been given a say in matters and presented with options, they responded favourably. When the opposite happens individuals became alienated and disengaged. Thoburn, Lewis & Shemmings (1995) found that in their study that individuals were actively involved in 65% of cases where the outcome was good and only in 35% where the outcome was poor or there was no change.

A focus on problems can be counter productive

There is evidence that an extensive focus on problems may well be counter productive. A recent study (Byrd-Craven et al., 2008) shows that extensive discussions of problems and encouragement of 'problem talk', rehashing the details of problems, speculating about problems, and dwelling on negative effects in particular, lead to a significant increase in the stress hormone cortisol, which predicts increased depression and anxiety over time. There is also evidence that the creation of new neural integrative links may be a learning process that remains possible into adulthood and that our brains retain the ability to continually reshape emergent properties that allow us to learn and grow with new experiences (Siegel, 1999). Bannink (2008) suggests that by focusing on resiliency, coping, and competencies (solution talk), new-positive-neural networks will emerge and old-negative-ones will 'die away'.

The Nisai Personal Challenge

The Nisai Personal Challenge is a ten-week group-coaching programme. It will be delivered through twice weekly live sessions and further activity within the NVA VLE. NVA teachers will facilitate the learning process and scaffold the student experience using a series of solution-focused frameworks and resources from coaching psychology. The programme will lead to recognised accreditation (NVA takes the view that the programmes it offers should lead to, or contribute towards, accreditation. As a stand alone course the *Nisai Personal Challenge* engages the learner in a number of competencies, many of which will be able to be mapped onto accreditation criteria, adding extrinsic value to the *Nisai Personal Challenge* for the learner).

The programme places an emphasis on learner variables, particular on motivation, as a predictor of real and lasting change taking place. Experience suggests that the NVA VLE has

a positive effect on learner engagement. With this in mind the aim is to blur the boundaries between learning activity and leisure activity by adapting a variety of solution-focused psychological coaching tools for online use. For example: what might traditionally have been an A4 paper framework may become a blog page to work on; a home work task might become a chat room topic; and a particular concept being discussed becomes an assignment to create a wiki. There are various functions within the NVA VLE and social networking capacities that will be explored including:

- Group chat threads
- Blogs
- Wikis
- Social networking
- Group reference and feedback

By re-casting psychological frameworks through use of the VLE tools and social media frameworks, it is hoped that an entirely new way of working will emerge. Examples of coaching resources are presented below to illustrate the work in progress. These coaching tools will be presented with a running discussion about how these tools will be re-constructed as part of an online approach.

The Solution-Focused Goal Planner

The solution-focused goal planner is a psychological coaching / consultancy framework. It was developed by one of the authors for use in personal coaching and organizational applications and is based on a combination of the Rubin Battino's (2006) work on constructing hopefulness and expectation, and the thoughts presented by Steve De Shazer (2001) on what really counts in solution-focused work. These ideas have been combined into a 5-stage process, as shown in figure 2 below.

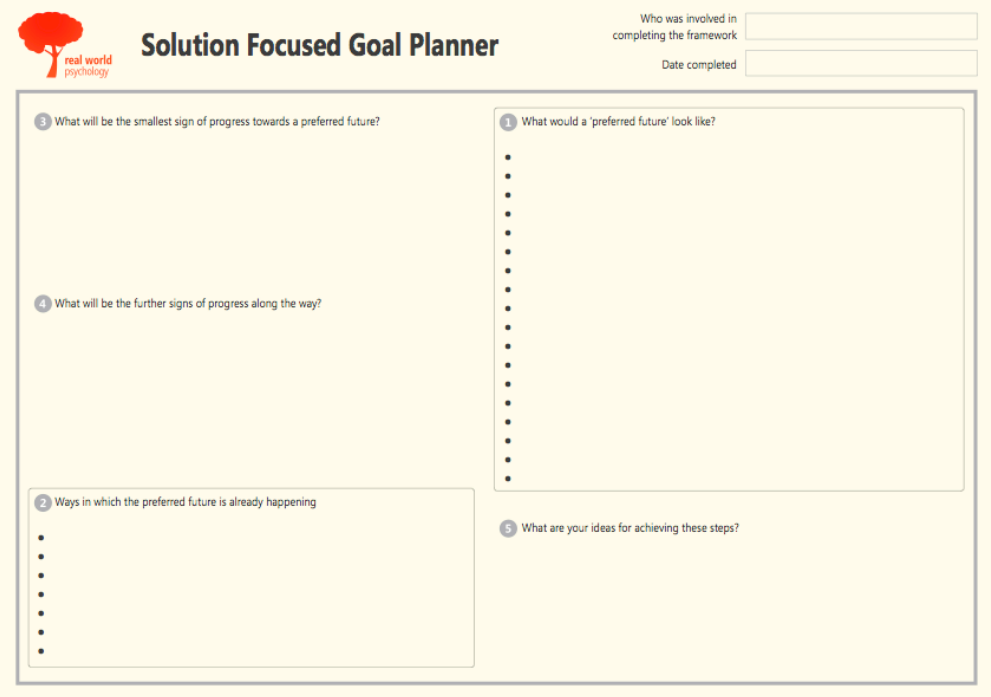

Figure 2. Solution Focused Goal Planner

De Shazer states that what was really essential in the solution-focused approach was eliciting a preferred future, and identifying signs, however small, of those elements of the preferred future already present. This was, in his view, the essence of the model. Questions 1 and 2 on the goal planner reflect these ideas. Battino suggests that hopefulness can be defined as having three key ingredients: a vision of a future worth working towards; a sense of path towards a preferred future; and the agency to take the first steps on the path. By constructing these elements in therapeutic work the aim is to offer a practical way of working on change by creating expectation. Questions 3, 4, and 5 reflect these ideas. The goal planner combines these steps and stages into a simple 5-stage process.

Our initial thinking regarding the goal planner is to re-cast the tool as a web log, or, as it is now better known, a blog. Blogs are often used as a personal journal or ongoing commentary about oneself (Herring, Scheidt, Bonus, & Wright, 2004; Huffaker, 2004) and are usually maintained by an individual with regular entries of commentary, descriptions of events, or other material such as graphics or video and functioning as a personal online diaries.

A goal planner blog would be able to combine text, images, and links to other blogs, web pages, and other media related to its topic - in this case the learner's development of their goals and progress towards them, as well as journal entries and feedback from other people. The group of students working together could leave comments in an interactive format and the teachers facilitating the programme, or even the teachers who teach the student, could leave feedback and give encouragement between sessions. The goal planner blog will act as the backbone to the Nisai Personal Challenge. The blog would be supported through weekly activities and investigations using solution-focused and psychological coaching frameworks as the basis for group work, work in pairs and individual work, along with mentoring from the teacher leading the course. Various activities would be used to unpack the 5 stages of the goal planning process, activities that would, in turn make use of the VLE. For example there may be a discussion thread on what the smallest signs of progress would be, with learners exchanging their ides. An example of a group activity would include a solution-circle, adapted for delivery through the VLE.

The Solution-Circle

Moving from intention into action will be a key success factor of the programme and during the design phase this is something that we have not left to chance. Therefore there are two specific opportunities during the 10 week programme for students to practice change, during which two live online sessions will take place across a day, with the first session early in the morning and the second session late in the day.

The first session will be a coaching conversation, akin to 'high impact" coaching and 'single session brief therapy', whereby the participant is encouraged to imagine "one of those times when things seem to work well" and to work with that imagery and plan small changes that could be made to move towards such a time. To help to make the process engaging, and to help the learners to work together as a group, an adaptation of a solution-circle (Pearpoint, 1996) will be used.

Marsha Forest and Jack Pearpoint of the Marsha Forest Centre in Canada developed the solution-circle format. It is a four step process that people tend to find generates action. It does not guarantee a solution, but it usually gets people "unstuck" and at least points to the

next logical step. The four-stage process involves a problem presenter (focus person), a process facilitator (team manager, time keeper, record keeper) and the rest of the group acting as a team to generate ideas. The solution-circle process as adapted for use in this context is provided in the appendix (Appendix 2). Solution-circles are used in educational psychology practice as a problem-solving tool, as well as in work with teams and organisations (Meier, 2005).

The opportunity to adapt this framework for a VLE seemed too good to miss as the key ingredient to an effective solution-circle is its facilitation. The process has to remain robust for the solution-circle to be effective. With this in mind there are some very clear potential benefits to adapting a solution-circle for use through the VLE:

- The NVA records the session so that the problem presenter has easy access to all the ideas exchanged
- The opportunity to facilitate the process using the VLE functionality, for example to manage timings
- The use of a graphical interface to engage young people
- The ability for participants to use text chat as well as voice chat, and the benefits this brings in terms of participants confidence to speak up

Given the structure the NVA VLE provides, the ease at which a facilitator can manage the participation of those taking part (such as facilitator control over who can talk to whom in a classroom, and the ability for private chat between the teacher and individual students)

Our Best Hopes

At this stage we are at the start of a journey. Our best hopes for the programme are that the NVA VLE offers a milieu that allows students to reflect upon their behaviour in ways that they would not in a face-to-face situation, and that this will help them to initiate positive changes in their behaviour as they take part in the coaching process.

By merging the learner centred pedagogy of NVA with therapeutic ideas and coaching psychology there is a huge opportunity for learning about the potential of the medium to deliver early intervention and preventative work in the area of emotional health and wellbeing. It is also hoped that the NVA VLE can adequately blur the boundaries between online leisure activity (such as social networking) and school activity, so that learners become fully engaged in the programme. If the artefacts produced in the course of the programme, such as a blog based on the solution-focused goal planner, can have veracity, they will seem relevant and owned by the learners and thus affect positive change.

As well as delivering a programme that makes a difference, the aim is also to learn as much as possible about emotional health and wellbeing work delivered through a VLE. This necessitates a clear model of evaluation.

Using Evaluation to Build an Evidence Base

Evaluation of the programme will be undertaken through a detailed cohort study approach, through a cumulative and systemic approach to evaluation. To achieve this, the programme will be evaluated by eliciting the views of the students, the schools that commission the work and the staff whom deliver it using a framework of questions orbiting round two key deliberations- “what worked well” and “how can the programme be better”. Questions will

be asked at regular and key points in the programme. This is an appreciative model, adequately illustrated through reference to Watkins & Mohr's (2001) statement of the basic beliefs of an appreciative approach is that:

> *The intervention into any human system is fateful and ... the system will move in the direction of the first questions that are asked. In other words, in an evaluation using an appreciative framework, the first questions asked would focus on stories of best practices, positive moments, greatest learning, successful processes, generative partnerships and so on. This enables the system to look for its successes and creates images of a future built on those positive experiences from the past.*
>
> (Watkins & Mohr, 2001, pp.183).

Preskill & Coghlan (2003) stress that evaluation through an appreciative framework can increase participation in evaluation, maximize the use of results and build capacity for learning and change in organizations and communities. For these reasons an appreciative posture has been adopted. By structuring in evaluation as part of the ongoing process of the programme it is hoped that improvements will be able to be made in formative manner along the way.

Final Thoughts

The Nisai Personal Challenge is an opportunity to develop early intervention psychological group work using innovate cutting edge technologies. In England and Wales there have been repeated attempts to extend and enhance the delivery of evidence-based work on emotional health and wellbeing in schools to targeted groups. The advent of online schooling provides new academic and pedagogical opportunities for groups of children and young people. What will set this work apart from other work in the area of preventative and early intervention work in the area of emotional health and wellbeing is the immersive online delivery of the programme and the potential that brings for young people.

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Appendix 1

Outcome Studies regarding Solution-focused work with children and families:

Geil (1998) study using classroom-based observation revealed improvements in behaviour in the case of one of the three pupils allocated to the SFBT condition. This unpublished study compared the outcomes from behavioural consultation and SFBT in a sample of eight elementary school pupils with externalizing classroom behaviour problems, using single-case designs.

LaFountain & Garner (1996) reported small, but statistically significant improvements in measures of self-esteem in the case of the pupils involved in the groups, and 81 per cent were reported by their counsellors to have achieved their goals. This work examined the effects of solution-focused group work in a study of the outcomes for 311 participants spread over elementary, middle and high schools with a range of presenting difficulties.

Littrell et al., (1995) found that SFBT was as successful as a problem-focused approach in alleviating high school student concerns following a single counselling session, based upon self-report Likert-scale outcome measures.

Finally, Seagram (1997), in a well-controlled unpublished study, reported lower rates of recidivism (20 per cent versus 42 per cent) at six months follow-up for adolescent offenders who had been involved in individual SFBT sessions.

Appendix 2

Adapted Solution-circle

The solution-circle model is highly structured process. In the NVA adaptation the total process will take a little over 15 minutes. Step one will last for 4 minutes, with the problem presenter having uninterrupted time to outline the worries or challenges they have. Normally the process facilitator has to keep time and make sure no one interrupts; through the VLE this will be achieved through the push of a button. The facilitator normally takes notes, and still can if the problem presenter uses audio chat. If text chat is used than the notes are produced through the recording of the live session. Everyone listens whilst the problem presenter takes the floor and has 4 uninterrupted minutes.

Step two involves 3 minutes of brainstorming, with everyone chiming in with ideas about creative solutions to what they just heard. It is not a time to clarify the problem or to ask questions. The problem presenter listens - without interrupting. The VLE will allow the facilitator to structurally cut off the problem presenter at this point, whilst the participants' contributions can be simultaneously presented.

Step 3 involves 4 minutes of group dialogue led by the problem presenter. This is time to explore and clarify the problem and consider positive points about what they have heard and what can be done.

Step 4 lasts for 4 minutes and involves planning the first steps towards ideas that the problem presenter wants to follow up on. The problem presenter and the group decide on first steps do-able within the next 3 days, with at least one step being initiated within 24 hours. A member of the group will be asked to volunteer to email the problem presenter within 3 days and check if they took their first step. The process ends with a round of words to describe the experience. The overall process will be recorded both as a live recording and also an artefact such as a simple four-quadrant framework, capturing notes from the 4-stage process.

A methodology for determining relationships between cognitive processes and the knowledge dimension when implementing tasks in virtual worlds

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Abstract. This paper presents the methodology utilised in an international collaborative project for developing metrics to evaluate learning in virtual worlds. During the research participants were required to discuss, design and solve real-world and in-world tasks in the programming of LEGO Mindstorms robots. A mixed-methods approach was adopted to combine data from in-world transcripts, reflective diaries, individual interviews with subjects, psychometrics, robotic programming data, and transcriptions and coding from video capture of interaction sessions between the participants. In order to frame what happened in a potential learning situation, Bloom's revised taxonomy was utilised as it provided a categorisation which allowed for the visualisation of relationships between cognitive processes and the knowledge dimension. The challenges for the international researchers though were how to capture, collate, analyse and present the task data in a meaningful and accessible format. The paper will therefore demonstrate the processes and technologies involved in implementing the methodology. Also, initial representations of the cognitive processes and the knowledge dimension determined from the research data will be presented for discussion.

Keywords: virtual worlds, methodology, tasks, Bloom's taxonomy

Measuring learning in virtual worlds

Informed use of technology in education is implemented in distinct phases (Baker, Gearhart & Herman, 1993; Sandholtz, Ringstaff & Dwyer,1997) and virtual worlds is no exception. The early phase of adoption often attempts to create engaging experiences in these new learning environments by replicating familiar real world buildings and institutions (Jennings & Collins, 2008) together with their associated approaches to the learning experience. This transposition of existing practice to these virtual world environments may not be appropriate and does not effectively utilize their unique design and communication opportunities in meaningful ways (Martin, Vallance, Wiz & van Schaik, 2010). Innovative articulation of virtual world collaboration requires a uniqueness of contribution by participants (personally or anonymously), synchronously and/or asynchronously (whichever is most comfortable for the user) with a democratization of the process that can lead to a sum product greater than individual contributions (Wiz & Vallance, 2008). This represents a move from the commonly seen replication of existing practice towards the exploitation of the unique pedagogical affordances offered by emerging technologies; a move from first to second order change (Cuban, 1992). To implement this necessary change, tasks (whether in-world or a blended

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combination of in-world and real world) are required that promote learner activities which would be difficult, if not impossible, in the real world. As deFreitas (2008) asserts, "In order to achieve this next step two related aspects are required: the first is developing better metrics for evaluating virtual world learning experiences, and the second is developing better techniques for creating virtual learning experiences (e.g. frameworks, approaches and models)" (p.11).

Virtual worlds provide an opportunity to explore new educational contexts for analyzing the cognitive process which lead to learning. Two recent studies suggest that this concept has merit. Hobbs, Brown & Gordon (2006) studied students' interactions within Second Life while completing a series of complex, open-ended tasks and found that, ''with careful planning the intrinsic properties of the virtual world can inform transferable skills and provide a rich case study for learning" (p. 9). These conclusions are supported by Jarmon, Traphagan, Mayrath & Trivedi's (2009) study, using a mixed methods approach demonstrating the effectiveness of Second Life in a project-based experiential learning approach where students learn by doing and then apply 'virtually' learned concepts to the real world.

Reviewing research on teaching robotics, Barker and Ansorge (2007) found that: [1] it is an effective tool for teaching science, engineering, and technology; [2] students who have engineered and programmed robots are exposed to other disciplines that are important for robotics, science and engineering; [3] there is exposure to real-world conditions with multiple possible solutions; [4] effective teamwork is a significant outcome; and [5] that female students respond positively to working with robots. We further posit that combining the teaching of robotics with virtual world collaborative technologies and task-based design has potential for increasing university students' science and technological skills. This potential can only be realised if clear objectives are established and if we know how to understand and measure the most effective ways to do this (Martin et al., 2010).

Bloom's taxonomy as an instrument for measuring learning

For over forty years Bloom has provided a valid and reliable taxonomy that has allowed educators to visualize teaching objectives and perceived learning together with the associated notation, categorization and assessment of aims (Bloom, 1956; Anderson, Krathwohl, Airasian, Cruicshank, Mayer, Pintrich, Raths & Wittrock, 2001). In Bloom's taxonomy, a range of learning objectives are presented as cognitive functions (Anderson et al., 2001) that enable cognitive learning, that is, "… recall or recognition of knowledge and the development of intellectual abilities and skills" (Bloom, 1956, pp.7). The six categories associated with the cognitive processes identified in the revised taxonomy are: [1] remember—retrieve relevant information from long-term memory; [2] understand—construct meaning from instructional messages, including oral, written, and graphic communication; [3] apply—carry out or use a procedure in a given situation; [4] analyze—break material into constituent parts and determine how parts relate to one another and to an overall structure or purpose; [5] evaluate—make judgments based on criteria and standards; and (6) create—put elements together to form a coherent or functional whole, reorganize elements into a new pattern or structure (Anderson et al, 2001). The verb sub-sets associated with these cognitive processes are: [1] remember—recognize, recall; [2] understand—interpret, exemplify, classify, summarize, infer, compare, explain; [3] apply—execute, implement; [4] analyze—differentiate, organize, attribute; [5] evaluate—check, critique; and (6) create—generate, plan, produce. Supporting the cognitive processes are four general types of knowledge that include: [1] factual knowledge—knowledge of discrete, isolated, content elements; [2] conceptual knowledge—knowledge of more complex, organized forms such as classifications, categories, principles, generalizations, theories, models and structures; [3] procedural knowledge—

knowledge of how to do something; and [4] metacognitive knowledge—knowledge about cognition in general, as well as awareness of and knowledge about one's own cognition (ibid). A strength of Bloom's taxonomy is that it provides a visualization of a relationship between both cognitive processes and knowledge (see Table 1 and Appendix). The clarity offered by the taxonomy has potential to make virtual worlds more accessible to educators and to allow exploration of the ways in which they differ from more traditional learning contexts.

Table 1. Bloom's taxonomy grid (Anderson et al., 2001)

Knowledge	Cognitive Process					
	Remember	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Create**
Factual						
Conceptual						
Procedural						
Meta-cognitive						

The language found in many assessment structures and marking guides in HE institutions reflects the hierarchy within Bloom's Taxonomy where, in the cognitive domain, evaluation and synthesis is privileged beyond analysis or application and above memory or understanding. For instance, in a university context remembering and understanding of knowledge (facts, theories, procedures, etc.) is often judged using such marking schemes (% marks) from 'weak' or 'flawed and inaccurate' (>39), through 'limited or insufficient' (40-49), 'acceptable' (50-59), 'clear and analytical' (60-69), to 'excellent and critical' (70+). Marks in the higher range are often also differentiated by the degree to which excellent and critical understanding of areas of knowledge is seen to be characterised as being 'organised', 'systematic' or, at the highest level, 'complete'. Whilst at times this terminology varies somewhat from one institution or programme to another, the marking schemes and guidelines we have found exhibit at the very least a significant congruence with the revised Bloom's sequence of 'remember', 'understand', 'apply', 'analyze', 'evaluate' and 'create' (Anderson *et al*., 2001).

A similar sequence is applied to knowledge dimensions that are assessed in student work, where the hierarchy of ways in which knowledge and understanding may be articulated is further elaborated by whether they are simply 'used' (factual), or are 'theorised' (conceptual or, depending on context, 'procedural') or, at the highest levels, presented in ways indicating that they are 'synthesised' (meta-cognitive). For example we find assessment frameworks characterise the weakest use of concepts (discussion) as 'insufficient' (>39), whereas above this their 'integration and analysis' into the work is rewarded more highly (40-49 and often 50-59). Beyond this students gain still higher marks for the integration and analysis of 'different' or 'diverse' concepts (60-69) and the strongest work shows evidence of being able to 'synthesise and interpret' complex concepts (70+). Similarly, the use of argument and discussion is increasingly rewarded as it is found to be 'unclear' or 'unsourced' (>39), 'invalid' (40-49), 'reasoned' and 'valid' (50-59), 'rational' or 'logical' (60-69), or evidenced by being 'sound', 'compelling' or at best 'original' (70+). In the same way the use of analytical and research methods may be 'narrow' or 'inappropriate (>39), 'limited' or 'ineffective' (40-49), 'adequate' (50-59), 'effective' (60-69), or 'very effective' or 'excellent' (70+).

The use of such language underscores the acceptance and adoption of Bloom's approach to forms and levels of learning as being organised into a series of strata, each of which is assumed to be a prerequisite for the one above it. The current project was thus conceived to facilitate an

exploration of learning in virtual worlds by studying the communicative exchanges between and within teams during problem solving activities. A closed and highly defined task seemed most likely to provide the necessary comparability and empirical data to determine the success of task completion. To enable this we adopted the programming of robots to navigate mazes of varying complexity.

Robots as a context for learning in virtual worlds

Lego Mindstorms NXT software version 1.1 was selected to create the robot programs. The design of the robot followed instructions 8527 of Quickstart-Mindstorms (see http://preview.tinyurl.com/yfw75s2) and was adopted due to its simplicity and its potential for sensors to be added as the research and task framework is further developed. Programming the Lego robots used in this study required the determination of an action and a vector. The variable of task difficulty in this context was thus defined as the minimum number of discrete manoeuvres required to successfully navigate a given maze (Martin *et al*., 2010).

Implementation

A structure was built within Second Life (SL) as a space to implement tasks. The SL space also provided a medium for communication between students represented as avatars in SL (*ibid*). Sixteen tasks were implemented. Each task aimed to facilitate the process of communication leading to a successful outcome, and to garner feedback on the use of the SL space for conducting learning activities. The use of NXT program blocks as manipulative, interactive images was included on the horizontal floor of the SL learning space while NXT block variables were represented as vertical images. Students were remotely located, so used avatars for text and voice communication. Student participants re-arranged the NXT blocks in SL (see Figure 1) to replicate the Mindstorms program. Another student participant simultaneously programmed NXT as instructed. The resultant program is then uploaded via USB to the Lego robot and tested. A summary of the process is as follows:

- Student teams A and B were physically in different locations
- Students A were provided a maze circuit by the researchers
- Students A had to 'teach' students B so that the maze was replicated
- The NXT program's 'building blocks' were created and maneuverer within Second Life (SL)
- On the SL walls were the various options for each block. The blocks were moved by both avatars
- Communication was by voice and text
- A thick blue arrow allowed avatars to point for physical direction and focus
- Two media presenters enabled images to be uploaded and changed. For example, an image of the robot was uploaded so that the USB ports could be identified
- The 'solutions' were periodically transferred to the robot and checked
- Modifications were sought and provided until the solution was achieved
- All communication was digitally recorded
- Screen capture of all text interactions in Second Life was recorded
- 16 tasks of increasing difficulty resulted in 60 hours of captured video (30 hours for each group A and B)

Figure 1. Participants (as avatars) collaborating in *Second Life*

The captured video was merged with the transcriptions for each task using *Transana* software (see Figure 2). This augmented data was then coded using the cognitive processes and knowledge dimension descriptors of Bloom's taxonomy.

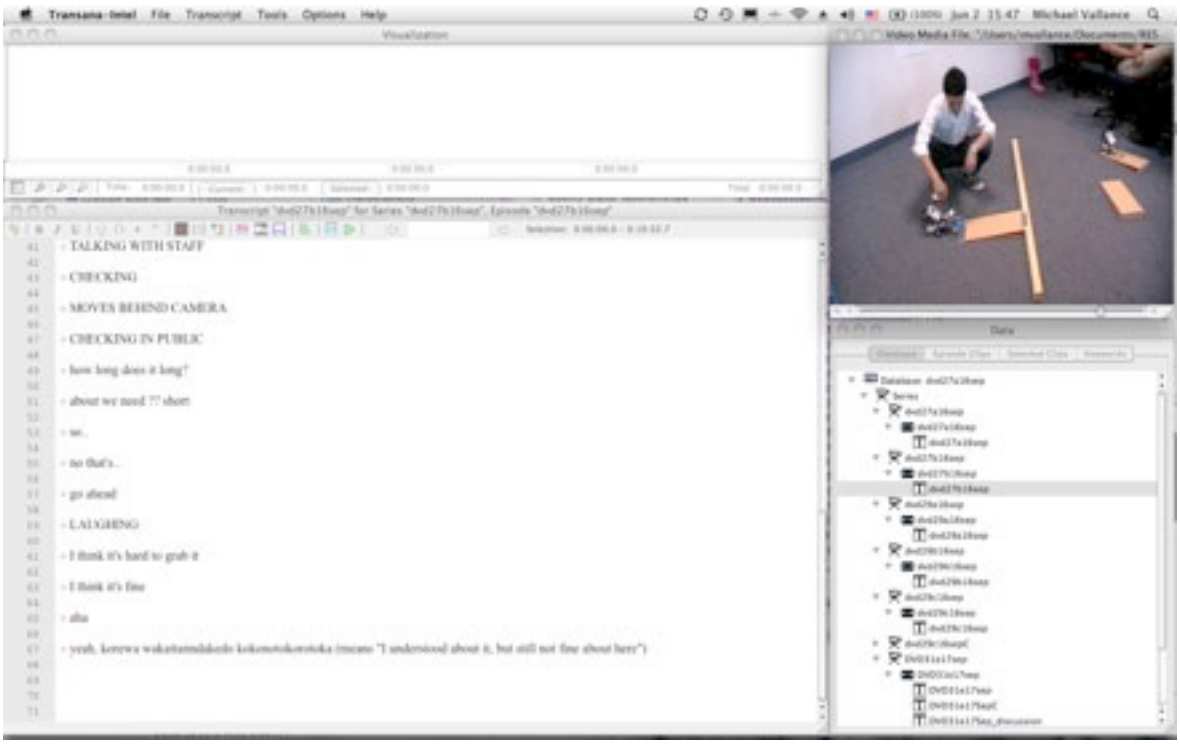

Figure 2. Augmentation of recorded data

The analysis was a collaborative effort so Google Docs was utilised to share the coded data files in real time. The data was initially viewed in a dynamic graph called a motion graph

(Rosling, 2009). This enabled us to look at the effect of one cognitive function on a particular knowledge domain, and attempt to draw conclusions from the 'processes' rather than just the 'outcomes'. The data was also graphically represented as an Excel chart. The next section will discuss the results of our initial analysis. We propose that the revealed dynamics between these taxonomic elements and the developed metrics will provide insights into the nature of effective pedagogy in these new learning and teaching environments (Martin et al., 2010).

Results

We did not anticipate that during their learning and communicative experiences subjects would display high frequencies of factual or meta-cognitive knowledge as both the nature of the activities and their relative unfamiliarity to the subjects made this less likely. It was our intention to focus activities on the use procedural and conceptual knowledge both because this was more appropriate for the tasks and in order to avoid trying to track a larger number of variables. We did anticipate that our tasks would generate greater instances of conceptual and procedural knowledge, particularly as task challenge was increased over time.

As expected, the observed frequency with which subjects employed procedural knowledge appeared to be unrelated to instances of 'remembering' and 'understanding' and was instead more frequently associated with 'analyzing' or 'creating'. The most frequent appearance of procedural knowledge was found when subjects were 'evaluating' and even more when 'applying' (see Figure 3).

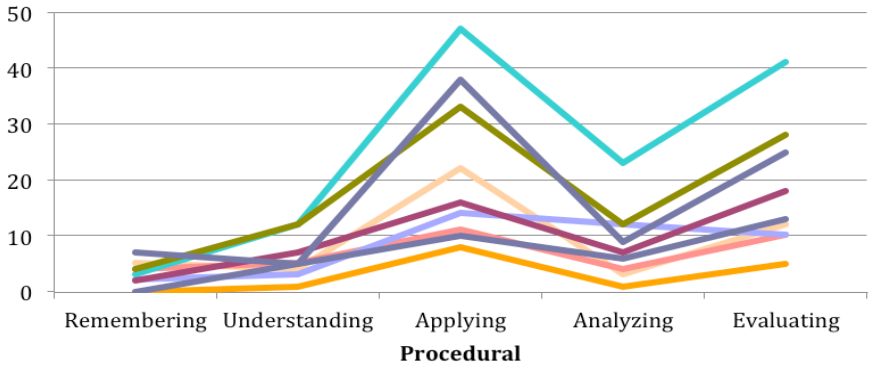

Figure 3. Activity counts from transcript coding, ordered by session (series).

Whilst these results were in line with our expectations, given the nature of the set tasks, it was surprising to see no consistent trend or development in the frequency with which elements appeared over time in the sessions, expressed as a percentage of the total session activity. The relative frequency with which particular kinds of cognition appeared in the data (e.g. 'applying procedural knowledge') was not patterned as tasks progressed and difficulty increased. When reading in session order from bottom to top for 'applying procedural knowledge', for example, we find that it occurs as a percentage of the overall total for this across sessions - session 1 + session 2 + session 3, etc. - as 19.1%, 8%, 16.6%, 5%, 23.6%, 4%, 7%, 5.5% and 11.1% of the total (see Figure 5). Given the steadily rising level of task difficulty and students' increasing mastery of these more challenging tasks as evidenced by their ability to complete them with fewer errors and in less time, Bloom's Taxonomy would suggest that some developmental pattern should be expected to emerge as the procedural knowledge required to complete them came to be more effectively applied and as student accomplishment increased. A similar situation was found for other elements (see Figure 4).

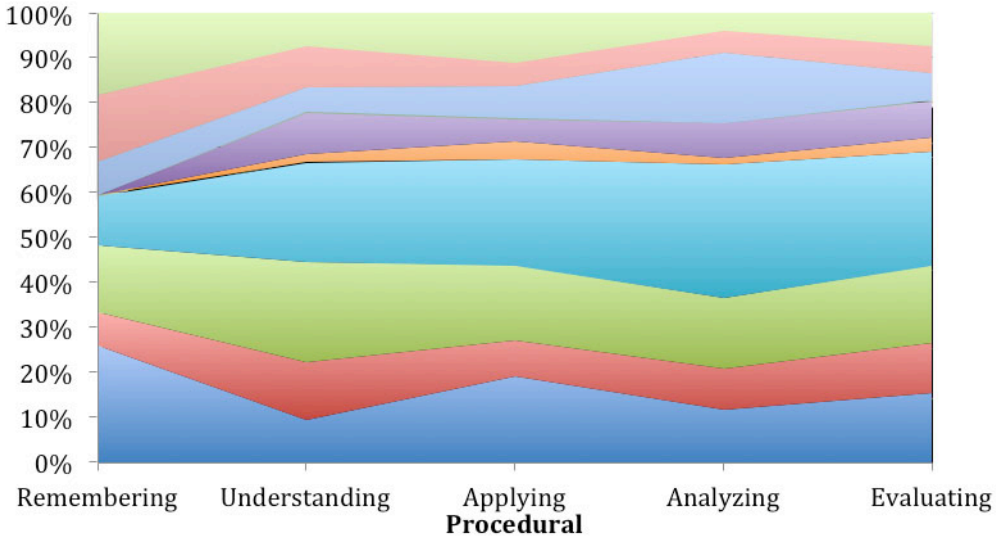

Figure 4. Activity counts from transcript coding, as % of activity per session, ordered by session (series)

Unlike the situation for 'procedural' knowledge, as sessions followed each other over the experimental period the observed cumulative frequency of 'conceptual' knowledge tended to increase for the dimensions of 'understanding', 'analyzing', 'evaluating' and 'creating' although most intellectual activity appeared to have been directed towards originating, comprehending, understanding and developing such knowledge rather than to applying it (see Figure 6).

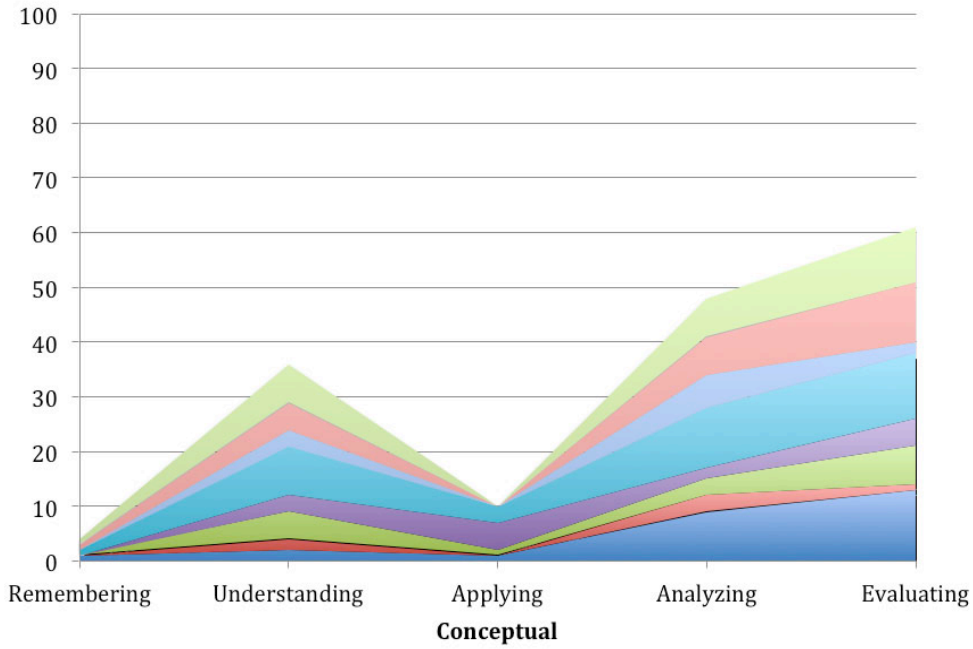

Figure 5. Activity counts from transcript coding, ordered by session (series)

However, as was found with 'procedural' knowledge, the relative frequency with which the different elements of cognition appeared in the data (e.g. 'applying conceptual knowledge') did not present itself as a linear or rising percentage of development but more often was disjointed.

This is implicit in earlier representations (see Figure 5) but is more clearly seen if reformatted (see Figure 6).

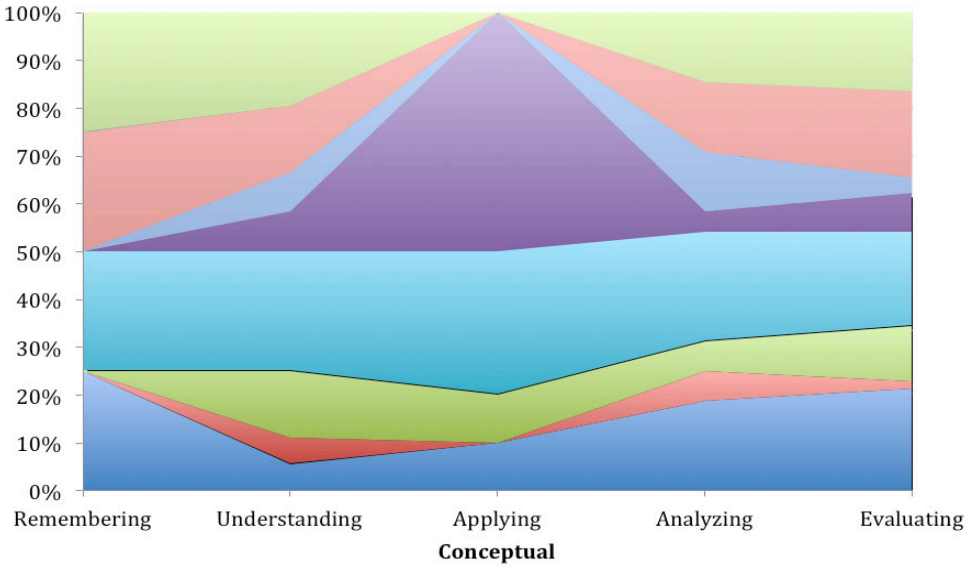

Figure 6. Activity as % of each session, ordered by session (series)

Discussion

There is widespread use by many educators of assessment schemes based on an ordered hierarchy of cognitive activity, where the judgments of educators on the learning progress of students is commonly expressed using either percentage marks or ranked alphanumeric grades. Such schemes possess high face-validity because they appear to represent common-sense descriptions of learning progression. Often they are implicitly and sometimes explicitly based on taxonomies of assessment identical or very similar to that developed by Bloom. However, Bloom's Taxonomy is not a theory of learning but is a taxonomy for learning, teaching and assessing and as such its primary purpose has always been intended as a framework for "categorizing educational objectives" (Anderson et al., 2001, xxi). It does not follow that such categorizations should be taken to imply that their structures represent a map of a smooth developmental sequence or process involved in the learning and mastery of particular cognitive skills and abilities.

The use of such frameworks for assessment would presume that educators provide their students with learning experiences designed to help them develop and articulate the elements privileged within them. It is our experience that educators frequently apply such frameworks as proxies for a theory of learning and assume that the ordered structures of cognitive elements in these hierarchies accurately map the structure and sequence of their students' cognitive development. This can raise expectations that learning will closely follow the hierarchy and order of the categorization of educational objectives being used for the purposes of assessment.

Looking at our current graphs it may be that we need more participants to undertake the same tasks. The data points would be increased and so a more cohesive pattern may occur. Our data shows that learning is not as structured as Bloom’s taxonomy suggests but can be quite irregular. However, more students and more data points may illustrate otherwise; particularly if graphically illustrated in a motion chart. In addition, the use of Bloom’s may be considered a limitation in an analysis of learning. However, the justification is that at some

point the outcomes from this longitudinal research experiment needs to be applied in the schools where activities are designed and assessed according to the Bloom's taxonomy. Our research aims to enable a design of activity in virtual worlds (a virtual worlds activity metrics framework) that will meet specific learning (or assessment) criteria based upon the experiments we have conducted.

We also acknowledge that the research implementation imposed many communicative constraints which led to participant frustration, and may have restricted further opportunities for learning. Our immediate challenge then is to create new tasks that will allow us to further the data for subsequent analysis using Bloom's taxonomy but with no restrictions of communication within world. We also acknowledge the limitations of our data collection; for instance, the coding of the transcriptions was manually undertaken by researchers. Although the use of the *Tams Analyzer* and *Transana* software attempted to alleviate errors in coding, there remains the fact that the researchers could only 'interpret' what they perceived to be going on given the textual and video evidence available. The transcriptions were of participants discussing how to work through the set tasks. Linking the transcripts to the captured videos attempted to visually interpret the discussions within the parameters of the Bloom's taxonomic elements. These discussions were not necessarily explicit expressions of learning. The researchers' analysis was an interpretation of what went on despite attempts of academic rigour by linking video to transcribed text, returning to the video and text (via the software) to confirm a taxonomic element, and prior benchmarking by the two researchers. Consequently, the researchers were attempting to interpret the participants' thinking and learning from their communication. This is a constraint of the research that needs to be overcome in the next iteration.

Conclusion

Although the outcomes derived from our research are derived from tasks conducted within a virtual environment, the associated learning and communicative interaction between subjects was conducted synchronously in the real world. It is from the real world manifestations of cognitive activity that data have been extracted and the coding and analysis conducted. Although interactive collaborative learning tasks were implemented in the virtual world, the communicative interactions in the real world that are signifiers of the learning process and its associated outcomes are the focus of our analysis, in the same way as is applied by educators to more traditional encoded expressions of learning (written work, discussions, presentations, portfolios, etc.). Interactions within and outcomes from the learning tasks in the virtual world can be applied to (and have implications for) real world interactions and learning contexts.

These outcomes appear to challenge the often held assumption within educational practice that a consistent and reliable proxy for increasing student mastery of cognitive skills is to be found in the outputs from assessment regimes derived from Bloom's hierarchy. Such assumptions are particularly questionable where assessment schemes presume an ordered relationship between the indications of increasing intellectual competence that they appear to provide and the actual acquisition of incrementally higher-order cognition by individuals. Our data suggests that the 'scores' (marks) derived from such assessment instruments may not correspond closely to the development and mastery of cognitive ability in an individual to whose work they are applied and that the use and mastery of cognitive skills and processes is more commonly unstructured. The range and sequence of values in our data suggest this to be particularly so in the 'higher order' realms privileged by assessment schemes derived from

Bloom's taxonomy.

It is anticipated that collaboration in virtual spaces will become more prominent in mainstream Higher Education within the next five years, and this research aims to provide educators with a framework upon which to construct their curricula, design effective tasks, and assess learning outcomes within such environments. By adding to the existing data we anticipate an evidence-based framework can be developed that will inform practitioners how to best implement tasks that require specific curriculum learning aims in virtual spaces.

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Appendix

	I am …	I am using facts	I am aware of theories and/or classifications being used	I am doing something (a procedure)	I am aware of what I know and/or what I do not know
remember	recognizing listing describing identifying retrieving naming locating finding				
understand	interpreting summarizing inferring paraphrasing classifying comparing explaining exemplifying				
apply	implementing carrying out using executing running loading playing operating				
analyze	comparing organising deconstructing attributing				
evaluate	checking hypothesising critiquing experimenting judging testing detecting monitoring				
create	designing constructing planning producing inventing devising making				

Nisai Virtual Academy and children with Myalgic Encephalomyelitis (Chronic Fatigue Syndrome): Improving learning outcomes through an online approach

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Abstract. Myalgic Encephalomyelitis, more commonly known as ME, is a debilitating illness that currently affects an estimated 250,000 people in the UK. Symptoms include neuropathic pain, exhaustion after minimal effort, loss of ability to concentrate, blurred vision and sensitivity to sound, light, and temperature (similar to meningitis). Everyday tasks and social situations can be impossible to manage and for young people with ME, attending school or college can be a real challenge. For students with ME, e-learning represents a transformation in terms of educational opportunity. The Nisai Virtual Academy has attempted to achieve this transformation through a vibrant, safe and secure social learning network and online community. NVA use cutting edge technologies with contemporary teaching expertise to provide a campus simulation that enables young people to engage in a learning community. Once logged into NVA, the students are immersed within a participatory learning environment where academic provision is enriched using secure social networking, blogs, forums and a range of online games, clubs and activities, all in a safe environment. The academy's first enrolment was in 2005 and now works with around 350 students from the UK and beyond. Most recent student learning outcomes indicate that NVA outperforms mainstream schools in terms of GCSE results, both for students with ME and overall. NVA are acting as systems leaders in this specialized area of work and this paper presents the key recommendations made by experts in the field of ME and tells the story of how the re-construction of the learning context as virtual and online through the NVA has in turn allowed for the re-construction of the student suffering with ME as being capable of continued participation in education, and, ultimately, success in learning at key stages in their lives. A series of vignettes are presented that give an initial insight into this innovative work. The voices of a parent, student and a professional are shared through these vignettes, which include enthusiastic comments and describe the positive experience of online learning through the NVA. The aim is to share this positive story and celebrate the effect technology has had on the lives of these young people with ME. The authors conclude through a number of suggestions for how online learning provides a unique opportunity to support the educational continuity and progress of students with ME.

Key words: Myalgic Encephalomyelitis (ME), inclusion, NVA, virtual school

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Introduction

Various authors have all highlighted the enormous potential of e-learning in revolutionizing education services delivery (Fry, 2001; Richard, 2002; Jessup, 2000) and there is some encouraging evidence regarding the positive effect of e-learning in general (Means, Toyama, Murphy, Bakia & Jone, 2009).

Many children with Myalgic Encephalomyelitis (ME) are unable to attend school, and for young ME sufferers the issue is not whether online learning is better than traditional learning; it is whether online learning might act as a lifeline to the continuation of their education which might otherwise be curtailed. ME can have a devastating effect on education and causes more long-term sickness absence than any other illness (Dowsett & Colby, 1997). It is a neurological disease of the brain and central nervous system that has existed under various names for centuries and is becoming increasingly prevalent. It is found in clusters in schools, families and communities. Potentially long-lasting (an average bout lasts four and a half years, relapsing over decades) it can be very disabling. It is known to be virally triggered. Microbiologists suspect that it is a variation on poliomyelitis (polio) not covered by vaccination and many children suffer similar symptoms to polio, including breathing difficulties and partial paralysis or muscle weakness, particularly after effort.

In the United Kingdom Every Child Matters: Change for Children (September 2003) sets out the national framework for local change programmes to build services around the needs of children and young people so that we maximise opportunity and minimise risk, and from an educational point of view, e-learning has a big contribution to make to securing positive outcomes for children for whom mainstream schooling appears insufficiently flexible to meet their needs. In the Education Act 1996 the government of England and Wales states:

> *each local (education) authority shall make arrangements for the provision of suitable education at school or otherwise than at school for those children of compulsory school age who, by reason of illness,…may not for any period receive suitable education unless such arrangements are made for them.* (19: 1)

The advent of online learning technologies is beginning to challenge the traditional notion of what is meant by such provision as described by the 1996 Act and in 2002 the Department of Health published a report on ME, which stated that nearly all children who are severely affected and many who are moderately affected will require the provision of home tuition and/or distance learning and that this may require information and communications technology, which can also help to improve social contact (DOH, 2002).

All too often the response to chronic ME is still the provision of home tuition, leaving the ME sufferer isolated and receiving a very narrow educational experience and there continues to be limited awareness of the appropriateness, or availability, of options beyond expensive home tuition for students with ME (Colby, 2006). This is despite Government feedback that mirrored the advice of the Department of Health above and included virtual education in its recommendations (see www.tymestrust.org/txt/alert200801whitepaper.txt).

Nisai Virtual Academy (NVA) is a successful model of offering young people more than that by going immersive, live and online. It is also cost effective - Home tuition often costs twice as much as a placement with NVA, yet an NVA placement brings the benefits of participation in a social learning community and a proven record of academic success for ME students. NVA currently provides an education service to around 350 young people

across the UK and beyond and when NVA first opened in 2005 some 80 per cent of their first enrolment of students were ME sufferers.

By 2009 the NVA examination results were above the national average for GCSE attainment and whilst these results are not proof of the success of this initiative, they suggest the model is feasible and that NVA provides an innovate example of the transformational potential of technology. As aforementioned, this paper aims to tell a little of this story and to signal the potential for hope that online live learning brings to children too ill to attend traditional school.

ME and Education

It has been known for many years that ME constitutes the biggest cause of long term sickness absence from school, in both staff and pupils (Colby, 2006). A five-year study of six widely spaced Local Education Authorities in England revealed it as responsible for 51 per cent of such absences (Dowsett and Colby, 1997). No other disease came close to this figure; cancer and leukaemia, the next most common, scored only 23 per cent. Nearly all children who are severely affected and many who are moderately affected will require the provision of home tuition and/or distance learning. Some young people will be too severely affected by their illness to participate in any form of education, even at home. The scale of the problem in children is substantial. The Dowsett and Colby study of 1997, researching long term sickness, reported on a school roll of 333,024 pupils and 27,327 staff, and found a prevalence of 70/100,000 in pupils and 500/100,000 in staff. 39% of cases were in clusters of 3 or more and the peak age was 14-16 years.

From an educational point of view the effect that ME has on students ability to learn requires a thorough reconstruction of traditional pedagogy. E-learning provides a rich opportunity for meeting the needs of young people with ME and one concerted effort to do this has been the collaborative work between NVA and The Young ME Sufferers Trust (TYMES Trust). This work has enabled young people suffering from ME to access mainstream educational programmes such as GCSEs, A levels, BTECs and Key Skills via live online group learning, accessible from anywhere with a laptop and Internet connection.

Making education work for students with ME

Since the first article on ME in children and educational considerations was published in the British Journal of Special Education (Colby, 1994), there has been a slow development in the recognition that children with ME need differentiated educational provision. When it comes to the best way to approach the education of children with ME disagreements over school attendance, curriculum, special educational needs, medical needs, school examinations, home tuition, virtual education, all arise because of conflict between strongly held beliefs among professionals. TYMES Trust is a respected national charity whose entire professional team give their time free of charge and is the longest established national UK service for children and young people with ME, and their families. They report that many affected children struggle for recognition of their needs and feel bullied by medical and educational professionals (Colby, 2006).

The most recent report from the Royal College of Paediatrics and Child Health (RCPCH, 2004) highlights examples of the devastating impact that ME can have on education and that children and young people are likely to require the provision of home tuition and/or

distance learning and it suggests that consideration be given to virtual education. Dr Darrel Ho-Yen, a well-known medical author, microbiologist and ME specialist, has pointed out that in this illness it is by living within the boundaries of energy that the boundaries expand as the body heals. The government DfES guidance states that when and if the child is deemed to be ready for re-integration to school, this process should be "slow and cautious", for it is known that this is a key cause of relapse.

What is clear is that ME sufferers require time to recover sufficiently before returning to school and whilst unable to attend school they require sustainable, energy-efficient and often home-based education. Therefore e-learning provides an opportunity for young people with ME to engage in an educational experience that can limit the impact of their illness. In many cases, educational success has replaced failure and healing has replaced repeated relapse.

Nisai Virtual Academy

The Nisai Virtual Academy is a comprehensive, safe and vibrant online learning community. Through a blend of leading edge technology and contemporary pedagogies, it enables young people to access educational programmes including GCSEs, A levels, BTECs and Key Skills, and in the future international GCSEs and the IB. A variety of learners from all over the UK and overseas use the NVA to access learning, support and mentoring.

Learning packages at NVA include a timetable of live, fully interactive lessons, lasting between 30 to 60 minutes. Subject specialist teachers act as facilitators to host lessons where students participate and work together in learning sessions from any location with access to the Internet. Lessons are designed to make the most of live classroom technology and small group sizes aim to ensure that students receive high levels of individual attention. The teachers use a range of tools and resources to plan an engaging learning experience. They are trained in online teaching through a programme with Staffordshire University. The NVA platform allows for both asynchronous and synchronous computer mediated communication, both text and audio-chat.

In addition to an academic provision, students receive support and mentoring to ensure positive growth and development and are able to contribute and socialise using secure social networking, blogs, forums and a range of online games, clubs and activities, all designed to take place through a fun, engaging and safe environment.

NVA aim to work closely with parents, guardians, schools, colleges and local authority staff, as well as third party organizations and health professionals. NVA also provides a platform for each member of a student's support system to come together as a community to form a team around each learner, an approach been developed based on the Team Around the Child (TAC) model and reflecting the focus of the UK Every Child Matters: Change for Children approach to the well-being of children and young people from birth to age 19 in England and Wales. The aim is for every child to have the support they need to be healthy, stay safe, enjoy and achieve, make a positive contribution, and achieve economic well being.

Parents, guardians and carers also have access to an online area where they can keep up to date with their child's progress, as well as interact with each other, NVA staff and with other members of their child's support team.

The NVA student community

When NVA first came into being the majority of students were sufferers of ME. Over time this has developed radically and now NVA also regularly supports a wide range of students, including:

- Young people unable to access mainstream education for medical reasons
- Excluded students or those at risk of exclusion (including young people exhibiting emotional or behavioural issues)
- Students requiring additional support within a mainstream setting
- Students living overseas
- Students requiring coaching and focused exam preparation

The percentage of NVA students who are attending NVA due to ME has dropped from 80 per cent in 2005 to 30 per cent in the current academic year, this change being due to a broadening participation in NVA not because there are less students with ME engaging with NVA. In fact Table 1, below, shows how the total numbers of students with ME enrolled has continued to grow.

Table 1. Student Composition: total number of students and number/percentage with ME 2005- 2010

Year	Total No. students	No. students with ME	Percentage with ME
2005	30	24	80
2006	40	30	75
2007	80	61	76
2008	103	55	53
2009	250	120	48
2010	346	104	30

This has brought a rich social mix for all students in NVA, including students with ME. There is a peer group of ME sufferers, which students with ME may or may not wish to identify with, and they can also experience and participate in a virtual school that has a mix of students from many different backgrounds, attending NVA for varied reasons.

NVA Virtual learning environment

The NVA interface

Tselios et al., (2001) compared user interfaces and suggest that the designs of platforms user interfaces may affect, for example, test performance even when educational content is identical and functionality similar. The NVA platform interface design is mapped out visually as a schema, with colours corresponding to areas within the schema that in turn represent areas of the academy. So for example at the heart of NVA is the "hub", represented as the green central area, as shown in the image below (Figure 1). The hub acts as a social networking space where the NVA community can meet, chat, exchange information and support one another.

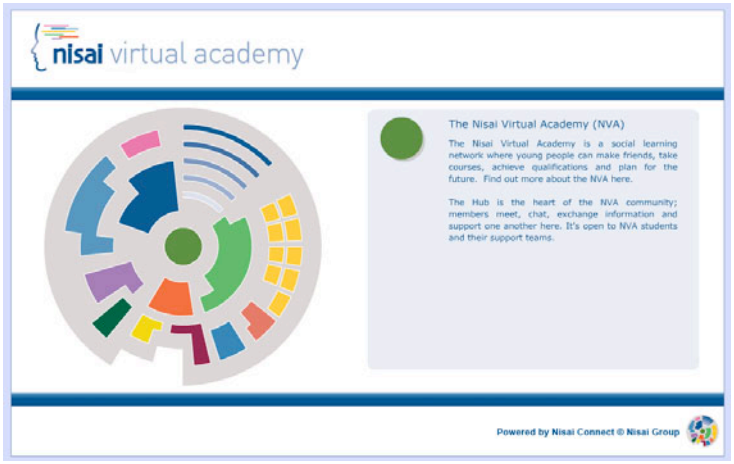

Figure 1. The NVA Interface

NVA workspace

The NVA workspace is where the learner can see, at a glance, their learning program in the form of live lessons, their due assignments, returned assignments, and access their course sites (where tutors store the teaching and learning resources). Following on with the use of the schema, the workspace is represented visually as an arc of yellow rectangles and Figure 2 below shows the initial workspace dashboard.

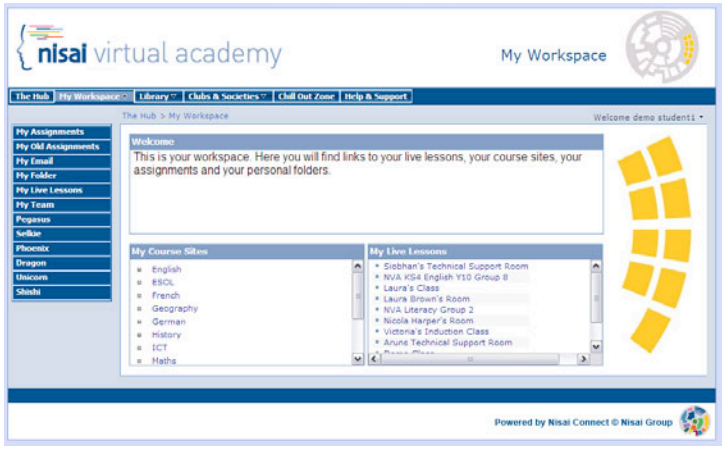

Figure 2. My workspace

NVA live classroom

The live sessions take place within the NVA live classroom and, dependent on the subject being studied, a variety of online tools and resources can be used. Figure 3 and Figure 4 show below, in turn, the NVA live classroom sign-in area and an example of a lesson progress, in this case an English lesson.

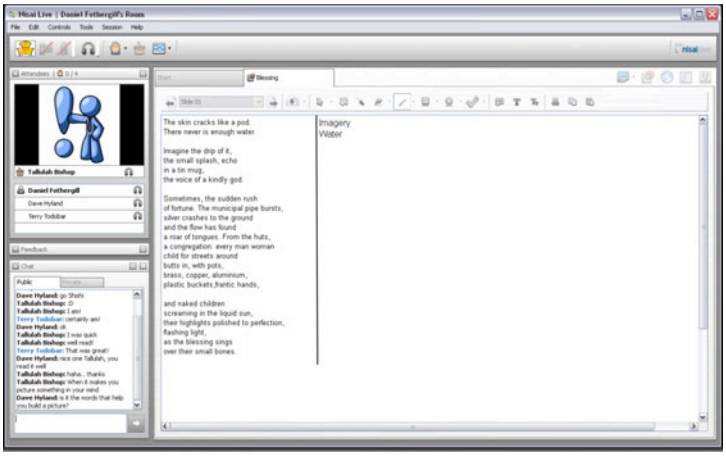

Figure 3. NVA live classroom

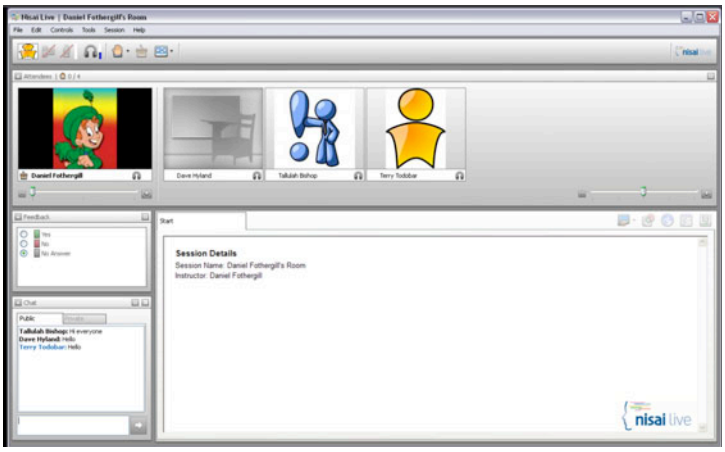

Figure 4. NVA lesson in progress

Figure 5. The Music Lab mixing desk

Resources to augment the virtual classroom

Figures 5 and 6 show examples of resources used to augment the NVA VLE; the music lab mixing desk (figure 5) and an example of a science lab resource (figure 6) are interactive resources that help to immerse the student in the online learning experience. Teaching staff make use of a range of resources and continuously add to the resource base.

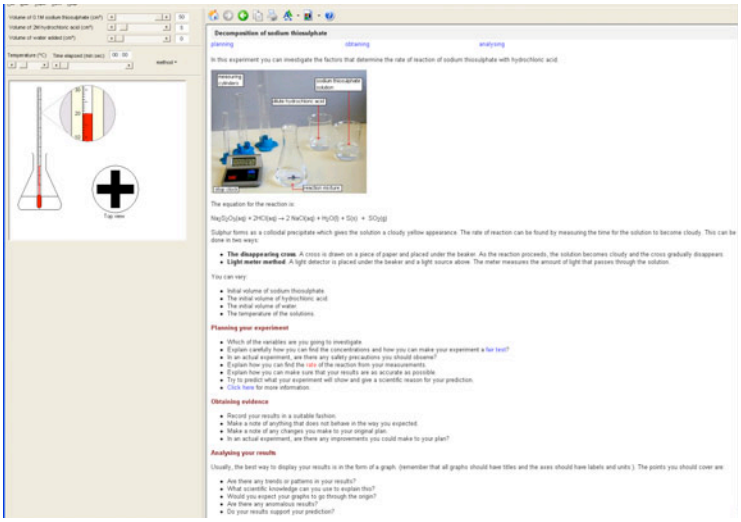

Figure 6. Science Lab resource

Clubs and Societies

Experience shows that clubs and societies have been found to play an important part in students' full engagement with NVA. The "N-tribe!" is a student magazine produced by students that demonstrates student engagement and application of learning from the courses they study and the use of ICT skills.

Figure 7. The N-tribe student magazine (June 2009 and February 2010 editions)

The "chill-out zone" acts as a social space within the NVA. The aim here is to provide learners with an experience that blurs the boundaries between school time and leisure time, allowing students to engage socially with their peers and teachers outside of a classroom environment, much the same way as they would in a face-to-face school. Extensive use of the on-line social networking facilities within NVA has been evident.

Figure 8. N-tribe Chill Out Zone

NVA academic outcomes

Every year the Department for Children, Schools and Families (DCSF) publishes information on the performance of pupils in all schools. This serves as a guide to how well a school is doing. They list National Curriculum test results for primary schools and examination results for all secondary schools in England. There are two key threads to the reporting of standards of attainment for pupils in secondary schools- examination results and CVA, or contextual value added.

NVA GCSE results

NVA have tracked their GCSE results since 2004, when the partnership with TYME Trust began. The five years of results make for positive reading, especially when one considers that the majority of learners engaged with NVA have experienced difficulties in mainstream education.

Most recently, of the grades awarded in 2009 to NVA students (who are unable to attend school for reasons such as illness, disability or behavioural or emotional issues) 64% were at a GCSE higher grades of A*-C (see Table 2 below). This figure is ahead of the national average for mainstream students which, in a like for like comparison with the subjects studied by students at the online academy, saw 62.25% of grades being awarded at A*-C. Figure 9 represents this data as a bar chart, which also demonstrates a steady increase in positive GCSE outcomes for the NVA students since the first year of enrolment. Students who work with NVA can also potentially remain on the roll of their original school. Examination success may then be included in the original school's yearly results.

Table 2. Outcomes of GCSE Students 2004 – 2009 (Percentage of grades at A* - C)

Year	2004	2005	2006	2007	2008	2009
NVA	53	53	57	68	63	64
National Average	45.5	42.8	50.7	63.7	65.7	62.3

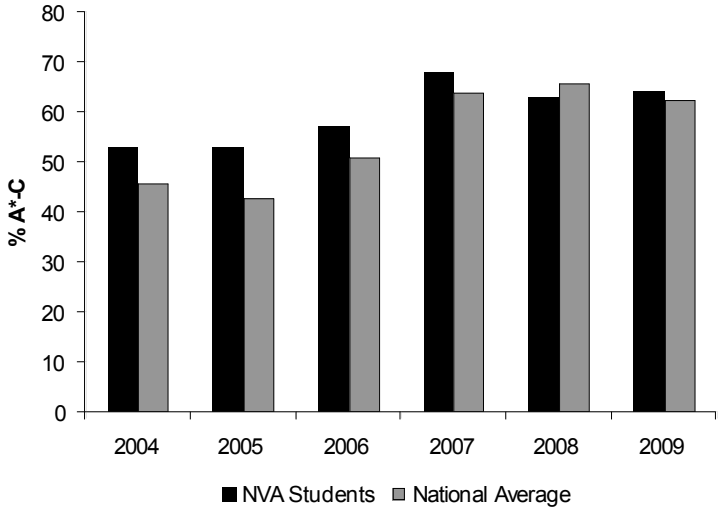

Figure 9. Graph showing NVA versus national average % GCSE A-C

Table 3. Students with ME achieving GCSE grades A-C (2004-2009) showing how the total number of NVA students breaks down into students with ME, how many students with ME took GCSEs each year and the percentage A-Cs in GCSE taken.

Academic year	Total No. students	Students with ME	Students with ME sitting GCSE each year (percentage A-C GCSE grades achieved)
2004-5	30	24 (80%)	17 (79%)
2005-6	40	30 (30%)	21 (70%)
2006-7	80	61 (76%)	49 (80%)
2007-8	103	55 (53%)	40 (74%)
2008-9	250	120 (48%)	90 (75%)
2009-10	346	104	

Other NVA examination outcomes

A Level students and those studying Skills for Life also achieved positive results in 2009 through the NVA, with a 100% pass rate being achieved at A level and an 84% pass rate achieved by students studying Skills for Life qualifications.

Contextual valued added (CVA) scores

The DCSF also publishes CVA scores for schools alongside the performance tables and these scores show the progress a school has helped its students make from the end of one key stage to another. The aim is for CVA scores to complement test and examination results that

are published, to give a fair guide to the performance of the value added by a school. The challenge of measuring the distance travelled for each of the learners in NVA is, in practice, a huge one. The main stumbling block has been getting high quality information on the previous attainment of learners as they engage with NVA.

Often young people engaging with NVA have been out of mainstream schooling for some time. It is perhaps a feature of their social exclusion that the mainstream system appears to disengage with actively tracking and monitoring their progress; tracking and monitoring that would be seen as being normal practice for students participating in mainstream education. In fact some of the children whom are now experiencing success with the NVA opportunity were experiencing very limited educational opportunity.

Celebrating the students' success

It is worth noting that despite the collective challenges the NVA students have faced in their learning prior to engaging with online learning at NVA, their academic results compare extremely well to mainstream schools in the UK. Many of the students, especially those who had been excluded from mainstream schools or who were classified as 'disengaged', were often not expected to achieve any qualifications at all before being enrolled at the NVA, making their success even more remarkable.

That this diverse group of learners come together across the internet, to learn and socialize together as part of a virtual academy, and in doing this achieve examination results that compare favourably with mainstream schooling, is an indicator of the power of this approach.

What these results show is that students who enrol with NVA are able to go on to achieve good grades in their GCSEs, and that the NVA model is "fit for purpose" in supporting young people to achieve key examination results at what is a crucial time in their lives. The vignettes that follow provide some qualitative insight into the lived experience of three members of the NVA community- a student, a parent and a Children's Services professional who commissioned NVA support.

Vignettes - the voice of the child, parent and children's services

E-learning offers a unique pedagogy. The NVA online classroom enables students to participate in real-time lessons with classmates from all over the UK, and provides students, including those with ME, with an opportunity to access learning in a way which can more readily meet their individual needs.

The following vignettes illustrate that the positive examination outcomes achieved by students at NVA are mirrored in qualitative feedback about the experience of students and other stakeholders that extends this positive story. These vignettes were collected as part of the annual NVA and TYMES Trust Learning Commitment Awards. These awards take place each year to celebrate the commitment to learning made by students with ME. Information was collected using the virtual classroom technology and also over the telephone. The 3 vignettes give a voice to:

- A parent of a student with ME
- A professional who commissioned the enrolment of a young person with ME
- A student with ME

Vignette 1 - the voice of a Parent

Richard, 18, is a young ME sufferer who began studying A Levels at his local college in 2008. However, due to his condition he missed substantial amounts of his learning and began to fall behind. Richard has now found a solution through studying an A level and GCSEs at NVA.

Richard's mother explained how Richard came to be part of NVA through a recommendation by their local Connexions adviser. Richard was able to obtain funding to study at NVA and opted to take an A level course in English Literature together with GCSEs in Maths and History. Richard's Mother's view of the engagement process was positive, saying:

> *our local Nisai representative was very helpful in explaining how the programme worked and enrolling was quick and easy…*

Studying from home means that Richard no longer needs to worry about having enough energy to get to college and if he does feel unwell, he can catch up by watching recordings of any missed lessons. This kind of energy-efficient approach to education is strongly advocated by experts in the field of ME. Richard's mother went on to say:

> *students with medical issues are given the opportunity to manage their illness due to the ease with which the NVA is accessed…recordings of every lesson ensure that students do not fall behind if they are unable to attend…*

Richard's Mother also commented about the ease of contact and communication with staff, which is supported by the shared use of the platform by staff and parents:

> *the teaching staff are easy to contact and parents are kept in the loop with regular updates…*

Richard's Mother highlighted social participation as a key positive thread in her son's online experience:

> *the opportunity to attend regular classes and interact in group discussions helping to reduce the sense of isolation so often associated with ME…*

The feedback from Richard's mother was overridingly positive, emphasizing social contact through the NVA, as well as pedagogical components, as salient features that made the model work for her son.

Vignette 2 - the voice of Children's Services

Another student, Hannah, was also experiencing difficulties in attending mainstream college due to ME. Hannah had suffered from the condition for a number of years and had missed large sections of her education. Hanna began studying GCSEs at the NVA in September 2008. Rachel Jackson from Lancashire Young People's Services commissioned Hannah's enrolment with NVA, and had been looking for a suitable solution for Hanna. Rachel gave a positive review:

> *I feel that the NVA can create a sense of belonging for a pupil who has been let down, lost or isolated by mainstream education…It also provides the opportunity to gain confidence and catch up to a level of education where reintegration is possible…*

In September 2009, Hanna's condition had improved to a level where she was able to return to her local college to continue her education. Rachel explained that:

> *the key is the tailored programmes that meet each student's needs and the level of accessibility (of the NVA platform). I feel that Hannah has really caught up with her education and developed the confidence to return to mainstream education...*

Rachel's comments reflect the fact that the (human) energy-efficient approach of online learning through NVA, as advocated as a key ingredient for students with ME (Colby, 2006), was a king positive ingredient in Hannah's improved health. Hannah's participation with NVA allowed her to *live within the boundaries of her energy*, as advocated by medical experts and this appears to have contributed to Hannah's increased health and wellbeing.

Vignette 3 – the voice of the Student

Sarah is a NVA student who had home tutoring through her GCSEs before joining NVA to continue her studies into Further Education when she was 16. She responded using the NVA VLE to the following written questions, and offered an insight into her personal experience of studying online. Sarah was asked to talk about how she came to be at the NVA. Her comments emphasize the importance of input from a "real life teacher" which studying from home:

> *I'm taking courses online essentially because I'm too ill to go to school in person, studying online helps me to carry on learning when otherwise I couldn't. I was looking for somewhere that taught interactively where I could also study from home, because I needed the input from a real life teacher, and the NVA seemed to be the only one around that did that for over 16s.*

Sarah was asked about her previous learning experiences, which included distance learning. She explained:

> *I did chemistry GCSE with the National Extension College and though the course materials were good I found it really hard because they weren't interactive and I really needed a teacher, so finding Nisai was really good.*

Again emphasis is placed on a relationship with a teacher. Sarah was asked about the biggest barrier she faces in her learning. This question tunes into some of the issues faced by students with ME, namely its effect on concentration and learning. Sarah again emphasizes the importance of interactive learning. She also highlights the benefits of the lesson recordings:

> *I needed the interactive stuff that the NVA do. I have issues with concentration and absorbing information in one go with my learning, so the fact that the NVA has the recordings available really helps because then I can go back and check on things I didn't quite get the first time round with my notes in the lessons.*

When asked to compare online learning with traditional schooling, Sarah continues with the theme of social interaction:

> *I find the hardest part is the socialisation areas - we can chat in the chat box and there's email and everything, but it's not the same as hanging out with friends. And I also find not seeing a teacher face-to-face quite hard.*

Asked whether she has made friends through the NVA, Sarah's answer indicated that she has benefited from being part of a peer group that understands ME:

> *Yes, I have. It's important from the work aspect so we can ask each other questions as would happen in a regular school and help each other out with group work, but it's also important generally because M.E. is a really isolating illness and being able to talk to people who understand what it's like not to go to school, even if they don't have the same illness, really helps.*

When asked about the features of the NVA, Sarah continued to emphasize the interactive nature of her positive experience of the academy:

I like that it's interactive, being actually taught helps a lot, and the whiteboard things are really good because it means we can do examples, particularly with maths, so we get a chance to practise in the lessons with the teacher there, which would be less likely in a normal school. Again, the materials/recordings are really good, and the fact that it's enabled me to study while I'm too ill to do anything else is probably the best thing about it for me. It makes learning a lot easier and the small classes are really good too.

An emerging pedagogy for online-learners with ME

For students with ME, NVA matches the advice of experts in ME; it can be home based, is energy efficient and can offer a pedagogical that is learner centric. The outcomes achieved by the students suggest the model is a viable alternative to home tuition and distance learning that does not have a live synchronous component. The vignettes above also begin to paint a picture of a positive and engaged community of learners whose education has been brought back to life through live online learning. The NVA platform and teachers engages with the students on a social and academic basis. The story of NVA and students with ME develops the case for the presence of online learning in alternative school provision for such students. Key threads that emerge, based on principles established by Colby (Colby, 2000) are:

- A focused curriculum that can serve as a building block for young people for whom a broad curriculum is a barrier rather than an opportunity
- Small group teaching and a highly individualised and flexible model of timetabling
- A longitudinal approach to achievement, where a student can study small numbers of subject intensively and take examinations whenever they are ready
- An approach that economizes on the physical energy it requires to engage with education. NVA is an energy-efficient approach where students are able to stay within the boundaries of their energy and catch up on their studies through recorded lessons, all from the home
- The approach is not confined to a particular building, or restricted to any single location or moment.
- Students can socialise online using now familiar social networking frameworks and the graphical interface design of the NVA blurs the boundaries between leisure time and learning time
- The available resources are managed in the interests of the learner

Colby's original article appeared in *Special Children*. The ten points for effective education for students with ME can be found at www.tymestrust.org/pdfs/tenpoints.pdf

Final thoughts and future directions

This overview of the NVA initiative for students with ME shows that the power of the approach seems to lie in the concerted effort to place the learner at the centre of the learning process. Evaluation of the 'quality' of learning experiences now needs to continue and deepen. Critically this needs to be undertaken along with a focus on both the outcomes achieved through the NVA and also ways of measuring the distance travelled by learners, or contextual value added, and what the active components of the model are.

The outcomes achieved by the students who have engaged with NVA suggest the model is feasible as a solution for the education of young with ME who are too ill to attend school. The vignettes in this paper used feedback from students, parents and professionals that implies an appreciation for the approach.

More rigorous research is needed to formally evaluate the success of NVA and the varying ways it can work for students with ME and other illnesses. An action research model would be appropriate as a vehicle for continuous improvement, along with a investigation into the subjective experience of learners and other stakeholders, inkling NVA staff. One possible evaluative approach would be the use of detailed cohort studies to further reveal the active ingredients that make NVA a successful educational experience for young people whose education was at risk.

Systems leading

The NVA model aligns with the medical advice regarding the education of young with more severe ME and is the leading edge of online educational provision for young people with ME; NVA provides with students with ME offers a promising solution. A sound pedagogical approach has been translated into a practical teaching model and a VLE that is designed to be intuitive and robust. This in turn has led to positive outcomes. It merits further exploration as a potential systems leader in this area of work as NVA continues to trail blaze and enter into unchartered territory.

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Gender differences in patterns of mobile game play

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Abstract. This paper seeks to investigate game play patterns of high school boys and girls in a game-based learning programme anchored on the mobile game *Statecraft X* and whether there are gender differences in mobile game play. The objective of the game is to enable students to role-play as governors by constructing and acting on principles of governance. One of our major findings indicates that students played the game most frequently at home compared to other spaces such as schools and eateries. Boys spent more time playing at home and in school compared to girls. Boys also used more player actions than girls in every type of player action. Distillation of the underlying factors, that give rise to the patterns observed, will provide a basis for refining the game design to elicit more even participation of both boys and girls, and hence more equal opportunities for learning.

Keywords: Mobile learning; Simulation game; Gender differences; Play patterns; Role play.

Introduction

Mobile learning is an emerging field of educational research as mobile devices such as PDAs, iPods, tablet PCs, and smart-phones have become increasingly affordable and central to learners' everyday lives (Klopfer *et al*. 2005, Norris & Soloway 2009, Pachler 2010). De Freitas and Griffiths (2008) also noted that convergence between games and mobile devices is also becoming a topic of interest in the educational context. They saw the potential of learners engaging in learning in different contexts. Instead of banning the use of mobile devices in the classroom, educators can harness the potential of supporting learning through the use of mobile devices.

Although mobile gaming via handheld consoles has been around since the 1990s, there was no possibility of have multiplayer games installed in such handheld consoles. With the advent of wireless networks, new possibilities of wireless networked gaming have emerged. Students can now be joined in learning together even though they are not physically together. Students can now experience new forms of educational experience as learning moves into new unchartered spaces. Some examples of mobile games in educational contexts in the past include *Savannah* (Facer *et al.* 2004) where children gained conceptual understanding of animal behaviour and interaction with the environment, *Mad City Mystery* (Squire & Jan, 2007) where students engaged in authentic scientific inquiry in location-based augmented reality game, and *Environmental Detectives* (Squire & Kloper 2007) where secondary school and university students used their GPS and PocketPC for the augmented reality game to study and to experience the practices of environmental engineers. In these three games, although students were mobile in a specific location, they did not the agency to choose the

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location of gameplay. To fill in the gap, this study seeks to explore patterns of gameplay using a mobile phone where student have the freedom to choose where they wish to engage in gameplay.

In this study, we explore mobile learning through the use of a game installed in an iPhone. In this new learning paradigm, learning takes place in the classroom as well as outside the classroom. With learning being moved outside the classroom, learners have the agency of choosing the time and space for learning as mobile game-based learning activities can be both synchronous and asynchronous for communication and collaboration. The purpose of this exploratory study is to characterise students' patterns of gameplay outside the classroom.

In the present study, the *Statecraft X* game installed in an iPhone seeks to engage students in learning about the principles of governance through gameplay. It is a multiplayer strategy game where teams of four to five players compete against one another to assume the leadership in the game kingdom of Velar. Students play the role of a governor and try to win the trust of the people in their own towns and other towns, in order to gain control of the kingdom through collaborating with other student governors in their own faction, and competing with governors in other factions. With the use of an iPhone, students can interact continuously with the game content, and chat with other fellow governors through the game messaging system across a multitude of physical spaces, thanks to the portability of the mobile device used.

The present data sources of post-intervention survey, the server-generated player action data, and the interview will provide the data for determining the patterns of gameplay of learners who engage in game-based mobile learning. This is important for the designing of game-based curricula for the use of new technologies as the new curricula should take into account of these patterns to support learning in this new educational context. The following research questions will be addressed in this paper:

1. What are the patterns of gameplay of the mobile game *Statecraft X* outside the classroom?
2. Are there gender differences in patterns of gameplay of the mobile game *Statecraft X* outside the classroom?

Method

Participants

Forty-one secondary three students, aged on average 15, attending an autonomous secondary school in the eastern part of Singapore participated in this study. Seventeen boys and 24 girls from a high-ability class in the Express Academic stream were divided into 2 games: Game 1 and Game 2. Students in each game were further assigned to four factions for gameplay: one all boys' faction, one all girls' faction, and two mixed group factions.

The research team conducted a two-day professional development session for the two female teachers who were involved in the study. The lead teacher of this study also observed the enactment of a four-day pilot study which took place in the same school.

Materials

The game used in this study, *Statecraft X*, was designed based on the principles of governance in the Social Studies curriculum for secondary three students. These four principles of governance which students could use to guide their player actions in the game world were:

1. Leadership is key:
2. Anticipate change and stay relevant;
3. Reward for work, and work for reward;
4. A stake for everyone, opportunities for all.

The students were each given an iPhone with the *Statecraft X* game installed during the first of six lessons. Figure 1 shows what students see on their iPhone when they logged in to the game. Teams competed against one another in this multiplayer strategy game to rule the fantasy kingdom of Velar populated by the four races of sentient beings: humans, dwarfs, elves, and trolls. At the beginning of the game, the previous ruler of Velar passed away without leaving an heir, thus setting up the stage for different student-governor-led political factions to compete for leadership of the kingdom.

Figure 1. Students' first view of the *Statecraft X* game on an iPhone

The first game objective is that all the teams must collaborate to ensure that their kingdom, Velar, survives in the face of attackers from other kingdoms. Second, individual teams must consolidate their power and position by winning the trust of the people in their own towns and also the people in the towns of other teams. This game aims to allow students to think as governors and thus appreciate the complexity of the task of nation-building. To realise these two objectives, faction members must realise short-terms goals such as developing towns under their control, diffusing internal and external threats as well as maintaining diplomatic ties with factions of the same kingdom of Velar and with neighbouring kingdoms of Nibelung, Alphege, Auki, and Salfreda.

During the intervention period of 18 January to 3 February 2010, events involving the game world were also triggered by the server. After Lesson 1, on 19 January, bandits stole resources being traded along players' trade routes. Student governors had to send out soldiers to attack the bandits.

After the second lesson on 21 January, a plague swept the kingdom, causing citizens to fall ill, first in a few towns and later in almost all towns in the kingdom. Student governors had to make use of the Healing Centre to ensure that the people in their towns survive the epidemic. On 23 January, the third event involving large numbers of bandits, from the neighbouring kingdoms of Alphege and Nibelung, arriving in Velar was triggered. Student

governors had to mobilise their armies to deal with these bandits. In the meantime, student governors attempted to take over neighbouring towns through warfare or diplomacy.

After the third lesson on 25 January, factions began to compete for remaining neutral towns. Three events happened between Lessons 3 and 4. First, on 25 January, student governors heard news that the neighbouring countries Alphege and Nibelung had gone to war and thus they had to prepare for a refugee influx. Second, on 25 January, there were a few Saldredans who immigrated into Velar. This served as a warning to student governors of the impending invasion from Salfreda. Third, on 26 January, dwarf, elf, and troll refugees from Alphege and Nibelung started arriving. Student governors had to decide whether to provide employment and housing to these refugees or ignore them, which would cause the refugees to leave the towns. Student governors could also prevent the refugees from entering the towns by changing the town gate settings.

After Lesson 4, on 27 January, the seventh event took place. Scouting parties from the neighbouring country Salfreda began to enter Velar. This was the second warning of the impending invasion for student governors. On 28 January, the eighth event took place when the king of Salfreda contacted the ruling faction of Velar through diplomatic channels and formally declared war on Velar. The king of Salfreda told student governors to surrender and not to resist. On 29 January, the first wave of invasion, the ninth event, took place. Large numbers of Salfredan soldiers attacked towns in Velar, bordering Salfreda. Student governors could ask the neighbouring kingdoms of Alphege and Nibelung for help. If they helped the refugees from Alphege and Nibelung in the earlier refugee event, the response from these two kingdoms would be more positive. On 30 January, the second wave of invasion occurred as Event 10. More Salfredans arrived and attacked towns closer to the capital city of Velar. On 1 February, the king of Salfreda initiated the eleventh event of diplomatic negotiation where he asked student governors whether they would like to surrender. If surrender were to take place, the game would effectively end here. The final event took place on 2 February. Salfredan soldiers attacked the capital city directly. If the student governors could fend off this wave of invasion, they would win the game. In this present intervention study, all student governors in both Games 1 and 2 could not fend off the attackers and therefore lost the game.

Through the game-play, the student governors experimented with different forms of governance to explore alternative models of governance. Figure 2 shows an example of how student governors check the effectiveness of their governance. For example, student governors might have chosen to build a welfare state where the state provides all their needs or they might have chosen to have a state where only certain races enjoyed privileges while others did not. The following are broad categories of player actions that student governors might have taken in the game: (1) exploring actions, (2) town management actions, (3) trading actions, (4) military and defensive actions, (5) diplomatic actions, and (6) messaging actions. See Table 1 for a more detailed breakdown of all the possible actions that a student governor was allowed to take within the six broad categories of player actions.

Table 1. Player actions in the *Statecraft X* game.

Category	Player action
Exploring	Visit a town hall
	Visit a house
	Visit a slum
	Visit a farm
	Visit a water collection
	Visit a wood mill
	Visit an ore mine
	Visit a factory
	Visit a healing centre
	Visit a trading post
	Visit a marketplace
	Visit a noble mansion
	Visit a cultural centre
	Visit barracks
	Visit a town wall
Town management	Set tax rate for citizens based on their income
	Set tax subsidy for citizens of a certain race
	Load town flip page (general town information)
	Set or modify the type of citizens allowed to enter the town
	Set tax rate for houses of a certain level
	Set rental rate for houses of a certain level
	Set tax rate for the farm
	Set tax rate for the factory
	Set tax rate for the wood mill
	Set tax rate for the water collection
	Set tax rate for the ore mine
	Hold a rest day celebration
	Hold a faction day celebration
	Hold a multicultural day celebration
	Build a new house
	Build a new farm
	Build a new factory
	Build a new wood mill
	Build a new ore mine
	Build a new water collection
	Build a new healing centre
	Build a new army barracks
	Sell a house
	Sell a farm
	Sell a water collection
	Sell a factory
	Sell an ore mine
	Sell a wood mill
	Demolish a house
	Demolish a farm
	Demolish a water collection
	Demolish a wood mill
	Demolish an ore mine
	Demolish a factory
	Demolish the healing centre
	Upgrade a house
	Downgrade a house
	Set salary for the employees of a certain skill level (farmers, water collectors, wood cutters, ore miners, factory workers, or healers)
	Hire one or several employees (farmers, water collectors, wood cutters, ore miners, factory workers, or healers)
	Fire one or several employees (farmers, water collectors, wood cutters, ore miners, factory workers, or healers)
	Train an employee (farmer, water collector, wood cutter, ore miner, factory

	worker, or healer)
	Set food price
	Set water price
	Set ore price
	Set wood price
	Set crystal price
	Set healing fee
Trading	Make a trade offer
	Cancel a player's own trade offer
	Accept a trade offer
	Reject a trade offer
	Buy food from the market place
	Buy water from the market place
	Buy ore from the market place
	Buy wood from the market place
	Buy crystal from the market place
	Sell food to the market place
	Sell water to the market place
	Sell ore to the market place
	Sell wood to the market place
	Sell crystal to the market place
Military	Hire a soldier
	Fire a soldier
	Train a soldier
	Change the class of a soldier
	Set the salary of a certain soldier class of a certain skill level
	Move a soldier on the world map
	Attack a soldier
	Attack a bandit
	Attack a town wall
	Capture a town by force
	Upgrade a town wall
	Repair a town wall
	Read combat log
Diplomatic	Request peace treaty with another faction
	Receive peace treaty requests from other factions
	Respond to a peace treaty request from another faction
	Request friendly ties with another faction
	Receive friendly ties request from other faction
	Respond to a friendly ties request from another faction
	Request surrender from another faction
	Receive surrender requests from other factions
	Respond to a surrender request from another faction
	Attempt to takeover a town belonging to another faction
	Request the governorship of a town belonging to a fellow faction member
	Receive the town governorship request from fellow faction members
	Respond to a town governorship request from a fellow faction member
	Request friendly ties with a neutral town
	Request peace treaty with a neutral town
	Request the governorship of a neutral town
	Threaten to invade a neutral town
	Request a noble town to surrender
	Visit the foreign embassy
	Check aid requests from foreign countries
	Respond to an aid request from a foreign country
	Request aid from a foreign country
	Request friendly ties with a foreign country
	Request peace treaty with a foreign country
	Receive surrender request made by foreign country
	Respond to surrender requests made by foreign country
	Request foreign country to surrender a town
Messaging	Load the message inbox
	Load all contacts

Send a message
Read a conversation

Figure 2. Students' checking the effectiveness of their governance in the *Statecraft X* game on an iPhone

The messaging system within the game *Statecraft X* also encouraged the student governors to communicate and collaborate with their faction members and other factions and with the helper from the research team. The iPhone also allowed student governors to text or call each other if they chose to do so.

In addition to the game, teacher-facilitated classroom activities (whole class discussion, debate, student presentation, group discussion) and online blogs and forums supported the learning of the *Statecraft X* curriculum using an iPhone game. The final assignment of the six-lesson study was the presentation of a speech by the students. The purpose of the speech was to assess the learning of principles of governance based on their game experience, in-class activities and outside-classroom activities. The students' speech were assessed on (1) strategies proposed for governance, (2) lessons learnt, (3) strength of personal narrative, and (4) effectiveness of persuasion.

Procedure

During the first lesson, these students were each given an iPhone with the game *Statecraft X* during the first of six lessons of this study. The research team taught them how to use the *Statecraft X* game through a tutorial session of town management, trading, movement on the world map, etc.

The gameplay timings were set on the following days and times to accommodate the wishes of the school management. On Mondays to Fridays, the game timings were from 6am to 8am and from 2 pm to 10 pm. On Saturdays, students could play the game from 6am to 11pm. No gameplay was allowed on Sundays. Every hour, students were awarded a fixed number of action points that they could use for the various player actions in the game world.

The post-intervention survey was administered at the end of the last lesson of the Statecraft curriculum. One boy was absent and did not participate in the post-intervention survey. After the last lesson, the first and third authors interviewed seven boys and seven girls in an air-conditioned room. All interviews were audio- and video-recorded.

Data Sources and Data Analysis

The data sources used in this paper were the post-intervention survey, the server-generated player action data, and the interview for the purposes of this study. To investigate whether there were gender differences in time spent in the varying spaces, a 2-tailed *t*-test was used on the time spent in each of the spaces (home, school, walking, bus, car, eating place, and mall) with gender as the independent variable. To further examine whether there were gender differences in patterns of gameplay from the server-generated data, the mean for boys and girls' login times was calculated for the following time slots (midnight to 1, 5-6 am, 6-7 am, 7-8 am, 8-9am, etc.).

To investigate whether there were differences in frequency of player actions used by boys and girls (exploring, town management, trading, military, diplomatic, and messaging), a 2-tailed *t*-test was also used for the number of player actions taken in each category with gender as the independent variable.

The Levene's test was used to test whether the variances were equal for both time spent in spaces and frequency of player actions. As the variances were significantly unequal, the *t* statistic which did not assume equality of variances was subsequently used to report the data.

Results

Patterns of Play across Physical Spaces

The results of patterns of play across physical spaces are presented in Table 2. Overall, the results indicate that the boys (M = 19.20, SD = 15.25) spent more hours playing the mobile game *Statecraft X* than girls (M = 7.34, SD = 6.81), t = 2.91, p = 0.009. Boys (M = 13.13, SD = 9.74) spent more time playing *Statecraft X* than girls (M = 3.99, SD = 4.63) at home, t = 3.50, p = 0.002. Boys (M = 2.75, SD = 3.07) also spent more time playing *Statecraft X* in school than girls (M = 1.07, SD = 0.92), t =2.13, p = 0.049.

Table 2. Mean, SD, and t-values of hours spent per week across spaces for male and female students

Space	Gender							
	Male *(n=17)*		Female *(n=23)*		All *(n=40)*			
	M	*SD*	*M*	*SD*	*M*	*SD*	*t*	*p*
Home	13.13	9.74	3.99	4.63	7.64	8.34	3.50	0.002
School	2.75	3.07	1.07	0.92	1.74	2.19	2.12	0.049
Bus	1.56	3.00	0.86	1.41	1.14	2.18	0.87	0.394
Walking	0.56	1.54	0.64	0.89	0.61	1.17	-0.17	0.865
Eating out	0.59	1.08	0.35	0.76	0.45	0.90	0.79	0.437
Car	0.45	0.89	0.31	0.55	0.37	0.70	0.55	0.591
Mall	0.16	0.35	0.13	0.45	0.14	0.41	0.25	0.807
Total	19.20	15.25	7.34	6.81	12.09	12.31	2.92	0.009

Overall, students spent the most time playing the *Statecraft X* mobile game at home (M = 7.64, SD = 8.34). Next, students spent the most time playing the game in school (M = 1.74, SD = 2.19). Besides playing the mobile game at school and at home, students did also spend some time playing the *Statecraft X* game while sitting on a bus (M = 1.14, SD = 2.18), walking (M = 0.61, SD = 1.17), eating out (M = 0.45, SD = 0.90), sitting in a car (M = 0.37, SD = 0.70), and in the mall (M = 0.14, SD = 0.41).

Patterns of Play across Time

Tables 3 and 4 present the times when students were logged on to play the *Statecraft X* mobile game. Most students usually were logged on to the game between 2 to 10 pm, with the peak logged-on time being around 3 pm. However, for the boys, the peak logged-on time was at 9 pm while the girls' peak logged-on time was at 7 pm. Boys were logged on more frequently than girls at all times. Contrary to the girls, the peak logged-on time in the morning for boys was between 6 to 8 am. During the interview, boys reported that they made use of the early morning slots to capture towns.

Table 3. Mean number of daily logins of male and female students before 12 noon

	Time slot								
Gender	0-1	1-2	5-6	6-7	7-8	8-9	9-10	10-11	11-12
Female	0.4	0.1	0.0	2.8	3.0	1.4	2.7	2.1	0.9
Male	0.2	0.0	1.9	7.5	7.6	2.5	3.2	3.7	2.6
All	0.3	0.0	0.8	4.7	4.9	1.9	2.9	2.8	1.6

Table 4. Mean number of daily logins of male and female students after 12 noon

	Time slot											
Gender	12-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12
Female	1.6	1.9	6.4	6.8	3.8	4.3	5.5	7.0	6.9	5.8	4.1	2.0
Male	2.1	3.8	11.3	11.5	9.7	8.8	10.7	10.8	9.1	12.2	7.1	2.0
All	1.8	2.7	8.4	8.8	6.2	6.1	7.7	8.6	7.8	8.4	5.3	2.0

Patterns of Player Actions

As shown in Table 5, students made the highest number of player actions in exploring followed by town management, messaging, military, trading, and diplomatic. Except for the category of messaging, there were significant differences between male and female students for all categories of player actions. Overall, boys (M = 3815.29, SD = 1914.35) used more player actions than girls (M = 1714.67, SD = 1088.24) in all categories of player actions, t = 4.08, $p < 0.001$. Boys (M = 2585.00, SD = 1146.00) used more exploring actions than girls (M = 1231.04, SD = 723.14), t = 4.36, $p < 0.001$. Boys (M = 558.88, SD = 302.10) also used more town management actions than girls (M = 215.92, SD = 141.12), t = 4.36, $p < 0.001$. Boys (M = 350.06, SD = 266.90) also performed more than five times the number of military actions compared to girls (M = 58.38, SD = 61.57), t = 4.42, $p < 0.001$. However, for diplomatic actions, boys (M = 75.53, SD = 45.85) only used them three times more frequently than girls (M = 25.54, SD = 28.49), t = 3.98, p = 0.001. Boys (M = 182.24, SD = 154.01) also engaged in more trading actions than girls (M = 50.92, SD = 46.95), t = 3.41, p = 0.003.

Table 5. Mean, SD, and t-values of categories of player actions for male and female students

Category	Gender							
	Male (n=17)		Female (n=24)		All (n=41)			
	M	*SD*	*M*	*SD*	*M*	*SD*	*t*	*p*
Exploring	2585.00	1146.00	1213.04	723.14	1781.90	1137.67	4.36	<0.001
Town Management	558.88	302.10	215.92	141.12	358.12	277.89	4.36	<0.001
Messaging	413.65	486.77	209.25	262.66	294.00	380.58	1.58	0.129
Military	350.06	266.90	58.38	61.57	179.32	227.68	4.42	<0.001
Trading	182.24	154.01	50.92	46.95	105.37	122.66	3.41	0.003
Diplomatic	75.53	45.85	25.54	28.49	46.27	43.92	3.98	0.001
All	3815.29	1914.35	1714.67	1088.24	2585.66	1801.28	4.08	<0.001

Discussion

The aim of this study was to examine characteristics of patterns of mobile gameplay and to investigate gender differences in patterns of mobile gameplay in secondary three students who participated in the mobile game-based learning curriculum *Statecraft X*.

Our research questions looked for patterns of mobile gameplay of boys and girls outside the classroom. Based on the survey data, students were able to engage in mobile game-based learning more at home than in the classroom. This ensures that learning is less teacher-centric and learner-centric. The learner-centric aspects of mobile learning are in line with previous work (Alexander & Murphy 2000, Lambert & McComb 2000). In this mobile game-based curriculum, students were actively engaged in their own learning. While planning strategies of gameplay, they had to monitor their own performance in the game and reflect on the principles which they used as governors. They had to actively construct their own knowledge of governance. This construction of knowledge also involved parents as students spent more time actively learning outside school. For example, during the post-intervention interview, one girl commented that because of the mobile nature of the *Statecraft X* game, she was able to discuss her gameplay with her mother while watching television and playing the mobile game at the same time. Although the girl had not been previously interested in current affairs, she was able to discuss current affairs with her mother while watching news together because the learning of affairs of governance that she was learning from *Statecraft X* game. Previously, when news was aired on television, she had retreated to her own bedroom. As a result, her mother told her that she had become more mature in her outlook because she wanted able to discuss current affairs with her mother.

Based on server-generated data, the results clearly indicated that boys spent significantly more time playing the mobile game *Statecraft X* than girls and were logged on more frequently than girls. These findings are consistent with previous results about males engaging more frequently in the use of computer games than females (Buchman & Funk 1996, Chou & Tsai 2007, Green & McNeese 2008, Solomonidou & Mitsaki 2009).

The player actions taken also showed differences in gender. For the exploring, town management and messaging actions, girls took half as many actions as boys. However, the differences were greater for the military, trading, and diplomatic actions. The greatest difference of player actions between boys and girls was found in the category of military actions. Thus, to reduce gender bias by making it more beneficial to choose diplomatic actions over military actions, two changes were made to the game design to ensure that student governors chose diplomatic actions rather than military actions. First, a "holding

rally" player action was subsequently added which made use of fewer action points than military actions. Second, the winning team of the game was not positioned as the team that captured the capital city of Velar but rather the team that had the highest composite two changes to the design of *Statecraft X* also emphasised the value of using non-violent approaches to solve conflicts in the game world. Thus, there is less dissonance of values in the game world *vis-à-vis* the real world.

Computer gaming is still perceived to be a gendered activity favouring males and the challenge is ensure that there is a level playing field for both boys and girls if computer games become a staple in the educational context. Marsh (2010) also highlighted the privileging of boys' interests in the selection of internet sites by educators to promote learning. By the same token, it is important to take note that in game-based learning, the fact that the curriculum is heavily based on a given computer game, girls who are not interested in playing that particular computer game may not learn as effectively as boys. Computer games used in the educational context must be designed to cater to the interests of both boys and girls so that game-based curricula can be effective. In the educational context, computer games designers need to get more design input from girls and women, and to test games more extensively in female populations. For the *Statecraft X* game, after the first intervention study, changes were made to the positioning of the game to elicit more participation in gameplay by girls for subsequent intervention studies. First, instead of emphasising that the winning faction was the faction that managed to capture the capital city in the following intervention in the same school which was held in April 2010, the game was positioned in that the winning faction was the faction with the highest composite score of the happiness level of the people governed, the profit made by the towns, and the population of the towns. With a shift of emphasis away from the taking over the towns, the girls might also participate in mobile game-play more fully.

From the interview data, the boys reported solitary play compared to girls who played in groups. Again, three major changes to the game design were made to encourage collaboration. First, each faction shared a common pool of money for the towns that they governed so that the plays had to collaborate to ensure that they money was spent most effectively in the faction's interest. Second, the winning faction was also positioned as the faction that had the highest composite score that comprised profit, happiness and population levels in all the towns that they governed. Third, six action points was given to each player every hour instead of twenty action points. Fewer action points were given every hour to each student governor so that strong players would not have enough action points to manage many towns effectively and thus had to give their towns away to the weaker players in the same faction, and advising them how to manage towns effectively.

In conclusion, game design and technical affordances are critical in a mobile game-based learning curriculum. The *Statecraft X* mobile game encouraged students to engage in learning continuously through the allocation of action points every hour. The portability of a networked multiplayer mobile game allowed students to play in spaces outside school and yet play together in portable communities. Learning also becomes less teacher-centric and more learner-centric as students choose their own time and space for the playing of the mobile game. The game design can also be changed to cater to the needs of girls who are less interested in warfare and who might prefer a game that emphasises more on people's happiness. Furthermore, game design could also encourage collaboration among students.

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Dr FOSTER went to Gloucester in a virtual world: Evaluating the potential of *Second Life* for flood science communication with decision makers

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Abstract: Five million people in the United Kingdom are at risk from flooding and recent extreme flood events, such as the Summer 2007 floods, have initiated an increase in flood management responsibilities for local government. In the light of this, communicating basic flood science to local government decision makers, namely Elected Members and Officers is essential. Supported by the Natural Environment Research Council and the Environment Agency, Project FOSTER (Flood Organisation Science and Technology Exchange Research) aims to provide a bridge between flood science researchers and decision makers in local government, improving flood science understandings through exploring the impact of face-to-face and immersive virtual learning experiences. Virtual environments such as *Second Life* could provide an invaluable interactive learning platform for local authority decision makers at County and District Council levels, for training, networking, meetings and seminars. This project will evaluate *Second Life* as a professional learning-scape, through innovative inquiry-based virtual workshops. Participants from Gloucestershire, Worcestershire and Warwickshire County Councils and related organisations are introduced to *Second Life* and will be encouraged to participate in virtual learning sessions focused on flood science, but designed for their specific needs. This paper introduces this action research project, examines the potential for *Second Life* as a science communication platform and discusses the initial reactions of the County Council representatives to using it.

Keywords: Flooding, science communication, learning, knowledge exchange, local government

Flooding in the UK

Flooding is the most serious natural hazard in the UK, and in 2007 extreme events in Hull and Sheffield preceded a catastrophe in the Gloucestershire region that affected over 340,000 residents and was unprecedented since the East Coast storm surge of 1953 (Baxter, 2005). The direct damage of the 2007 floods amounted to the substantial sum of £3 Billion and triggered a fresh wave of legislation that focussed on organisational and community resilience measures (The Pitt Review 2008, Flood and Water Management Act 2010, Environment Agency, 2007). In 2007, an independent review of the summer 2007 emergency was commissioned from Sir Michael Pitt. Entitled 'The Pitt Review: Lessons Learned from

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the 2007 Floods', it provided a crucial framework for the development of the Flood and Water Management Act 2010 and drew heavily on the experiences of the events in Gloucestershire and the surrounding counties. This Act places new responsibilities upon local authorities, superseding and complementing the previous guidance enshrined in documents such as *Planning Policy Statement 25: Development and Flood Risk (PPS25)*, which broadly aimed to discourage development on floodplains (Richards, 2007).

Managing floods in the UK is fraught with difficulties, ranging from a lack of basic hydrological data, through social and physical engineering matters, to a need to take challenging and potentially unpopular political decisions about the relative costs and benefits of different strategies, including that of 'doing nothing'. The Pitt Review's recommendation that local authorities should undertake the front-line decision making roles with the support of other relevant organisations, rendered Officers and elected Members, who are typically not experts in this field, responsible for flood risk management and local emergency co-ordination (P. XVIII, The Pitt Review, 2008).

The Flood and Water Management Act 2010 codification hence requires local authorities to improve their understanding of the science of flooding and the hazard it poses for their communities, in order to become intelligent commissioners of specialist consultancy work and communicators with the general public. In order for this to happen, fluency of dialogue amongst stakeholders, including scientists in universities and specialist research organisations, engineers, local decision makers, and representatives of community 'at risk groups' must be significantly enhanced.

At present, in reality, there is limited exchange of flood science ideas between the hydrological research community and local authorities. The knowledge transfer gap appears to arise from differences in prior science knowledge, terminology, policy, limitations in time and money, and the rather insular nature of research organisations and only recent attention to science knowledge exchange by the Research Councils. Project FOSTER experiments with bridging this gap by communicating cutting edge flood science research to three local authorities within the River Severn catchment, Gloucestershire, Warwickshire and Worcestershire, and taking their views back to the science community in order to set new challenges for researchers.

All three areas were seriously affected by the July 2007 flooding, and many of the local authority Officers and Elected Members became acutely aware of the limitations of their understandings (Worcestershire County and District Joint Scrutiny Report 2008). The challenge is to develop a method of science communication to meet the needs of Officers and Elected members, who typically have a very wide range of educational and professional backgrounds, ages and levels of technical capability. Significant proportions of Elected Members are retired professionals with spare time to invest in local community support. They nevertheless play crucial roles in administration, chairing or attending key decision-making committees, including the planning committees that approve or reject floodplain development, and committees that decide on budgets for specific activities.

Project FOSTER: Flood Organisation Science and Technology Exchange Research

Exploring the project's aims and partner needs

Project FOSTER aims not only to provide educational opportunities for local authority Officers and Elected Members but also to evaluate different methods of learning, in order to provide a framework for best practice in flood science communication to these stakeholder groups.

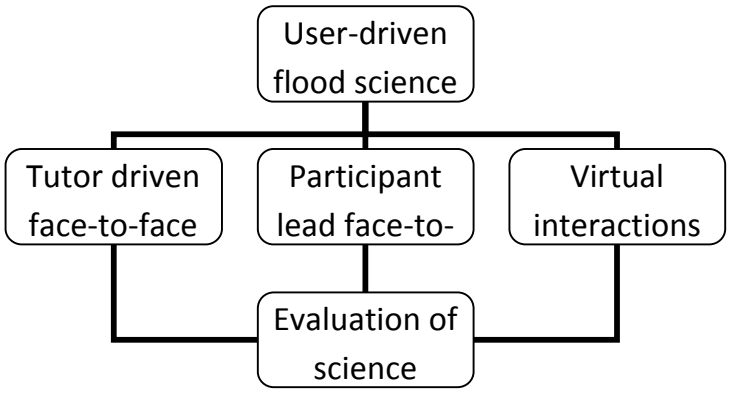

Figure 1. Diagram showing Project Foster framework

Figure 1 shows Project FOSTER's working framework, which firstly required an evaluation of the learning needs of key decision makers. Preliminary work on this was undertaken immediately after the flooding of 2007, through an extensive series of face-to-face interviews with stakeholders in the three counties (NERC, GLIF project 2008), and this was then expanded upon through a participatory workshop with key representatives from the three County Councils. The identified learning needs of the users focussed on a better understanding flood maps, models, the impact of climate change on flood management and uncertainties flood science.

A distinctive aspect of this project is to create a dialogue relating to the uncertainties in flood science research and the assumptions made during the creation of flood maps and models. This aspect of flood science is rarely discussed with decision makers and yet could have a large impact on flood management.

Communicating scientific uncertainty is one of the major challenges. In hydrological contexts, essential information on the uncertainty in flood prediction is not translated efficiently into the minds of those who have to manage the outcomes on the ground (Faulkner et al., 2007). Estimates of flood risk have a variety of sources of uncertainty, including short and fragmentary rainfall and river flow records, complex and unknown variations in the actual system inputs such as patterns of rainfall and snow in time and space, and untested assumptions about different statistical techniques and modeling. Superimposed on this, the systematic shifting of climatic patterns adds complexity and direct human contributions to flooding (such as dam failures or increases in urbanised surfaces) are frequently underrepresented (Morss et al., 2005). These all create uncertainties in the final predictions or forecasts. Communication may break down further because of issues surrounding the ownership of the information, legal liability associated with forecasts, and specialist language.

The user identified learning outcomes provide the scaffolding for the design of three contrasting yet comparable learning interactions, that will be trialled over winter 2010-11. These interactions will use three learning methods: face-to-face seminars, scenario simulations (or role-plays), and virtual or remote interaction in *Second Life*. Representatives will participate in one of the selected modes of interaction, and their experiences of using it will be evaluated using standard qualitative pedagogical research methodologies. These three learning methods will not only be used as specific training tools but could also change ways of communication and networking within the local authorities. The aims of Project FOSTER are therefore:

- To research further, evaluate and benchmark scientific knowledge needs amongst a wide range of flood management decision makers in government organisations at local and regional level
- To pilot innovative and inquiry-based learning experiences and, working alongside County Councils and associated organizations, to assist the flow of knowledge between the research community and flood science users
- To identify best practice for capacity building in learning communities made up of scientists and non-specialist stakeholders

Potentially useful educational materials and experiences identified from this interdisciplinary project will be customised so that they are suitable for using by decision makers in different geographical settings within the UK. However, it is the novel Virtual Learning Environments (VLE) that could have the biggest impact for local authorities; VLEs may well provide a low cost tool for effective learning and networking, encouraging dynamic advances in science communication.

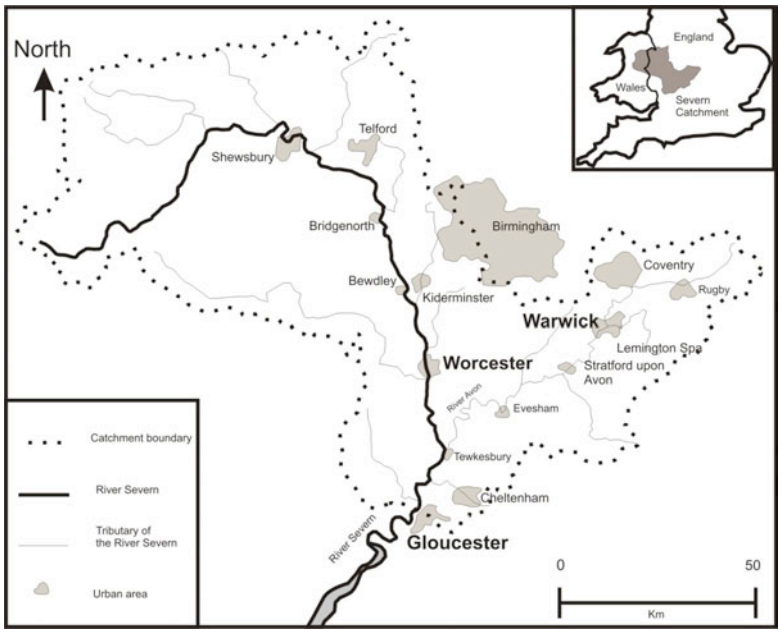

Figure 2. The River Severn catchment and main urban areas

Working in partnership

The lead local authorities involved in Project FOSTER, Gloucestershire, Warwickshire and Worcestershire County Councils, were chosen because, as Figure 2 depicts, they are all located within the River Severn catchment, UK, and were all seriously affected by the 2007 floods. The extreme nature of the event rendered local decision makers very aware of their

responsibilities to their local communities, cognisant of deficiencies in their understanding in flood risk and its management, and agreeable to participation in the project.

Gloucestershire was the UK county worst affected by the prolonged and intense rainfall in June and July 2007. The equivalent of two months of rainfall fell in just fourteen hours towards the end of the month causing both surface water flooding (from extreme precipitation) and fluvial flooding (from rivers) In this county alone, well over 5,000 homes and 400 businesses were flooded, with the true figure unknown as a result of under-reporting. Additionally there were failures in key parts of the regional infrastructure, and consequently some 48,000 homes were left without electricity for two days and 340,000 people lacked a mains supply of water for up to seventeen days when Tewkesbury's Mythe Water Treatment Plant was inundated (Gloucestershire County Council, 2009). Roads and railway lines were closed, significant structural damage was done to buildings, and extreme hardship ensued for substantial groups of the population; large numbers of people remained in temporary accommodation for over twelve months. The event was accurately described at the time by the Chief Constable, Dr Tim Brain, as the 'greatest civil emergency in the UK since World War II'.

In Worcestershire, where some 10% of the land area is at risk of inundation, a further 3,500 homes and 800 businesses were flooded. The direct economic cost to the county was estimated at £6.4 million per week during the height of the flooding. Those living on the border with Gloucestershire also lost their water supply, in addition to numerous roads and bridges being rendered impassable (Worcestershire Joint County and District Councils Scrutiny Report, 2008). Warwickshire lies within the River Avon catchment, a tributary of the River Severn, and has relatively flat topography with a dense web of watercourses. The effect here was widespread, with at least 2,000 properties in 75 communities across the county being affected (Warwickshire County Council, 2010).

These floods were the worst in living memory to affect the middle and lower Severn catchment, but they highlighted the need for all local authorities to have an improved understanding of flood science, and a cost-effective training tool that enables decision makers to share their understandings, and to explore how their own work interacts with that of others. The paper therefore focuses on the use of *Second Life* as a science communication tool, examining in turn the role of virtual learning environments within science communication, the initial responses of the project partners to using *Second Life*, and finally, how flood science information may be communicated through *Second Life*. The paper concludes by looking forwards to the implementation stage of the research programme.

Bridging the gap: science communication

Engaging the public in science and technology has recently become a popular theme within government and academia (Powell & Colin, 2008; Stocklmayer et al., 2001). The phrase 'science communication' is a term that is in widespread use and according to Burn et al., (2003:199) represents 'a significant field of enterprise worthy of ongoing research' that 'provides skills and dialogue to enable the general public, mediators and science practitioners to interact with each other more effectively'. Despite this position, the dissemination of scientific research findings is rarely evaluated, and so the effectiveness of different styles of dissemination programme is usually unknown. Research such as Project FOSTER, that translate and move scientific knowledge across the boundaries of different

social worlds, act as a knowledge brokers (Meyer, 2010). Despite the useful role of knowledge brokers, Meyer (2010) argues that the ways in which this information is transferred or exchange have never been properly explored.

Historically, most academic water resource specialists have been understandably focused on their research and have rarely had the time, resourcing or skills effectively to translate and communicate their results to non-experts. Equally, as Weis (1986) implies, most policy-makers or decision-makers at local level are extremely busy with routine matters, and rarely find time to engage with research findings from hydrologists carefully. This gap has been recognised by the large UK research councils such as the Engineering and Physical Sciences Research Council and the Natural Environment Research Council, and specialist funds are now being made available to investigate best practice in dialogue between the public and scientist (Davies, 2008).

Flood science communication to decision makers

Communicating flood information to decision makers and the public is essential yet fraught with difficulties as stakeholders confront problems in translating uncertainties in flood science into comprehensible and meaningful explanations, dealing with terminological differences and divergences in the agendas of different users. These challenges have been well demonstrated by the recent high-profile international dialogue over interpretations of climate change information, and its translation into public policy (Patt & Dessai 2005).

In hazard management, as in any research that crosses social milieu, academic disciplines, professions or real borders, language or terminology differences are a major issue (Mitchell, 2000; Bracken & Oughton, 2006). Science communication tends to be enhanced by dialogue encouraging an exchange of information about different terminology, across sectors. Finding a common language is a challenge but one that could be overcome through the formation of partnerships. Inter-organisational partnerships normally require understanding, patience and a common meeting place to be successful. When stakeholders can be distributed over a wide area, travel and hosting costs can be a major consideration for face-to-face meetings. Space that is accessible to all partners, available at low cost and that encourages discussion and training is therefore beneficial. Recent technological advances have produced online virtual spaces that can host meetings, discussions and trainings, and these Virtual Learning Environments (VLEs) can potentially provide future solutions for science dialogue. VLEs can range from Moodles to Webinars but within this paper we will focus on immersive avatar based environments, specifically *Second Life*.

Learning organisations such as the Open University have already widened their reach through the use of VLEs, and have begun to evaluate the benefit for previously excluded, disenfranchised or resistant audiences. These virtual environments have also been identified as an appropriate subject for research by institutes within UK universities; the Serious Games Institute at Coventry University, for example, develops and evaluates the impacts of virtual environments (http://www.seriousgamesinstitute.co.uk).

Virtual Knowledge Brokering Environments

Project FOSTER will use and evaluate three different learning methods. The most novel of these is the use of *Second Life* (SL) as a VLE in which to broker interactions for learning about expert flood science. SL is a multi-user, three dimensional, virtual environment that enables

participants to meet and converse with people in other places, without leaving their computer. According to Lim (2009) there has been an increased interest in virtual worlds as educational domains and SL has been adopted by many universities and businesses as a space for interaction and learning.

Second Life's official guide presents this virtual world as an idealised imitation of reality, with interlinked regions of water, land and sky. The land areas, or islands, are discrete areas that can be bought by stakeholders such as individuals or organizations, to use for mounting a range of activities including meetings and lectures. As Minocha and Robert (2008:188) explain, an island can 'provide a dedicated environment for learning which helps ensure a sense of belonging and purpose'.

SL is populated by avatars (virtual representations of specific individual learners) that can interact, travel between islands and attend workshops or meetings as the participant wishes (Rymaszewski et al., 2007). There is also the potential for creative learning as participants within Second life can build and create objects and as well as their own virtual surroundings.

Although SL was used by the early adopters purely as a social meeting place, its potential for distance learning has recently been explored by university teachers (e.g. Chodos et al., 2009; Jarmon et al., 2009; Roush et al., 2009; Livingstone et al., 2010). Minocha and Roberts (2008) note that SL encourages collaboration and socialisation amongst learners because the avatars provide an individual social presence, a trait that has been identified as an important aspect of distance learning. Other electronic communication methods such as email, conference calls, video conferences appear more limited in providing an effective distance learning tool as they lack the potential for personalisation, the stimulating and interactive graphical environment, and the data storage and sharing capabilities of virtual worlds. Jarmon (2009) notes that alongside a sense of presence, virtual worlds provide opportunities for creativity, experiential learning, collaboration, dissolution of social boundaries, lowering of social anxiety and the potential for accommodating a 'millennial generation', all desirable attributes for knowledge exchange. However, this has to be set against the potential for innovative on-line technology being too challenging for some specific audiences; most of the stakeholders involved in flood management, although professional and expert in their own right, are not 'digital natives' (Prensky, 2008); some may be technophobic and resistant to communicating by new technologies.

The choice of using SL within Project FOSTER was influenced by previously published evaluative research (e.g. Chodos et al., 2009; Jamaludin & Chin, 2009; Roush, 2009; Tsiatsos et al., 2009; Andreas et al., 2010). This literature notes SL's capability to provide a social presence appears better than any other currently available virtual worlds (Chodos et al., 2009*). Second Life's* growing popularity with educators is also a function of its widespread availability, accessible support, ability to provide a professional environment for interaction, ability to utilise voice, potential for mounting simulations and encourage a diversity of educational activities. It is also possible to present slides or stream in videos in order to create an environment that stimulates and stimulates all types of learner. However, most published research on SL focuses on university teaching and very little literature describes its use as a professional training environment for government agencies or businesses. Although the potential for the public sector could be great, there are potential obstacles in using any innovative tool. A review of existing literature relating to *Second Life* determined an initial set of key concerns (see Table 1).

Concern	Comment
Technical capability	With participants from a diverse range of backgrounds, some could struggle with the technical skills required to participate within SL.
Security	Flooding is a politically sensitive topic and seminars would have to use restricted or closed areas within SL. Discussions within SL would also need to be treated in the same way as interviews, and their
Cost	The initial cost of buying an island in SL, and other unforeseen technical costs, could preclude participation.
Legacy/ shelf life	The sustainability of the materials generated by Project FOSTER is crucial and although project partners would be able to use SL for further meetings, materials would need to be made available beyond
Access	Ability ofICT access and security protocols in Local Authorities to allow access to second life

Table 1. Initial concerns for using *Second Life* as a science communication tool for local government

Technical capability

The technical capability of participants within Project FOSTER is likely to be the most significant issue in using SL as a learning tool. As Lim (2009:4) notes, certain members of senior management are "not likely to be literate in operating and navigating in virtual worlds". Participants range from County and District Council officers in planning, engineering, transport, human resources, social services and other departments, through to Elected Members of all ages, interests and aptitudes. The variability in their technical skills will therefore be considerable, and SL was of interest because it appeared to have a relatively simple, intuitive and user-friendly design, especially the most recent version, Viewer 2. Despite this apparent ease of operation, participants in the seminars will need to attend a training or ice-breaker to cover the basic creation and management of an avatar such as customizing, communicating and teleportation.

Security: Bringing partners from various organisations together in a public domain to share ideas about a sensitive topic such a flooding may raise concerns about confidentiality. The seminars would have to be closed to wider public participation but SL can be customized to restrict island access to pre-designated avatars, providing a private setting. Recent improvements made by SL owners Linden Labs in an effort to sectionalise certain conventionally anti-social behaviour has provided a more acceptable and 'safer' environment for professional learning.

Cost: The cost of purchasing an island can be substantial and for a research project with a limited life span this may be unsustainable. Fortunately, with the consent of owners, islands can be shared, complementing the collaborative nature of Project FOSTER. If the project partners wished to continue training and meeting with SL afterwards, then buying their own shared an island might be more cost effective. This cost could potentially be shared across Local Authorities. Within this project collaboration with the managers of the Open University's 'Deep|think' island has provided a monitored and inspiring learning environment to be used (Rapanotti et al., 2010).

Legacy: Project FOSTER is a two year research programme funded by the Natural Environment Research Council, and in order for the project to produce a useful legacy the resources and results need to be available to Local Authorities afterwards. To create a long term resource within SL, purchasing an island may be the only option and this space would need to be made public. These two requirements restrict the legacy opportunities in SL. Hence running alongside the interactions, a 'Moodle' VLE linked to a project website may be required to provide the longer term legacy necessary for a knowledge exchange research project.

Initial reactions to using *Second Life* within Project FOSTER: expectations and concerns

However important the research team's initial concerns, Project FOSTER's intended learning outcomes are led by the partners, and their views also influence the design of the interactions. By collecting data on expectations, and combining it with themes identified in the literature, a basic framework has been produced to aid the design of the SL interaction for Local Government.

Question Number	Content
1	What do you currently know about virtual worlds and their use in professional communication or training?
2	Do you have any concerns about using virtual worlds as a method of training or communication for your officers and members?
3	Can you see any potential benefits of using virtual worlds for training or communication for your officers and members?
4	Currently, what interactive training or communication systems are in use by your organisation e.g. conference calls? And what are the advantages and disadvantages of your current system?
5	How do you think virtual worlds may fit in with your organisation's current training or communication system for your Officers and Members?
6	What do you think may be achieved by using virtual worlds for training or communication for your officers and members?

Table 2. The semi-structured questions posed to key representatives from all three County Council project partners

Leaders of the three County Councils' flood management teams, emergency planning, and training programmes were asked to complete a short, semi-structured questionnaire in order to gauge their initial reactions to the prospect of using a VLE. As Table 2 suggests, the questionnaire was designed to allow flexibility in response, with open questions and opportunity for general commentary.

Some respondents found the questionnaire difficult to complete because they initially knew very little about the use of VLEs for any purpose. This is potentially advantageous for the research programme because the respondents are not influenced by previous positive or negative experiences; they express 'pure' opinions that can shed light on the conceptual issues surrounding the introduction of new technologies, knowledge transfer and open-mindedness within local authorities. This pilot questionnaire was completed by six

respondents and is a starting point in an action research process that will evaluate individual experiences of SL for learning - before and after the science communication experience.

Initial benefits and concerns

Question 1 was intended as an introduction to the role of delivery styles, and offered an opportunity to gauge the respondent's general knowledge of virtual worlds. 80% of the respondents noted that they had essentially no previous knowledge of virtual worlds and yet most were keen to 'try new things'. Respondent A, noted for instance that the:

> *'general consensus is that organisations <should> adopt an open mind to any innovation that has the potential to improve the way they conduct communication and training, especially if the workforce is widespread'*

This positive yet straightforward reaction was unanticipated, as even when the outcomes are likely to be valuable, the introduction of new technology within a complex organisation can be a long, complicated and potentially negative experience (Szulanski, 2000). The respondents' pragmatism was also encouraging, suggesting an acceptance of the research focus, and of the experimental nature of the programme. Such holistic and open-minded attitudes are, as Tress et al., (2001), Cambell (2005) and many others have found, almost essential for the success of any inter-organisational and interdisciplinary project.

Although it was encouraging that the project partners were generally positive towards novel technology, some concerns nevertheless remained. A common apprehension was that this 'hi-tech method of training' (D) would not be 'welcomed' by a significant number of Officers (County Council staff) and in particular by Members (elected Members of Council). In this case the respondent supposed that the virtual worlds or learning environments would be conceptually too radical for County Councils, who in his mind were highly entrenched in their ways:

> *'Many find email enough of a challenge, and I can't imagine them getting on well with the virtual world approach' (D)*

The acceptability of this method of learning by Elected Members was a particular concern. One respondent suggested that virtual worlds and SL would be significantly more effective for a younger generation who are familiar with the technology, perhaps by virtue of gaming:

> *'I can imagine that virtual worlds would probably work well with young school and university students who have grown-up with I.T, but I don't think that virtual worlds are likely to have much success in our organisation as it is at the moment – computer literacy amongst Officers and Members is not at a consistently high enough standard.' (D)*

Trying to encourage a younger generation to engage with local government was one of the original reasons for exploring the potential for a VLE within Project FOSTER, and had emerged from earlier discussions with those Officers and Councillors directly affected by the 2007 event.

Other concerns relate to '*the technology understanding level – IT getting in the way of actual learning and the ability for the IT to be accepted*' (A) in the systems. To clarify, the respondent implied that there were three separate concerns (one of which had previously been identified by the research team): the technical capability of participants; the need to focus on learning outcomes rather than letting the technology take over; and finally, that this software would be unable to run on the widely available networked computers. As

previously noted, the technical capability of participants will need to be addressed during a face-to-face session prior to the formal interaction, whilst the ability of networked computers to run SL can be overcome by adjusting the host organizations' electronic firewall, isolating certain computers or encouraging participants to interact via their home computers.

Most importantly, it must be recognised that the *content* of the interaction is more immediately important in this project than the learning environment *per se*. Although SL may provide an exciting and creative space, the focus of the project remains on knowledge exchange and signposting research about flooding, rather than the 'cosmetics' of using a VLE. There is a fine balance between encouraging an appropriately social and creative environment, and using this territory effectively for focused learning. As Dillenburg et al., (2002:15) note, 'development is sometimes too much driven by technology instead of the pedagogic goals'. This concern, emphasised by the literature and also raised by the project partners, encourages reflectivity when designing and implementing the interaction.

Despite a concern that technical aspects of SL could overshadow the pedagogic goals, the respondents nevertheless noted that SL could potentially provide participants with a '*richness of experience*' (A) that is '*invigorating*' and '*memorable*' (B). Furthermore, the potential for a less '*labour intensive*' (A) learning experience suitable for a scattered group was appealing to partners because their travel costs and time commitment could be greatly reduced through the electronic communication.

The ability to bring together a widespread group of personnel from different agencies and departments within SL was another appealing aspect noted by majority of respondents. One commented that '*benefits not only include cost saving – they also increase the chances of getting the right people at the meeting*', thus aiding 'multi-agency response' to emergencies (B). Another said *'If Members can access <it> in their own house at a time to suit them then yes, this would be beneficial.'*(C). Inter-agency and multi-agency communication at all stages of emergency management is essential, and its effectiveness has been found to depend heavily on prior experiences of the same groups working in partnerships (Manoj and Baker, 2007). Although predetermined, well rehearsed institutional responses should be triggered during an emergency such as a flood, previous collaboration between responsible organisations is often minimal, and routine communication is frequently overlooked entirely until disaster strikes (Bharosa et al., 2010). As Pearce (2003) explains, preparation for a disaster needs to be proactive, and therefore a virtual system that enables communication and training across geographical and agency boundaries could be a useful tool for disaster planning and mitigation.

How SL can improve upon current communication and training technologies?

Question 4 attempted to gauge how well SL would mesh with current methods of institutional communication and training, thereby providing an indication of 'how smooth' any transition to using SL could be.

All three local authorities use conference calls as a routine method of communication and all noted that these are especially useful in emergency situations, as they help to reduce the need for travel. Despite the participants' likely familiarity with conference calls, and their speed of arrangement, there are hindrances for educational exchanges that could potentially be overcome by replacing them with SL. For example, 'sound only' conference calls can be challenging if there are more than three or four parties involved for example, either as a

result of unintentional interruptions, or conversely of participant passivity. Without the ability to see facial expressions or body movements such as a smile or a nodding head, it is challenging for speakers to gauge a level of agreement or commitment, or even to know if others are present and engaged. By contrast within SL, avatars can make a number of gestures that indicate whether the participant is taking notice and listening. Chodos et al., (2009) found that avatars in SL had significant levels of behaviour available to them, although more subtle forms of expression were not then possible. The avatars are able to indicate that they wish to comment and they can then go ahead, akin to a real meeting. Moreover SL allows for a large number of participants to gather in one 'space' and interact without the danger of interruptions.

As discussed by one respondent, some recent technological shifts have reduced face-to-face communication within organizations such as local authorities, and response to this has tended to be negative. Although emails have an important role in organizations, researchers have found that in comparison with face-to-face meetings they can have a negative effect on staff, for example producing information overload (Dawley & Anthony, 2003) or escalating disputes (Friedman & Currall, 2003).

> *'following the introduction and significant shift towards dependency on emails as the main means of communication, many Officers and Members have very strong opinions that this has not been a positive move as* ***it has stopped face-to-face communication between individuals****. In fact, Officers have been actively encouraged to reduce the number of emails and to pick up the telephone or make face-to-face contact instead' (D) (Emphasis added).*

Using SL may therefore provide a partial solution to the loss of individuality and courtesy, because the avatars can be manipulated to represent each person with an appropriate standard of etiquette. As mentioned previously, using an avatar within SL provides a 'social presence', a feeling of meeting face-to-face. Minocha and Roberts (2008:188) go further in suggesting that 'a 3-D virtual world provides a social setting similar to a face-to-face setting where the relationships are being mediated by bodies (avatars) which are <only> one step removed from Earthly bodies'.

Two of the respondents mentioned the experience of using individual e-learning training packages (self- instructed online courses) and how, although they were useful because the learner could go through the training package at their own pace and in their own time, there were drawbacks.

> *'E-learning does not necessarily encourage the individual to engage and learn, but instead the aim is to tick the right boxes and ensure they pass the test.' (D)*

Both respondents noted that e-learning packages do not usually allow people to share experiences, and that the learning does not 'embed as well as training in traditional style'. Instead it is largely seen as a procedurally-driven 'box ticking exercise' and it is potentially 'easy to cheat if it is a pass/fail process' (A). Another more optimistic view was that in SL it

> *'might also be easier to repeat those bits one doesn't understand the first time (or 2nd or 3rd) – without fear of being labelled a twit or being embarrassed by holding everyone else up.'*(C).

Concurring with these respondents, Cantoni et al., (2004:336) observes that e-learning frequently lacks 'part of the informal social interaction and face-to-face contact'. If true, participatory or socially-interactive education for flood science understanding would be preferable to self-paced individual tuition through online packages and tests. As Lim (2009) suggests, SL theoretically provides an enhanced environment for learning by exploring,

collaborating and 'being'. SL can therefore be seen as an environment that intrinsically encourages interactive, memorable and social learning.

Key considerations for incorporating *Second Life* into professional learning experiences

Several important themes have emerged from exploring of the pedagogic research literature, questioning key Council representatives, and reflecting on the initial research team's concerns on training in a VLE. These themes are providing the scaffolding for the design of Project FOSTER's flood science interactions. Three of these key themes are shown in Figure 3: allowing for the technical capability and willingness of participants; focusing on learning outcomes rather than learning environment; and engaging participants in a social context.

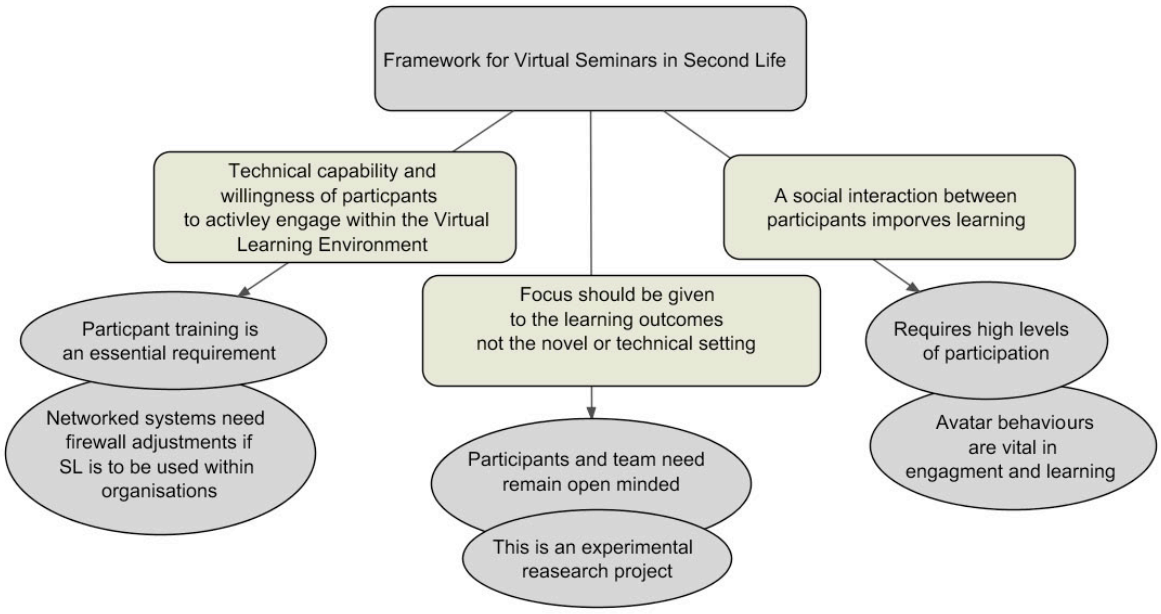

Figure 3.The key themes identified to aid the development of virtual seminars in *Second Life* for local authority participants

As discussed previously, the most common concern about using VLE for training within County Councils is the level of technical capability and willingness of the participants. Therefore in order for the interactions in SL to be acceptable and comprehensible, and for the fears of the hesitant to be allayed, the format is being designed to reflect an educational style that is otherwise simple, familiar and conventional. During this trial SL's complete range of learning options will not be drawn upon, and the format will be similar to that of a conventional workshop or seminar. This also allows the pedagogic research to isolate those facets of the educational programme that are notably advantageous or beneficial, rather than being influenced unduly by the real or virtual surroundings.

Using SL's ability to mount presentations and video, the participants will nevertheless be able to watch and hear a presentation on relevant flood topics, then interact with the tutor and each other as they would in a 'real life' seminar. This 'simple' use of SL can be extended by introducing basic role plays at an appropriate time. A drawback is that participants will have to 'attend' the virtual seminars concurrently, although learning resources could remain

in SL for a period of time afterwards, encouraging participants to return to reflect, or meet independently or in informal groups to discuss the themes in greater depth.

Retaining a more conventional educational 'feel' by holding the seminars in a space that reflects a place of discussion and meeting (see Figure 4) will also allow the research team and participants to focus on evaluating the learning outcomes rather than the dynamic environment or the aesthetics of the experience.

Figure 4. Snapshot taken from SL of a more conventional meeting place (within the Open University Island) with screens for viewing video or presentations.
Source: Courtesy of the Open University *DeepThink*

Engaging the participants in a more strongly 'social' context than has been possible for Councils using other e-learning tools, should help to engage and encourage participants to interact and discuss, thereby embedding the learning outcomes more deeply.

Conclusion

In the aftermath of the 2007 summer floods, new legislation has lead to an increase in responsibility in flood management for local government. In order to make informed decisions about planning and flood remediation, local authorities need to improve their understandings of flood science and draw on expert research findings as appropriate. Currently the link between flood science research in academia and decision makers faced with implementing systems to respond to flood hazards is weak, but Project FOSTER aims to bridge this gap by systematically evaluating the effectiveness of the transfer of knowledge in different modes, including through the use of *Second Life*. Virtual learning environments have the potential for improved engagement and socialisation, reduced cost and simple involvement of different agencies. However, the actual effectiveness of *Second Life* as a learning environment can only be gauged by the users' opinion. Evaluating user experiences will be a key part of the research process, as Project FOSTER progresses into the delivery phase.

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Real-time HIL simulation: A powerful visualisation technique to support the development of safety-critical control systems

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Abstract. Distributed and embedded control systems play an increasing role in modern safety-critical systems, and their development poses several key challenges from an Engineering and Computer Science perspective. In particular, the creation of dependable software for such systems can be particularly problematic; operational code defects (or specification errors) may lead to environmental damage and loss of life. In a safety-critical system there are both moral (and legal) requirements to get things right in the first place; 'beta' versions cannot be accepted. In most situations, for safety reasons it is not possible to 'test-drive' a prototype in its real environment; even if this is possible, practical reasons prevent full code coverage being achievable, leading to significant testing and verification issues. To address this problem, Hardware-In-the-Loop (HIL) simulation can be employed. Through appropriate physical interfaces, a virtual re-creation of the target environment (which is simulated in real-time) is interfaced to the real development system, allowing controlled testing and verification to take place. This paper describes recent experiences in both developing and employing HIL techniques in such situations; in particular, it focuses upon the creation of a novel real-time simulation of a section of a three-lane motorway (M1), complete with traffic; this simulation is then employed to partially verify a driver-assistance system consisting of an adaptive cruise controller.

Keywords: Distributed Embedded Systems, HIL simulation, Real-time control, Safety-critical systems.

Introduction

Embedded systems are now more ubiquitous and pervasive than ever; it has been estimated that for every desktop processor that has ever been sold, around 100 processors have been sold for embedded applications (Helmerich et al., 2005). In many of these applications, end users are often not aware that a microprocessor or microcontroller is even present in the products or services that they make use of.

For example, in the modern passenger vehicle there can be in excess of 100 electronic control units (ECUs), which are connected to a variety of sensors and actuators in order to realise high-level functionality and services (Lean et al., 1999). To reduce cabling costs and improve flexibility, these ECUs are often connected to one another via one or more serial communication buses. Figure 1 shows a typical automotive electronics architecture (VW Passat, reproduced from Leohold, 2005). A multitude of networks are required to carry

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critical real-time traffic (ABS, Engine Timing) along with non-critical traffic (body electronics, infotainment) between the ECUs. With the advent of heavily sensor-based control technologies and driver assistance systems, such as drive-by-wire and automatic collision avoidance, these distributed embedded systems (DESs) have no mechanical backup and play a crucial role in safety (Iserman et al., 2002).

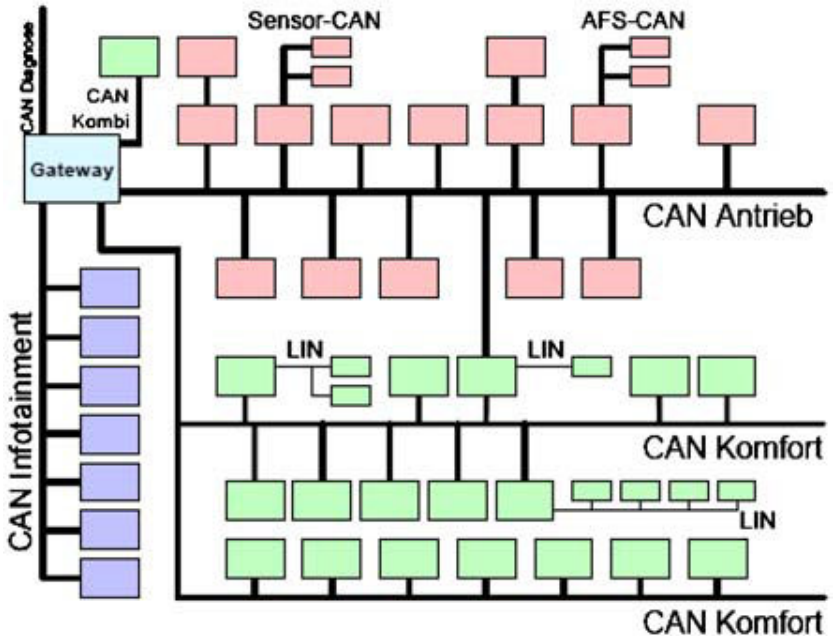

Figure 1. Network architecture of the VW Passat, showing CAN and LIN bus connections

This situation is by no means exclusive to the automotive industry. In many avionics, nuclear, chemical and medical applications, similar trends can be observed; that such trends are likely to continue (and even increase in pervasiveness) is now undisputed (Buttazzo, 2006; Helmerich et al., 2005).

The design of distributed and embedded control systems is a multi-disciplinary exercise that requires inputs from many different areas of the sciences, including Engineering (such as electronics, dynamic modeling and control, communications, reliability analysis), Computer Science (such as real-time systems and schedulability analysis, algorithms and data structure design, operating system and protocol stack integration, complexity analysis), and even diverse areas such as Psychology and Biology (such as human-machine interface design, 'human-in-the-loop' analysis). Modern Distributed and Embedded Systems (DESs) are generally accepted as being close precursors to next-generation 'Cyber Physical Systems' (CPSs) (Buttazzo, 2006).

The expectation is that in the coming years, further advances in science and engineering will dramatically increase the adaptability, autonomy, efficiency, functionality, reliability, safety, and usability of CPSs. These advances will effectively broaden the potential of CPSs in several different application areas, including the following (taken from NSF, 2009): precision and manufacturing (e.g., robotic surgery and nanotechnology); operation in dangerous and inaccessible environments (e.g., nuclear applications, search and rescue, deep-sea exploration); coordination and optimization (e.g., air traffic control, tactical and military operations); efficiency and renewables (e.g., zero-net energy buildings); and augmentation of human capabilities (e.g., healthcare monitoring and delivery). However, in order for the full potential of CPSs (or even DESs) to be realised, there are several pressing

issues - such as testing and verification - to be addressed; in this respect, virtualisation seems to have a large role to play and is the subject of the current paper.

This paper is principally concerned with the use of DESs in safety-critical and safety-related applications. A safety-critical system is a system whereby a failure of the service it provides - such as a malfunction or other unexpected behavior - can potentially result in serious injury or loss of life, damage to property, equipment, or the environment (Storey 1996). When developing safety-critical DESs, it is often inappropriate, unethical or even impossible to test the system completely within its natural operational environment (Storey, 1996; Levenson, 1995). In such cases, "hardware-in-the-loop" (HIL) simulation of the system and its environment can allow developers to make an initial assessment of performance without compromising safety. In particular, this paper will discuss recent experiences in the creation (and use) of an open-architecture HIL framework. In order to tighten the focus of the paper, emphasis is placed on automotive and vehicular control applications.

The remainder of this paper is organized as follows. Section 2 describes the principle of hardware-in-the loop simulation of DESs, along with some complimentary techniques. Section 3 describes a flexible and open-architecture HIL framework that has been previously developed. Section 4 presents the application of this framework to produce a real-time simulation of a busy UK motorway. Section 5 describes a case study that has been performed to assist with the verification of a driver-assistance system, an automotive cruise-control system. Section 6 concludes the paper and outlines some potential areas of future work.

Elements of a HIL simulation

Basic concept

The principle of HIL simulation of an embedded system is illustrated in Figure 2. The embedded system outputs are fed directly to the simulator, where they are sampled and used as input variables. A dynamic simulation model, acting on these input variables, is evaluated (normally in real-time, but this is not always the case). The outputs from the simulation, which are synthesised from the dynamic model(s), are then fed back into the system under test as outputs, thereby closing the control loop. Importantly, if the simulation is designed and implemented correctly, HIL testing can be regarded as a representative virtualisation technique that allows a potentially large design space to be explored and tested, with few (if any) consequences should a particular design fail at run-time. Since the equipment under test is fully representative of the final system implementation, this latter point becomes very important – defects that may result in catastrophic failures may be removed before the system enters operational service (Short et al., 2008; Short & Port, 2008; Storey, 1996).

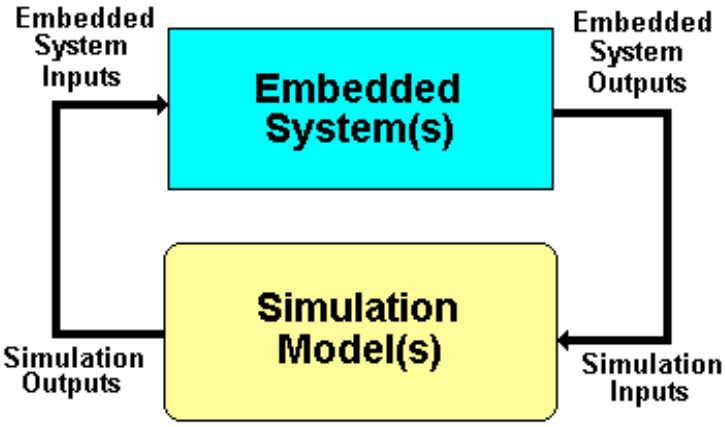

Figure 2. HIL Simulation Principle

Additionally, HIL simulation has been shown to both increase the end quality and reduce the time-to-market (and hence development costs) of prototype vehicle DESs (e.g. Short & Pont, 2008; Elims, 2000; Li et al., 2002; Kendal & Jones, 1999; Hakiwara et al., 2002). Simulators of this nature are not exclusive to the automotive domain and have been used successfully in a variety of applications, including (for example) verification of new manufacturing machine tool designs (Stoepler, 2005), commercial aircraft autopilot system design (Gomez, 2001) and numerous military applications (Cole & Jolly, 1996).

Given the above features, use of HIL simulation is deemed to be particularly appropriate during the verification and validation stages of the development lifecycle of safety-critical systems (Storey, 1996; Levenson, 1995). The complexity involved in such large-scale testing of distributed embedded systems and software dictates that structured, well-defined testing procedures and benchmarks are preferred over more 'traditional', ad-hoc methods for assessing system performance (Broekmann & Notenboom, 2002). However, from the perspective of safety-critical systems, standalone HIL testing is insufficient, for reasons that are discussed below.

The software testing problem

Performing rigorous assessments of safety and reliability properties of complex, reactive DESs (such as automotive control systems) is a wide and ongoing area of research. For safety-critical systems, special measures must be taken at all stages of the design process to ensure that the required Safety Integrity Level (SIL) has been achieved. SILs are a safety measurement standard developed by the IEC and formalised in Standard 61508: a discussion of how these measurement standards apply to the automotive domain may be found in (MISRA, 2001). The SIL of a system depends on the consequences of system failures, which can be determined using risk assessment; a required dangerous failure rate λ_d is then assigned for a system based on this risk. The four SIL levels defined by IEC61508 and their associated target failure rates are shown in Table 1. Demonstrating that the dangerous failure rate for a system is at a specific level requiring many factors to be taken into consideration; a major element in this process is the determination of reliability measures for each sub-system and component.

Table 1. Safety Integrity Levels as defined in IEC 61508

SIL	Probability of a dangerous failure per hour, λ_d
4	$\geq 10^{-9}$ to $< 10^{-8}$
3	$\geq 10^{-8}$ to $< 10^{-7}$
2	$\geq 10^{-7}$ to $< 10^{-6}$
1	$\geq 10^{-6}$ to $< 10^{-5}$

The traditional method of validating reliability is through life testing: however for real-time, software-based systems designed to have a failure rate less than 10^{-5}, such as those considered in this paper, this form of testing is impractical (on any reasonable timescale) and alternate means must be considered (Butler & Finelli, 1993).

Aside from the simplest of DESs, most designs for SIL1 and above will employ some form of redundancy for tolerance to the (unavoidable) faults and failures that will occur in subsystems, to achieve the required levels of safety integrity (Storey, 1996). This redundancy can take many forms; static and dynamic redundancy of electronic components and processing elements, communication systems and sensor/actuator subsystems in conjunction with software-based redundancy management algorithms (Iserman, 2002; Hammett, 2002). In such cases, fault injection is the preferred means for extracting dependability information (e.g. see Arlat et al., 1990). Fault injection enables the estimation of fault coverage parameters for analytical system models; however great care must be taken in selecting appropriate test sequences and determining representative rates of fault occurrence for such experiments. In the following section two techniques which may be used to great effect to complement basic HIL simulation techniques are described, in order to improve the efficiency of the testing process and help to ameliorate the problems outlined above.

Complementary techniques

One interesting area of research has involved the rare events technique (RET). The RET originated in the field of Operations Research as a methodology for speeding up simulations in which certain events of interest occur with extremely low probability: Heidelberger (1995) provides a useful survey of this technique. The primary aim of the RET is to determine the effects of rare events using simulation models such as Markov chains. From the perspective of real-time HIL simulation, the RET seems particularly suited for use in automatically generating representative test sequences (in a relatively short space of time) for the system under investigation. This is because the events of interest (such as sensor failures) happen very rarely.

Also of relevance in this context is the concept of Control Performance Monitoring (CPM). CPM provides on-line, automated control performance information to operators and plant engineers: this may be used to determine whether specified performance targets are being met for the controlled processes. Many different approaches have been taken in this area. For example minimum variance benchmarking, linear quadratic regulator benchmarking and various model-based approaches: Jelali (2006) provides a recent summary and

comparison of work in this area. Most of these techniques provide performance indices in the range [0, 1] that indicate good or bad control over a specified time history.

From the point of view of safety-critical control systems, measures of system functional safety can be obtained, in part, by applying the principles of CPM and determining how close the controlled variables are to perceived critical levels (such as reactor temperature, vehicle separation distance etc) by using an idealised system specification as a benchmark. As shown by Short et al. (2008), both the RET and CPM are highly applicable to automated fault-injection testing for performance and dependability evaluation in complex safety-critical control systems. The following section reviews a general framework that has been proposed for such an implementation.

A generic framework for HIL simulation

Basic structure

The generic framework consists of three basic elements; a HIL simulator, complemented by a performance monitor and a fault injector. The structure of the framework is as shown in Figure 3.

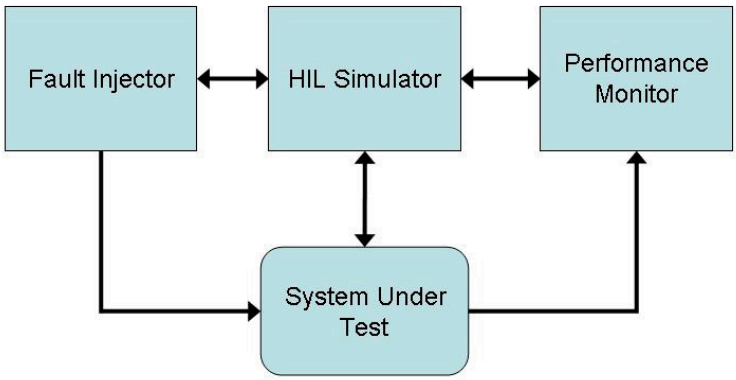

Figure 3. General structure of the HIL simulation and performance assessment framework

The framework operates as follows. A test sequence is initially started, and the HIL simulator is then used to generate the real-time inputs to the system under test and read its outputs. The fault injector implements a statistical model of the system under test, adapted using the RET. At 'random' times, faults and abnormal operating conditions are introduced into the system, either using direct fault injection or through the HIL simulator. The performance monitor continuously assesses the quality of control of the system under test in real-time, and provides a log of the recorded performance. This log, in conjunction with the log of faults injected, may then be used to calibrate suitable reliability models of the system. Full details of the fault injector and performance monitor are given in Short et al., (2008). Brief details are given below.

Fault injection framework

The RET, as applied in the evaluation of high-integrity software, starts from a single basic assumption: "Well designed software does *not* fail in routine operating conditions". This assumption is validated by numerous data from sources such as NASA (Lutz & Mikulski, 2003). In addition, when software has been designed using the rigorous techniques that are

mandated for high-integrity systems (e.g. see MISRA, 2004; Holzmann, 2006), and put through an initial test/debug phase, it can be assumed that all high-intensity defects have either been designed out of the system or have been removed during initial testing (Indeed, where formal techniques have been employed in the software design process, it may be possible to prove mathematically that *all* such defects have been removed. However, even in such cases there is a need to validate that the design specification itself is correct, especially when the specification contains functional techniques for the management and tolerance of unexpected system conditions such as hardware failures). It follows that all subsequent failures are caused by non-routine conditions such as abnormal / unexpected input sequences, erroneous computer states and hardware failures.

The rare events technique allows a qualitative assessment of the system under test by exploiting the discontinuity between 'routine' systems events, and abnormal or 'rare' system events. Although determining the operational profile for sets of system inputs is (in general) extremely difficult, since most rare events (such as abnormal inputs) are generally caused by well-understood physical phenomenon, there is normally a single point which can be selected to distinguish between "normal" and "abnormal" operation (Hecht & Hecht, 2000; Lutz & Mikulski, 2003). This is highlighted in Figure 4, showing the operational profile of a typical system and highlighting the point P_{rare} where normal operation ends and abnormal operation begins.

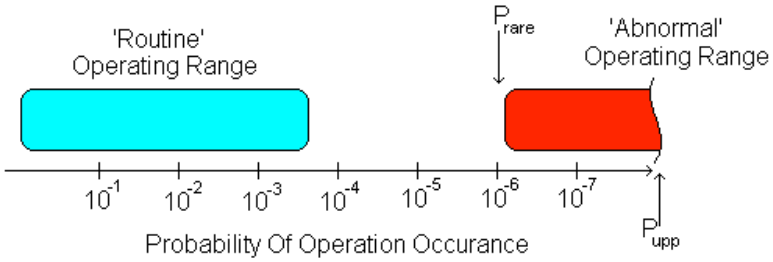

Figure 4. Normal and abnormal operational profiles

Also indicated in Figure 3 is an upper limit P_{upp}, which is an estimated upper bound for all the rare / critical operations of the system; that is the probability of a critical or rare event Pc is limited as follows:

$$P_{rare} > P_c > P_{upp} \tag{1}$$

In particular, to make the assessment of failure rate, the entire operational profile of the system is placed into one of two sets: [1] the regular set containing normal system operations or_1, or_2 … or_n or [2] the critical set containing abnormal operations oc_1, oc_2 … oc_n. The associated probabilities of occurrence for these operations are then pr_1, pr_2 … pr_n and pc_1, pc_2 … pc_n, satisfying the conditions shown in (2):

$$P_r = \sum_{i=1}^{n} pr_i, \quad P_c = \sum_{i=1}^{n} pc_i, \quad P_r + P_c = 1 \tag{2}$$

where $P_r >> P_c$ in order to maintain consistency with the assumptions above (and shown in Figure 3). In order to exploit the limited test time available for a reliability assessment, two factors must be considered. The first is that the probabilities of occurrence of the operations

in the critical test set are adjusted by a likelihood ratio α (see (3)) during the period of testing T, giving pc_1', pc_2' … pc_n':

$$pc_i' = pc_i.\alpha \tag{3}$$

in which the likelihood ratio α is chosen as some suitable value for a tractable test, e.g. $1/P_{rare}$. The second is that the test sequences must be selected to cyclically exercise as many of the operations in both the regular and (adjusted) critical sets in the least possible time, to obtain maximum possible test coverage. Suppose that during the testing time T, both routine operations and critical operations are randomly selected (with adjusted critical operation probability). If m failures are observed due to routine operations, and n failures are observed due to critical operations, the failure rate λ may then be estimated as shown in (4).

$$\lambda = \frac{m}{T} + \frac{n}{\alpha T} \tag{4}$$

However, it is assumed that the system should not fail for routine inputs: m should therefore be zero (if this is not the case then further, standard testing should be performed to remove these high-intensity defects), and a reasonably confident estimate of the likely system failure rate can be obtained.

On-Line Performance Monitor

Despite being a relatively new field of engineering, performance monitoring of control systems has expanded rapidly over the last decade and many innovative algorithms and methodologies have been proposed. From recent survey material, an analysis of the existing methodologies reveals that from the point of view of HIL simulation, where dynamic models of the process under control are readily available, a model-based approach would seem to be the most suitable (Jelali, 2006). The monitor is shown in Figure 5 and consists of three separate parts; the actual control system implementation and existing HIL simulation, a reference model that specifies the required closed loop dynamic behaviour, and the metric calculator. From an implementation perspective, integration of the monitor to an existing HIL simulator should be relatively straightforward, as the monitor can potentially utilise the same timing and computation resources as the simulator.

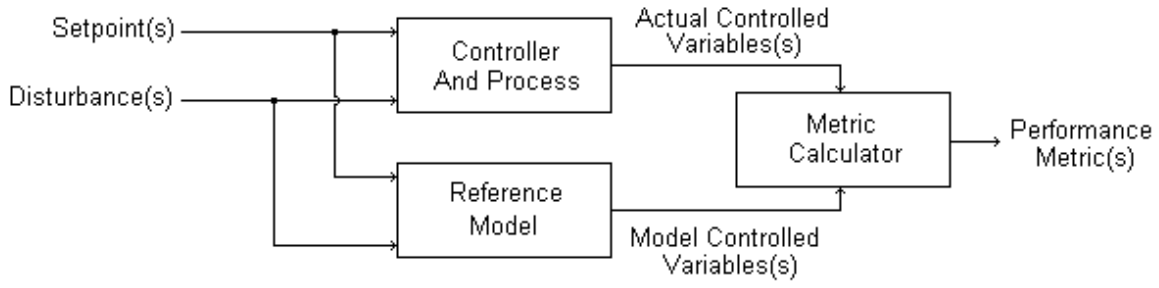

Figure 5. Performance monitor

Selection of a suitable closed loop reference model will depend highly on both the controller and process dynamics. For many plants and controllers, the required closed-loop

reference model can be as simple as a low-order transfer function. For certain classes of non-linear processes and controllers, the reference model may be obtained from the required performance specifications for the control system. For the most complex of controllers, the required closed loop system behaviour may even be generated by a secondary, idealised simulation of both the process and controller.

Once this required reference model has been determined, the actual set points and disturbances that are fed to the real controller and process are also fed into the reference model, thus dynamically generating idealised target outputs for the controlled variables. These reference model outputs are then passed, along with the actual controlled outputs, to the metric generator for further comparison and processing, to generate the performance assessment.

Implementation

The system is intended to be implemented around a number of standard desktop PCs, which do not require the need for expensive or proprietary interface equipment. Figure 6 shows the overall simulator architecture.

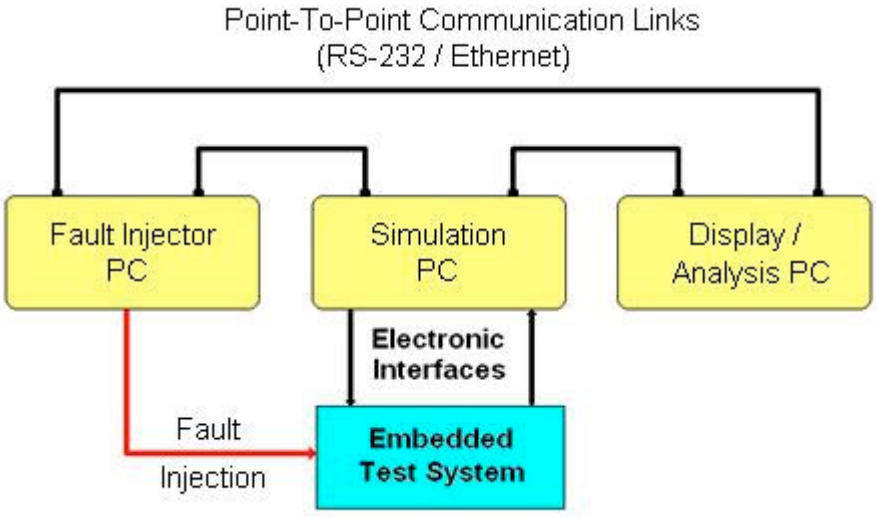

Figure 6. Simulator framework

In the Figure the hard real-time simulation applications run on DOS-based PCs, while the soft real-time applications run on Windows®-based PCs. A primary PC, running the DOS operating system (or equivalent), is used as a host for the main real-time elements of the software. Software libraries have been created to implement a real-time OS kernel and provide execution of periodic tasks through a fully-preemptive timer-driven Earliest Deadline First (EDF) scheduler. The timer has a resolution of 1 μs, although the basic tick rate may be adjustable to any integer multiple of this. Such a scheduler is known to be optimal (in a real-time sense), highly stable and scalable, and may be implemented very efficiently with small *O(1)* overheads Short (2010). Given a set of real-time tasks T (with each task having a period p_i and computation requirement c_i), the scheduler is guaranteed to allocate at least c_i units of computation every p_i time units to execute each task, assuming the following inequality holds:

$$\sum_{i \in T} \frac{c_i}{p_i} \leq 1.0 \tag{5}$$

In other words, it will allow the full utilisation of the host CPU whilst executing tasks in a timely fashion. The kernel also provides interfaces to both the parallel and serial ports for digital, analogue and serial I/O. Libraries have also been created to implement inter-PC communications using RS-232 and Ethernet links, realise the performance monitor, and to enable simulation variable logging.

A second (optional) PC runs the Windows® operating system, and is labeled the display / analysis PC in the Figure. If used, this employs a (custom) software library to decode the simulation information transmitted from the primary PC. A further library was also created for this second PC (using OpenGL): this allows 3-D visualisation of the simulation information. This interface can be used to show the simulation graphically evolving in (soft) real-time. Software was also created to upload and analyse data files generated by the main PC. In both cases, the libraries and analysis tools consist of code and components for the Borland C++ Builder® development IDE. A multimedia timer with a resolution of 1ms may be used for periodic updating.

The third (optional) PC again runs the DOS operating system, and is labeled as the fault injection PC in the Figure. Software libraries again are used to perform real-time task execution via a scheduler and to provide interfaces to both the parallel and serial ports for digital, analogue and serial I/O. Libraries are also created to implement and manage the rare events technique.

Interface considerations

To keep costs to a minimum, the input/output interface is implemented entirely through the use of standard PC serial and parallel ports. Digital TTL input and output pins can be directly used; analogue signals can be interfaced to the simulation via these TTL pins using low-cost, low-power ADC/DAC chips connected to the parallel port. Drivers have been created to allow both reading and writing of digital and analogue signals. Please note that, for an effective simulator, it is usually argued that analogue signals should be sampled and generated with a greater resolution than the system under test, and that the update interval of the dynamic model(s) should be in the region of 5-10 times smaller (Gomez 2001). For serial digital I/O, drivers have been created for synchronous and asynchronous RS232 communication. The hardware and software fault-injection mechanisms can be implemented via these interfaces.

Real-time motorway simulation

Simulation scope

The simulation described in this paper provides a real-time microscopic representation of road users traveling down an infinitely long three-lane motorway (plus hard shoulder) in the UK. Road users are represented over a 2 KM (1.24 mile) section of road, at the centre of which lies the host vehicle (which is controlled by the embedded system under test). The co-ordinates of the simulated road section are implemented as a moving frame of reference that is attached (longitudinally) to the host vehicle (Figure 7). A consequence of this is that the relative velocity between the host and each other vehicle dictates their position in the

simulation, as time advances. The hard shoulder lies to the leftmost (slowest) lane in the Figure and is labeled Lane 0 and is only used for emergency purposes.

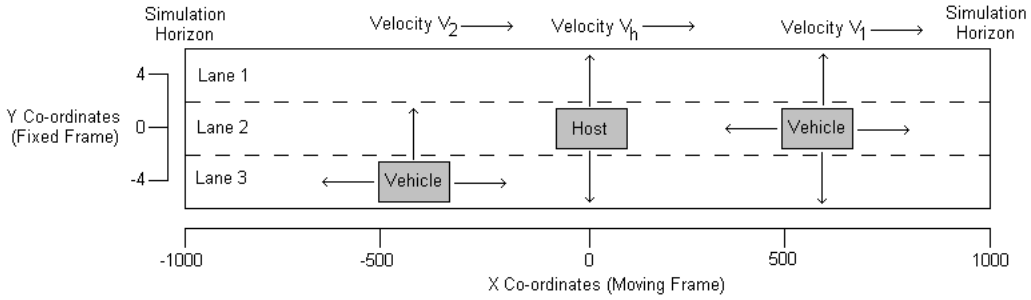

Figure 7. The motorway co-ordinate system

The simulation has an initialisation procedure, where each simulated vehicle is assigned a desired speed and following headway, and given an initial position in the simulation plane. As the simulation evolves, faster vehicles exit the frame of reference to the host vehicle's front, while slower vehicles exit to the rear. When this occurs, new vehicles will be generated and assigned desired speeds and headways, entering either the front or rear of the simulation depending on the current velocity of the host.

The version of the simulation described in this paper is concerned with control of the host vehicle longitudinal velocity only: this is reflected in the granularity of the host vehicle dynamic model. The additional road users consist of heavy goods vehicles (HGVs) and passenger vehicles, while the environmental variables included in the simulation consist of the road gradient, traffic density, weather conditions and prevailing wind/turbulence level. For further details of each of the models, and a full justification of their use, please refer to (Short & Pont, 2005; Short & Pont, 2008; Short et al., 2008).

Host vehicle dynamics

A two-wheel traction model was chosen to represent the host vehicle. A schematic of this model is shown in Figure 8.

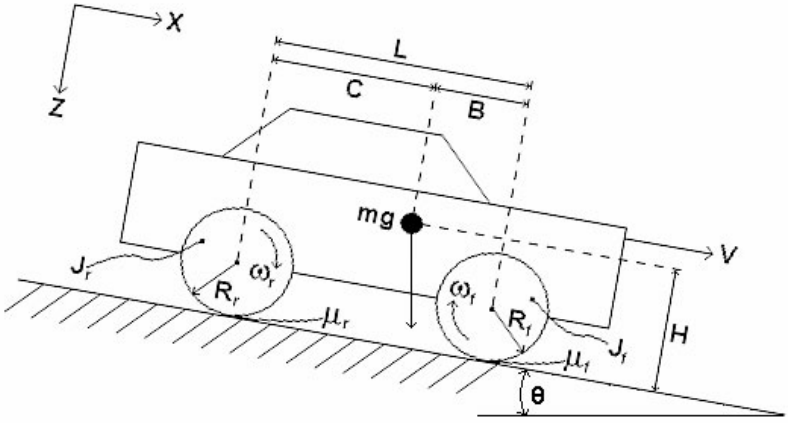

Figure 8. The two-wheel traction model

The resulting dynamic equations that were created to implement this model were non-linear and of high order. A block diagram outlining the main elements of the vehicle model, and the system variable dependencies between them is shown in Figure 9. In the simulation, the dynamics of the host vehicle were updated every 1 ms.

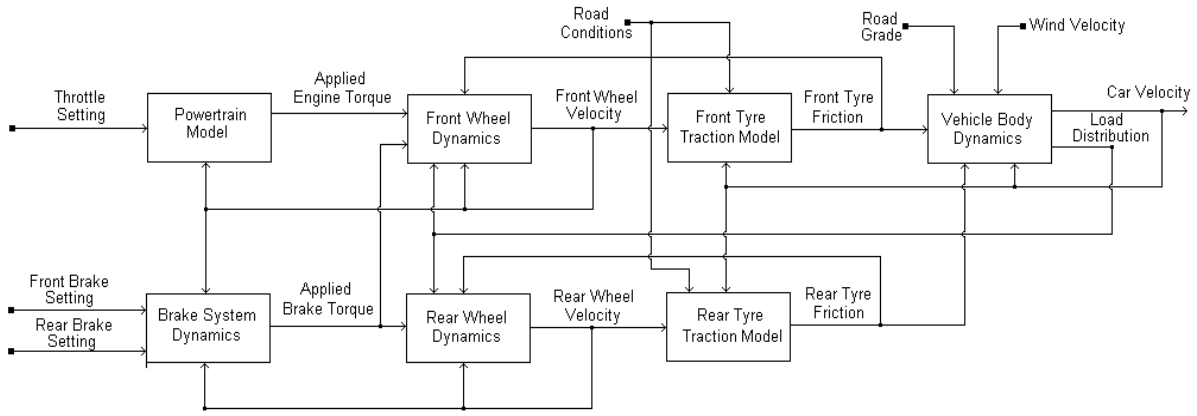

Figure 9. Host vehicle model block diagram

Additional road users

Additional road users are represented by a simplified dynamic model, which is given by (6), where x_2 is the vehicle velocity and x_1 the vehicle position.

$$\begin{aligned} \dot{x}_1 &= v_h - x_2 \\ \dot{x}_2 &= \min\left(\alpha_a, \alpha_{\max}\right) \end{aligned} \tag{6}$$

The host vehicle velocity is v_h, and the vehicle driver provides the acceleration signal α_a. The saturation level α_{max} takes into account the vehicle speed, gradient and road condition to provide accurate modelling and increase the realism. The dynamics of additional road users were updated every 10 ms in the simulation.

Modelling the driver

In order to provide the acceleration signals for the additional road users, and to decide when to change lanes, we implemented microscopic driver models for both longitudinal and lateral vehicle control. In this simulation two different types of longitudinal motion are to be modelled:

- Free Driving – the driver endeavors to achieve and maintain the desired speed.
- Car Following – the driver attempts to maintain a safe distance to a leading vehicle in the same lane.

In both cases, the driver behavior was implemented as a feedback control system acting on the simulation kinetics. The free driving model was implemented as a proportional controller producing an acceleration signal α_{fd}, and the car following model as a proportional-velocity controller producing an acceleration α_{cf}. The actual applied acceleration signal α_a was taken to be the minimum of the two, to provide smooth switching between controllers. A block diagram of the controller is shown in Figure 10. The controllers are updated every 10 ms in the simulation.

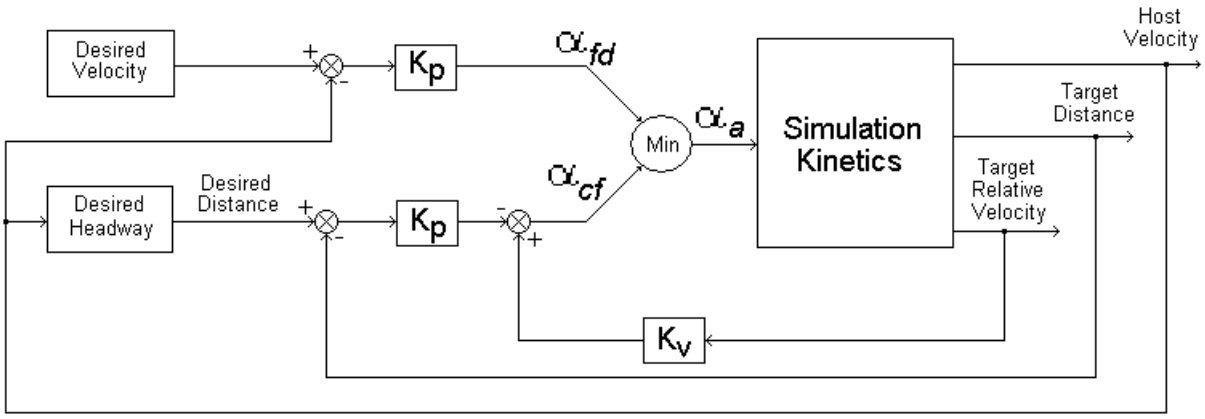

Figure 10. Longitudinal acceleration controller

Lateral

Lane changing is a notoriously difficult and complex behavioral process to model. It is best considered in terms of a number of perception thresholds, which consider the risk involved in accepting a gap in neighboring lanes, compared to a benefit factor of some kind when performing the maneuver. This simulation is concerned with discretionary lane changes only, since the motorway is considered infinitely long. A block diagram of the implemented lane change models is shown in Figure 11. Actual lane changes were implemented as a sinusoidal trajectory, described by (7):

$$y_t = y_s + \frac{y_d}{2} + \sin\left(-\pi + 2\pi\frac{t - t_0}{t_1}\right) \times \frac{y_d}{2} \tag{7}$$

In this equation, y_s is the initial y co-ordinate (at time $t=t_0$), and y_d is the final y co-ordinate (at time $t=t_0+t_1$). The trajectory accommodates a changing velocity v, and the change time t_1 was made inversely proportional to the move urgency, centered on a mean maneuver time of 6.2 seconds. The lane change models are updated in the simulation every 10 ms.

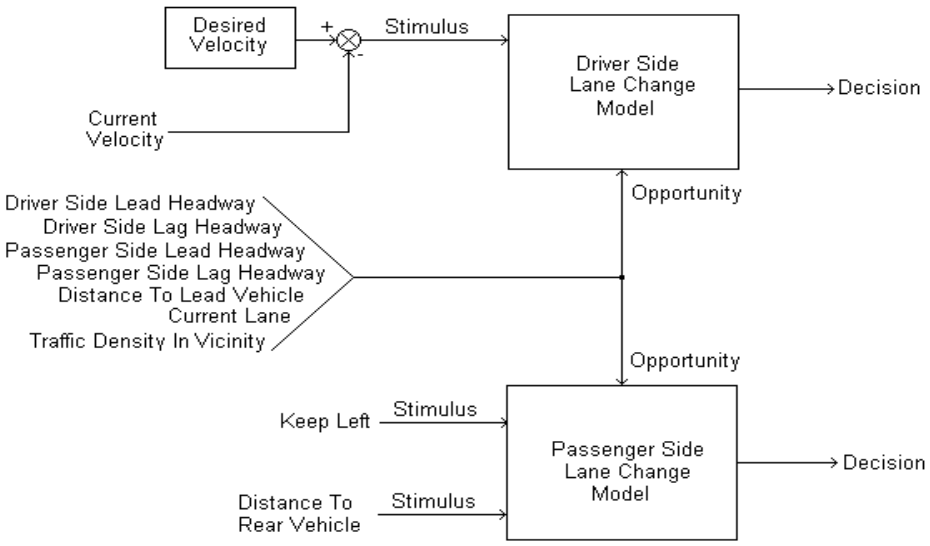

Figure 11. Lane change models

Parameter selection

The longitudinal and lateral driver models both possess calibration parameters that determine how aggressively they will react to the road conditions around them. A simple least-squares optimisation procedure was used to modify the parameters of the models to produce macroscopic flow/lane occupancy behaviour close to that observed in practice. After this procedure, the simulation produced the flow/occupancy relationship as shown in Figure 12, and is extremely accurate compared to available empirical data (McDonald et al., 1994).

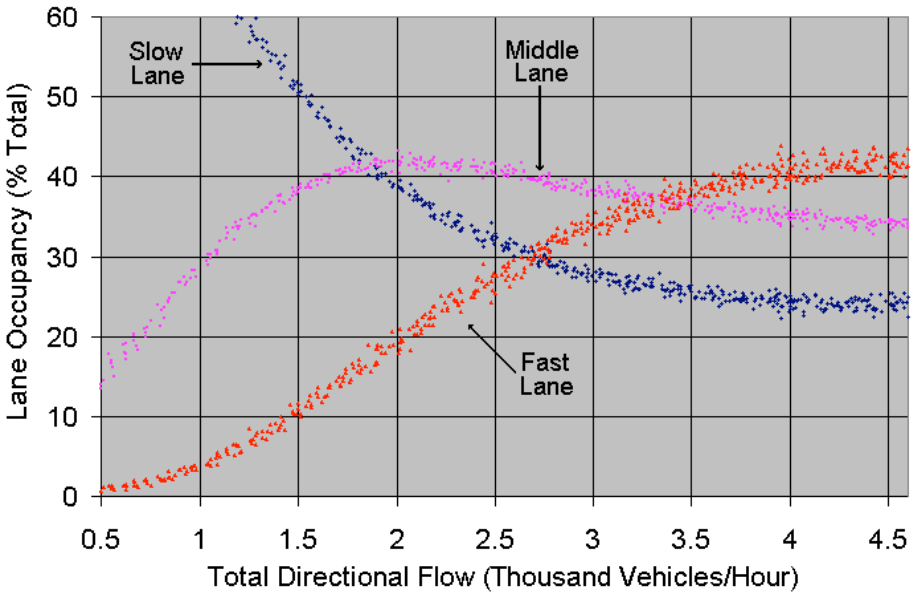

Figure 12. Simulation traffic flow vs. lane occupancy

Hardware configuration

The HIL simulator described in this paper was implemented using three standard desktop PCs. The primary and tertiary real-time PCs had a clock speed of 400 MHz, and the secondary graphical interface PC has a clock speed of 700 MHz. The primary PC scheduler was configured with a 'tick' interval of 1ms, while the tertiary PC was configured with a 'tick' interval of 5ms. CPU utilizations were found to be 85% and 12% respectively, thus all real-time constraints could be met according to (5). A total of four parallel ports were used for I/O purposes on the primary PC. Ten analogue output signals were generated from the primary PC, and 2 analogue inputs were required. A single RS232 channel (in addition to the high-speed RS-232 links to the secondary/tertiary PCs) was required. In total, 45 digital inputs and 11 digital outputs were used. These basic I/O channels were extended into the simulation by the use of 'virtual' sensor and actuator interfaces, which represent individual sensor/actuator dynamics, measurement accuracy and noise models. In this case parameters for time constants and the accuracy of each virtual sensor/actuator in the simulation were taken from manufacturers' data sheets and survey data (Turner & Austin, 2000). The sensor and actuator models were coded into tasks which were updated every 1 ms in the simulation.

Visualisation

The second PC, running the Windows operating system, was connected to the first via a duplex 1 Mbps serial link, and provides an interactive, graphical interface for user feedback and simulation control. A screenshot of the user interface is shown in Figure 13.

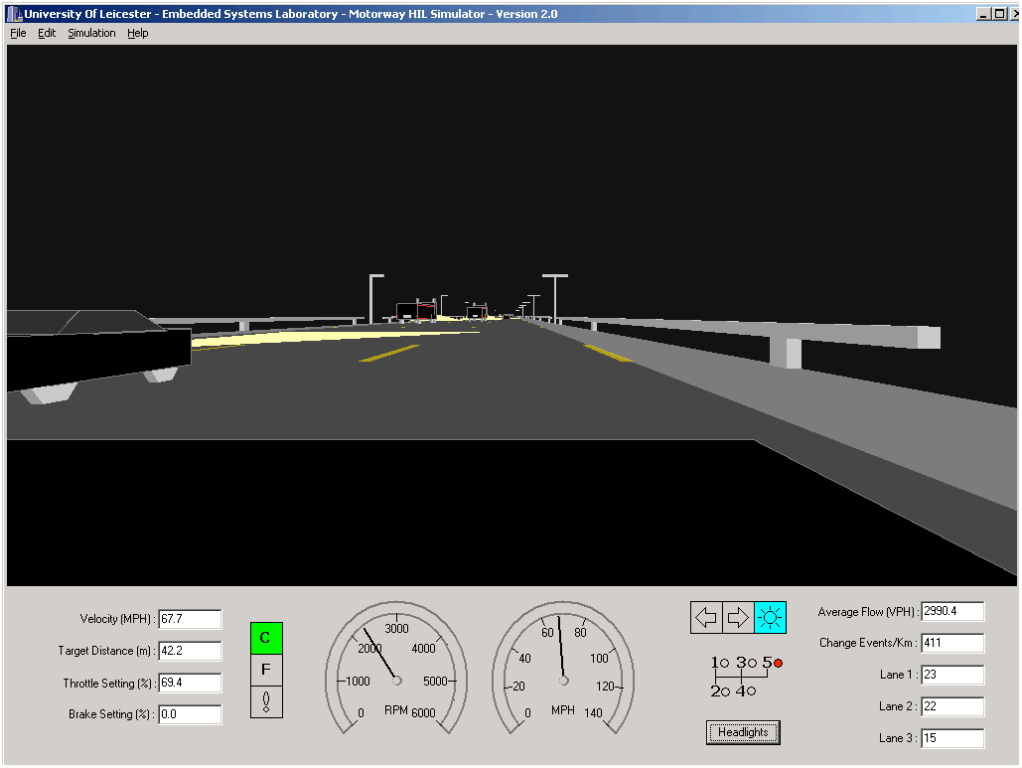

Figure 13. Test facility virtualisation and graphical display interface

Case study

Description

The performance of the simulation is illustrated in this paper using an example based on an Adaptive Cruise Control (ACC) system. ACC is a relatively new technological development in the automotive field, and is thought to reduce driver fatigue and the rate of auto accidents, whilst increasing fuel efficiency (Stanton et al., 1997). The main system function of ACC is to control the speed of the host vehicle using information about the distance between the subject vehicle and any forward vehicles (using Doppler radar), the motion of the subject vehicle itself and commands from the driver, as shown in Figure 14. Based upon this information, the controller sends commands to the vehicle throttle and brakes to either regulate the vehicle speed to a given set value, or maintain a safe distance to any leading vehicles. It also sends status information to the driver.

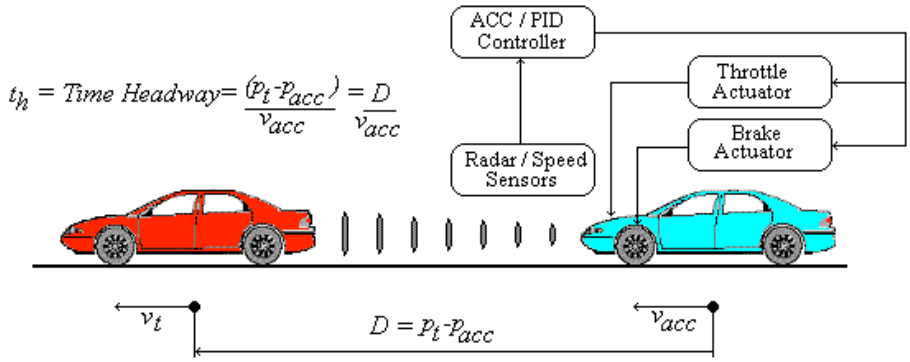

Figure 14. Basic ACC concept

The system under consideration in this study is a Type 2b ACC system: such a system employs active braking. Vehicle acceleration is limited to 2 m/s^2, deceleration to 3 m/s^2 in order to comply with ISO standards (ISO 2003). Further details of the nature of the controller itself may be found in (Short et al. 2008). When the cruise control system is disengaged, the throttle and brakes are activated via electronic signals from sensors attached to both the brake and throttle pedals. Given the level of risk associated with each element of the system, we classified the required Safety Integrity Level (SIL) for the overall system at SIL 3, with a maximum failure rate of 10^{-7} dangerous failures / hour. The rationale behind this decision was taken directly from MISRA guidelines (MISRA, 2001).

The test system was created using Infineon C167CS microcontrollers (one per node) running at a 20 MHz oscillator frequency. A total of 9 nodes were used in the basic system, connecting to 500 kbps twisted-pair Controller Area Network (CAN) links (Bosch, 1991). A time-triggered, co-operative scheduler was implemented on each node, using a shared clock methodology to synchronise each clock (Pont, 2001). The system tick interval, which is provided by the Master node via the CAN network, was 1ms, and the ACC controller was implemented with a sample frequency of 10 Hz.

Test scenario

A possible weakness of the shared-clock system, described in the previous section, is that a failure of the Master node to send the system ticks will cause the remaining nodes in the system to fail to function correctly (Pont, 2001). This is a common weakness in distributed systems featuring a global clock. Should such a failure occur in this system, the remaining (Slave) nodes will each enter a fail-safe state. In certain situations, such as during a car-following incident, an ACC system entering a fail-safe mode in a manner similar to this may not be enough to prevent an accident from occurring (Stanton et al., 1997).

It is well known that the use of redundancy is an effective way of providing fault tolerance (Iserman et al., 2002; Storey, 1996). As an initial investigation of the effectiveness of the simulation, another version of the system was implemented. In the second version, a back-up Master node microcontroller was added. If the Master node fails, the back-up Master node will detect the absence of systems Ticks and will quickly take over (a form of 'hot backup' redundancy). A schematic representation of the system with the back-up Master is shown in Figure 15.

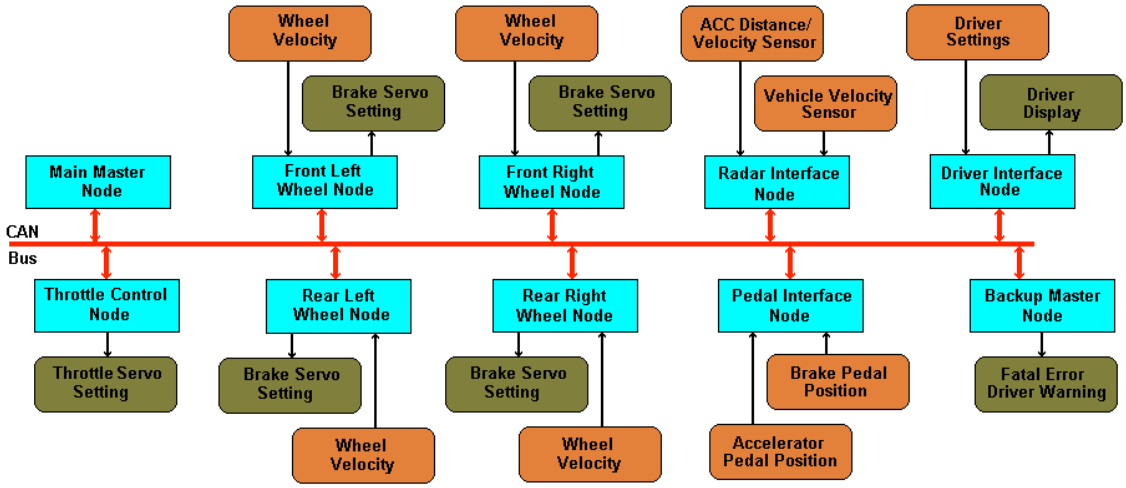

Figure 15. 10-node ACC implementation, with back-up Master node

The simulation scenario we created was to have the host vehicle - with the ACC enabled - traveling down the motorway, following a lead vehicle. Initially, both host and target vehicles were traveling at a velocity of 70 MPH. Approximately 10 seconds after data logging was initiated, the lead vehicle braked and reduced its speed to 30 MPH with a maximum deceleration of 4 m/s^2. At this point, a fault was injected into the test system Master node, simulating a catastrophic electronic failure. Note that probability of such an occurrence is approximately 1.17 x 10^{-6} failures per hour for this particular device (Short & Pont, 2008).

Results

The information gathered from the simulation outlined in the previous section was used to compare the failure modes of the systems with and without the back-up Master. The failure modes of the two systems are presented in Figures 16 and 17. Figure 16 shows the operation of the system without a back-up Master node, and it can be clearly seen that a collision occurs at 38.1 MPH after 17.78 seconds.

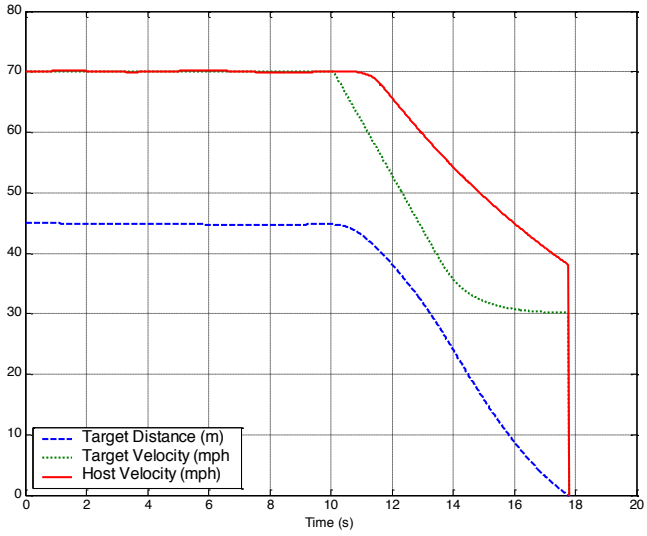

Figure 16. Simulation results (without back-up Master)

Figure 17 shows that with a back-up Master in place, the system recovers with enough time to decelerate the host vehicle and prevent a crash. The 'driver', alerted to the fault by the back-up node, then brought the vehicle to rest on the hard shoulder. Although this scenario has been used for illustrative purposes only, under extensive RET testing it is known that without a backup, the probability that a Master failure will lead to a dangerous outcome whilst driving on the motorway is 0.98; with a backup in place, this drops to 0.04 (Short et al., 2008). Given the component failure rate of 1.17×10^{-6}, it is clear that in this system only a design which employs a backup can ever hope to achieve the target SIL.

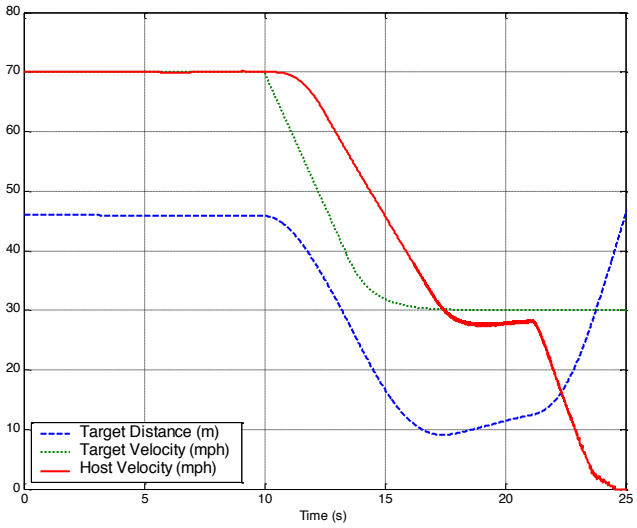

Figure 17. Simulation results (with back-up Master)

Conclusions and further work

This paper has considered the use of HIL simulation (and related techniques) as an aid to visualisation, test and verification of safety-critical DESs. It has considered the requirements for such a simulation, and has discussed a low-cost and flexible real-time simulator previously developed by the authors. Descriptions have been given as to how this test facility has been configured to represent a road vehicle travelling down a three-lane motorway under free flowing traffic conditions, using a realistic representation of a particular section of motorway in the UK. A simple case study has been introduced to illustrate the use of the simulator, and show that it is an effective means of visualising the functional behaviour and examining the functional safety of different possible designs for automotive control systems, in such a manner that would not be possible without the use of HIL simulation.

Further results obtained have shown that this framework can allow developers to rigorously assess the impact of adopting different hardware configurations on the control performance and safety integrity of automotive systems (Short & Pont, 2008; Short et al., 2009). It is hoped that ultimately, experience gained from the use of current-generation DESs may help to pave the way for future generations of CPSs. As such, the use of HIL - and other related virtualisation techniques – may help to contribute some way towards this goal.

Finally, the work described in this paper has been limited to research-based applications. The authors initial experiences (at the University of Leicester) strongly suggest that frameworks such as that described in this paper may be successfully used to support the

teaching of safety-critical DESs, principally at a postgraduate level. The further exploration of this final observation is seen as a principal area of future work for the authors.

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Mobile work based learning up close and personal

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Abstract. Mobile learning is about knowing and understanding how to use everyday life worlds as learning spaces. The increased capacity, capability and functionality of mobile technologies mean that support, instruction, collaboration, communication and assessment of and evaluation for learning, can happen anytime, anyplace. Work based mobile learning is an emergent paradigm of lifelong learning, which has two perspectives, one associated with the concept of time and biographical learning, education in the life span and one set in a social dimension in a global context of biographicity. Thus, the work based mobile learning process should enable students to engage collaboratively with others and communicate to share and transfer knowledge across different learning contexts and learning spaces. The author is developing a 2010/11 pilot module (work based mobile learning) requiring learners to record, review and reflect on work based learning activities hosted in an immersive virtual workplace. Learners' interactions with the virtual workplace will be mediated with a mobile device on which they are able to create personal biographical records of their learning. This paper seeks to highlight and review some of the key issues associated with the design of the module.

Keywords: mobile, biographical, lifelong, work based learning.

Introduction

There is a growing demand for employability learning to be addressed within the curriculum from students, employers and the government (BIS, 2009, CBI, 2009). Currently, the Higher Education Academy (2009) define work based learning (WBL) as "a process for recognising, creating and applying knowledge through, for and at work which forms part or all of a higher education qualification." [http://www.engsc.ac.uk/er/wbl/index.asp].

In the BIS Higher Ambitions report, Lord Mandelson suggests that "without employability skills: several important strands in UK employment and skills policy may be unachievable" (BIS, 2009, pp.4). He goes on to explain that Universities have a responsibility through knowledge generation and stewardship to prepare our people for the world of modern work. Thus, work based learning is a model of learning which Universities are increasingly recognising as important to their curriculum provision.

Changing modes of delivery and the recognition of technology enhanced learning as a pedagogical approach which can enhance learning is leading to new innovative pilots in HE sector and other sectors (Traxler, 2008). The reason studies of actual use of mobile devices in learning is important is explained by Conole & Dyke (2004). They explain that the ways in which meaning is attributed to technologies is based on the perception of what a particular technology makes possible/disallows. Thus the impact/effectiveness of mobile technologies to support learning is highly contextual, associated with tutor and learner characteristics and

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preferences, the pedagogical approach employed, the organisation of the learning environment as well as the omnipresent disciplinary and institutional culture and norms (Kennewell, 2001).

Winters (2006) theorises mobile learning as any form of learning when mediated through a mobile device. The fundamental distinction between learning and mobile learning is the use of a mobile device to mediate learning. The use of mobile technology as a mediating tool enables learning experiences to be captured, discussed and reflected on as part of convergent or divergent assessment activities any time, any place in an array of situational contexts. Hall (2009) explains that mobile technologies can be used to connect students' informal and formal learning. Mobile learning can be spontaneous, personal, informal, contextual, formal, ubiquitous and pervasive (Kukulska-Hulme & Traxler, 2005). Outside the classroom, the use of mobile devices offers more opportunities for learning and students have increased choice in where, how and when they learn.

The heterogeneity, complexity (Braidotti, 2001) and super-complexity (Barnett, 2000a; 2000b) of everyday life worlds as learning spaces, means geographies of learning are being reconfigured all the time. The author seeks to explore the design of a new geography of learning brought into existence by the virtualisation of a workplace, to consider how, with virtualisation, the "space and time of learning as a lived experience" (Ellsworth, 2005, pp.17) and consider to what extent virtualization impacts on learners' ability to adopt agency of their biographical learning in the context of a new pilot module (mobile work based learning).

The author seeks to consider ways in which the transformative potential of mobile technologies can be used to enable lifelong learners to use everyday life worlds as learning spaces. In addition to this, she seeks to consider how virtualisation of the workplace impacts on the process and design of learning activities.

The impact of virtualisation of the workplace and its impact on learners' interactions and adoption of agency in determining learning which is relevant to them is personal, highly contextualized and will originate within a micro-sociological theory of practice. It is this notion that Tarde (1899) refers to as "everything in the world of facts proceeds from small to great" (pp.111). Hence, it is the context of practice and not general laws influencing these interactions. It is for this reason that the author is going to use a case study (pilot module) to illustrate some of the issues of 'mobile work based learning up close and personal'.

The design of the module enables a mobile device to be used to bridge formal and informal learning spaces and provide a connectivity of place to the virtual workplace. Tacit knowledge gained by students through learning activities and informal learning is made explicit through the process of reflection. The module creates an opportunities for learners to choose when, where and how they learn. It offers a personalized, immersive learning experience in which the learner adopts agency of their learning. However, this approach has pedagogical implications in terms of the geography and ownership of learning and constructive alignment (Biggs, 1996) of learning and teaching activities with assessment.

It is these pedagogical implications arising from a new geography of learning that the author seeks to refer to in this paper.

Work based mobile learning

The author views learning as a process of cognitive and social development (Vygotsky, 1978) in which social interaction is mediated by cultural tools, such as language and technology, Vavoula and Sharples (2002) explain learning can be mobile in terms of space i.e. happening in the workplace or at home. They explain that learning can be mobile between different areas of life e.g. relating to work demands, self improvement and that learning happens at different

times of the day, working days, weekends etc. Sangster et al (2000) state, "work based learning perceives learning as a continuous process grounded in experience"(pp.50).

Although the diversity of models of learning in HE has led to an increasing interest in work based learning, it has been theorised as a model of learning for over 40 years. Pedler (1974) explains that for work based learning to be effective the student must be at the centre of the learning experience. A work based learning approach examines what the learner is doing in the workplace i.e. output orientation and appropriate academic theories to work place activities' analysis in order to attain better understanding (Portwood & Garnett, 1995).

Work based learning answers the calls for an integration of knowledge with experience (Beck, 1992; Raelin & Schermerhorn, 1994) and thus narrows the gap between theory and practice. Work based learning enables the 'transformation of experience' (Kolb, 1984). However, the knowledge developed in the workplace is often tacit, being categorized as practical and situationally specific (Eraut, 1992; Maclure & Norris, 1991). Studies in this area have referred to the inseparable and implicit nature of learning at work and the importance of tacit knowledge gained in the workplace. Tacit knowledge is an abstract, complex ideology but the author proposes that it is simply knowledge that is unspoken but understood.

Tacit knowledge is acquired via informal learning interactions and is not always acknowledged consciously by the learner. Rogers (2006) likens informal learning to breathing and explains that informal learning is ... "seen as a natural activity which continues at all times; it is highly individualised, contextualised" pp.4. Tacit knowledge is deeply rooted in cognitive and spatial interactions and influences personal attributes, values and beliefs, perceptions and behavioural norms. That is an unconscious psychology of learning that the learner becomes aware of through the process of discussion and reflection. Jarvis (2006) suggests in essence learning always occurs in a social context.

The design and intended learning outcomes of the pilot module recognizes the significance and importance of personalized, biographical learning twinned with learning in a social context. This means creating opportunities where learners understand their personal development needs and goals, in and outside formal learning settings. Learners become engaged with and immersed in their learning when they gain self reflective understanding of what they have learned and have yet to learn. Their interactions in and with the virtual workplace and the effectiveness of how these interactions are managed is integral to extent to which learners are immersed, but more importantly gain knowledge and understanding.

Biographical learning

Learning in one's life-world is personal and contextual. Learning occurs as a result of an interaction process between the learner and their environment which is influenced by and inter-dependent with cognitive thought, value and beliefs, conation, social constructions, culture, prior knowledge and personal frames of reference.

Learning how to learn is in essence the strategy and tools of a 'lifelong learner' Houle (1969) who explains that this is what individuals need to facilitate continuous learning a range of contexts. Iterative deployment of these strategies and tools in life-world contexts over continuous time and space, leads to better understanding and sense making of learners' learning and knowledge. Continuous learning across a range of informal and formal learning contexts is a challenging experience for learners. The value of learning is appropriated in relation to personal definitions of relevance where learners are constantly creating their own contexts of and for learning.

Alheit & Dausien (2002) define biographical learning as, "a self-willed auto poetic accomplishment on the part of active subjects in which they reflectively organize their experience in such a way that they generate personal coherence , identity and a meaning to their life history and a communicable socially viable life-world perspective for guiding their actions" (pp.17).

Self reflexive understandings

The author recognizes that embodied interaction is central to the review and evaluation of the design of a virtual workplace. Context is not stable, but arises from situated learning activities engaged in by involving both technological and socio-cultural resources by which learners are enabled to engage agentively.

Mobile devices can be used to encourage learners to act agentively in deciding the relevance of their learning experiences in different life worlds. Hence, a dialectic relationship emerges between self-reflexive understandings and perceptually subjective life worlds (Schütz, 1967). The subjectivity of every day life worlds coupled with micro socio-cultural conditions and constraints of learners' perception, willingness and ability to use the affordances of mobile technologies for learning creates the personal context and embodiment of learning experienced in different ways, at different times by learners. The affordances of mobile technologies for biographical learning are wholly dependant on relational context.

One of the issues raised in this paper is the impact that virtualization has on the interactions between learners themselves and their learning environment. Castells (2001; 2010) provides a historical account of the 'complex matrix of interaction' between social forces and technological change originates from media/technological convergence and the ubiquitous nature of technology which has produced an information age in which 'the diffusion of technology endlessly amplifies the power of technology, as it becomes appropriated and defined by its users' (Castells, 2010, pp.31). De Certeau's (1984) explains the sociology of everyday life; 'focuses on the heterogeneity of 'disseminated practice' (pp.188) in which passive consumers become active 'users', 'makers' and 'unrecognized producers' (pp.xvii).

The experience and engagement of personalised self-reflexive understandings through an action-cycle of learning (Schon, 1967) is an integral aspect of learning and is central to the intended learning outcomes of the pilot module. Action learning is a complex cognitive process, involving the application of sense-making through perception, value and beliefs etc in an ever-changing life-world, where learner is constantly mediating their position and connections with the perceptually subjectivity of everyday life. The product of these self-reflexive understandings is knowledge.

However, Jameson (1991) argues that the challenge to and indeterminacy of knowledge is a central feature of contemporary social life, as technology enables information which is not valid or credible to be made available, resulting in a profileration of knowledge frameworks. However, there is now widespread adoption of technologies which promote virtual learning and the author's orientation towards virtual technology is a pragmatic and optimistic one, grounded in a view of complex cultural & social practice.

A case of virtualization: work based mobile learning

Virtualisation of the learning experience

Silva (2009) explains that virtualization is a technological process which connects all of the components utilized in delivering an application over the network, and includes the process of making all pieces of an application work together regardless of where those pieces physically reside. The author takes the view that virtualization gives users an opportunity to access information and services remotely. Virtualisation creates an opportunity for students to engage in practices which have a transformative effect on their learning. This transformative effect impacts on spatiality, pedagogic and learning interactions, knowledge production and learner/tutor roles and identity.

The pilot module has been approved and is currently being developed as a module for Level 6 Business studies students (n = 20). The model of learning for the module has a mix of mentorship from a real employer (n = 4) and university based mentor (n =1) with autonomous learning undertaken in spaces chosen by the student. Learners will work collaboratively in 5 member action sets, in the capacity of defined team roles but will create a personalized record of their learning.

Learners will use the virtual space to access learning activities, engage in discussions, communicate with mentors etc. However, they accord value to their biographical learning journey experience by recording, reflecting and reviewing self-reflective artifacts of learning created using the functionalities of their mobile device. These self reflective artifacts are organized by the learner into an e-portfolio to evidence their biographical learning journey and used for assessment.

The module has been conceptualized as an alternative learning experience for students who are unable (for a variety of reasons) to undertake an optional one year "real life" placement. The virtualization of the workplace enables students to engage with authentic learning to solve real world problems in a variety of situational contexts whilst providing a supportive learning environment. Savin-Bade (2008) notes that multiple knowledge is made possible in virtual immersive worlds as space is open for knowledge reconstruction and contestation across time and space.

The Global Positioning project by Leeds University used virtual virtualization to develop 'nugget contents' iteratively and collaboratively which were reusable within and between institutions and made freely available via online repositories (Durham and Arrell, 2007, pp.796). The ethos of the work based learning module in case is aligned with this objective. The researcher intends to collaborate with a variety of stakeholders; employers, placement staff, students, alumni etc. to develop re-usable learning objects which can be developed and disseminated collaboratively.

Reusable learning objects e.g. audio files, video content, podcasts, presentation slides etc are being sourced or developed for use in the virtual workplace for learners to access. In addition to this, spaces for collaboration, discussion, privacy etc are being creat. Virtualisation enables the creation of different spaces for different purposes to be accessed via a portal. Also, importantly, resources and information from spaces outside the virtual space can be embedded within the space. In practice this means that the virtual learning space will have links to relevant and supplementary information which the collaborators feel is credible, valid and value adding to learners' learning experiences.

Formal and informal learning spaces

The work based mobile learning module is hosted in the University virtual learning environment (VLE) called X-Stream (a version of Blackboard) and is currently being designed in partnership with local employers and employability stakeholders. The VLE is a virtualization of a workplace with formal and informal learning spaces. The formal learning spaces e.g. office space, virtual filing cabinet, meeting room are rule bound, hierarchal and controlled by the mentor and/or employer. The informal spaces e.g. chat room, brainstorming room, social network area are what Deleuze & Guattari (1987) conceptualise as 'smooth space,' which are discursive, virtual and related on a continuum of conductivity, flux and immersion (Massumi, 1992, 5-6) which allows for transformation and change of spatial relations.

Supervision and mentoring throughout the module takes place largely in the virtual workplace, through virtual communication, although there is some physical interaction at the beginning, during and at the end of the module. Virtual communication will take a number of forms; email, virtual filing cabinets and social spaces in the VLE, discussion forums, video links, web-conferencing and periodic skype calls. However, learners will meet each other face to face at a social event before commencement of the module and engaging in virtual communication online.

Virtualisation of the workplace reduces the spatial isolation experienced by students who are employed on "real life" placements, who are geographically isolated from their peers. Virtualisation enables learners to connect with each other in group discussions and during collaborative learning activities. The use of virtual communication e.g. web conferencing, online discussion boards, intends to push away temporal boundaries, structures of geographical proximity and a change in the dynamic of pedagogic relations and learner interactions. However, the compression of time and space can lead to time discourse and issues with expectations.

Learning activities

Learning activities on the module are periodic learning activities modelled on a real life business problem proposed by an employer. The learning activities are action and enquiry based and pushed out on a selective release via a formal learning space in the VLE. They will take the form of multi-media/digital outputs, so that they are reusable and re-purposeful.

The learning activities will have strict deadlines for completion, although learners can choose to complete them anywhere, at any time. Learners will be sent reminders of periodic tasks and meetings via SMS on their mobile devices and important dates will be posted to the calendar board in the VLE, which can be synchronized with personal mobile devices.

Learners will be moved into and through a diverse range of learning activities and processes in which collaboration and review with peers will develop learners' self confidence in virtual and discursive learning spaces, where they will be supported by each other and their mentor and/or employer. Learners will collaborate with other peers within their team and access information from the VLE. Learners will also be encouraged to access information outside the virtual workplace as part of their learning. It is intended that all learners will become knowledge producers.

The author believes that contemporary society and recognized changes in teaching practice acknowledges the 'proliferation of knowledge frameworks,' this is evidenced by the growth of wikis. Giddens (1991) suggests that this is a characteristic of 'late modernity' whilst Lyotard (1994) refers to this as our 'incredulity towards meta narratives.' However, it is important that learners are recognized as credible knowledge producers. The author abandons the notion of

elite knowledge production, but retains the view that the tutor should facilitate, steer and validate learning and knowledge production. This raises important questions about learner/tutor role and interactions

Assessment

Learners will be formatively assessed via the completion of periodic work related tasks which they reflect on progressively via blogs and reflections of individual artifacts of learning. Learners will be assessed summatively on the validity and achievement of learning outcomes and competencies evidenced by the self organized, completed e-portfolio. A competency framework will underpin the assessment for learning frame which will match competencies/learning outcomes with examples of artifacts that learners can create and reflect on to evidence their development/ achievement. Validity of learners' development in accordance with the assessment for learning frame will be achieved when all the competencies on ticked off by the learner, have been agreed by the employer and mentor.

Students will adopt agency in deciding what learning is relevant to what they want to say about themselves and what they have learned and experienced, through the self organisation of their learning artifacts. However, self organization of the artifacts of learning will be scaffolded by an e-portfolio system increasingly used in the sector called PebblePad.

There is an assumption that the learner will be 'self willed', 'active' and 'auto poetic in recording, reflecting on and reviewing their learning experiences and creating their biographical records of learning. However, the virtualization of the workplace and absence of physical interaction between learners and mentors means that there is a heightened need to address pedagogical issues in order to enable a quality learning experience.

Pedagogical issues

Ethics - participation and equity

Mobile devices allow students to access and store all sorts of knowledge almost instantly. Mobile devices with internet access use the web as a medium where user generated content is promoted and learners have a voice via blogs, wikis etc. In addition to this, learners can capture images, sounds data and voice themselves on their mobile devices and reflect on events as they happen specific to where and when they happen. Mobile students are able to create access and publish information about everyday life-worlds in which they live as students, friends, members of families etc. They can distribute functional information via contacts, calendars, tasks, notes etc. or more intimate information via social networking sites such as Facebook or Twitter.

Choice and control can be exercised on a purely personal level and a problem faced by the author is to how to encourage participation and engagement amongst learners and a feeling that their personal world of knowledge can be shared with other peers who may not be their friends and authoritative figures e.g. mentor and/or employer.

The author aims to address this issue through several means – firstly ensuring that all students on the modules have web enabled personal mobile devices. It is important that students have an unqualified acceptance of the device that they use, so for this reason students will use their own personal devices that they are familiar with and happy to use.

All mobile devices will be installed with Facebook mobile and PebblePad PDA (e-portfolio software) as well as Windows mobile (in order to synchronise calendar & outlook). The author

will clearly and explicitly demark the virtual workplace in terms of formal and informal learning spaces.

However, the author will publish weekly "socials", collaborative weekly tasks which involve learners sharing personal (but not sensitive) information e.g. hobbies, sporting achievements etc with each other in a bid to progressively break down any barriers that may exist between learners in their virtual community of learning.

The other important measure will be to fomalise the sharing of learners' personal worlds of knowledge through their e-portfolio which is assessed, thus removing learners' power of choice. Learners may choose not to share their self-reflective artifacts of learning with their peers progressively through the module (though they will all be published to a Gateway that the mentor/employer will be able to access). However, they will be required to share their e-portfolios at the end of the module, with their peers and other communities of learning in a showcasing event to be attended by all employers and teams on the module.

Role dislocation

The proliferation of situational, personal tacit information through the virtualization of the learning environment, as well as the process of learning and reflection means that the tutor's role becomes one of support and guidance. This is one of the reasons why all learners will have a mentor available to them for advice and support. It is hoped that as the student learns and develops (s)he will become more active agents and experts in their role. Steel and Hudson (2001) explain that a reconfiguration of the tutor's role to one of guides and facilitators of learning, often results in tutors feeling a sense of dislocation from traditional perceptions about their authority and expertise.

Practioners of work based learning become dislocated (Edwards and Usher, 2001) as learners' personal and professional lives integrate and learning becomes borderless. It becomes imperative that formal learning spaces are rule bound and hierarchal, with a clear code of conduct and practice that is communicated formally to learners. This is the reason why the workplace is hosted via the X-Stream and not on a remote website, as students expectations will be aligned with that of other formal modules, despite the life world being a virtual workplace rather than a University module repository of information.

The mentor could be exposed to learning and discussion that has taken place in and outside the formal learning spaces of the workplace, through the informal learning spaces. Although all learning is personal and deeply rooted in cognitive, social interactions, learning in a 'smooth space' (Deleuze & Guattar, 1987) that is not rule bound means that the mentor may be exposed to discussions between learners and their peers which may not reflect the beliefs, interpretations or perceptions of the learners not viewed by themselves. Thus, informal learning spaces will be monitored periodically for cyber bullying by an unconnected person e.g. an administrator to ensure that everyday accepted societal norms apply and this person will intervene in online conversations if necessary. However, students will be permitted to discuss with each other openly and without formal constraints and rules.

Virtual isolation

A new geography of learning in a virtual learning context can lead to issues with learner identity, interactions and engagement. Schostak (2002) describes this as 'the vulnerable sense of depth, unfathomableness, the existential "I" behind the eyes' (pp.41). Lave and Wenger (1991) explain that central to the learning process is participation in activities which fosters and is fostered by socialization within a community of practice.

Shilling's (2000) notion of 'emotional effervescence' theorises notions of academic identity and engagement in relation to virtual activities. Kerawalla et al., (2008) research findings showed that students used blogs for various purposes including creating shared resource and support networks. Thus, though the issues of 'emotional effervescence' and virtual isolation are real and pertinent issues in some cases, in others, virtual spaces can be used to promote participation and facilitate community building within learning groups. Nevertheless, regardless of context, all virtual communities of learning need be supported.

Digital skills of learners

The virtualization of the learning environment means that for students to be engaged and participate effectively in virtual communities of learning, they must possess digital communication skills. This means both a willingness and capability to use technology to communicate with each other in a virtual learning environment. In the case in point, learners will access the virtual workplace using mobile technologies, which themselves require a level of capability and willingness in use to be effective mediating tools of learning.

Review of the literature suggests that the majority of students who engage with mobile technologies are of the "Net Generation," the ideology of which, Jones & Cross (2009) explain, are students born after 1983. Tapscott (2008) argues that young people are different to previous cohorts because of their experiences of networked and digital technologies.

Oblinger & Oblinger (2005) state, "although these trends are described in generational terms, age may be less important than exposure to technology" (2.9, pp. 20). It is this difference in understanding that allows for older students to have different approaches based on their exposure to new technologies. Prensky (2009) conceptualises exposure to new technologies in the terms 'Digital Natives' and 'Digital immigrants'.

Selwyn's study of UK students (2008) agreed that the new generation of learners were no more homogenous than previous generations and pointed to the continued existence of gender differences. There is increasing empirical evidence that suggests caution in defining a new generation of students in relation to their exposure to digital and networked technology. JISC/MORI 2008 report that there is evidence of a small but significant minority of students who do not actively engage with information communication technology. Hence, it is important not to over-generalise and make inappropriate assumptions in relation to engagement of students and mobile work based learning, especially with the increasing emphasis on lifelong learning and mature students returning to Higher Education.

Students on the module will be a heterogeneous population of learners (n=20) with a mix of age, gender, economic and social background and importantly, exposure to technology. Learners will need to apply to the module and will be accepted onto the module via a recruitment and selection process. Learners will be successful on the basis of an application form and video, demonstrating an ability and willingness to engage with and further develop digital technology and reflection skills. Once on the module, all learners will be provided with training and support by a computing services officer.

Time discourse

Adam and Groves (2007) explain the time discourse emergent through mobile device use as a displacement of time rather than a replacement of time as 'embedded, embodied and contextual and point to a simultaneity rather than dichotomy of time. Selvin (2008, p115) states that virtualization reconfigures spatiality, in that with technology, learning is becoming vastly more decentred as well as all-embracing compared with what went before. Teaching and

learning can happen at any time and in any place. Which of course may be convenient for the learner but not for the tutor.

Fortunati (2002) explains that the mechanical representation of time is more and more unacceptable at a social level. We currently live and work, in an age of immediacy in terms of communication and information. Informal learning spaces are open, borderless spaces without constraint. In practice what this means is that there can be a blurring of protocols and acceptability of behavioral norms and expectations in formal learning environments.

Learners are constantly attempting to mediate their position in everyday spaces, but discourse can emerge when personalized mediating tools of communication and connection are used in formal learning spaces. Thus an important consideration in pedagogical design is how to minimize the discourse which emerges from time and space compression.

Learners will be made aware that office hours apply in the virtual workplace and tutors/mentors will not be available to answer queries or offer support outside these hours. A clear workplace rules mandate will be issued in the module handbook outlining the rules of the workplace, as well as indicating that informal learning spaces in the workplace will be monitored, although not rule bound.

Censorship

Though learners will have ownership of devices that they have unqualified acceptance of, an understanding of what is appropriate in terms of what is shared in formal learning spaces will be outlined in the workplace rules posted in the VLE and made available in the module handbook.

Content populated in the formal learning environments e.g. brainstorming threads, mind-maps, MP3 files etc. in the workplace will have to be created in accordance with the assessment for learning frame. Virtual communication in informal spaces will be facilitated by tools and applications made available only in the VLE, for example in the chat room of the virtual workplace.

Learners will be instructed to communicate with each other via these tools and use will be monitored by an unconnected person e.g. administrator. This is in a bid to provide some objectivity in the evaluation of dialogue and acceptable behaviours, as the mentor and/or employer will no doubt be influenced by their involvement in supporting learners in the module. However, information and content (offensive, sensitive etc) that is accessed outside the VLE via the learners' own personal mobile device and not evidenced in the virtual workplace (in which case the mentor or unconnected person would intervene) will remain the authority and responsibility of the learner.

Conclusion

In recent times constructive alignment (Biggs, ibid) has extended beyond its constructivist learning premise to incorporate settings influencing learning, curriculum aims and design, learning and teaching activities, learning support, assessment and feedback, course management, students background, knowledge and aspirations (McCune and Hounsell, 2005; Hounsell and Hounsell, 2007). Hardy et al (2009) explain that the interaction between these factors and the quality of students' learning is termed, 'congruence.'

Congruence is a challenge facing all practioners of learning and assessment design. The virtualisation of a learning environment and absence of physical boundaries means that there

is a heightened need for pedagogical issues to be addressed. It is important that the learning environment is regarded as a valid and safe learning environment.

The open space of the virtual workplace is beneficial in terms of access to learning objects and learning experiences. It enables a wide range of students who might otherwise not have access to work based learning and create a variety of situational contexts in which the learner is supported. However, virtualization impacts on learner identity, interactions, pedagogic role and the process of knowledge production.

In order to achieve congruence on this module, it is recognised that technology has the scope to promote constructivist modes of learning in which student participation and creativity play an important role. Thus, assessment for learning encourages that creativity and participation whilst providing a frame which scaffolds how participation is evidenced and seeks to provide some ethical boundaries for knowledge production.

In this paper, virtualisation is considered in a transformative form, where the affordances of mobile technology use for biographical learning are wholly dependant on relational context and interactions between the learner and their learning environments whether, real or virtual. Some of the key pedagogical issues discussed in this paper arise because of the lack of boundaries within virtual learning spaces. However these are issues which can be managed with careful planning and well thought out interventions.

In virtual learning settings, choice of engagement and control are legitimate powers of the learner, but it is the tutor who should act as gatekeeper of formal learning spaces and retain control through explicit rules and hierarchal structures. In the case of the pilot module, control of the virtualized learning environment is retained by the mentor, yet learners are encouraged to be 'self-willed, 'auto-poetic', 'active' agents of their learning. In doing so, learners are immersed in their learning and develop self reflective understanding of their own personal learning.

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Measuring flow experience in an immersive virtual environment for collaborative learning

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Abstract. In contexts other than immersive virtual environments, theoretical and empirical work has identified flow experience as a major factor in learning and human-computer interaction. Flow is defined as a 'holistic sensation that people feel when they act with total involvement' (Csikszentmihalyi, 1990, pp. 477). Our purpose was to apply the concept of flow to modelling the experience of collaborative learning in an immersive virtual environment. Pairs of small teams engaged in collaborative problem solving tasks while communicating by way of an immersive virtual environment. Flow was measured after each session, using Guo and Poole's (2009) inventory for measuring flow in human-computer interaction. Evidence was found for the effect of individual differences and experimental manipulations on flow. In conclusion, this work contributes to the development of measurement models and structural models of flow in immersive virtual environments.

Keywords: computer-mediated communication; cooperative/collaborative learning; interactive learning environments; programming and programming languages; virtual reality.

Introduction

Cognitive factors have been studied in human learning for many years, particularly in relation to learning performance and the design of effective instruction (see, e.g., van Merriënboer, 1997). However, more recently the study of experiential aspects of learning with computers (e.g. Pearce, Ainley & Howard, 2005) and without computers (e.g. Engeser & Rheinberg, 2008) has emerged. An important concept in this work is flow experience ('flow' for short). Flow is defined as a 'holistic sensation that people feel when they act with total involvement' (Csikszentmihalyi, 1990, pp. 477). Nine dimensions of flow (see Table 1) have been distinguished and measurement instruments for these dimensions have been developed and validated (e.g. Jackson & Marsh, 1996). It is important to note that flow is not a matter of 'all or nothing', but people can experience a degree of flow on each of the dimensions. Using a bottom-up research approach (the method of grounded theory), Pace (2004) provides further evidence for the dimensions of flow in Web users. It has been demonstrated that flow experience is an *independent* positive predictor of (learning-task outcome (after controlling for other [cognitive] variables) in the domains of computer-game playing (Murphy, Smith & Hancock, 2008), mathematics (Heine, 1997; Engeser & Rheinberg,

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2008), foreign languages (Engeser & Rheinberg) and computer-based statistics (Vollmeyer & Imhof, 2007). Engeser and Rheinberg (2008) propose two pathways for the positive effect of flow on performance outcome. First, flow is considered to be a 'highly functional state' which, therefore, should promote performance (a state where 'individuals ... are highly concentrated and optimally challenged while being in control of the action', Engeser & Rheinberg, 2008, pp. 158). Second, flow is a driver of motivation for continued activity, which leads people to select higher challenges in order to experience flow again. In addition, it has been established that, in American college students, flow (a) is a full mediator of the relation between the characteristics of academic work and psychological well-being and (b) has an indirect positive effect on physical health through psychological well-being (Steele & Fullagar, 2009). Furthermore, flow has been significantly associated with psychological well-being in Japanese college students (Asakawa, 2004, 2009) and British college students (Clarke & Haworth, 1994). Thus, justifications for the study of flow in relation to learning are its beneficial effect on the performance of tasks that are being learned and its importance as a predictor of mental well-being and physical health.

Table 1. Dimensions of flow experience (Jackson & Marsh, 1996)

Dimension	Description
Balance of challenge and skill	"The person perceives a balance between the challenges of a situation and one's skills, with both operating at a personally high level." (pp. 18)
Mergence of action and awareness	"The flow activity is so deep that it becomes spontaneous or automatic." (pp. 18)
Goal clarity	"Goals in the activity are clearly defined (...), giving the person in flow a strong sense of what he or she is going to do." (pp. 19)
Feedback	"Immediate and clear feedback is received, usually from the activity itself, allowing the person to know he or she is succeeding in the set goal." (pp. 19)
Concentration	"Total concentration on the task at hand occurs when in flow" (pp. 19)
Control	"A sense of exercising control is experienced, without the person actively trying to exert control." (pp. 19)
Loss of self-consciousness	"Concern for the self disappears during flow as the person becomes one with the activity." (pp. 19)
Transformation of time	"Time alters perceptibly, either slowing down or speeding up" (pp. 19)
Autotelic experience	"Intrinsically rewarding experience. An activity is autotelic if it is done for its own sake, with no expectation of some future reward or benefit." (pp. 20)

Immersive virtual learning environments offer a particularly appropriate context for assessing flow experience in learners. This is because these environments can facilitate constructivist learning through meaningful, highly involving experiences as a result of performing purposeful learning tasks (Martin, Vallance, van Schaik & Wiz, 2010). In constructivist learning, students are engaged in active cognitive processing (as opposed to simply recalling or memorising information) and are paying attention to relevant incoming information, but are also organising this into a coherent representation and integrating it

with existing knowledge (Mayer, 1999). Although flow has been demonstrated to be an independent predictor of learning task performance and a predictor of psychological well-being and physical health, there is a lack of research measuring flow in immersive virtual environments and establishing its sensitivity to learning-task characteristics. This is true even though these learning environments have great potential to promote experience-based learning, in particular given their potential for highly involving experiences.

In their measurement model of flow, Guo and Poole (2009) conceptually distinguished three precursors of flow (the dimensions of balance between challenge and skill, clarity of goals and feedback) from flow experience 'proper'. Flow experience is seen as a reflective higher-order construct with the remaining six dimensions of flow (mergence of action and awareness, concentration, control, loss of self-consciousness, transformation of time and autotelic experience) acting as indicators. In a structural model, the precursors of flow then are mediators of the effect of the person, artefact and task characteristics involved in a particular activity on flow, according to Finneran and Zhang's (2003) person-artefact-task model (PAT; see Figure 1). Guo and Poole (2009) found strong evidence for their measurement model and, in a partial validation of the structural model, empirically demonstrated that the effect of perceived web site complexity (as an artefact characteristic) on flow was mediated by the precursors of flow. The current study applies this conceptual and empirical approach to the study of flow in immersive virtual environments.

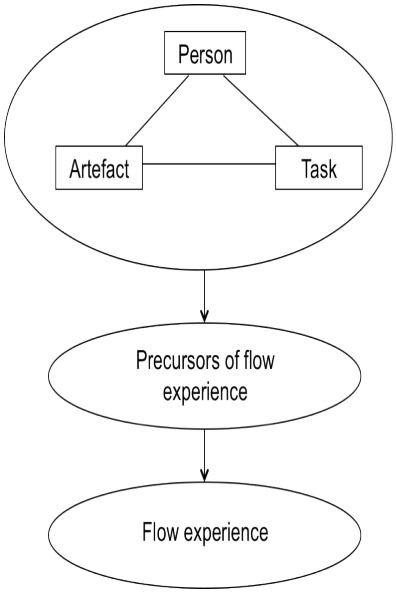


Figure 1. Person-task-artefact model (based on Finneran & Zhang, 2003; and Guo & Poole, 2009)

The educational tasks provided for students within an immersive virtual environment needed to represent a range of authentic activities found in real-world scenarios. At the same time, the tasks needed to be broadly representative of typical problem-solving activities used in engineering and science classrooms and also sufficiently representative of those within other subject areas in order to permit generalisation. In both real-world and classroom-based contexts, some tasks will be more challenging than others, depending on their level of constraints and experience with the tasks. For example, tasks with more constraints would provide a better balance between challenge and skill for when learners are less experienced, but tasks with more constraints might provide a better balance when learners are more experienced. Task constraints and experience were therefore examined in

the current study as important task characteristics. A data set from a series of collaborative learning activities, in which task constraints and experience were controlled experimentally, was analysed in order to establish the effects of individual differences and experimental manipulations on flow experience.

Method

Design

The design of each task in a series of collaborative learning activities was developed in response to participants' performance in the previous activities within the series (see also Vallance, Martin, Wiz & van Schaik, 2009, 2010). The independent variables were task constraints (problem type) and experience (problem number within a problem type) – see Table 2.

Table 2. Design of collaborative-learning sessions

Session	Teams[a]	Problem type	Problem number within problem type
(Seven practice sessions)			
1	A, C	Maze	1
2	B, D	Maze	1
[b]3	B, D	Maze	1
4	A, C	Maze	2
5	B, D	Maze	2
6	B, D	Maze	3
7	A, C	Maze	3
8	B, D	Maze	4
9	A, C	Maze	4
10	A, C	Maze	5
11	B, D	Maze	5
12	AB[c], CD[d]	Obstacle course	1
13	AB, CD	Obstacle course	2
14	AB, CD	Obstacle course	3
15	AB, CD	Obstacle course	4
16	AB, CD	Obstacle course	5

[a]Teams A and B: Japanese. Teams C and D: UK-based. [b]Session to complete the task started in Session 2.
[c]Teams A and B as one team. [d]Teams C and D as one team.

In more constrained tasks learners had to solve a maze problem and in less constrained tasks learners had to solve an obstacle-course problem. Within each problem type there were five problems to solve (problem number ranging from 1 to 5). The dependent variables were precursors of flow experience (balance of challenge and skill, clarity of goals and feedback) and flow experience (mergence of action and awareness, concentration, control, loss of self-consciousness, transformation of time and autotelic experience).

Participants

Participants were four undergraduate students (three male, one female) from Yokohama National University, Japan (mean age = 20, SD = 1) and four postgraduate students (three

male, one female) from Teesside University, UK (mean age = 31, SD = 5). The Japanese students had some experience of using an immersive virtual environment for learning (Second Life). The UK-based students had no experience of using Second Life, but were trained in its use before taking part in the study.

Materials and equipment

Two configurations of computer were used. The first consisted of desktop PCs running Windows XP Service Pack 3, using 3.0 GHz Intel Core 2 Duo processors (model E8400), with 2 GB RAM, ATI X1300 graphics cards and 17" LCD monitors with screen resolution set to 1280×1024 pixels. The second consisted of Apple MacBook Pro laptops running OSX version 10.5.X, using 2.26 GHz Intel Core 2 Duo processors, with 2 GB RAM, NVIDIA GeForce 9400M graphics cards and the 13" inch laptop display set to 1280×800 pixels. Lego Mindstorms NXT software version 1.1 was used to create robot programs. The design of the robot followed instructions 8527 of Quickstart-Mindstorms (see *http://preview.tinyurl.com/yfw75s2*) and was adopted due to its simplicity and its potential for sensors to be added as the research and task framework are further developed (Figure 2).

Figure 2. Robot design displayed within the Second Life experimental environment

The Second Life interactive 3-D Internet environment was used to support inter-team communication and record 'chat' communication, using a private secure island developed for the purpose of this research and leased from Linden Labs. Two video cameras were used to record intra-team communication for each of the teams. Additionally, a bespoke Visual Basic program was developed and employed to measure flow using Guo and Poole's (2009) psychometric inventory with visual analogue scale as the response format (with responses converted to the range 0-100) – see Figure 3. The flow scale measured three precursors of flow (clarity of goal; fast, unambiguous feedback; and perceived balance of challenge and skill) and six dimensions of flow (concentration, perceived control, mergence of action and awareness, transformation of time, transcendence of self and autotelic experience). The scale

has good psychometric properties in terms of convergent and discriminant validity and reliability (Guo & Poole, 2009).

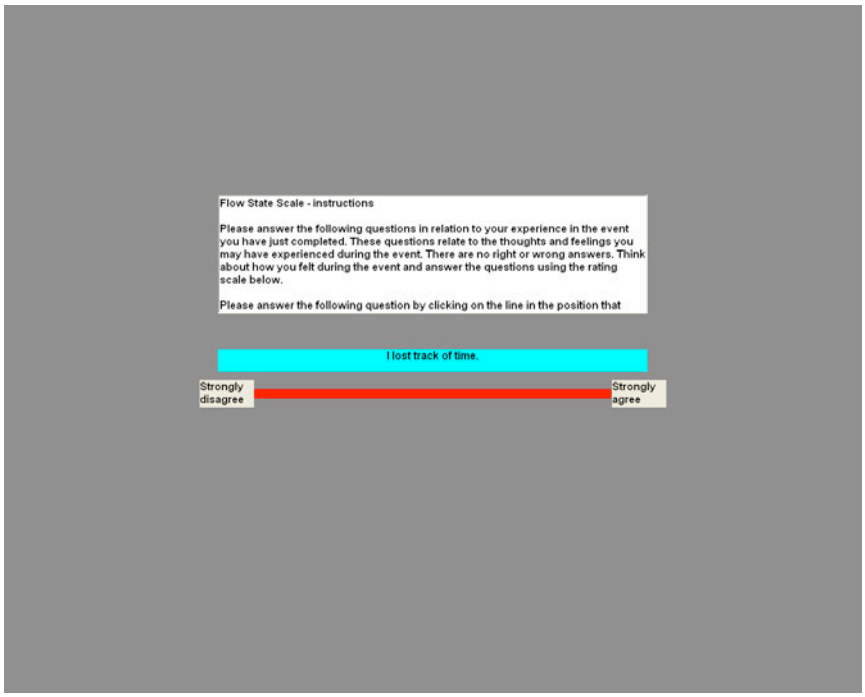


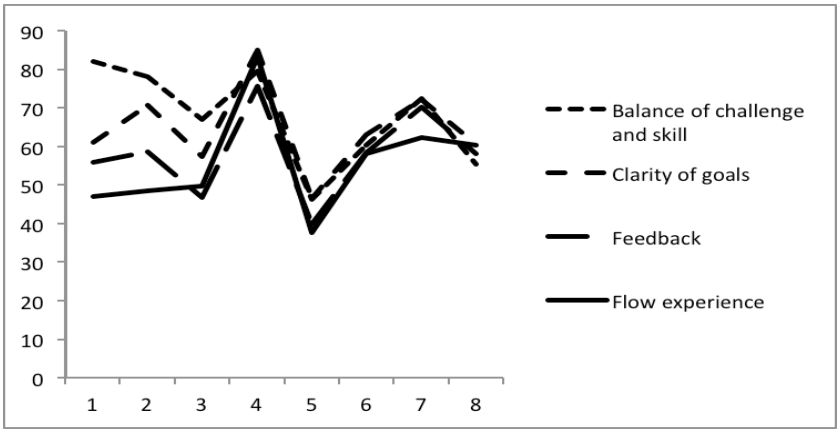
Figure 3. Visual analogue scale to measure flow experience

Procedure

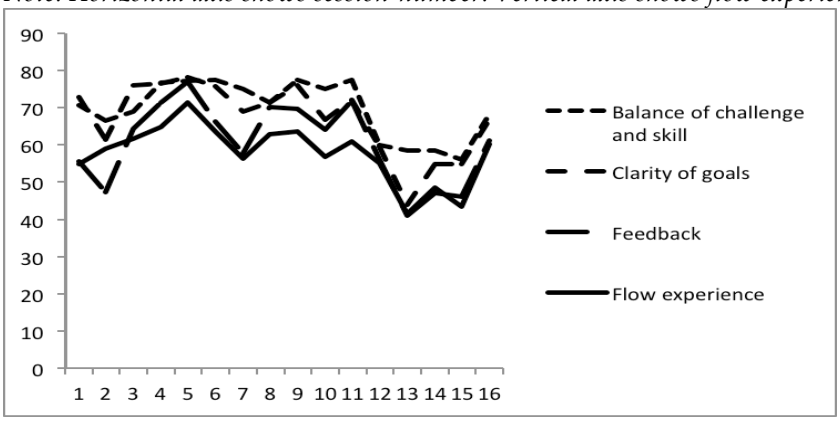
Problem solving with online communication was recorded during the consecutive running of sessions for given tasks. In each session, two teams (each consisting of two learners, except in the last five sessions where teams consisted of four learners. In the first of the last five sessions, one of the teams consisted of three learners) were located in two physically separate computer laboratories within the same building. Communication between teams was supported by Second Life's chat facility and the behaviour of participants' avatars in the environment. In maze problems, each team had to design the course of an identical robot on the floor of their laboratory using adhesive tape. In obstacle-course problems, a configuration was given in which a robot had to navigate a course while achieving a predefined series of goals. Next, one team's task was to act as 'learners' and create a robot program (using the MindStorms software) to follow the course that the other (teaching) team had designed (for maze problems) or that was provided (for obstacle-course problems), drawing on the information provided within the strictures of communicative constraint being applied. The learning team used the information provided in an attempt to solve the robot-programming problem. Once the learning team had designed what they judged to be a suitable program they sent this by email to the teaching team. The teaching team used their robot to run the program on the taped course to establish its success and were encouraged to offer feedback on this via the Second Life environment to the learning team when the robot executed an incorrect manoeuvre and in answer to questions from the learning team, without giving the solution to the problem that had to be solved. However, the communication between the teams was mediated by the protocols pre-set for each experimental run as described above. The implications of this are discussed below.

The cycle of learning and teaching through communication, programming and testing was iterated and the task was terminated when the teaching team concluded that the learning team's executed program for navigating the designed course was successful, after allowing for uncontrolled variables such as mechanical differences between the two robot devices in traction, drive variability and other variability due to the manufacturing tolerances inherent in mass-produced robotics kits. Then the teams switched roles and the new learning team (the teaching team in the first run) had to create a robot program to solve the course designed by the new teaching team (the learning team in the first run). Tasks were designed to achieve a balance of challenge and skill by increasing the challenge inherent in the tasks, where appropriate, based upon learners' performance in the previous sessions. Learners solved each of the maze problems successfully within a session (as an exception, Teams B and D took two sessions to solve their first task), therefore allowing an increase of challenge in subsequent tasks/sessions. However, although learners made progress in solving obstacle-course problems, they did not solve them completely. Therefore, challenge was not increased in subsequent sessions involving the obstacle-course problems.

A. *Flow experience and precursors as a function of participant.*
Note. Horizontal axis shows participant-number. Vertical axis shows flow experience (range: 0-100).



B. *Flow experience and precursors as a function of session*
Note. Horizontal axis shows session-number. Vertical axis shows flow experience (range: 0-100).



C. *Flow experience as a function of gender and participant group*
Note. Horizontal axis shows flow experience (range: 0-100).

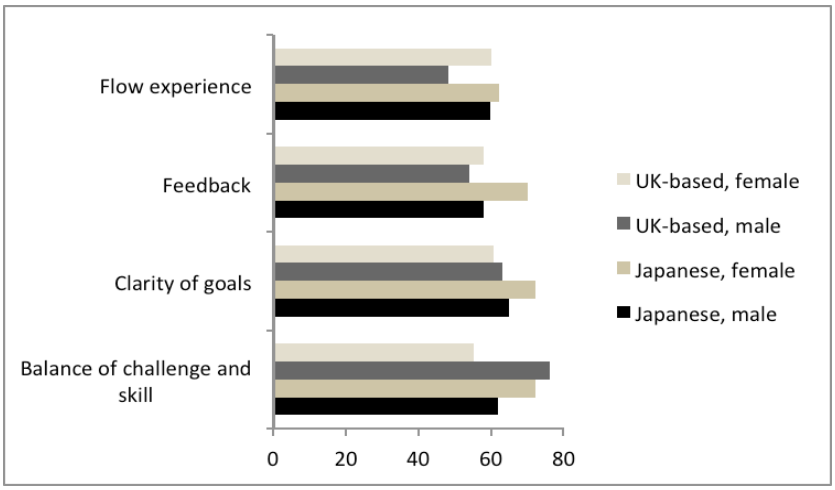


Figure 4. Flow and its precursors as a function of extraneous variables

Results and Discussion

Individual differences

From Figure 4 it appears that flow experience and its precursors varied as a function of the following individual differences: (a) participant, (b) session and (c) gender and participant group. For example (see Figure 4B), flow experience initially increased from Session 1 to 5; after a decrease, flow remained stable and then decreased in Sessions 13-15; a similar pattern was found for the precursors of flow experience. These individual differences were taken into account in later analyses of the effect of experimental manipulations on flow experience and its precursors. Full results will be reported in a future publication.

Experimental manipulations

From Figure 5 it appears that flow experience and its precursors varied as a function of problem type and problem number within participant. In particular, flow experience declined over sessions when maze problems were solved. Flow level was more variable when obstacle-course problems were solved. Therefore, the difference in flow level between the two problem types varied with problem number. On the precursors, experience was more positive on maze problems and remained relatively stable, but over sessions levels of experience converged between maze and obstacle course. Full results will be reported in a future publication.

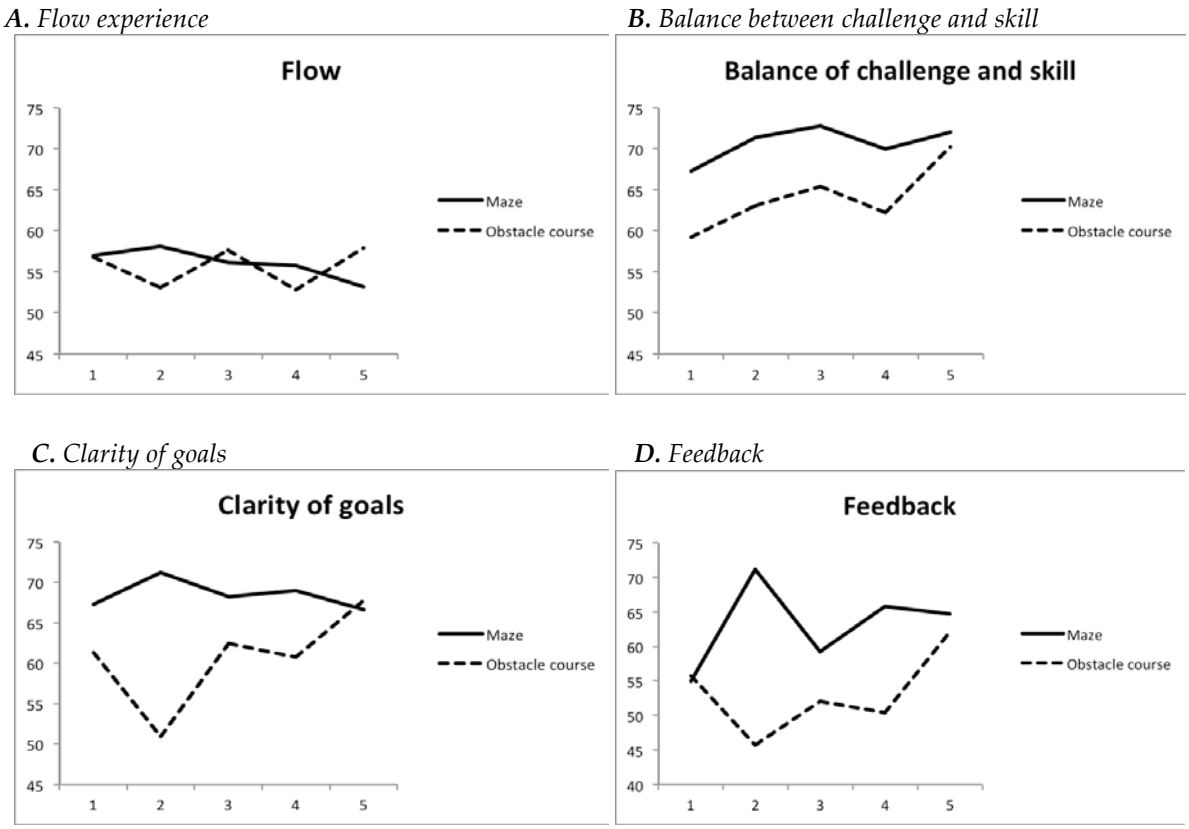


Figure 5. Flow experience and precursors as a function of problem type and problem number. Horizontal axis = session-number within problem type. Vertical axis = flow experience (range: 0-100)

Note. *Mean values of balance of challenge and skill, clarity of goals and feedback are adjusted for participant and session. Mean values of flow experience are adjusted for balance of challenge and skill, clarity of goals, feedback, participant and session.*

Conclusions

The current study established that in immersive virtual environments for learning flow experience can be comprehensively measured (both flow proper and its precursors) with good psychometric properties. It was also found that the precursors of flow are mediators of the effect of problem characteristics on flow. This work therefore contributes to the measurement and the testing of hypotheses regarding learning in immersive virtual environments.

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Quality in E-Learning: User experiences in China

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Abstract. E-learning plays an increasingly important role in Chinese education. Its role in future education will be significant, especially given the trend of lifelong learning. Considering the degree of autonomy in terms of student participation it is essential that user experiences on platform quality and perceived service quality are optimal. Over the past decade China has invested much in its e-learning systems. The East China Normal University (ECNU) of Shanghai implemented a virtual learning environment and requested an assessment on the user experience. A quantitative questionnaire was developed based on the 'Perceived Service Quality model (PSQ)'. Based on literature the model measures reliability, responsiveness, assurance, validation of learning resources and empathy. Using a confirmatory factor analysis in LISREL PSQ is validated and the total verdict of the e-learning platform is positive.

Keywords: E-learning, user experience, virtual learning environment, online education, service quality

Introduction

The fast and recent changes on the Internet and the diverse digital technologies have made the Internet a powerful and interactive medium enabling cost-effective electronic learning (e-learning)(Khan, 1997). In recent years, educational institutions worldwide have invested extensively in implementing this approach in their education (Alexander, 2001; Bates, 2005; Pflichter, 2006; Gulati, 2008; Wang, Zhu, Chen & Yan, 2009). In particular countries like China, which have many rural areas, benefit greatly from this new form of (long) distance education (Wang, et al, 2009; Ye, Su & Yan, 2009).

In 1999 the Chinese government provided several Chinese universities with the task of creating new e-learning departments. One of the most distinguished universities in China, the East China Normal University (ECNU), established a Distance Education College (DEC) in 2001. The main focus concerns making e-learning, degree and non-degree, available for teacher education students in China. In 2009, the DEC had over 20.328 trainees studying in 80 distance training centres all over China (Wang, et al, 2009; Ye, et al, 2009).

According to Bates (2005), e-learning can be viewed as an innovative approach for delivering well designed, learner-centered, interactive, and facilitated environments to anyone, anyplace, anytime by utilizing the attributes and resources of various digital technologies along with other forms of learning materials suited for open, flexible and distributed learning environments. As such, e-learning focuses on its user (McCombs, Vakili,

S. Martin (Ed.), Immersive Technologies for Learning: A multi-disciplinary approach. pp. 185-197
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2005; Miller, 2005; Motiwalla, 2007; Kidney, Cummings, & Boehm, 2007). This definition can subsequently be used to develop a framework providing insight into the extent to which e-learning as a service is valued.

This study was conducted on location in China at the ECNU. The aim was to obtain insight into students' perceived service quality on the e-learning systems as provided by the ECNU. The results contribute to the continuing development of cost-effective e-learning in China. The application of the PSQ-model gives us further insight into relevant e-learning service quality indicators.

Theoretical framework

Currently 68 universities and colleges in China have been approved by the Ministry of Education to provide distance education. Today Chinese citizens have the opportunity to be educated using distance education in one of the more than 140 majors in 10 different disciplines (Ye, Su & Yan, 2009). Given the central function of e-learning it is crucial that the provided educational platform and service are of the highest quality.

In scientific literature, evaluations of e-learning systems regularly focus on educational principles or technical features. In contrast, the main perspective concerning the evaluation in this study will be dissimilar and innovative. As stated in the introduction the goal of this research project is to provide an evaluation of the perceived service quality of the e-learning system as used by the students of the East China Normal University. Due to better accessibility students are given more freedom of choice in education, thereby increasingly requiring universities to compete. In light of this competition quality of service is of prime importance for universities to distinguish themselves. In this study will will draw upon knowledge and insights from the field of service marketing and Human Computer Interaction (H.C.I.) in order to assess service quality.

Service Quality of E-learning

The General Agreement on Trade in Services (GATS) of the World Trade Organization, states that education is part of the field of service industry (Robertson, Bonal & Dale, 2002). When education is perceived in this way, the success of educational programs should be measured by the service quality it provides. Service quality is important for the future of an organization. In research amongst American, European and Japanese business managers more than 78 percent indicated that improving quality and service to customers is the key to success (Berry & Parasuraman, 1992). The success of a service organization depends on the ability of the organization to enhance its image by consistently meeting or exceeding customers' service expectations. The measuring of consumer perceptions as to the level of service quality therefore becomes critical (Joseph & Joseph, 1997).

E-learning systems, a specific form of education, can also be considered a service. Consequently, measuring the service quality can provide an organization with important information by shedding light on the quality of the education it delivers, and answering the question whether e-learning has been implemented successfully and effectively.

Views on quality of education have undergone significant changes. One of the most important transformations in education originally comes from the business sector (Rosenberg 2001). In this sector training is essential in the context of lifelong learning. A transformation has taken place from the amount of training to its actual value for the trainee.

One of the ways in which success of training was measured in organizations was by the amount of training that was provided (Rosenberg, 2001). Now it has become much more important that the training has a positive influence on the working activities of the trainee. This way training acquires an actual business value. Rosenberg (2001) states that it is important to keep in mind that the training itself is not enough to create a good business value of training, you also need the right tools, a good working environment, enough motivation and enough feedback and coaching. The same can be said for the education sector. Providing lessons itself is not enough to create a good value of education. To obtain an accurate view of the actual value of education provided by an institute, it is important to get an overall view of the service quality. This includes the learning environment, facilities, tools, teachers, lesson material et cetera.

To accommodate service quality of e-learning systems, Zhang et al. (2004) used the ISO 9001:2000 system. This standard regulates business processes in a formal way. It provides a number of requirements that an organization needs to fulfill to achieve customer satisfaction. This can be achieved through consistent delivery of products and services which meet customer expectations. The ISO standard is implemented in the service quality framework as provided by Zhang et al. (2004). To successfully implement an e-learning service quality system, there are some general requirements that have to be taken into account. First of all, it is important to understand that the service quality of e-learning should not be viewed in isolation; the quality of an e-learning system can only be maintained if service quality becomes an integral part of institutions' management system. This is why we speak of an e-learning service quality management system. According to Zhang et al. (2004) institutions should establish, document, implement, maintain and continually improve their service quality management system, rather than focusing solely on service quality.

Learners' perspective

The learning process of an e-learning system can be perceived as a co-production process between the learning-environment and the learner (Ehlers, 2004). In this study the focus on quality of the e-learning platform is determined by the learners. Perceived Service Quality (PSQ) is the learners' perception of the service quality of the e-learning platform as provided by the ECNU. PSQ is measured in terms of the result of using the e-learning system, instead of measuring the properties of the system itself. The perceived service quality is the combined effect of the characteristics of the system for the learner.

In the evaluation phase of the process of a service quality management system, the framework of e-learning service quality provides a good hands-on approach for testing the service quality. The framework of Zhang et al. (2004) can be transformed into a measurable model for the perceived service quality of e-learning.

Study objectives & research question

The main objective of this study is to obtain a general view of students' perceived service quality on the e-learning systems, as provided by the ECNU, by measuring their user experiences. Ultimately the study provides guidelines for more successful implementation of an e-learning platform in the future.

The main research question (RQ):
What are the students perceptions of service quality of the e-learning platform as provided by the ECNU?

Model development

The objectives and the main research question can be answered by dividing the content in to multiple hypotheses. To test these hypotheses a research model was developed based on the PSQ Framework.

PSQ-Framework

A widely used empirical method for measuring service quality is SERVQUAL. This multiple-item scale measures consumer perceptions of service quality on five dimensions; tangibles, reliability, responsiveness, assurance and empathy (Parasuraman, Zeithaml & Berry, 1988; Findlay & Sparks, 2002). The students are regarded as consumers because they consume the offered educational service. In 2004, in their 'Specification for Service Quality Management System of e-Learning' Zhang, Zhu, Hu, & Li (2004) used SERVQUAL's dimensions and translated them to the e-learning framework. Each dimension is divided in sub-dimensions, reliability, responsiveness, validation of learning resources, empathy and assurance. Combined the framework measures the service quality of e-learning (Zhang et al, 2004).

Perceived quality is the consumer's judgment about an entity's overall excellence or superiority (Findlay & Sparks, 2002). Perceived Service Quality (PSQ) concerns the student's experience and judgment on the e-learning service as facilitated by the educational institution. Using the PSQ framework, the user provides the researcher with detailed information about the perceived quality of each of the five dimensions. Consequential the PSQ-framework does not only result in an overall judgment, it provides the institution an empirical instrument for tracing usability problems.

Figure 1. Perceived Service Quality Framework

In Zhang et al., (2004; also see Bates, 2005) the framework of e-Learning Service Quality construct of PSQ, which was adopted here, consists of five distinct dimensions: *Validation of*

learning resources; *Assurance*; *Responsiveness*; *Reliability*; and *Empathy*. Each of these are subsequently subdivided into multiple sub dimensions; a summary of all dimensions and subdimensions in this framework is provided in Tables 1 to 5; also see Figure 1. In the new PSQ paradigm the following hypothesis is formulated:

Hypothesis 1 (H1) Perceived Service Quality (PSQ) on e-learning at the East China Normal University (ECNU) is determined by the five dimensions of service quality

Table 1. Validation of Learning Resources in the Framework of e-Learning Service Quality

1	**Validation of learning resources**	**E-learning providers should offer credible, effective and rich learning resources**
1.1	Scientificity	Learning resources should be credible and valid, excluding any error, prejudice or redundant information and should be expressed impartially
1.2	Accessibility	Learning resources should be organized by reasonable way to make it easily accessible
1.3	Integrity	Learning resources should be integral, can offer information related to the objective in depth and width, as learning pre-requirements, related resources, assessment rubric etc.
1.4	Real-time	Learning resources should be updated periodically and information on person or organization, time and frequency of updating should be indicated as well
1.5	Selection of media	Selection of media and technology should be integrated with curriculum design and should support teaching objectives and the satisfaction of students

Table 2. Assurance in the Framework of e-Learning Service Quality

2	**Assurance**	**Faculty and staff engaging in e-learning should be professional and knowledgeable to ensure the student trusts them and find them reliable**
2.1	Integrity of teaching plan	Educational institutions should provide instruction plans in detail: including learning objects, entrance qualification, learning material, learning contents, teaching schedule, evaluation process, qualification authentication, tuition fees and other expenses, time limitation of study, clause of suspending or postponing study and technology requirements etc.
2.2	Providing related information on courses	Educational institutions should provide all students with clear and comprehensive information about the course, including course objective, learning requirements, examination methods and information on assessment
2.3	Security of private information	Educational institutions should ensure the security of the students' personal information
2.4	Technology guidance	Educational institutions should provide technology service and guidance to students in course studying, including detailed guidance on hardware and software, practice opportunity before examination and technology staff
2.5	Professional knowledge of the teacher	The teacher should have adequate knowledge to teach
2.6	Complaint mechanism	Educational institutions should set up a complaint mechanism for students and give them a valid reply in time.

Table 3. Responsiveness in the Framework of e-Learning Service Quality

3	**Responsiveness**	**E-learning providers should support the student's study and provide prompt service**
3.1	Responsiveness of service request	Educational institutions should satisfy the student's service request in time
3.2	Responsiveness of the teacher	The teacher should answer students' questions and review their assignments in time (less than three weeks).
3.3	Publishing information in time	E-learning providers should publish information of teachers and management in time. For example notifications for class, exam, schedule, scores of exam, etc.

Table 4. Reliability in the Framework of e-Learning Service Quality

4	**Reliability**	**E-learning providers should perform promised service dependably and accurately**
4.1	Reliability of education institution	Promises of the educational institution should be reliable
4.2	Reliability of network system	The performance of the learning platform should perform with reliability, veracity, stability and rapidity
4.3	Reliability of questions answer	Answers provided by the educational institution and teacher on students' questions should be reliable
4.4	Reliability of evaluation	Teacher's comments on the students' performance should be impartial and reliable

Table 5. Empathy in the Framework of e-Learning Service Quality

5	**Empathy**	**E-learning providers should understand the needs of users and should offer individualized service**
5.1	Convenient learning schedule and facility	Educational institutions should schedule the time and facility to the convenience of all students
5.2	Easy to use	Learning platform, learning resources etc., should be easy to use and access. A minimum of instruction should be needed for user input
5.3	Customized service	The teacher should know the individual requirements of the student to offer customized needs
5.4	Care	The teacher should care for every student, and help them to overcome difficulties in study. Faculties should treat every student warmly and answer their questions patiently
5.5	Comfort environment	Environment of educational institutions (computer lab, etc.) should be spacious and bright
5.6	Interactivity	During the teaching process, the teacher should use many kinds of interactive methods (e-mail, BBS, telephone, etc.) to actively lead students into learning activity

PSQ-Model

Having identified which constructs form PSQ, the conceptual model was developed. The five dimensions all function as components of PSQ.

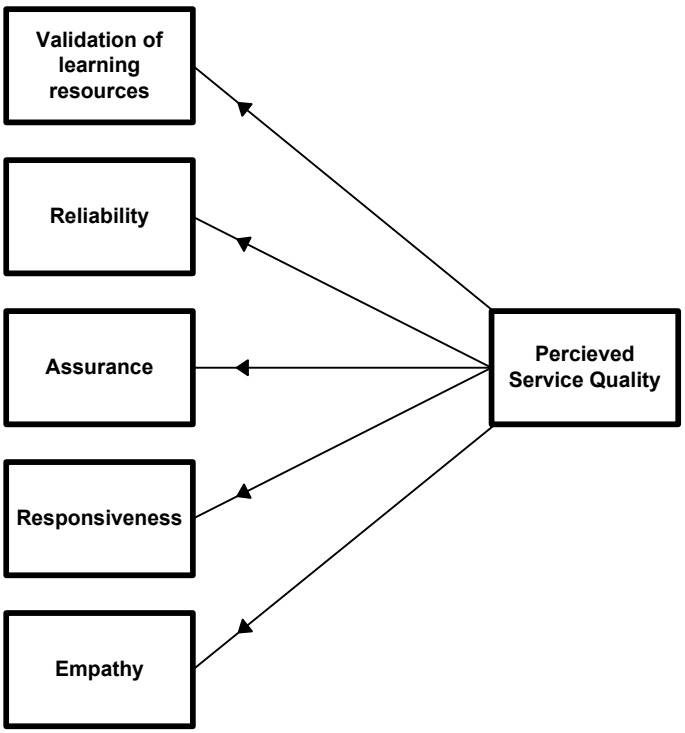

Figure 2. PSQ model on e-learning

Figure 2 shows the PSQ model on e-learning. The five dimensions combined compose PSQ.

Research methods

Data Collection

A survey technique was used to collect data. The population sample was selected from the non-degree students from the East China Normal University. After measuring for twenty-one days 212 usable questionnaires were obtained.

Measurement

To progress the investigation of PSQ by quantitative research an appropriate measure of the underlying constructs is required. Each construct, and its sub dimensions, was extensively measured using multiple questions as derived from the PSQ framework. To maximize the response ratio the questionnaire was translated from English to Mandarin Chinese. In monitoring the quality a backward translation system was used. Each question was translated by one person, then translated back by another, without the second translator seeing the original question. The backward translation was compared to the original version to see whether the questions were interchangeable. This process was repeated until the most accurate translation was developed. Finally the results of this process were carefully discussed by a team consisting of several Dutch and Chinese academics in finalizing the questionnaire.

To rule out translation issues in analyzing the data, for example the loss of meaning in the answers, the respondents had to answer the questions by means of a 5-point Likert scale. The response options ranged from completely agree to completely disagree.

Results

A total of 212 completely filled in, usable questionnaires were returned. Of these 212 questionnaires, 48 respondents are male and 164 are female. Respondents were also asked to inform on their age. This construct was divided into six groups. Most of the respondents are under the age of 30. The results show that the majority of respondents are in the age categories 20 – 25 (86 respondents) and 25 – 30 (62 respondents).

Hypothesis 1 (H1) Perceived Service Quality (PSQ) on e-learning at the East China Normal University (ECNU) is determined by the five dimensions of service quality

A confirmatory factor analysis was performed using LISREL to validate the conceptual model (PSQ). As the Chi Square Test is statistical robust, yet problematical because of the complexity of confirmatory factor analysis, the fit of the conceptual model was indicated using four steps.

First the examination of the critical number. This is the minimum sample size, below which the results cannot be validly interpreted. The sample size, n=212, exceeds the Critical Number (CN), = 111.35, needed for reliable interpretation. Second the significance of the Chi Square is considered. Both the Minimum Fit Chi Square and the Normal Theory Weighted Least Squares Chi-Square show the Chi Square is not significant (p=0.00), so a good fit between the data and the model can be made. Thirdly we examined the Chi Square Degree of Freedom Ratio, which is obtained using Chi Sq / Deg Freedom. Although the prior step show no significance, below 0.05, the Chi Square Degree of Freedom Ratio exceeds 2 (5.76). Finally, the fourth step, the Goodness of Fit Index, is required to determine the fit. The Goodness of Fit Index scores 0.95 and confirms a good fit between theory and data. Concluding we argue that the conceptual model is validated using the observed data.

General Outcomes

Prior to the general outcomes of the research the reliability was measured by means of the internal consistency. Consistency was measured using Cronbach's Alpha in SPSS. Each component scored an Alpha of .8 or higher verifying reliability on all constructs. Correlation with PSQ is significant for each dimension, as can be observed in table 6.

Table 6. Correlation on PSQ

	N	Dependent	Significance	Correlation
MeanReliability	212	PSQ	Yes	.877
MeanResponsiveness	212	PSQ	Yes	.927
MeanAssurance	212	PSQ	Yes	.957
MeanValidation	212	PSQ	Yes	.851
MeanEmpathy	212	PSQ	Yes	.928

RQ: What are the students perceptions of service quality, based on their user experiences, on the e-learning platform as provided by the ECNU?

After the reliability analysis the mean of every construct was measured. The result is a number between 1 and 5, where 1(mostly positive answers) is very good, and 5 (mostly negative answers) is very bad. The results are given in Table 7. In this table an interval per answer per construct is given and the means per construct can be read. From this table it becomes clear that Empathy has the highest mean (2.2603). This indicates that the respondents have answered the most negative on the questions in this construct. Reliability has the lowest mean (1.8805), which indicates that the respondents answered the most positive about this construct and are thus most satisfied with this aspect.

The mean of the total service quality was measured as 1.9021. On a scale from 1 (very good) to 5 (very bad), this indicates that the total service quality of e-learning at the ECNU is considered to be good.

Total service quality can also be measured by the mean sum of the individual five constructs (reliability, responsiveness, assurance, validation, empathy) of the perceived service quality model. The mean sum of these constructs can be compared to the total service quality as measured by the construct MeanQuality. To analyze if the respondents review these different constructs higher or lower than the total service quality as measured by the construct "MeanQuality" we have created the construct "MeanSUMQuality". As stated MeanSUMQuality is the mean sum of the five individual constructs. The results show that the mean of MeanSUMQuality is lower than the mean of MeanQuality. This answer reveals that when respondents are asked directly about the service quality of e-learning they give a more negative answer then when asked in different constructs. In other words, service quality is rated lower when asked directly, then when different constructs are added. A remark is that the mean of MeanQuality can still be regarded as good.

Overall the e-learning platform, as facilitated by the ECNU, is graded positively as perceived by its students. Reliability and assurance are ranked highest and empathy seems to be tending towards a more neutral place.

Table 7. Mean Results per Construct

	N	Minimum	Maximum	Mean	Std. Deviation
MeanReliability	212	1.00	3.56	1.88	0.50
MeanResponsiveness	212	1.17	3.22	2.05	0.49
MeanAssurance	212	1.00	3.34	1.98	0.51
MeanValidation	212	1.24	3.61	2.14	0.50
MeanEmpathy	212	1.24	4.15	2.26	0.53
MeanQuality	212	1.00	3.50	1.90	0.53
Valid N	212				

Conclusions and Discussion

In this chapter the results of the research will be discussed. The chapter is divided in three sections; perceived service quality, cultural differences and future research.

Perceived Service Quality

The service quality of the e-learning platform, as facilitated by the ECNU, is graded positively as perceived by its students. In more detail, the five dimensions are also graded positively. Reliability and assurance are ranked highest and empathy seems to be tending towards a more neutral place. Reliability is graded the most positive. The students' perception of the reliability of the educational institution, the network, the answer on questions and evaluation is very good. The same can be said for assurance, the students perceive the integrity of the instruction plan, the provided information, technology guidance and professional knowledge of the teacher as very good. On the other hand empathy was graded the most negative. Further research will have to point out which other possible variables are moderating PSQ.

Cultural differences

One of the issues when conducting research in China is social desirability. When the questionnaire was developed social desirability was kept in mind. The constructs were formulated in different ways and with both positive and negative questions. By using this method it was attempted to reduce the number of social desirable answers. However due to cultural differences, mainly the importance of hierarchy (power distance) and the importance of preventing loss of face may still influence the way the students have answered the questionnaire (Hofstede, 1984). The empathy questions relate in particular to the functioning of teachers and cultural influences like power distance may have resulted in social desirable or neutral answers.

Chinese higher education has a high standard of quality. Unfortunately a lot of Chinese research is written purely in Mandarin Chinese. English is not compulsory for Chinese students. This results in the fact that a lot of Chinese students are not proficient at reading and writing in English. For this research the questionnaire was translated in Chinese by using the backward translation technique. This technique has the benefit that the second or third translator never sees the original English question. Although this translation technique provides a proper translation, the translation was still done by Chinese students. It can never be guaranteed that the translation really is fully correct, because the researchers cannot read or write Chinese.

Social desirability is one of the issues that can influence the answers from Chinese students. Not only the questionnaire can be of influence on the answers of students, also the setting in which the questionnaire is conducted can be important. For this research the students had to fill in the questions after an exam, in front of the teacher. This setting is not optimal. For an optimal result without any influence of a teacher, it is advised that a questionnaire about quality (including quality of the institution and teachers) is conducted in a private setting.

Another point of interest is the fact that the perceived service quality framework has been based on SERVQUAL, an empirical method for measuring service quality. This multiple-item scale was developed with a Western cultural perspective in mind an based on the same cultural principles. As stated by Hofstede (1984), there are many work related value

differences between different cultures. These work related value differences can have a large influence in the way different cultures define service quality. In hindsight some of dimensions of the perceived service quality framework and the questionnaire based on it can therefore be culturally biased. For future research it can be interesting to review the questionnaire for cultural biased dimensions.

The PSQ model: Concluding remarks

One of the goals of this study was to develop an appropriate model for measuring the perceived service quality of e-learning platforms. The study has shown that Perceived Service Quality can be determined by the five dimensions; reliability, responsiveness, assurance, validation and empathy. Our results have shown that these insights in user perceptions can lead to a continuing improvement of such platforms. It is not excluded that there are no other dimensions which co-determine perceived service quality. Future research should reveal the existence of other dimensions.

Recommendations ECNU

As stated, overall the perceived service quality of e-learning at the East China Normal University is rated positive. The results show that the students have rated empathy the lowest of all variables. Although the variable empathy is not rated negative, but more neutral, it can be important for the overall success of the organization to optimize this variable. The variable empathy consists of the dimensions convenient learning schedule, ease of use, customized service, care, comfort environment and interactivity. This means that the university can improve the perceived quality of empathy in three ways. First of all the personal circumstances of the students during the use of the virtual learning environment can be optimized. By emphasizing a more personal approach, the teacher can optimize the dimensions customized service, care and interactivity. To further optimize the service quality concerning empathy, the East China Normal University will also have to critically review the comfort of educational facilities such as the computer lab, etc. Finally, a critical examination of the usability of the e-learning environment itself is required.

To fully optimize the perceived service quality of their e-learning systems, the East China Normal University should implement a yearly control mechanism into the evaluation phase of its service quality management system. For example, by using a questionnaire each year, students can give their opinion on the provided service quality and the university can see if the perceived service quality improves over time. The questionnaire developed in this research by means of the perceived service quality model will give a good hands-on approach for the evaluation phase in a continued service quality management process.

Future research

The research was performed at the East China Normal University only. In future research it will be interesting to measure at multiple universities in China. Comparing the results on the five dimensions will lead to an optimal PSQ framework which will be beneficial in successfully implementing e-learning on a global scale. Because of the particular outcome on empathy further research on this dimension of PSQ and cultural influence will be both interesting and necessary in obtaining completely reliable results.

Perceptions of the provided service quality are also determined by influencing factors like self-efficacy. The individual relationships could also be moderated by different personality

traits of the students. Lee, Kim and Chung (2002), showed in their research on the usage of mobile Internet services that social influence and self efficacy significantly affect the perceived usefulness and perceived ease of use. According to Bandura (1986; 1997) it is not about the skills a person has, but his or her perception of how they can use them effectively. In learning self-efficacy counts as a predictor of student's motivation and learning (McCombs & Marzano, 1990; Schunk, 1995; Schunk, Pajares & Wigfield, 2002; Zimmerman, 2002). Further self-efficacy influences computer usage. Lower levels of computer self-efficacy are related to lower learning outcomes (Welsh, Wanberg, Brown & Simmering, 2003). In their study on computer self-efficacy in predicting continuance usage of e-learning systems, Hayashi, Chen, Ryan & Wu (2004) also mention several studies that found strong evidence of a relation between self-efficacy and computer behavior at universities. Future research concerning the effects of self-efficacy on PSQ is therefore strongly recommended.

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iVERG works in collaboration with universities worldwide. Research on virtual environments for use in learning and teaching is diverse and complex and draws upon specialisms in education, computing, sociology, psychology and anthropology.
It has an important contribution to make to the effective uses of these environments which are being increasingly taken up by a wide range of educational institutions worldwide. Although they have an intrinsic appeal founded upon their origins within gaming and social networking, immersive virtual environments need research informed practice to ensure their effective educational use.

Research projects funded by the Engineering and Physical Sciences Research Council (EPSRC), the British Council and the Japan Advanced Institute of Science and Technology (JAIST) are investigating communication, learning and identity within virtual worlds. From this work, the International Virtual Environments Research group was established. It brings together academics and practitioners who wish to study and carry out research in the uses of immersive virtual environments for learning, training and teaching.

Strong interaction between academia and practitioners is a major benefit of the group, helping to shape and hone research to focus more directly on real concerns.

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