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Opportunities for building learning activities around real patients have decreased and various representative simulations have become an increasingly common alternative. The use of virtual patients is one such simulation developed to support the delivery of clinical teaching. Game-based learning has been considered a new way of delivering clinical teaching that is more suited to the new generation of ‘digital natives’. Online multi-user virtual environments offer rich interactive 3D collaborative spaces where users can meet and interact. This paper discusses different learning types and the virtual patients developed in Second Life that follow a game-based learning approaches based on a four-dimensional framework, as well as other design considerations that look at emergent narratives and modes of representation. Attitude towards game-based learning was assessed by measuring four components, including 21 statements, each scored on a 5-point Likert scale. General recommendations on delivery of game-based learning for virtual patients in Second Life are presented.

INTRODUCTION

Medical education faces difficult challenges in the 21st century. Increasing pressure upon doctors to deliver service targets, the European Working Time Directive and changes in the way in which we deliver healthcare, coupled with higher numbers of students entering medical education, have increased the demands on academics, resulting in less time for teaching (Olson LG et al. 2005). Opportunities for building learning activities around real patients have decreased, and various forms of representative simulation, many of which use digital technology, have become an increasingly common alternative in healthcare education (Begg et al. 2005b).

The convergence of information and communication technologies has led to a rapid expansion of digital applications that support all aspects of teaching and learning in medicine (Youngblood and Dev 2005).

Many high-quality e-learning materials are being produced by medical schools and healthcare organizations (Ruiz et al. 2006). Virtual patients is one of the models developed to support the delivery of clinical teaching. Healthcare students are familiar with the concept of virtual patients, as they are frequently exposed to actors performing the role of patients in clin-
tical examinations. In the area of medicine, however, there are limitations to what these cases can offer in terms of either a game-informed learning experience or a real patient experience, as the narratives that accompany and describe many current virtual patient scenarios are simplistic and linear (Begg et al. 2005b).

**Virtual Patients - Game-Based Learning**

All learners in their 20’s belong to the ‘games generation’, being ‘native speakers’ of the digital language of computers, video games, DVD players, mobile phones, eBay, iPods and the internet (Holloway, 2003). They are ‘digital natives’ (Prensky 2001).

Anecdotal evidence from teachers suggests that the impact of gaming on millions of digital natives who grew up playing best-selling games such as SimCity is starting to be felt (Squire 2002). The designers of computer and video games have perfected a way of learning that goes well with the new skills and preferences of these digital natives. Video and computer games are in many ways a ‘perfect’ learning mechanism for this group (Prensky 2006).

The term game-based learning has emerged as a generic name for the use of games for learning or educational purposes. It has also been termed ‘serious games’ which include fully immersive environments (or ‘metaverses’), in which learners can take on virtual presence in virtual worlds (Joint Informations Systems Committee, 2007). As Greenfield (1984) observed, early work has shown rich inferential learning taking place as a result of game play. Gee (2003) also observed how successful game play and experiential learning opportunities have been shown to share common aspects (Aarsand, 2007).

Virtual patient scenarios offer opportunities for ‘game-informed learning’. This is due to their experiential and problem-based learning approaches as prime pedagogic drivers. The process of game play is so similar to the learning processes outlined in problem-based learning that they are almost interchangeable (Begg et al. 2005a).

Branching stories that represent virtual patient scenarios are not new in medical education. Some medical schools have successfully included their delivery across the medical curriculum, pointing out that they offer opportunities for ‘game-informed learning’. They shift the emphasis from case-based scenarios towards a more controlled position in which the learner is able to steer the case (Begg et al. 2005a).

The reason for using game-based models is simple: people learn better when they don’t know that they are learning. Game-based learning tends to be a pleasant break from traditional linear content (Aldrich 2005).

As Begg et al. (2005a) observed, the lack of an immersive contextual framework tends to fail to engage students within the activity. The authenticity of the environment and the value of the actions taken by the learner will reflect on the level of immersion and, therefore, the reality of the learning experience. However, development of three-dimensional representations is challenging, and it requires a lot of information in order to create a credible ‘metaverse’ (Ryan 2001).

It is believed that branching virtual patient scenarios offer a more challenging and engaging learning experience that the learner can relate to; however, they lack immersion (Begg et al. 2005a). This lack of immersion in current virtual patient delivery, as well as the familiarity of our ‘digital natives’ with virtual and game-based environments, has been the motivation for this piece of research.

The research conducted was based on the background described. The project aims to assess attitude towards game-based learning for virtual patients in Second Life, measuring four components –affective components, perceived control, perceived usefulness and behavioural components. The surveys, including 21 statements each, were scored on a 5-point Likert scale.
The project also aims to explore the experience of computer and videogame play among medical students and to identify any gender-related differences and social opportunities that might exist between high gamers and low gamers in their approaches to game-based learning in Second Life.

- High gamer includes all participants who responded having played computer or videogames a few days ago or a few months ago.
- Low gamer includes all participants who responded having played a few years ago or never.

**A Framework for the Design of Game-Based Learning**

The problem of adapting complex games or developing new game-based learning activities, as described by De Freitas and Martin (2006), would be alleviated if systematic frameworks and toolkits were developed that ease the implementation and integration of game-based learning activities in the curriculum.

The framework for evaluating games and simulation-based education developed by De Freitas and Martin (2006) will be adapted for this research.

The framework requires consideration of four main dimensions in advance of using games and simulations. These focus on the:

1. particular context where learning takes place, including macro-level contextual factors
2. attributes of the particular learner or learner group
3. internal representational world of the game or simulation
4. pedagogic considerations, learning models used, approaches, etc.

According to De Freitas and Martin, the four dimensions provide a framework for consideration of both existing and future educational games and simulations, as well as other forms of immersive spaces, such as virtual reality. This framework provides a close relationship with the systems of Activity Theory (Kuutti, 1996).

**SECOND LIFE - Multi-User Virtual Environment**

We have outlined the factors that are currently driving the design, development, and evaluation of game-based learning activities for virtual patients in a multi-user virtual environment (MUVE). One example of such an environment is Second Life (http://www.secondlife.com), which is currently being developed and used by our team. Online MUVEs offer rich interactive 3D collaborative spaces where users can meet and interact (Livingstone 2007). Second Life users are represented by avatars and can be moved in the environment using mouse and keyboard controls. Users can communicate using instant messages, voice chat or text-based 'notecards'.

There has been increasing investigation and trials of the potential of Second Life for learning (Heimler 2007). Second Life has common community and collaborative features with recent contemporary developments such as Facebook, YouTube, Wikiped, and Flickr, which place it in the Web 2.0 spectrum.

The following outlines some of the advantages and disadvantages of using Second Life as a learning environment in medical education.

**Advantages**

- The use of a pre-existing engine which makes the development of game-based learning activities easier
• A media-rich social learning environment
• Anonymity may help when training in sensitive medical subjects such as mental and sexual health
• It is a ‘safe place to fail’. Students can interact with virtual patients, trying different treatments and investigations

**Disadvantages**
• Learning curve: basic orientation takes more than 4 hours; mastery of the environment takes far longer
• High bandwidth demands
• Requires a high-specification computer with good graphics card
• Demand for in-house information technology (IT) support
• Current architecture limits the number of concurrent users in any region

**Second Life – Games In Educational Contexts**

There is little agreement among educational technologists on why we should use games, how they should be designed to support learning, or in what instructional situations games make the most sense (Gredler 1996). The instructional context that envelops gaming – how the game is conceptualized, the kind of constructivist learning activities embedded in game play, and the quality and nature of debriefing – are all critically important elements of the gaming experience (Squire 2002).

According to De Freitas (2006), learning in immersive worlds is beginning to have a wider range of uses and applications. The Second Life community demonstrates how interactions within and between groups are opening up new opportunities for learning beyond the physical constraints of the classroom. This provides novel challenges and opportunities to explore ways to create innovative approaches to learning.

Some authors recognize Second Life as a game-based application providing a space in which games can be created, allowing highly structured linear experiences as well as more open-ended ones. However, some do not classify it as a game because of its lack of predefined goals (Livingstone 2007).

Second Life marks a paradigm shift in the possibilities open to those wishing to adopt game-based approaches (Helmer 2007). It may provide the infrastructure to develop the next generation of virtual patients, offering not only 2D linear or branching structures, but also immersive 3D experiences.

Second Life already provides a ready-made games engine. The challenge for medical education and for the research currently being carried out by our team is to identify game-based activities that can drive experiential, diagnostic and role-play learning activities within the 3D world, aiming to support learning about patients’ diagnoses, investigations and treatment.

**Learning Types and the Learner as a Consequent Agent**

Different learning types are identified and discussed by Helmer (2007). Demonstration learning involves the least interaction and is most closely aligned with traditional educational experiences. Experiential learning involves a higher level of engagement, providing a more immersive, time-based experience than a demonstration. Diagnostic activities involve interaction with a simulated environment, designed to promote inquiry, analysis and identification. Role-play should cover engagements that have embedded learning objectives. It is already one of the primary activities in Second Life. Construc-
tive learning involves giving learners the opportunity to create or ‘build’ elements within the environment.

Murray (1997) discussed three potential influential factors of emergent narrative that might allow the learner feel their interactions have real consequences. These have already been put into context by Begg et al. (2005b) and are described under the next three headings, putting the development of Second Life into context.

**Emergent Narrative - Linear Content**

The progress of the story is defined and influenced by the choices the learner makes. The navigational pathways in the virtual patient case in Second Life will be enriched by the ‘metaverse’. Introductions in the form of audio, video and ‘notecards’ allow the learner to progress through the case.

**The Responsive Environment**

The learner will expect the environment to respond to his/her input. These expectations will not be limited to one path in Second Life. Learners will be able to follow different routes and move from different areas within the virtual hospital, e.g. laboratory and radiology department. Different activities will then be triggered and the results of investigations will be released to learners depending on their choices, using Scaffolding information in the form of audio, video and ‘notecards’.

Some forms of Assessment, mainly using multiple-choice questions, will also be provided.

**The Psycho-Social Moratorium - Cyclical Content**

Successive attempts will be made to achieve the main objective of the case. Each attempt will be increasingly informed by knowledge acquired in previous attempts. Learners will be encouraged to return and try again. Diagnostic capabilities are driven by credit in Linden $ given at the beginning of the case. A series of Triggers will be implemented to allow the learner to progress through the case. A database-driven solution will be implemented in order to record and track learners’ activity and progression. This means that when learners return to the case, they will be able to continue at the point they left. Cyclical content will be implemented when:

- timing is critical (doing the same things too early or too late)
- incremental signs inform the learner when things are going well or badly
- magnitude is important – the instances where doing the same thing a bit more or a bit less matters.

The four-dimensional framework described by De Freitas and Martin (2006), plus the learning types described by Helmer (2007), as well as the different aspects of emergent narrative described by Murray (1997) have provided the basis for the design of game-based learning activities for the first virtual patient in Second Life under two different categories: context and learner specification, and narrative and modes of representation.

**Virtual Patients in Second Life - A Game-Based Learning Approach**

A virtual patient that follows a game-based learning approach has been developed. A region has been developed in Second Life (http://slurl.com/secondlife/Imperial%20College%20London/150/96/27/), where a virtual teaching hospital has been created. Different aspects of the learning types already described by Helmer (2007) have been implemented.

The following sections provide more information about the way the framework has driven the development of game-based learning activities within the ‘metaverse’.

**Context, Learner Specifications and Pedagogic Considerations**

The design of game-based learning activities in Second Life (Table 1) focused on the first, second and fourth dimensions outlined by De Freitas and Martin (2006).
Table 1. Framework for the design of game-based learning activities – context and learner specifications

<table>
<thead>
<tr>
<th>Context</th>
</tr>
</thead>
<tbody>
<tr>
<td>Game-based activities will be delivered in Second Life to third-year undergraduate medical students at Imperial College London.</td>
</tr>
<tr>
<td>A module on respiratory medicine focused on pneumothorax will be embedded in Second Life using game-based learning activities.</td>
</tr>
<tr>
<td>This module has already been embedded in the curriculum as part of the Year 3 e-lecture program.</td>
</tr>
<tr>
<td>Significant technical support and resources will be required during the first delivery of this module in Second Life.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Learner specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Third-year students. Average age 22 years.</td>
</tr>
<tr>
<td>The game-based activities can be used by learners working singly or in groups.</td>
</tr>
<tr>
<td>The virtual presence of the tutor is not required.</td>
</tr>
<tr>
<td>At present, it can only be played as part of the pilot project.</td>
</tr>
</tbody>
</table>

Pedagogic considerations

Use of theories, such as Kolb’s theory of experiential learning (1984) where the learner ‘touches all the bases’, i.e. a cycle of experiencing, reflecting, thinking, and acting leading to observations and reflections. These reflections are then assimilated into abstract concepts with implications for action.

Learning outcomes

By the end of the activity learners will be able to:

- Identify and select the right investigations leading to the right diagnosis.
- Provide the right diagnosis for different respiratory emergency cases.
- Provide the right treatment based on the final diagnosis.

**Narrative and Modes of Representation**

Some aspects of the third dimension described by De Freitas and Martin (2006), as well as some of the learning types outlined by Helmer (2007), are described in relation to aspects of Second Life in Table 2. This table also identifies different aspects of the emergent narrative described by Murray (1997), which allows the learners to feel that their interactions have real consequences. Different narratives and modes of representation for the sections, introduction and medical history can be seen in Figure 1. Different narratives and forms of representation, which allow the participant to buy the investigations required, can be seeing in Figure 2.
Methods

Subjects
This investigation involved 42 undergraduate medical students (21 years old). The gender distribution of the respondents was 42.85% female (n = 18) and 57.14% male (n = 24).

Instruments
The survey ‘My feelings when playing games’, developed by Bonanno and Kromers (2008) was applied. The survey comprises 21 statements. Six statements related to the affective component, five statements about perceived usefulness, six statements about perceived control and four statements about behavioral components. All statements describe behaviors while...
using games. The statements were adapted depending on the groups: ‘My feelings when learning in Second Life’ and ‘My feelings when learning via e-modules’. Situations with positive feelings as well as situations with negative feelings such as fear, lack of control and hesitation have been addressed. A five-point Likert scale was used.

Gaming competence was addressed by identifying participants under two different computer/videogame categories: high gamers or low gamers.

- **High gamer** includes all participants who responded having played computer or videogames a few days ago or a few months ago.
- **Low gamer** includes all participants who responded having played a few years ago or never.

**Procedure**

Data about gaming competence were collected at the beginning of the investigation aiming to identify gaming tendencies among undergraduate medical students.

The sample analyzed included 118 full-time undergraduate medical students of average age 22 years. The majority of respondents (47%) were male, and 34% of all students completed the survey.

The majority of participants surveyed were classified as high gamers (70%). The majority of male participants were high gamers (87% of all males surveyed), while only about half of the female participants were high gamers (54%).

The majority of the participants had never heard of Second Life (66%). However, 50% of male participants had heard of Second Life, in comparison to only 13% of female participants.

From this group, a stratified sample (n = 42) was selected according to gender and high and low gamer categories. One group (n = 23) was given access to the game-based learning activity for a virtual patient on respiratory medicine developed in Second Life following the framework described in this paper. The second group (n = 19) was given access to the same content, covering the same virtual patient, but delivered as an interactive e-module. The surveys ‘My feelings when learning in Second Life’ and ‘My feelings when learning via e-modules’ were given to the groups, and were to be completed at the end of each 40-minute session. The scores for the separate statements were coded in Stata version 10, using reverse scoring for unfavorable statements.

The results based on computer and videogame player categories by gender for the Second Life group are shown in Table 3 and those for the e-module group in Table 4.

The Second Life group was given an introduction (20 min) at the beginning of the session. The introduction covered basic navigational techniques in Second Life, e.g. how to access notecards.
A focus group was also carried out with only the Second Life group at the end of the activity in order to address the social dimension for collaborative work when learning in Second Life, as well as to address other accessibility and usability issues not covered in the survey.

Results

Data about gender, gaming competence and identified attitude components were entered in Stata using the appropriate codes. A number of variables were constructed by computing individual scores for the different statements related to the affective components, perceived use, perceived control and behavioral components. The main results for the separate statements are given in Table 5.

Chi-square or Fisher’s exact test was used to compare categorical variables between both groups. The questions were combined into groups 1–3 (disagree) and 4–5 (agree). Statements in Table 5 with reverse scoring are shaded.

The scores for each statement related to the various attitudinal components presented in Table 6 and Table 7 were summed forming four computed variables, computed affective components, computed perceived control and computed behavioral components.

The scores for each statement related to the various attitudinal components presented in Table 6 and Table 7 were summed forming four computed variables, computed affective components, computed perceived control and computed behavioral components.

Table 5. Statistical data for the 21 separate variables.

<table>
<thead>
<tr>
<th>No</th>
<th>Question</th>
<th>Description</th>
<th>Chi-square/Fisher’s exact</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A1</td>
<td>Given the opportunity to use an e-module/Second Life as a learning tool, I am afraid that I might have trouble in navigating through it.</td>
<td>0.009</td>
</tr>
<tr>
<td>2</td>
<td>U1</td>
<td>Learning using e-modules/Second Life helps me relax and thus do my work better.</td>
<td>All disagree</td>
</tr>
<tr>
<td>3</td>
<td>C1</td>
<td>I could probably teach myself most of the things I need to know about accessing and learning using e-modules/Second Life.</td>
<td>0.002</td>
</tr>
<tr>
<td>4</td>
<td>B1</td>
<td>I would avoid learning using e-modules/Second Life.</td>
<td>0.613</td>
</tr>
<tr>
<td>5</td>
<td>A2</td>
<td>I would use an e-module/Second Life as a learning tool in case I lack expertise.</td>
<td>0.149</td>
</tr>
<tr>
<td>6</td>
<td>U2</td>
<td>Learning using e-modules/Second Life can enhance the learning experience to a degree, which justifies the extra effort.</td>
<td>0.492</td>
</tr>
<tr>
<td>7</td>
<td>C2</td>
<td>I am not in complete control when I use e-modules/Second Life for learning.</td>
<td>0.012</td>
</tr>
<tr>
<td>8</td>
<td>A3</td>
<td>I don’t feel uneasy about using e-modules/Second Life.</td>
<td>0.004</td>
</tr>
<tr>
<td>9</td>
<td>C3</td>
<td>I can make the computer do what I want it to do while learning using e-modules/Second Life.</td>
<td>0.0001</td>
</tr>
<tr>
<td>10</td>
<td>B2</td>
<td>I would only use an e-module/Second Life for learning if I were told to.</td>
<td>All disagree</td>
</tr>
<tr>
<td>11</td>
<td>C4</td>
<td>I need an experienced person nearby when I am learning using an e-module/Second Life.</td>
<td>0.105</td>
</tr>
<tr>
<td>12</td>
<td>A4</td>
<td>Learning using e-modules/Second Life does not scare me at all.</td>
<td>0.468</td>
</tr>
<tr>
<td>13</td>
<td>U3</td>
<td>Most things that one can get from learning using e-modules/Second Life can be obtained or arrived at through other means.</td>
<td>0.049</td>
</tr>
<tr>
<td>14</td>
<td>B3</td>
<td>I would avoid learning a topic if it involves an e-module/Second Life.</td>
<td>0.075</td>
</tr>
<tr>
<td>15</td>
<td>C5</td>
<td>If I get problems using an e-module/Second Life, I can usually solve them one-way or the other. F &lt; 0.0001</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>A5</td>
<td>I hesitate to use an e-module/Second Life as a learning tool as I’m afraid of making mistakes I can’t correct.</td>
<td>0.024</td>
</tr>
<tr>
<td>17</td>
<td>U4</td>
<td>Learning using e-modules/Second Life provides more interesting and imaginative ways for learning. F &lt; 0.0001</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>B4</td>
<td>I would access an e-module/Second Life regularly for learning.</td>
<td>1.000</td>
</tr>
<tr>
<td>19</td>
<td>C6</td>
<td>I do not need somebody to tell me the best way to use an e-module/Second Life for learning.</td>
<td>0.014</td>
</tr>
<tr>
<td>20</td>
<td>A6</td>
<td>Using an e-module/Second Life makes me feel uncomfortable.</td>
<td>0.011</td>
</tr>
<tr>
<td>21</td>
<td>U5</td>
<td>E-module/Second Life makes it possible to learn more productively. F &lt; 0.0001</td>
<td></td>
</tr>
</tbody>
</table>
Is There Evidence of an Association Between the Two Groups on the Different Attitudinal Components?

Discussion is organized around the four major components relating to the students’ attitudes, and the statistical significance of some of the statements is discussed in relation to the pedagogical implications.

Affective Component

The affective component addresses feelings of fear, hesitation, and uneasiness experienced before and while learning in Second Life. Members of the e-module group were less apprehensive about accessing a virtual patient via e-module than the Second Life group, and they felt more confident when using and navigating through an interactive linear virtual patient case (Q1: P = 0.009). Pedagogically, this might be due to the fact that the virtual patient case is delivered in a linear way using an interface the students are used to.

Neither group is inhibited by beliefs arising from negative perceptions of looking stupid with others when accessing a virtual patient via e-module or in Second Life (Q5: P = 0.149). Learning in these environments is perceived by both groups as an intelligent and socially accepted activity. Therefore, game-based learning in Second Life should be promoted as a stim-
ulating academic activity. Regarding hesitation in the use of an e-module or Second Life (Q16: P = 0.016), it is interesting to note that the e-module group is 100% hesitant to use it, whereas the Second Life group is more confident (17/23, 73.91%). It is interesting to see how the e-module group showed feelings of uneasiness when accessing the virtual patient case. These students have been exposed to the same interface during their current e-lecture programme, which is normally very well received by the students and is very highly rated. It is worth pointing out that there are important instructional design differences when delivering interactive e-modules and when delivering virtual patients. Although the students like navigating through an e-module, they might find it difficult to navigate through a virtual patient case provided in a linear format. This is something worth exploring further in future research projects.

Both groups felt uneasy about learning in Second Life using game-based learning and e-modules (Q8: P = 0.004). Therefore, when building game-based learning in MUVEs continual reinforcement and support should be given.

Perceived Usefulness
This involves behavioral arising from beliefs about the advantages of learning in Second Life or via e-modules. Regarding the therapeutic effect of learning via a specific platform, all participants in both groups disagreed that learning in Second Life or via e-modules relaxes them so that they could learn better. The Second Life group had never accessed Second Life before, and although a 20 min introductory session was provided at the beginning of the pilot, it was not enough for them to familiarize themselves with the environment. In relation to the e-module group, again this is something worth exploring further since interactive e-modules are normally very well received by the students. However, this is a linear virtual patient delivered as an e-module.

The Second Life group was more sceptical than the e-module group about the instructional potential of learning in Second Life, considering that other means (Q13: P = 0.049) provide what can be learned from game-based learning in Second Life. The Second Life group perceived learning in MUVEs not as a unique learning and entertaining experience, but just as another way to learn.

It is interesting to note that both groups considered learning either in Second Life or via e-module as a way to enhance the learning experience to a degree that justifies the extra effort (Q15: P = 0.002). Activities for the Second Life group can be provided offering more guidance and support when facing problems. Regarding the sense of control when learning in Second Life (Q7: P = 0.012), the Second Life group felt much more in control of the virtual environment, (15/23, 65.22%) and thus more
capable of performing the demanded actions. However, more feedback and guidance should be provided to make sure learners accessing game-based learning activities feel in control at all times.

**Behavioral Component**

Positive behavioral are manifested as willingness to use Second Life for learning. Negative behavioral involve avoidance tendencies. Both groups declared that they do not avoid using Second Life or e-modules for learning (Q4: $P = 0.613$), therefore showing their disposition to engage in learning using both environments. A group difference was obtained in relation to avoiding learning if it involves using Second Life or e-modules (Q14: $P = 0.075$). Interestingly, the e-module group was less in favor of avoiding using e-modules to learn about virtual patients (17/19, 89.47%) than the Second Life group (14/23, 60.87%). This shows a more favorable reaction towards using Second Life for learning.

Regarding their willingness to use Second Life or e-modules for learning if they are told to, both groups completely disagreed. When asked if they will continue to use Second Life or e-modules in the future (Q18: $P = 0.358$), both groups declared that they would not access virtual patients either in Second Life or via e-module regularly for learning. This could be explained again by the feedback received during the focus group in which the students were not in favor of accessing virtual patients and preferred direct contact with real patients when possible.

**Is There Any Relation Between Gaming Competence and Attitude To Learning in Second Life?**

There is some evidence of an association between gaming competence and gender for Second Life. ($P = 0.03$): 5/11 (45.5%) of females are high gamers, while the proportion of males who are high gamers is higher (11/12, 91.7%). There is no evidence of an association between gaming competence and gender for e-module ($P = 1.00$).

In subsequent research papers this project will further explore any gender-related differences and social propensities that might exist between high gamers and low gamers in their approaches to game-based learning in Second Life.

**Discussion**

Learning in immersive worlds is beginning to have a wider range of uses and applications (De Freitas 2006). Second Life provides a space in which games can be created, and the infrastructure for the design of open-ended, game-based immersive 3D experiences.

The literature demonstrates that game-based learning shows some initial evidence of accelerating learning and of supporting the development of higher-order cognitive and thinking skills (De Freitas and Jarvis 2007). The survey ‘attitude to learning in Second Life and via e-module’ is a useful instrument from a pedagogical perspective because it addresses attitudinal components. The survey findings have helped to identify key elements that should be looked at more carefully during the design of game-based learning for virtual patients in Second Life. These findings have driven the implementation of a series of changes in the original design, aiming to support learners under the different categorical values identified in the survey (affective component, perceived control, perceived usefulness and behavioral component).

Based on the evaluation and findings, the following caveats encountered in this study are highlighted and general recommendations are made when implementing game-based learning for the delivery of virtual patients in Second Life:

• General feedback and guidance for cyclical content should be provided at all times for students accessing game-based activities for virtual patients in Second Life. It is suggested that a ‘badge’ be provided for learners at the beginning of the activity, which they can wear and by which they can receive feedback from the system. Feedback will be delivered to the student
if they have not carried out any activity for the last 5 minutes. The feedback will inform the students about the patient they
last treated and the last activity carried out on that patient.

- ‘Demanded feedback’ for cyclical content should also be provided by the patient’s area. The student should be able to click
on a ‘Check status’ sign and receive feedback on where they were the last time they accessed the patient.
- Regarding control over the activity, it would be useful to provide a ‘Reset’ button which the students could access to reset
the virtual patient activity in case they wanted to start all over again and therefore have more control over the activity.
- Some limitations in terms of space were found when the students were all trying to access the same virtual patient in the
virtual hospital. It is important to take into account the number of potential users expected to interact within a specific
environment in Second Life and therefore design the environment accordingly.
- It is suggested that the virtual patient area be designed to be as spacious as possible in order to accommodate several avatars
accessing the virtual patient at the same time.
- It is suggested individual feedback be restricted to notecards or individual text messages in order to avoid congestion of
the general chat text window and thus reduce confusion among the students.
- More guidance should be provided within the messages delivered when learners are not doing the right thing.
- It is worth pointing out that although a high percentage of the students in the Second Life group were high gamers, they still
faced problems navigating in Second Life. It is important to keep in mind that the interface offered in Second Life is unique.
- It is suggested that the study ensure that the students are exposed to Second Life for at least 4 hours before engaging
in any learning activity in this environment.

It is important to highlight the fact that following the four-dimensional framework and development process discussed in this
paper has helped with the implementation of the learning outcomes originally proposed for the delivery of game-based learning for a
virtual patient in the area of respiratory medicine. The pilot study carried out has been extremely important in the evaluation of stu-
dents’ attitudes towards learning using this delivery mode. The feedback received has informed the development of Phase II, which
incorporates a multi-patient approach. Five virtual patients suffering from different respiratory problems, such as Asthma and COPD,
have been implemented. The same narrative and activity model is applied for all these patients including different modes of representation.

It is worth pointing out that after implementing the changes driven by the feedback received from this evaluation, further
analysis has to be carried out in order to continue evaluating attitudes towards game-based learning for the delivery of the
potential next generation of virtual patients.

This research is still ongoing and the findings highlighted above form part of a larger research project.

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