Game-based learning for virtual patients in Second Life®

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December 2011
To my dear and brave mother ‘Rose’
Abstract

In the field of medicine, various representative simulations have been developed to support the decreasing number of learning opportunities with real patients; the use of virtual patients is among them. Virtual patients are real-life clinical scenarios used for the purpose of medical education. They usually follow a linear or branching approach and they are usually accessed via a computer browser or as part of a computer programme.

The purpose of this thesis was to design, and develop a platform for the delivery of virtual patients following a game-based approach in the virtual world of Second Life®, investigating attitudes and gender differences among medical students at Imperial College London.

Virtual worlds, such as Second Life®, are 3D spaces in which users meet and interact and in which learning opportunities can take place. Second Life® was selected for this study due to its popularity among UK Higher Education Institutions at the time of the development. The virtual patients’ activities were designed following game-based learning and pedagogic principles. The technical infrastructure was designed following a Component-Based System (CBS) structure as a distributed three tier architecture presenting information via a Heads-Up-Display (HUD).

The first study carried out concentrated on the survey “My feelings when playing games” developed by Bonnano and Koomers (2008). The survey was comprised of 21 statements. Six statements related to the affective component, five statements are about perceived usefulness, six statements about perceived control and four statements about behavioral components. Two groups were involved, one accessing a virtual patient via Second Life® and the other via an e-module. This study involved 42 Year 3 undergraduate medical students (21 years old). The gender distribution of the respondents was 42.85% female (n = 18) and 57.14% male (n = 24).

The tendency encountered in each group towards the different attitudinal components was analysed as well as gender-related attitudes. Both groups showed very similar results in relation to the Attitudinal Components. In general, females demonstrated a more positive attitude overall for the perceived usefulness component. Other studies looked at and contrasted, provided interesting thoughts and reflections on gender tendencies and game play. It was concluded that more inclusive and holistic studies in this area ought to be carried out in order to identify game play tendencies in professional-level simulation with adults at university level, which may counteract outdated perceptions about age and gender differences in game play.

The second study described the use of the Nominal Group Technique (NGT) to assess students’ attitudes again. Two groups of undergraduate medical students (Yr 3, n=14) were invited to participate. The research question posed was: “In your opinion what are the advantages and disadvantages of learning in Second Life® compared with other methods?” The results provide a different perspective to the ones highlighted in the first study. Results from the first group focused on the learning experience highlighting its importance for clinical diagnosis as a structure for learning. The second group focused on the clinical exposure although they were ambivalent about the advantages of this type of delivery mode. In general, learners did not find the virtual patient activities challenging enough.
The results of this thesis show that although a game-based learning approach was followed in the design of the virtual patient activities and interfaces, the repetitive linear presentation of the cases did not motivate the students enough, targeting only low-end Cognitive skills which may be more suitable for students in Year 1 and 2. The use of more challenging branching learning experiences, such as the ones developed by the PIVOTE authoring system are suggested for the delivery of virtual patients in clinical years.

All the programming code used in the CBS has been released as open source, licensed under a Creative Commons Attribution-Non Commercial 3.0 License, in order to stimulate other interested parties in the development of similar applications in the virtual world of Second Life®.
I would like to sincerely thank all the people that in one way or another helped me in the production of this piece of work. My appreciation goes to Luleå University of Technology for giving me the opportunity to carry out this research at the Department of Human Work Sciences. My appreciation also goes to my supervisor, Professor Ulf Mellström for his guidance and support throughout these years.

I would also like to express my appreciation to the Faculty Education Office – Medicine at Imperial College London for allowing me to carry out this research at the Faculty of Medicine and for partially funding my travel expenses. I would like to sincerely thank Professor Martyn Partridge for his continuous support, encouragement and trust during the life of the study. I would also like to thank Mr. Richard Barnard for his support at the beginning of the project. I would like to express my deepest gratitude to Professor Jenny Higham for her constant support and for always having the time to listen and giving me words of advice.

I would also like to express my gratitude to Dr Sue Smith and Dr Michael Barrett for their support and Ms Sue English for believing in me. I would also like to thank my colleague Mr. Ashish Hemani for his input in the development of BLEnDT© and for being there when I needed him most.

Thanks to my dear friends Patricia Rojas and Hasse Nylander for always making me feel at home in Luleå. My special thanks should also go to my family, especially my mother for teaching me to follow my dreams and believe in myself. My special thanks should also go to my dear partner Liz, for all her support and for always being there when I need her. And last but not least, I would like to express my gratitude to my dear son Sebastian Vicente for arriving later than his due date and giving me the opportunity to finish the final publication!
List of original papers

The papers and book chapter that constitute this thesis are listed below:

**Paper I**

**Paper II**

**Paper III**

**Chapter I**
The following papers and conference proceedings have also been published within the framework of the author’s research:


Toro-Troconis, M., Partridge, M. and Barrett, M., Mellström, U (2008), 'Game-based learning for the delivery of virtual patients in Second Life', The Academy Subject Centre for Medicine, Dentistry and Veterinary Medicine Newsletter 01, no. 17, Summer 2008, pp. 3-4 ISSN 1479-523X. http://tinyurl.com/6ysrzuh Accessed 28 October 2011

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1. Introduction

1.1 The thesis outline

This study began when I started to explore possibilities of developing learning activities for undergraduate medical education in the virtual world of Second Life® at Imperial College London. The use of Second Life® (a trademark of Linden Research, Inc.) in Higher Education (HE) in the UK, was starting to grow (Kirriemuir, 2009), and although several other virtual worlds had been available for a long time, Second Life® seemed to start offering the environment and support for HE institutions in the UK.

The early developments of UK Higher Education institutions in Second Life® focused on replicating real university campuses, offering virtual tours of their installations to visitors. Few inspiring learning activities in the area of medicine were found in Second Life® at the time. The heart murmur simulation, created by Jeremy Kemp was the first learning activity I found in Second Life® that made me realise Second Life® could be used for more guided and focused learning activities. Virtual hallucinations created by Dr. Peter Yellowlees, Professor of Psychiatry, and colleagues at the School of Medicine at the University of California, helped one to appreciate what it is like to have Schizophrenia. This was another example of a focused learning experience in the area of medicine at the time.

Although the two activities mentioned above were developed within virtual university campuses in Second Life®, they provided a learning structure and flow allowing learners to accomplish certain learning objectives by going through the learning activities. It was then when I started thinking about the potential of developing immersive and guided learning activities in Second Life®, which did not require synchronous communication between learners and tutors, but learning activities which allow learners exploration and intervention in a guided way. It was then when the ‘game’ concept came to place. It believed that a game approach in the design of the learning activity would provide the narrative required as well as the information presentation and interactions at different stages controlled by triggers as it happens in games. It was also believed the target user population (medical students - average age 21 years old) was going to be receptive to the use of games, finding probably a high number of gamers within this group.

After evaluating the technical infrastructure of Second Life® and the way Second Life® can communicate with external components, it was realised that it could provide the platform in which game-based activities could be created enabling a game-based learning experience at low cost. The infrastructure was considered low cost due to its capacity for enabling the production of other virtual patient cases using the same infrastructure. Then after several discussions with Professor M. Partridge we came to the conclusion it was worth exploring the development of a respiratory virtual ward in which learners could interact with virtual patients suffering from different respiratory conditions, following certain rules before diagnosing a patient, buying investigations with a certain budget, collecting investigations from different departments, doing a final diagnosis and finally working on the management plan of a patient.

In medical education, the opportunity for developing learning activities around real patients has been challenged by several factors. Pressures upon doctors to deliver service targets, as well as higher numbers of medical students entering medical education have increased the demands on academics in this sector, resulting in less time for teaching and patient contact with students (Olson LG et al. 2005). All these have stimulated the development of various forms of representative simulation including virtual patients (Begg et al. 2005).
Various initiatives and projects for the development of virtual patients were known at the time. A number of medical schools in the UK and abroad had already developed computer based virtual patient applications as authoring tools aiming to populate a large number of virtual patient cases and in some cases share them with other partner organisations. The University of Edinburgh’s Learning Technology Section in the College of Medicine and Veterinary Medicine was leading in this field for a number of years. They developed an in-house authoring tool called Edinburgh Reusable Object Sequencer (EROD) which allows the development of virtual patients following linear narratives which are progressed by student response to questions. As a consequence of the limitations found in EROS, The University of Edinburgh developed another authoring platform called Labyrinth allowing a more dynamic narrative with branching scenarios in which learners can see the consequences of their choices. An analysis of these two types of delivery modes for virtual patients (linear vs. branching) in the context of this research will be discussed later on in this thesis.

The concept of virtual patients delivered in the virtual world of Second Life® had not been discussed amongst the medical education community until a short paper was presented in 2007 at the International Association for Medical Education Conference (AMEE 2007) (Toro-Troconis & Partridge, 2007). A prototype of the virtual hospital and the Respiratory Ward in Second Life® with one patient was then presented provoking a lot of thought among the audience. Representatives from different medical schools at the time were inspired by this development. Some of the ideas discussed at the time focused on the use of virtual patients for Problem-Based Learning and Communication Skills among others.

The term ‘game-based learning’ was employed as a means to focus the design of the learning experience in the virtual world. Game-based learning includes fully immersive environments such as Second Life®. According to the JISC report (2007), the term refers to different kinds of computer applications that use games for educational or learning purposes. De Freitas (2006) adopts a fairly neutral approach in her JISC report, defining games for learning as:

‘applications using the characteristics of video and computer games to create engaging and immersive learning experiences for delivering specified learning goals, outcomes and experiences’. (De Freitas, 2006, p. 9)

A series of case studies presented in this report provides evidence that suggest although immersive worlds were primarily used to support professional development and training in the past, the use of games and simulations in schools and colleges was evident at the time the report was produced (De Freitas, 2006).

‘Serious games’ is another term commonly used to refer to the use of games and simulations to support formal education and training. According to De Freitas (2006):

‘the serious games movement aims to meet the significant challenge of bringing together game designers and educationalists to ensure fun and motivation as well as demonstrating educational value.’ (De Freitas, 2006, p. 6)

At the point when this study was initiated back in 2006, the design of learning activities in virtual worlds was very limited due to the innovative nature of these environments. Game-based learning activities specifically designed for virtual worlds were nonexistent at that point. It was then as part of the process of thinking about the design of the game-based learning experience, it was realized that it was necessary to follow a pedagogic approach in its design. Several frameworks that have emerged in recent years were found. According to Barab et al., (2005), these frameworks help practitioners use games for learning in a more effective way.
The four-dimensional framework developed by de Freitas and Oliver (2006) was developed in order to support the use and design of games.

'The Four Dimensional Framework, builds upon the earlier work of Mayes and de Freitas (2004, 2006), advocating a pedagogic approach that utilizes associative, cognitive and situative approaches to learning, through an alignment of learning outcomes with learning activities and modes of assessment.'

(De Freitas, 2006, p. 23)

This framework (De Freitas and Oliver, 2006), which provides a close relationship with the systems of Activity Theory (Kuutti, 1996), is one of the few tools presented in the literature that helps in the design of game-based learning activities and not only for the use or implementation of games in learning. Therefore, the framework was selected as the pedagogic foundation for the design of the game-based learning activities in this study. Activity Theory relates to game-based learning due to the fact that game-based learning is formed by a series of activities rather than the activity of an isolated entity or user. As it is mentioned in the Background section of this thesis, an activity takes place when tools are used for a purpose within an activity system. The key connection is between the individual participant and the activity system’s purpose. This relationship is not direct, but is mediated by tools, and participants are usually part of communities in which rules mediate their relationship for acceptable interactions (Mayes & De Freitas, 2004).

The learning types described by Helmer (2007): Demonstration, Experiential Learning, Diagnostic activities, Role-Play and Constructive Learning were also taken into account for the design. In addition to that, it is worth clarifying the last three influential factors taken into account in the design which were described by Begg et al. (2005): emergent narrative, originally described by Murray’s (1997), the responsive environment and the psycho-social moratorium originally described by Gee (2003). Emergent narrative relates to the progress of the story which is determined by the choices the learner makes. The responsive environment focuses on the expectations the learner has in relation to his/her input in the system; the system ought to respond according to the learner’s input. The psycho-social moratorium deals with the successive attempts the learner can perform in order to achieve the main objective. Each attempt will be informed by the previous attempt.

It is not clear from Paper II and Chapter I that the three influential factors were originally described by Begg (2005); highlighting Murray (1997) only refers to the responsive environment and Gee (2003) to the psycho-social moratorium. A chapter published in 2010 under additional publications (Toro-Troconis & Partridge, 2010) also mentioned these influential factors by Helmer and Murray in italics when they should not be in italics since they are not a textual copy.1

The game-based learning activity forms part of a Blended Learning programme (Conversational Framework: Laurillard, 2010), which is based on Cognitive Theories (Constructionism (Papert, 1991), Constructivism (Vygotsky, 1962), etc); which are explained in detail in the Background section in this thesis.

The Blended Learning programme was not part of the evaluation carried out as part of this research. We only concentrated on the evaluation of the game-based activity. However, the Blended Learning programme and its theoretical foundation are explained in the Background section in order to contextualise the study.

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1 It is important to mention some sections of text have been repeated in some publications, e.g. in Paper II and in a chapter mentioned in the list of further publications by the author (Toro-Troconis et al, 2010). This is due to the fact some of the publications were written and sent for publication around the same time and were successful in both occasions.
In a couple of the publications (Paper II, Paper III) as well as in one of the publications listed in the list of further publications by the author (Toro-Troconis et al, 2010), the word ‘pilot’ was used intentionally instead of ‘study’ because the Faculty of Medicine wanted the students to appreciate the study being an exploratory pilot which was not going to be embedded as a compulsory or required learning activity within the undergraduate medical curriculum at the time.

A Component-Based System (CBS) structured as a distributed three-tier architecture was designed and developed enabling monitoring and information visualisation of application activity as well as presentation of feedback to learners via a Heads-Up-Display (HUD) (Paper I). The CBS provided the technical infrastructure required for the effective delivery of the virtual patient activities.

Once the pedagogic and technical design were finalised, implemented and tested (Phase I: Paper I & Paper II), the research was intended to evaluate general attitude and gender differences when learning using virtual patients following a game-based learning model in Second Life® (Phase II: Paper III, Chapter I). The methods involved a study applying the survey ‘My feelings when playing games’ by (Bonnano and Kommers, 2008) and the use of the Nominal Group Technique. The quantitative and qualitative analyses of the students’ experience are reported in the respective publications (See Figure 1).

The Imperial College Research Ethics Committee (ICREC) approved the ethics of this research in 2007. A statement mentioning this has only been provided in Paper III when it was highlighted by the reviewers at the time.

1.2 Aims of the study and research questions

The purpose of this thesis was to evaluate general attitude and gender differences when accessing virtual patients following a game-based learning approach in Second Life®.

The specific aims of this study were the following (the number in brackets refers to the original papers):
1. To design a game-based learning activity following a pedagogic framework for the delivery of virtual patients in Second Life® (Paper II).
2. To design and implement a technical infrastructure to support the delivery of game-based learning activities for virtual patients in Second Life® (Paper I).
3. To investigate general attitude towards the delivery of game-based learning activities in Second Life® (Paper II & Chapter I).

The research questions are:

1. What kinds of attitudes do undergraduate medical students (average age 21 years old) have towards learning in virtual worlds, such as Second Life®?
2. Are young students (average age 21 years old) high gamers in general?
3. What are the impressions of undergraduate medical students (average age 21 years old) about learning using a game-based learning approach?
4. Do undergraduate medical students (average age 21 years old) prefer a game-based learning approach when accessing virtual patients?
5. Are male undergraduate medical students (average age 21 years old) more receptive to learning using games than female ones?

1.3 Publications

This section provides a general overview of the main publications related to this thesis:

Paper I

This paper is focused on the technical infrastructure developed to support the delivery of the game-based learning activities for the delivery of virtual patients in Second Life®. The Component-Based System (CBS) developed as a three-tier architecture is explained. The CBS was designed to accommodate three types of users (designer/programmer, learners and academics). The Heads-Up Display (HUD) developed to keep learners informed of their progress is also explained in this paper.

Paper II

In this second paper, the pedagogical framework followed for the design of the game-based learning activities is explained (De Freitas and Oliver, 2006), as well as other considerations that look at emergent narratives and modes of representation (Helmer, 2007; Begg et al. 2005; Murray’s, 1997; Gee, 2003). The game-based learning activities are then described following these principles. This paper also presents the methodology used to assess learners’ attitudes towards game-based learning by measuring four components (affective component, perceived usefulness, perceived control and behavioral components) following the survey ‘My feelings when playing games’, developed by Bonnano and Kimmers (2008). One group was given access to the game-based learning activity for a virtual patient in the virtual Respiratory Ward. The other group was given access to the same content, covering the same virtual patient but delivered as an interactive self-guided online module. Discussion is organised around the four major attitudinal components, and the statistical significance of some of the statements in relation to the pedagogical implications.

Paper III
This paper discusses the study described in Paper II exploring in more detailed gender-related attitudes towards game-based learning in Second Life®. This paper also draws on three recent studies to furthermore explore gender related issues in computer and video game play. This paper argues that gender gap in gaming and learning is becoming less analytically significant, and in conjunction with that, game experience is a variable concept that ought to be viewed in a more inclusive perspective in relation to game genre, gender and age. It is important to maintain a holistic view of game play, looking carefully at how game players are classified and how game genres are used by different gender and age groups.

Chapter 1

This chapter describes the use of the Nominal Group Technique (NGT) to assess students’ attitudes to game-based learning in the delivery of virtual patients in Second Life®. The NGT was used as an alternative to Focus Groups. The NGT is a highly structured group process that is used to generate prioritised list of responses to a question or problem (Delbecq et al, 1975; IoM, 1985). A primary purpose of the NGT is to ensure that opinions of all participants receive equal representation (Hall, 1983). The research question posed was: “In your opinion what are the advantages and disadvantages of learning in Second Life® compared with other methods?”. Thirty items were generated in each group, and then reduced to 10 items. These were classified into 3 themes 1) learning experience 2) clinical exposure and 3) technical experience. Results from the first group focused on the learning experience highlighting its importance for clinical diagnosis and a structure for learning. The second group focused on the clinical exposure although they were ambivalent about the advantages of this type of delivery mode.
2. Background

2.1 Pedagogic principles underlying the development and delivery of virtual patients

The delivery of virtual patients following a game-based learning approach is part of a clinical Blended Learning programme for medical students at Imperial College London. The Blended Learning programme has been developed following the Blended Learning Design Tool: BLEnDT© (Toro-Troconis, 2011), which will be explained in more detail later on in this section.

According to BLEnDT©, the clinical Blended Learning Programme can be best delivered following a combination of Collaborative/Constructivist as well as Self-guided/Instructionists activities. In order to accommodate the wide range of academic activities and pedagogic approaches for the delivery of this clinical programme, the Conversational Framework (Laurillard, 2010) has been put into practice. The Conversational Framework (Laurillard, 2010), covers a wide range of pedagogic models which seem to fit such a challenging programme.

The virtual patients delivered via Second Life® are part of this clinical Blended Learning programme. The evaluations carried out as part of this study have only concentrated on the delivery of the virtual patients and not on the programme as a whole. However, this section will explain how the delivery of virtual patients fits within the delivery of a major clinical Blended Learning programme discussing the different pedagogic principles and theories underpinning it.

2.1.1 Blended Learning

According to Beetham (2007), new technologies expose some aspects of teaching which were previously taken for granted. Blended learning is the approach that combines e-Learning technology with traditional face to face instructor-led teaching.

According to Oliver & Trigwell (2005), the term ‘blended learning’ is widely used as a description of particular forms of teaching embedding the use of technology. Whitelock & Jelfs (2003) provided three definitions:

- blended learning combines the integration of traditional learning with web-based online approaches;
- blended learning is the combination of media and tools embedded within an e-learning environment; and
- blended learning is the combination of a series of pedagogic approaches, irrespective of learning technology use.

A combination of some of the definitions explained above will be used in this thesis. Therefore, for the effects of this thesis, Blended Learning is defined as:

‘a combination of traditional face to face learning with self-paced online learning with facilitator support and peer collaboration’.
The Blended Learning Design Tool: BLEnDT© (Toro-Troconis, 2011) has been used to identify the best Blended Learning model for the clinical Blended Learning programme mentioned before. BLEnDT© maps the learning outcomes of the learning activities to Bloom’s Taxonomy of Learning Domains (Bloom, 1956). This taxonomy provides a system to enable learning objectives to be planned and measured properly.

Bloom’s Taxonomy describes the three domain structure:

- **Affective domain** focuses on feelings, emotions and behaviors, i.e. attitude (Krathwohl, Bloom, Masia, 1964).
- **Psychomotor domain** which focuses on manual and physical skills (Simpson, 1972; Dave, 1975; Harrow, 1972) and
- **Cognitive domain**, which focuses on intellectual capability, i.e. knowledge (Bloom, 1956; Anderson et al., 2001).

The emotions such as feelings, values, appreciation, motivations and attitudes are related to **Attitude (Affective Domain)** (Krathwohl, Bloom, Masia, 1964). Learning activities that focus more on the **Psychomotor Domain (Skills)** include imitation, manipulation, precision, articulation and naturalisation (Dave, 1975).

In order to be more explicit in the discussion about the learning activities that focus more on **Knowledge development (Cognitive Domain)**, a newer adaptation of Bloom taxonomy will be used (Anderson et al., 2001). It is the refined work of one of Bloom’s former students, Lorin Anderson. The Knowledge Dimensions described by Anderson et al. (2001) will be used to simplify the process of classifying the learning activities that best fit the **Cognitive Domain**.

- **Factual Knowledge**: this dimension refers to essential facts, terminology or elements learners must be familiar with to understand a discipline: retrieving, recalling or recognising.
- **Procedural Knowledge**: refers to knowledge that helps learners to perform something specific to a discipline or subject. It refers to methods of enquiry, techniques and particular methodologies: distinguishing, differentiating, organising, executing, implementing.
- **Conceptual Knowledge**: refers to knowledge of classification, principles, models, structures related to a discipline: interpreting, classifying, summarising, inferring, comparing, explaining.
- **Metacognitive Knowledge**: refers to the level of reflective knowledge gained which allows learners to solve problems and cognitive tasks: assessing, critiquing, reorganising, generating, planning, producing.

The different levels of the Cognitive Domain explained by Anderson et al. (2001), show how learners can move from the low end of the domain, being able to just remember or recall **Factual Knowledge** and differentiate and organise information (**Procedural Knowledge**), to high levels of the domain where learners not only can remember facts and differentiate information, but they can also explain and interpret information (**Conceptual Knowledge**), gaining the highest level when they can generate their own ideas, be critical about the information and produce new information (**Metacognitive Knowledge**).

According to the BLEnDT© framework, the **Blended I** approach is encouraged when there is a perfect match between the Cognitive, Psychomotor and Attitudinal Domains. **Blended II** approach reaches higher Cognitive and Attitudinal development levels. This means learners would need more active collaborative environments following a *Constructivist* approach in which they have both the means and the opportunity to develop high level cognitive and attitude levels. Collaborative environments can
be delivered either face to face or online as long as it promotes active participation and discussion among the learners. **Blended III** is applied to learning through experience, to training programmes that tend to focus more on the Psychomotor Domain (skills) and on the low end Cognitive Domain (factual & procedural knowledge) following an *Instructionist* approach. Blended III model suggests the use of online self-guided learning materials to achieve the learning outcomes (See Figure 2).

![Figure 2. BLEnDT© Blended Learning Design Tool](image)

According to the learning outcomes identified within the clinical Blended Learning Programme and the Learning Domains where they fall into, the BLEnDT© framework suggests the use of the **Blended I** approach for the delivery of the learning outcomes related to the delivery of this clinical programme.

This means the implementation of the virtual patients following a game-based learning approach are part of a blended model that encourages a *Constructivist* and collaborative environment in which knowledge can be constructed. It also supports the use of self-guided learning activities to target low end cognitive skills as well as psychomotor skills. The following sections will explain further the pedagogic principles highlighted in this section providing a more detailed explanation about the principles and theories underpinning the development and delivery of the game-based learning activities for virtual patients as part of a bigger Blended Learning model.

### 2.1.2 Pedagogic principles

Different pedagogic principles have been evolving from over a century. They have always been focused on what it takes to learn, addressing the complexity of cognition (Dewey, 1938). This section will concentrate on the following main areas: Behaviorism: *Instructionism*; Cognitive Development: *Constructionist* & *Constructivist* Learning Environments, *Socio-cultural and collaborative learning*; *Activity Systems*; Reflective Practice (Kolb’s cycle) and The Laurillard Conversational Framework.
Behaviorism

Behaviorism originates in the early 20th century when it was thought human activity or learning could be explained by analyzing the behavior of animals. The learning model was refined with the studies carried out by Pavlov (1927) focused on the effect of conditioning. He used experiments with dogs to demonstrate the hypothesis linking a sound with the provision of food which caused salivation in the dogs. The repetitive exposure to this condition made the dogs to salivate.

Watson (1930) was another person working in this field. He thought that sensations, feelings and instincts were not linked to the process of learning. He concentrated on what the ‘subject’ was doing in response to the stimulus rejecting the concept of memory. He believed responses were due to learning and therefore, we respond when we are confronted with the stimuli again.

These theories early developed by Pavlov (1927) and Watson (1930) were criticized as they only concentrated on mechanics analyzing human behavior as a consequence. However, as Reece & Walker (2007) mentioned, stimulus-response is quite a powerful action as well as the effect of conditioning.

The behaviorist learning theory suggests we learn by receiving a stimulus that consequently produces a response. Behaviorists not only see the theory applied to low level cognitive tasks or psychomotor skill learning, they consider the theory of behaviorist learning as the basis of attitudinal learning as well, highlighting for example how appreciation of music can be achieved as a consequence of a stimuli-response cycle (Reece & Walker, 2007).

Instructional System Design (ISD) derives from the Behaviourist perspective, although focusing on task analysis (Mayes & De Freitas, 2004). ISD principles have been widely accepted by the organisation training culture. The most prominent are the instructional theories of Gagné, Merrill and their successors (Gagné 1974, 1985; Merrill, 1991; Reigeluth, 1983). The principle is that competence in complex tasks is built sequentially from simpler units of knowledge and skills, which as a consequence, add co-ordination to the whole structure (bottom-up approach). The Blended III approach described previously falls under this category concentrating on learning through experience following an online self-guided instruction.

Cognitive Perspective

While Behaviorists focus on the task and the stimulus-response approach, the Cognitivists, on the other hand, focus their attention on how students gain and organise their knowledge (Reece & Walker, 2007). Dewey (1938), highlights the process of learning is not just doing something but reflecting and learning from it.

Constructionist and Constructivist Learning Environments

Constructionism emphasises the importance of constructing a model or object as part of the learning process. Constructionism theory of knowledge was derived from Piaget (1970), but coined by Papert & Harel (1991). It is based on the assumption that learners construct their concepts through active and personal experimentation and observation, rather than following a passive approach copying and absorbing ideas from the external world. Constructivism applies the general principles of constructionism into social settings in which teachers identify learners’ current ideas in order to modify or leave them before they can construct new meaning. The process of understanding and constructing knowledge becomes an active and continuous process (Driver & Bell, 1985). The origin of social constructivism is largely attributed to Vygotsky (1962).
**Socio-cultural and collaborative learning**

*Socio-cultural learning* is derived from the work of Vygotsky (1962) and Wertsch (1985) focusing on the importance of discussion as part of the process of learning in which communication technologies are used. Vygotsky in his book *Thought and Language* (1962) explains the connection between inner speech and oral language in connection with the development of mental concepts and cognitive awareness. *Collaborative learning* has its roots on the work developed by Piaget (1970) and Vygotsky (1962). It combines the construction elements of the learning process as well as the social aspect of it using integrated technologies to support the process (Dillenbourg, et al., 1996).

**Activity Systems**

According to De Freitas and Oliver (2006), different studies show how popular different theories for supporting learning with technology include the use of Activity Theory (Kuutti, 1996). Activity Theory focuses on the *activity system*, rather than on the individual learner (Kuutti, 1996). It derives from Vygotsky (1962), focusing on the importance of discussion as an aspect of learning. An activity takes place when tools are used for a purpose within an activity system. The key connection is between the individual participant and the activity system’s purpose. This relationship is not direct, but is mediated by tools, and participants are usually part of communities in which rules mediate their relationship for acceptable interactions (Mayes & De Freitas, 2004).

The Pedagogic Framework developed by De Freitas and Oliver (2006), used in the design of the game-based learning activities discussed in this thesis, presents a close relationship with Activity Theory. This is also the case for many other contemporary models of learning with technology (De Freitas & Oliver, 2006). Table 1 maps the relationship between the four dimensions of the Pedagogic Framework (De Freitas and Oliver, 2006) and the systems of Activity Theory (Kuutti, 1996).

<table>
<thead>
<tr>
<th>The four dimensions (De Freitas &amp; Oliver, 2006)</th>
<th>Activity Theory (Kuutti, 1996)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1</strong> Context: where play/learning takes place is a critical factor for the use of e-learning tools. It includes, for example: access to tools, tutor’s background and access to technical support.</td>
<td>Community &amp; Division of labour</td>
</tr>
<tr>
<td><strong>2</strong> Learner specification: may include the age and level of the group involved in the learning activity, learning styles and preferences.</td>
<td>Subject</td>
</tr>
<tr>
<td><strong>3</strong> Modes of representation: may include the mode of presentation, the interactivity, levels of immersion and fidelity within the game.</td>
<td>Tools</td>
</tr>
<tr>
<td><strong>4</strong> Pedagogic approach: refers to the different models and theories that will underpin the learning activity.</td>
<td>Rules &amp; Object (through intended learning outcomes)</td>
</tr>
</tbody>
</table>

*Table 1. Relationship between the four dimensions of the Pedagogic Framework (De Freitas & Oliver, 2006) and the systems of Activity Theory (Kuutti, 1996).*

Paper II explains further the development of the game-based learning activities following the Pedagogic Framework developed by De Freitas and Oliver (1996), which focused on the systems of Activity Theory.
Reflective Practice

According to Schön (1983), reflective practice is:

"the capacity to reflect on action and so as to engage in a process of continuous learning".

Reflective Practice becomes very relevant in learning settings where individuals are learning from their own professional experiences. Reflective Practice is centered on the idea of lifelong learning. This is the case, for example, of health professionals who are confronted with complex and ever changing learning environments (Hendricks, Mooney and Berry, 1996). The concepts underlying Reflective Practice were originally introduced by Schön (1983). John Dewey was the first author to write about Reflective Practice with his concepts of experience, interaction and reflection (Dewey, 1933).

Kolb (1984) is another author who wrote about Reflective Practice. He states his cycle of experiential learning maintains the view that we learn through experience, but only if we process that experience and make sense of it (transformation of information into knowledge). According to Shields, Aaron and Wall (2001), the transformation of information into knowledge after a situation has occurred happens when the practitioner reflects on the experience gaining a general understanding of the situation and then testing the general understanding when a new situation occurs. In this way, the knowledge that is gained from a situation is continuously applied and reapplied building on prior experiences and knowledge.

The Laurillard Conversational Framework

Laurillard’s conversational framework (Laurillard, 1993, 2002, 2010) has been very influential in the development of e-learning within the Higher Education sector in the UK. The framework integrates several theories of learning such as the ones explained above: Behaviorist: Instructionism, Constructionist and Constructivist learning, Social-cultural and collaborative learning, etc. Its representation is based on Pask’s analysis of learning as a form of conversation (Pask, 1976). According to the framework, the learner’s conception and the way they apply it in practice will develop through interaction with: the teacher, their own practice, debate with their peers, and comparison of their own practice with that of their peers (Laurillard, 2010).

According to Laurillard (2010), two contrasting levels can be identified: the Conceptual: discursive, allows discussion and articulation of the theory, ideas, concepts and forms of representation. The Practice: experiential allows experimentation, acting on the world and practicing on goal-oriented tasks. These two levels of operating must be connected for learning to take place and it is where the adaptive and reflective aspects of the learning activity are found. Actions are adapted in the light of understanding, and reflection on practice informs theory or concept development. Laurillard stresses the need for meaningful extrinsic feedback from the teacher in terms of right/wrong comments, new materials or a different task. Intrinsic feedback is also stressed. It informs the learner about how close he/she is to the goal, or what the effect of their action is.

2.1.3 Blended approach in the delivery of virtual patients following the Conversational Framework

This section will concentrate on explaining The Laurillard Conversational Framework mentioned before (Laurillard, 2010), applied to the delivery of the Blended Learning Programme supporting the delivery of academic and clinical teaching for undergraduate medical students at Imperial College London during their first clinical year (Year 3).
As explained before, two contrasting levels can be identified within the Conversational Framework (Laurillard, 2010): Conceptual: *discursive* and Practice: *experiential*. These two areas refer to the delivery of concepts and theories (*Conception*), at the top level, and the application of that theory and concepts in (*Practice*). According to Laurillard (2010), these two elements must be connected for learning to take place and that is where the *adaptive* and *reflective* aspects of the learning become relevant. Interaction is a key element for the development of learner’s *Conception* and the way they apply it in *Practice*. Figure 3 shows several interactions taking place between learner and teacher, the learner’s own practice and the learner with their peers (Laurillard, 2010).

Figure 3 highlights the activities that take place in the delivery of this *Blended I* approach during the clinical Blended Learning programme. Each of the interactions identified either at *Conception* or *Practice* levels are explained in detailed below bringing in and discussing the different pedagogic principles discussed before.

It is important to highlight section IIa specifically, since this section refers to the delivery of the game-based learning activities for virtual patients developed in this thesis.

**Steps in the application of The Conversational Framework (Laurillard, 2010) in the delivery of a clinical programme**

I. **Delivery of Conception: discursive (first phase)**
   a. A traditional face to face lecture is delivered covering basic concepts about the topic of Respiratory Medicine. The students are informed about the different interactive online modules available via the Virtual Learning Environment.
   b. The students have 2 weeks to complete the interactive e-modules and communicate their questions with the lecturer via the online Forum.
   c. Students exchange ideas about the concepts with other peer students, questioning and offering ideas via the online forum.
   d. The lecturer is able to assess the students’ level of understanding from the questions posted as well as the formative assessment available.

*Instructionist* principles are represented in this section with the delivery of concepts using self-guided learning materials. At the same time, *Socio-cultural* and *collaborative* principles are put into practice in steps Ia, Ib, Ic and Id when teachers and learners communicate and reflect using online collaborative tools such as online Forums.

II. **Delivery of Practice: experiential**
   a. The students are given access to the virtual patients in the virtual Respiratory Ward in Second Life® receiving *intrinsic feedback*.
   b. The students then interact with real patients at the clinical sites guided by clinical tutors receiving *extrinsic feedback* from clinical tutors, patients and peer students.
   c. Students and peers reflect on feedback received and adapt their practice.

The concepts of *Reflective Practice* (Kolb’s cycle) are represented in the steps: IIa – IIc, when the students learn from their own practice, gaining a general understanding about the management of different medical conditions.
It is also important to mention the *Social-cultural and collaborative aspect* of the interactions between students, real patients, virtual patients, tutors and peers. This is a very important aspect of this Blended Learning model. The collaboration and dialogue that takes place and develops between them help students put into practice their concepts at *Practice* level receiving important feedback.

According to De Freitas: ‘*games need to be embedded into practice to ensure effective learning*’ (De Freitas, 2006, p. 7). In the case of the virtual patients, the students are asked to access the virtual patients in Second Life® following the game-based learning approach developed. This helps the students gain a better understanding about the different Respiratory conditions and practice their diagnosing skills in a safe environment receiving *intrinsic feedback* within Second Life®.

At the moment of students getting into contact with real patients suffering from Respiratory conditions, the students are able to relate what they have learned, receiving *extrinsic feedback* from students, real patients, tutors and peers helping them develop knowledge at higher levels of the Cognitive Domain. Further discussion about the effectiveness of the delivery of the virtual patients in Second Life® will be discussed later on in this section. The studies carried out as part of this thesis show interesting findings in this area.

### III. Delivery of Conception: discursive (second phase)

a. Once the students have completed the two online weeks on Respiratory Medicine, as well as participated in their clinical attachment, the students attend a second and final face to face session.

b. During that face to face session the lecturer adapts the teaching session according to the students’ needs reflected during those two online weeks. The lecturer makes use of Personal Response Systems ‘*clickers*’ to assess students’ understanding during that face to face session, adapting once again the content of the lecture to the needs of the students at the time.

It is worth highlighting in this section the concept of *Constructivism* previously discussed. The teacher in this case, identifies the learners’ needs and their current ideas about Respiratory Medicine, based on the questions discussed during the two online weeks via the online Forum. The teacher then uses the ‘*clickers*’ to guide even more the development and consolidation of new knowledge among the students.
The Conversational Framework (Laurillard, 2010) has demonstrated to be very effective in the implementation of a clinical Blended Learning programme, bringing together different pedagogic principles and the use of virtual patients for intrinsic feedback. However, the evaluations carried out as part of this research show that the game-based learning activities developed in Second Life® for the delivery of virtual patients have followed a very linear approach, making the learning opportunities less challenging to students, targeting low end Cognitive skills (Paper II, Chapter I).

Although the Blended Learning model discussed (Laurillard, 2010), offers a robust learning framework in which high Cognitive skills can be targeted and knowledge can be developed, the fact that the virtual patients developed in Second Life® are not targeting the levels of engagement required, can be seen as a major drawback as part of the intrinsic feedback received within the Blended Learning model used.

Different principles of gameplay were indeed used in the development of the virtual patients in Second Life®, as it has been discussed in detailed in Paper II. However, although learners were stopped by triggers, such as having to wash his/her hands before talking to the patient, the learner always followed the same path to complete the virtual patient case (patient history, differential diagnostic, investigations and final diagnostic).
As Begg et al. (2008) discussed, the use of branching virtual patients in comparison to linear ones, allow decision-dependant emergent narratives, supporting a wide range of cognitive activities being sufficiently effective as a learning tool in the healthcare sector. He argues that when accessing sequential virtual patients (linear virtual patients), the competence tested is mainly at the low end of the Cognitive Domain. As learners progress through clinical years, they are expected to develop and apply a high degree of cognitive abstraction, therefore, moving more into higher levels of the Cognitive Domain. At this level is when branching virtual patients can shift the emphasis allowing the learner to steer the cases being in a self-directed and reflective position (Begg et al, 2008).

According to Murray (1997) emergent narrative is one of the key principles in good game-design. The progress of the story should be defined by the choices learners make. Another principle discussed by Murray (1997) is related to the responsive environment. Learners’ choices should not be limited to one right path. Begg et al. (2008) pointed out the fact that when a learner takes a path that prompts to several deviations without resulting in a termination point, the learning environment will prove to be more engaging and responsive.

These two aspects related to emergent narrative and the responsive environment (Murray, 1997) were not fully put into practice in the development of the game-based learning activities for virtual patients in Second Life® showing as a consequence mayor weaknesses. This came out strongly at the Nominal Group Technique (Chapter I). Further discussion on this topic will be expanded later on in this thesis.

Two other definitions are also worth explaining further. These are the concepts of game-based learning vs. game-informed learning. According to Begg, Dewhurst and Mcleod (2005), the term ‘game-based learning’ is a general term used when curriculum content is embedded in games. On the other hand,

‘game-informed learning suggests that educational processes should be informed by the experience of game’

(Begg, Dewhurst and Mcleod, 2005, p.1)

In game-informed learning, the learner needs to be engaged in a learning environment where reflection is encouraged and supported (Begg, Dewhurst and Mcleod, 2005). It can be said that when delivering virtual patients in Second Life® as a stand-alone activity –as it was evaluated in this study, the learning activity can be classified as a game-based learning activity. On the other hand, a game-informed learning approach can be found when the use of virtual patients in Second Life® were embedded as part of the clinical Blended Learning programme explained before.

2.1.4 Motivations for playing games

According to Aldrich (2005), people learn better when they don’t know that they are learning, being this the reason for using game-based models. Motivations for playing games has been discussed in almost all the publications in this thesis. The Flow Theory (Csikszentmihalyi, 1991), has been the main theory used to describe motivations for playing games. The Flow Theory is based around the relationship between challenge and skill. According to this theory, arousal will increase as a task becomes more challenging but performance and enjoyment will depend on the level of skills. If the level of skill is higher than the challenge presented, the learner will be bored. If the challenge is higher than the level of skill, the learner can become anxious.
According to Squire (2003), motivation is driven by a series of games components, such as character traits, game rewards, obstacles, game narrative, competition and opportunities for collaboration with other players. Only a Game (2005) points out a series of rewards that play an important role when driving motivation, e.g. currency rewards, rank rewards, mechanical rewards, victory, etc.

The other aspects of how rewards are designed are the way the delivery of the rewards is structured. For example: the information may be delivered using the following schedules: fixed, variable, fixed interval, etc. These rewards and schedules are explained further in one of the further publications (Toro-Troconis et al, 2010).

As it was mentioned before, the virtual patient activities followed a linear approach. There were not enough actions (challenges) leading to consequences that encouraged the learners to carry on playing the game or accessing different virtual patient cases. Therefore, from the Flow Theory point of view (Csikszentmihalvi, 1991), the relationship between the challenge presented by the virtual patient cases and the learners’ level of skill was not matched, making the learners feel the learning activity was too predictable and therefore boring.

2.2 Virtual worlds

Several authors discuss the advantages of virtual worlds as places where learners can meet and interact in collaborative learning spaces, fitting a wide range of areas, such as: tourism, business and education (Livingstone, 2007; De Freitas, 2008).

The popular Multi-User Dimensions/Dungeons (MUDs) and Multi-Object Oriented MUDs (MOOs) were the first virtual worlds to appear in the early 1970s. Multi-User Dungeon also known to former players on CompuServe as British Legends was developed in 1975. It is the world’s oldest virtual world which can still be played (British Legends, 2005). These environments had the characteristics of modern virtual worlds except they were text-based. They provided the foundations for the development of modern online communities that are supported by 3D spaces. Following these social text-based communities emerged the first virtual world which used graphics and avatars. Lucasfilm’s Habitat, came out in 1985 and supported its online community for six years.

The transition that took place between those virtual worlds developed in the 1970s and the virtual worlds developed in the 1980s can be attributed to the increased broadband and graphics capabilities and higher PC specifications available in personal computers. Currently Massively Multiplayer Online Role Playing Games (MMORPGs), or Massively Multiplayer Online Games (MMOGs), have been used and are the most widely used examples of 3D environments. Some examples of these include: Everquest, Guild Wars, Lineage, Lineage 2 and World of Warcraft.

Current MMOGs are not designed to accommodate and support formal education. However, according to De Freitas, 2008, some studies have indicated the use of these leisure games for educational purposes.

Virtual worlds, games and social networking worlds offer similar capabilities making difficult to identify boundaries between them. For the purpose of this thesis, we will focus only on open-ended social virtual worlds which support social networking, live chat and offer authoring tools which allow users to collaborate in building 3D virtual worlds. These virtual worlds have been very popular among educational institutions in the UK, as well as many other universities across the world, particularly in...
USA and Northern Europe (Molka-Danielsen & Deutschmann, M., 2009; Wankel & Kingsley, 2009; De Freitas 2008; Kirriemuir 2009). Examples of these worlds include Second Life®, Active Worlds Educational Universe, There.com and OpenSim.

Second Life®¹, created by Linden Lab in 2003, is a free 3D virtual world where individuals can interact, learn, socialize, shop, and play represented by ‘Avatars’. Users are taken or ‘Teleported’ when they first login to the Second Life® Welcome Island where basic navigation, communication, and interaction guidelines are provided. Different actions can be programmed and assigned to different objects offering different ways of interacting with users, e.g. via text based ‘notecards’, video and audio. In November 2010, 21.3 million accounts were registered, although there is no prove of long term accounts among those. In May 2010 concurrent users averaged about 54,000².

‘Second Life® demographics show that 83% of the population is 25 years or older, with the users over 44 years of age being the heaviest users on average. There is a close to even gender split among residents (57% male, 43% female), and more than 55% of the SL citizens come from outside the United States.’³

Second Life® was identified as the best social virtual world for the development of the game-based learning activities for virtual patients when the study was initiated back in 2006. Second Life® offers a wide range of tools for developing new content as well as a scripting language that allows developers extend the functionality within this social virtual world.

‘This feature extends Second Life® from a platform suitable for constructivist learning to one in which it is readily possible to build constructionist (Papert & Harel, 1991) learning experiences’. (Livingstone, 2007, p. 186)

A large number of regions have been developed in Second Life® in the area of medicine (Meskó 2007):

- **The heart murmur simulation:** this simulation was an early example of the potential of Second Life® as a game-based learning platform, which very much inspired the work presented in this thesis. This region was built by Jeremy Kemp, the host of SimTeach, a community for educators using virtual environments.

- **Virtual hallucinations:** This Second Life® region focused on the psychoses of actual patients. It was created by Dr. Peter Yellowlees, Professor of Psychiatry, and colleagues at the School of Medicine at the University of California to help medical students appreciate what it is like to have schizophrenia.

- **The sexual health region:** offers opportunities to test knowledge of sexual health through quizzes and games, web resources integrated within the virtual context and live seminars on sexual health topics.

- **Indiana University's School of Medicine** developed a virtual clinic for medical student training using chat-enabled patient simulations for learning medical microbiology and infectious disease medicine. It provides training on diagnosis, laboratory medicine and problem solving.

¹ Second Life. http://tinyurl.com/9pg98s
The Virtual hallucinations region and the heart murmur simulation were particularly inspiring when this study was initiated. The way a badge has to be worn when accessing the hallucination room in order to interact with the environment and receive feedback was particularly useful at the moment of designing the Imperial College badge and later on the Heads Up Display (HUD). The heart murmur simulation was very useful to conceptualise how the virtual patients were going to interact with the learners.

Another relevant and important project that has been going on for a long time in the area of medical education in virtual worlds is the Australian project Pharmatopia developed by Monash University. Pharmatopia features the development of an interactive virtual laboratory in Second Life® in which tablets can be produced. According to the Pharmatopia team this simulation provides a real laboratory environment to learners making the learning experience more effective by reducing the exposure time required when producing the tablets in a safe environment⁴.

There have been two other projects worth mentioning in the area of medicine that focused on simulating hospital activities. The first project is the UK project called Second Health⁵. Second Health was created by the Department of Biosurgery and Surgical Technology at Imperial College London. They created a virtual hospital with a series of documentary films showcasing different healthcare activities. The second project is the Palomar West Hospital⁶. The real Palomar West Medical Campus in San Diego offers tours of the hospital to visitors and information about the technology being used.

It is also worth highlighting other regions in Second Life® mainly focused on the exploration and provision of information using the tools available in Second Life®. These are:

- The gene pool, which provides quizzes, animations and the possibility of wearing different chromosome textures and
- The virtual neurological education centre which has been developed as an experiential learning environment for an identified community and health care professionals.

Another development in Second Life® which is worth mentioning is the PIVOTE application. This application was developed as part of the PREVIEW: Problem Based Learning in Virtual World project (Conradi, 2008). PREVIEW was a UK project funded by the JISC: Joint Information Systems Committee. Its main aim was to develop paramedic assessment scenarios for St George’s Hospital, University of London. The UK based company Daden Limited was charged with the development of such virtual environment for the PREVIEW project and that is how the PIVOTE application was initiated. The authoring environment of PIVOTE has evolved becoming an authoring environment that fits the design of complex scenarios in virtual worlds (Burden & Jinman, 2011).

The PIVOTE Editor is a powerful web-based application that allows the development of branching cases enabling nodes definition, links to asset nodes, identification of variables, rules, etc. The ability to author branching cases is a key advantage presented by this web-based application in comparison to the Imperial College virtual Editor which can only author linear cases. A more detailed discussion about the PIVOTE application and the Imperial virtual application developed for this study can be found in (Paper I).

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⁵ Second Health. [http://tinyurl.com/6sxu337v](http://tinyurl.com/6sxu337v)
⁶ Palomar West Hospital. [http://tinyurl.com/5uvrdzj](http://tinyurl.com/5uvrdzj)
According to Livingstone (2007), two major studies also apply a game-based learning approach in which game-like quests are given to learners to complete. These studies which have been developed in the virtual world *Active Worlds* are Quest Atlantis (Barab et al., 2005) and RiverCity (Dede et al., 2004). As Livingstone (2007) points out, the effects of the simulation provided in these game-based learning environments can be compared to those present in real worlds combining opportunities for action and reflection as the ones required for experiential learning (Kolb, 1984).

It is also worth discussing a bit more about OpenSim. According to the leading OpenSim developer Adam Frisby:

‘OpenSim is not itself a virtual world but code designed to run virtual worlds. By his analogy, OpenSim is to virtual worlds what Apache is to websites. The Apache webserver is not a website but ~50% of the websites online are running Apache.’

(Wagner, J., 2008, p. 1)

IBM and Linden Lab are working to make Second Life® and OpenSim interoperable. OpenSim was not available when this study was initiated. OpenSim was first released in 2009.

### 2.3 Virtual patients

As it was explained before, when describing the Conversational Framework and its applications within the clinical Blended Learning programme, the two areas: *Conception* and *Practice* need to be connected for learning to take place (Laurillard, 2010).

Begg et al. (2008), also highlights the importance of ‘the practicum’ as a way of making the learning experience connect with the real world. Begg et al. (2008) point out that in the healthcare profession ‘the practicum’ is usually achieved by organising clinical attachments in which learners can interact with senior and junior doctors as well as other healthcare professionals and their patients. However, gaining effective levels of interaction between them has become extremely challenging in the health care sector for many reasons.

‘Advances in clinical techniques and therapies have led to less invasive procedures, leading in turn to a significant reduction in the time spent by patients in hospitals. In addition, many countries are introducing directives limiting physicians’ traditionally long working hours, and this –along with growing concerns over the liabilities associated with allowing unlicensed (and therefore less accountable) students in the clinical workplace –is exacerbating the problem further.’

(Begg et al., 2008, p.1)

For these reasons is that medical simulations and other forms of connecting learners to *Practice* have been developed over the years. In the words of Piturro (2008), medical simulation covers a wide range of skills, starting from exposing future surgeons to skills development activities, such as getting the feel of handling a drill by using a block or wood to more sophisticated high fidelity simulations. According to Kneebone et al. (2006), medical simulation also encompasses the use of mannequins and actors playing the role of patients, including the use of simulated body parts in some instances. Medical simulations can also be created and orchestrated in virtual worlds including: virtual hospitals, emergency departments and surgical theatres (Piturro 2008).
‘Virtual patients’ is also another type of high-quality e-learning materials produced by schools and healthcare organisations to support clinical teaching introducing problem-based scenarios focused on clinical or/and general/community practice (Ruiz et al. 2006). The use of virtual patients have proved to be a valid and effective alternative in the healthcare profession (Pickell et al., 1986; Elleway, 2004; Zary et al., 2006).

‘A virtual patient is “an interactive computer simulation of real-life clinical scenarios for the purpose of medical training, education or assessment”.

(Elleway et. al., 2006, p. 2)

As it was explained before, virtual patients can be produced as stand-alone self-guided resources using linear or branching approaches targeting different levels of Cognitive skills. It is important to emphasis that although virtual patients support and enhance the delivery of clinical teaching, virtual patients are not supposed to replace or limit student-patient contact. This is something that was very much highlighted by the students during the Nominal Group Technique (Chapter I).

2.4 Gender

Several aspects of gender have been discussed in this research (Paper III). Games have often been described as exclusive masculine social spaces (Turkle, 1984). The main gender association of computer and gaming have been with the hacker stereotype and some authors associate games with the ‘boy’s room’ image (Weizenbaum, 1976). The gender analysis carried out in this research and further explained in Paper III, shows no significant evidence in gender differences between the students that took part in the study when learning in Second Life®. These findings are in line with other research on gender, computing and games: there is little empirical evidence today that associates games exclusively with masculine social spaces.

Other authors also claim that gender differences are no longer analytically important, highlighting the same fact in relation to access and ownership of mobile phones (Gansmo et al. 2003). Different studies focused on the use of computer and video games among British, American and Finish gamers (Pratchett, 2005; Lenhart et al., 2008; Kallio et al., 2007) were looked at and compared in Paper III. These studies give an indication on how current game studies are driving research in this field. However, it is important to highlight the fact that these studies classified gamers differently as well as game genres and age groups which makes it impossible to draw firm conclusions.

As it was pointed out by a paper produced at Stanford University, games that challenge gender stereotypes may enhance diversity in video, online and computer games. It is important to analyse sex and gender in order to influence social change and therefore allow game designers to produce dynamic representations of gender. It is also important to develop design strategies that allow games to become experiential places for changing gender norms”.

vii Video Games: Engineering Innovation Processed. Stanford University: http://tinyurl.com/6fekn4d
3. Materials and Methods

The study carried out in this research concentrated on the survey “My feelings when playing games” developed by Bonnano and Kommers (2008). Two groups were involved, one accessing a virtual patient via Second Life® and the other via an e-module. The path required to complete the virtual patients in Second Life® and via the e-module was the same. It was a linear approach first introducing the students to the Patient History, doing a Differential Diagnosis, selecting Investigations to confirm the diagnosis and then doing a Final Diagnosis. The statements were adapted depending on the groups: ‘My feelings when learning in Second Life®’ and ‘My feelings when learning via e-modules’. Paper II discusses the attitudinal components in both groups whereas Paper III discussed the attitudinal components based on gender differences. The Nominal Group Technique (NGT), was also used in this study. Chapter I discusses the NGT findings.

3.1 Survey – Papers II & III

3.1.1 Subjects

This investigation involved 42 year 3 undergraduate medical students (21 years old). The gender distribution of the respondents was 42.85% female (n = 18) and 57.14% male (n = 24).

3.1.2 Instruments

The survey ‘My feelings when playing games’, developed by Bonnano and Kommers (2008), was applied. The survey comprises 21 statements. Six statements relate to the affective component, five statements are about perceived usefulness, six statements about perceived control and four statements about behavioural components. 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. This study was approved by the Imperial College Research Ethics Committee (ICREC) in 2007.

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, whereas low gamer includes all participants who responded having played a few years ago or never.

3.1.3 Procedure

Data about gaming competence were collected at the beginning of the investigation, aiming to identify gaming tendencies among undergraduate medical students. From a Year group of 350 full-time undergraduate medical students, 118 students (34%) (average age 22 years), completed the survey. The majority of respondents (47%) were male. It is believed that the fact that these students were in their first clinical year was the main obstacle for getting higher participation in 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
thesis (Paper II). 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, to be completed
at the end of each session, which lasted 40 min each. 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 2, and those for the e-module group in Table 3.

<table>
<thead>
<tr>
<th></th>
<th>Total number</th>
<th>Total %</th>
<th>Male (%)</th>
<th>Female (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Second Life®</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low gamer</td>
<td>7</td>
<td>30</td>
<td>4</td>
<td>26</td>
</tr>
<tr>
<td>High gamer</td>
<td>16</td>
<td>70</td>
<td>48</td>
<td>22</td>
</tr>
<tr>
<td>Total</td>
<td>23</td>
<td>100</td>
<td>52</td>
<td>48</td>
</tr>
</tbody>
</table>

*Table 2. Computer and videogame player categories by gender for Second Life® group*

<table>
<thead>
<tr>
<th></th>
<th>Total number</th>
<th>Total %</th>
<th>Male (%)</th>
<th>Female (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>e-module</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low gamer</td>
<td>3</td>
<td>16</td>
<td>10</td>
<td>6</td>
</tr>
<tr>
<td>High gamer</td>
<td>16</td>
<td>84</td>
<td>53</td>
<td>31</td>
</tr>
<tr>
<td>Total</td>
<td>19</td>
<td>100</td>
<td>63</td>
<td>37</td>
</tr>
</tbody>
</table>

*Table 3. Computer and videogame player categories by gender for e-module group*

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, etc.

**3.2 Nominal Group Technique – Chapter I**

The Nominal Group Technique (NGT), originally developed by Delbecq, Van de Ven, and Gustafson for
organizational decision making and problem solving was used. The NGT is a highly structured group
process that is used to generate prioritised list of responses to a question or problem (Delbecq et at, 1975;
IoM, 1985). A primary purpose of the NGT is to ensure that opinions of all participants receive equal
representation (Hall, 1983). The NGT offers equal opportunities for each participant to express their
opinion (Carney, O. et al, 1996).

**3.2.1 Participants**

This investigation focused on two groups of Year 3 undergraduate medical students. On average,
participants were 21 years old (+/- 1.26 ). The gender distribution of the respondents was 7% female (n =
1) and 93% male (n = 13). Two sessions were held with 6 in one group, and 8 in the other.

**3.2.2 Process**

An introduction to the virtual hospital and the Virtual Respiratory Ward was given to each group of
students. The students spent 30 minutes assessing five virtual patients at the Respiratory Ward in groups
of two. The moderation of the NGT was not researcher-led which avoided domination of the leader’s
concerns rather than those of the participants. Three members of staff led the process and students were
asked to consider the following question: "In your opinion what are the advantages and what are the
disadvantages of learning in Second Life® compared with other methods?". Two sessions were carried
out with 7-8 participants in each session.
4. Results

4.1 Survey

Data about gender, 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. Chi-square or Fisher’s exact test was used to compare categorical variables between both groups (Paper II). The Mann-Whitney test was used to compare general attitude by gender for each group (Paper III). The questions were combined into groups 1–3 (disagree) and 4–5 (agree).

4.2 Attitudinal components – both groups (Paper II)

Table 4 summarises the tendency encountered in each group towards the different attitudinal components. The symbol ‘+’ shows a positive attitude, the symbol ‘-’ shows a negative attitude and the symbol ‘---’ shows a neutral attitude. This table helps summarises the attitudinal components found in each group for further discussion.

<table>
<thead>
<tr>
<th>Affective component</th>
<th>Second Life®</th>
<th>E-module</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feel less apprehensive about accessing virtual patients and felt more confident.</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>Perceptions of looking stupid in front of others when accessing the learning activity.</td>
<td>----</td>
<td>----</td>
</tr>
<tr>
<td>Hesitant to access the virtual patients thinking they can make mistakes the can not correct.</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>Perceived usefulness</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Feel skeptical about the instructional potential of the learning activity.</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>Learning using this type of activity enhance the learning experience justifying the extra effort.</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Learning using this method of delivery is a less efficient and effective learning experience.</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Perceived Control</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Feel more competent.</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>Feel much more in control of the learning environment.</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>Behavioural component</td>
<td></td>
<td></td>
</tr>
<tr>
<td>They don’t avoid learning in the learning environment.</td>
<td>----</td>
<td>----</td>
</tr>
<tr>
<td>Avoid learning if the learning environment is involved.</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>Disagree regarding their willingness to use environment for learning if they are told to.</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Totals</td>
<td>5 (-) 4 (+) 2 (----)</td>
<td>5 (-) 4 (+) 2 (----)</td>
</tr>
</tbody>
</table>

Table 4. Summary of tendency found in each group towards the different attitudinal components
The Affective Component addresses feelings of fear, hesitation and uneasiness before and after exposure to the learning tool. Members of the e-module group were less apprehensive about accessing a virtual patient via e-module than the Second Life® group, and felt more confident when accessing a virtual patient via e-module (Q1: P=0.009). Neither group seems to be affected by perceptions of looking stupid in front of others when accessing the learning activities (Q5: P=0.149). The e-module group is 100% hesitant to access the virtual patient thinking they can make mistakes they cannot correct. The Second Life® group seems more confident (17/23, 73.91%) (Q16: P=0.016). Both groups felt uneasy about learning using virtual patients in Second Life® and via e-modules (Q8: P=0.004).

The Perceived usefulness Component involves behaviors arising from beliefs about the advantage of learning in Second Life® or via e-modules. The Second Life® group was more skeptical than the e-module group about the instructional potential of Second Life® (Q13: P=0.049). Both groups considered learning in Second Life® and via e-modules as a way to enhance the learning experience justifying the extra effort required (Q6: P=0.492). Neither group agreed that learning either in Second Life® or via e-modules provides more interesting and imaginative ways of learning (Q17: P=0.0001). The Second Life® group regarded learning using that method of delivery as a less efficient and effective learning experience (Q21: P=0.0001).

The Perceived Control Component refers to feelings and reactive behaviors while manipulating technological tools. In this respect, the e-module group claimed more competence (Q15: P=0.002). However, the Second Life® group felt much more in control of the virtual environment (15/23, 65.22%) (Q7: P=0.012).

The Behavioral Component is manifested as willingness to use either learning platform for learning. Both groups claimed they do not avoid either learning platform for learning (Q4: P=0.613). In relation to avoiding learning if the use of either tool was involved (Q14 P=0.075), the e-module group was less in favor (17/19, 89.47%), compared the Second Life® group (14/23, 60.87%). Both groups completely disagreed regarding using Second Life® or e-modules only if they were told to (Q18: P=0.358). This means that they may be encouraged themselves to use either platform without being encouraged by any external party to do so.

4.3 Attitudinal components – gender (Paper III)

Regarding the Affective Component, in the Second Life® group both males and females perceive using this learning mode as an intelligent and socially accepted activity showing nearly the same median values. Males, median 20.5 (interquartile range [IQR 19-23] and females, median 20 

In relation to Perceived usefulness Component, the Second Life® group shows a weak evidence of a difference here in relation to genders (P= 0.0751); females show higher medians 14 [IQR 12-15], compared to males 11.5 [IQR 10.5 – 13]. In relation to the Perceived Control Component, there is no evidence of a difference between genders in the Second Life® group (P= 0.2878); females, median 20 [IQR 19-21], and males 21 [IQR 18-22]. There is no evidence in the e-module group neither (P= 0.2739); females, median 17 [IQR 17-18], and males 17 [IQR 16-18]. There is no evidence of a difference in the Behavioral Component between genders in the Second Life® group (P= 0.6130); females 9 [IQR 6-10], and males 10 [IQR 8-10]. There is no evidence in the e-module group neither (P= 5472); females 9 [IQR 6-9], and males 7.5 [IQR 5-9].
4.4 Nominal Group Technique (Chapter I)

Initially, 30 possible items were generated by the two groups assessing the advantages and disadvantages of learning in Second Life®, based on the question ‘In your opinion what are the advantages and what are the disadvantages of learning in Second Life® compared with other methods?’. The 30 items generated by the participants during the silent phase and subsequently ranked during the voting phase can be found in Chapter I.

Following the first round of voting, participants had an opportunity to view the voting results and express their opinions or discuss queries if it was considered some items had been emphasized incorrectly in their opinion. The discussions that preceded the first round of voting clearly influenced how individuals ultimately voted. Ten items had received final votes in both groups resulting in greater consensus (Table 5). The established items have been grouped into three main areas: learning experience, clinical exposure and technical experience.

<table>
<thead>
<tr>
<th>Suggested item (n=10)</th>
<th>Number of votes</th>
<th>Suggested item (n=10)</th>
<th>Number of votes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1</td>
<td></td>
<td>Group 2</td>
<td></td>
</tr>
<tr>
<td>Useful as reinforcement of other teaching.</td>
<td>27 L</td>
<td>Too simple to teach diagnostic skills, more complicated</td>
<td>56 C</td>
</tr>
<tr>
<td></td>
<td></td>
<td>scenarios needed, should allow you to make mistakes.</td>
<td></td>
</tr>
<tr>
<td>Integrates learning that is not covered in other way, e.g.</td>
<td>22 L</td>
<td>Chance to encounter scenarios you wouldn’t encounter in</td>
<td>47 C</td>
</tr>
<tr>
<td>breath sounds and other things not always taught together.</td>
<td></td>
<td>the hospital.</td>
<td></td>
</tr>
<tr>
<td>Very easy to use in own time, anywhere.</td>
<td>21 T</td>
<td>Not realistic, don’t practice communication skills.</td>
<td>45 C</td>
</tr>
<tr>
<td>Break from other formats of learning.</td>
<td>20 L</td>
<td>Makes you think about the tests you order.</td>
<td>43 C</td>
</tr>
<tr>
<td>Predictable – removes thought process, becomes mechanical</td>
<td>19 L</td>
<td>Wider variety of cases – bank of cases, abnormal</td>
<td>35 C</td>
</tr>
<tr>
<td>process.</td>
<td></td>
<td>presentation.</td>
<td></td>
</tr>
<tr>
<td>Structured way to learn – framework for learning.</td>
<td>19 L</td>
<td>Explanations about results – good.</td>
<td>32 C</td>
</tr>
<tr>
<td>Would be better for clinical beginners – helps structure</td>
<td>17 C</td>
<td>Scenarios – make you remember / learn better.</td>
<td>25 L</td>
</tr>
<tr>
<td>thinking.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Restrictive choice of tests/no option to add new</td>
<td>16 C</td>
<td>Can’t ask specific questions during history taking.</td>
<td>24 L</td>
</tr>
<tr>
<td>investigations (limited capacity to make mistakes).</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reduces the doctor/patient relationship and associated</td>
<td>15 C</td>
<td>Bridges gaps between lecture and hospital – framework</td>
<td>23 L</td>
</tr>
<tr>
<td>skills – antisocial.</td>
<td></td>
<td>for years prior to clinical practice.</td>
<td></td>
</tr>
<tr>
<td>Does not prepare for experiences on the ward.</td>
<td>14 C</td>
<td>Can’t see advantage over other forms of e-learning.</td>
<td>22 L</td>
</tr>
</tbody>
</table>

Items groups according to the following areas:
Learning Experience: L  
Clinical Exposure: C  
Technical Experience: T

*Table 5. Final votes during NGT - Group 1 and Group 2.*
5. Discussion

According to the summary presented in Table 4, both groups show the same results in relation to the Attitudinal Components (four positive attitudinal components, five negative attitudinal components and two neutral). These results and mixed opinions about the use of either learning environment makes it impossible to reach a firm conclusion on the general attitude of medical students in early clinical years towards the use of virtual patients in Second Life® or via e-modules when accessing virtual patients. The survey developed by Bonnano and Kommers (2008), used in this study is a useful instrument. However, in order to assess the attitudes of this group of students, a bigger student sample may be required in order to get a more realistic and representative view. This study intended to work on a bigger student sample. However, it was very challenging to register, train and run the study with a high number of students in Second Life®. That is the main reason why the sample had to be kept small in this study.

The other study carried out using the NGT gave us a better insight about the main problems the students found in relation to the delivery of virtual patients in Second Life® and how they perceived the game-based learning activity. The NGT gave students the opportunity to freely articulate their concerns and their appreciations about the learning activity. The main problem articulated by the students during the NGT was focused on the simplicity of the virtual patients narratives presented in Second Life®. The students enjoyed and felt enthusiastic about accessing the first virtual patient case due to its novelty. However, the students disengaged soon after accessing the second virtual patient case, realising the narrative involved followed the same linear approach. It is worth pointing out the students expressed a positive attitude to the learning experience in Second Life® as a whole during the NGT highlighting the fact that virtual patients delivered in this format provide a structured way of learning and a useful activity as reinforcement for other teaching.

As it was mentioned before in Section 2 of this thesis, two important aspects of good game-design: 'the emergent narrative' and 'the responsive environment', discussed by Murray (1997), which concentrate on the narrative of the game and story line were not put into practice in the design of the game-based learning activities in Second Life®. These aspects concentrate on the options the learners have to define the story by the choices they make, providing more than one correct path to follow in the completion of the activity. Although game-design principles were followed in the design of the learning activity (De Freitas and Oliver, 2006) (Paper II), the narrative or story of the virtual patients either in Second Life® or via the e-module, always followed a linear path which discouraged the students breaking their ‘state of Flow’ (Csikszentmihalvi, 1991).

A more responsive environment and the use of branching virtual patients were initially intended for the design of the Second Life® learning activities. However, the efforts of developing more complex narratives for these virtual patients imposed extra efforts at the design and implementation levels which were not feasible. The Content Matter Expert was keen on representing the majority of the most common respiratory conditions in the virtual Respiratory Ward which meant a big challenge if each of the cases was going to be developed following a branching model. The development of one branching case followed by the rest as linear cases was thought of. However, it was very complicated and time consuming to develop the technical infrastructure to accommodate the two different approaches.

Another aim at the beginning of the project was to offer students the experience of most common respiratory conditions in the virtual world which meant having to provide at least 5 different virtual patients. This influenced the development of a more sustainable model for authoring and delivering several virtual
patient cases, deviating from the main aim of the game-based learning activity in order to accomplish the development and delivery of a higher number of virtual patients compromising the quality and effectiveness of the learning experience.

The virtual patients developed in this study were intended to be used by medical students during their first clinical attachment, aiming to reinforce their clinical teaching targeting high Cognitive skills. However, as it was explained before in this thesis, when accessing sequential virtual patients (linear virtual patients), the competence being tested is mainly at the low end of the Cognitive Domain (Begg et al, 2008). The repetitive nature of games allows for practice of knowledge application but learners quickly master the knowledge level required (O’Brien, 2010). Therefore, it is suggested to offer students the opportunity to explore the virtual patients developed in Second Life® at earlier years when low Cognitive skills need to be targeted. A more competitive approach to gaming, such as using branching narratives, can be used so their command of knowledge is at the analysis level.

The delivery of virtual patients in early years should be part of a Blended Learning programme making sure the feedback received from virtual patients ‘intrinsic feedback’, is appropriately complemented by ‘extrinsic feedback’ at Practice level. The Blended Learning programme should also make sure the Concepts taught at that year level match the Practice delivered via virtual patients (Laurillard, 2010).

It is worth exploring the development of branching virtual patients in Second Life® evaluating further their effectiveness when introduced at later years of the medical curriculum. Unfortunately, the efforts required to modify the Imperial College virtual Editor in order to enable the creation of branching virtual patients is out of scope in this study and future studies envisaged by the Faculty of Medicine. It is suggested to explore the possibility of using the PIVOTE Editor discussed in (Paper I) to design, deliver and evaluate branching virtual patients. It is also important to keep track of any new evaluations related to the learning activities generated by the PIVOTE web authoring environment, specifically in relation to virtual patients, in order to assess its effectiveness in the use of this web authoring environment for branching cases in later years of the undergraduate medical curriculum.

The studies on gender and video and computer games discussed in Paper III shows interesting findings. Game play in terms of game genre as well as frequency of play seems to vary significantly between male and female players which leads to different interpretations and even contradictory views of game play among the age group studied in this thesis.

Some of the studies discussed in Paper II show a fair gender split between male and female gamers (British and Finish gamers). However, these studies also include a significant number of older people, as is the case in the Finish study. The studies discussed in Paper II give an indication of how current game studies are shaping game play research. However, in order to draw conclusions on game gender tendencies it is important to be aware of how game players are classified and how game genres are used by different gender and age groups which becomes very challenging when comparing different studies conducted using different methodologies.

The gender split among the different countries and age groups looked at in this research varies. For example, in the British study, although the lowest proportion of female gamers (44%) was found in the 15-24 year old age group, there was a fair gender split in this group among heavy, medium and light gamers. A similar tendency is found among the Finish group showing a fair gender split among the ‘Active Gamers’ group in the 15-24 age range. Contrary to these findings, the American and Imperial studies do not show a fair gender split between males and females.
The general and limited perception of gamers being younger in age, mainly male in gender and mainly ‘hardcore’ game players is challenged by these findings. Due to the variability of data and research findings in this area, it is important to keep a more holistic and inclusive view of game play. Access to gaming activities is becoming more multi-platform, therefore reaching wider groups. Access to more accessible mobile technology is having a big impact in this area as well as access to game consoles offering more collaborative and family driven gaming experiences engaging males and females from a wide age group.

A large number of medical simulations and environments have been developed in Second Life® as it was explained in the Background section of this thesis. Some of them have been limited to the presentation of information to users, some others provide a more complex and engaging learning experience as is the case of the PIVOTE project. It is believed our study was a pioneering development within the area of medical education when it was first started in 2006, which justifies why it was featured in CNN – Edge of Discovery at the time.

The development of the virtual hospital and the virtual patients in Second Life® were not only unique at the time but also the research carried out to find out learners’ perceptions was ahead of other developments and studies in Second Life®. A large number of virtual worlds were presented in Second Life® at different conferences and subject meetings. However, very little evaluation and research complemented them. This situation has changed over the years with a large amount of research on going in this area.

It can be said that this study was an inspiration for many medical education institutions when developing learning activities in Second Life®. It was the first virtual hospital at the time to deliver virtual patients activities designed following a game-based learning approach and evaluating its use using research methods.

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6. Main findings and conclusions

1. The linear virtual patients developed at the Imperial College virtual hospital target low Cognitive skills being more suited to medical students in earlier years.

2. Branching virtual patients with more complex narratives should be implemented in order to increase the challenges presented to medical students in later years targeting high Cognitive skills. The PIVOTE application discussed in this thesis and in Paper I may be used to develop these virtual patients (Burden & Jinman, 2011).

3. The delivery of ‘Intrinsic feedback’ via virtual patients following a game-based learning approach should be embedded to ensure effective learning (De Freitas, 2006). This can be achieved as part of a Blended Learning programme in which Concepts and Practice match providing a reflective and constructivist learning space (Laurillard, 2010; Vygotsky, 1962; Wertsch, 1985).

4. Males and females seem to have similar attitudes towards the use of game-based learning activities for virtual patients in virtual worlds. However, this is an area worth exploring further using a wider group and medical students from earlier years.

5. Medical students are receptive to the use of virtual patients as long as it does not reduce patient contact which they consider vital in their clinical training.

6. The virtual world of Second Life® was able to accommodate the design and delivery of the technical infrastructure for the virtual patients developed in this study. However, other virtual worlds are also worth exploring. For example, the open source virtual world ‘OpenSim’ mentioned in this thesis.

7. The pedagogic frameworks followed for the design of the game-based learning activities for virtual patients proved to offer important pedagogic guidance assisting the instructional design process of the game-based learning activities (De Freitas & Oliver, 2006; Helmer, 2007; Murray’s 1997 & Gee, 2003).

8. The ‘Heads-up-Display’ or Dashboard implemented in Second Life® was very effective in the delivery of rewards information as well as keeping learners informed of their progress.

9. For any learning activity taking place in virtual worlds, it is recommended students are exposed to the virtual world to be used for the learning experience. It is recommended at least 4 hours of exposure in the region where the learning activity will take place to ensure the students are used to the environment and therefore able to concentrate on the learning activity.
7. Suggestions for further research

Social virtual worlds offer unique opportunities for the development of multi-user game-based learning activities. The capabilities of social virtual worlds could be extended to match the collaboration opportunities already offered by MMOGs. In the area of medical education, the implementation of game-based learning to support Inter-professional activities could move the application of this technology a step forward. Social virtual worlds, such as Second Life® may offer the game-based learning environment able to accommodate and orchestrate the delivery of Inter-professional activities for different health care professions, such as: nursing, midwifery, pharmacy and physiotherapy.

The study of gender differences within social virtual worlds and MMOGs is an unexplored territory which ought to be further researched. It would be useful to study a wider range of game-based learning activities focused on different genres within the same virtual world as well as in different virtual worlds to assess any potential differences. The analysis of the application of game-based learning to other medical activities not related to virtual patients would be useful. Medical students seem to be reluctant to interact with virtual patients favoring real patient interaction. Findings from further research in this field of gender and game-based learning in virtual worlds would help identify design trends more suited to new students’ generations.

It is believed the main benefit of social virtual worlds, such as Second Life® in education will be seen once the characteristics of MMOGs are embedded and delivered via these environments. There are great challenges ahead not only in relation to developing pedagogic frameworks and guidelines for the design and delivery of game-based learning activities to support developers and learning technologists but also in relation to how these environments will provide “user friendly” and interoperable authoring environments.
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Original papers

Paper I

Paper II

Paper III

Chapter I

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Design and Development of a Component-Based System for Virtual Patients in the Virtual World of Second Life®

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Abstract—This paper presents the development of a Component-Based System structured as a distributed three-tier architecture, enabling monitoring and information visualisation of application activity as well as presentation of feedback to learners via a Heads-Up-Display (HUD) in the virtual world of Second Life®. The activities follow a game-based learning approach and take place in a Respiratory Ward in Second Life®, where learners interact with virtual patients receiving intrinsic feedback about their diagnosis, investigations and treatments. The proposed architecture developed by the authors, consists of different virtual patient components that provide the relevant personal and clinical data to the clinical scenario; a data availability model that enables the sequencing and progressive disclosure of a virtual patient identifying triggers and scaffolding information, and an activity model which encodes the activities available and how the learner will be able to engage with the virtual patients.

Index Terms— Component-based system, three-tier architecture, Second Life®, virtual world, virtual patients

I. INTRODUCTION

Virtual worlds are 3D spaces in which users interact and meet using a virtual representation of their persona in the form of ‘avatars’. The first virtual worlds appeared in the early 1970s with the characteristics of modern virtual worlds. However, all the broadband and multimedia capabilities currently offered, were not available at the time. In the 1980s Massively Multiplayer Online Games (MMOGs), such as Everquest, Guild Wars and the World of Warcraft were developed and widely used as online 3D game-platform environments.

According to Reference [10] and [4], these environments offer interactive, engaging and rich collaborative learning experiences. However, it is difficult to differentiate between virtual worlds, games and social networking worlds. For the purpose of this study, we decided to concentrate on open-ended social virtual worlds such as: Second Life®, Active Worlds Educational Universe, and There.com. These open-ended virtual worlds allow the use of video and sound for live chat and events as well as the use of online authoring tools for the construction of 3D assets within the worlds.

Second Life® was selected as the virtual world for this study in 2007 due to its growing use in UK Higher Education institutions [7], as well as for its potential for developing the Component-Based System intended.

The Component-Based System intended at the time, and later developed, manages the way learners access a series of virtual patients in a virtual hospital created in Second Life®. The design follows a game-based learning approach in the virtual world using triggers and scaffolding information to engage the learner in the process of diagnosing and treating virtual patients [18], [19], [20]. Figure 1 shows the Respiratory Ward in the virtual hospital.

Figure 1. Respiratory Ward in Second Life®
A demonstration of the activity in Second Life® can be accessed on YouTube at: http://tinyurl.com/mwpm2r and from the Faculty of Medicine e-learning website at: http://tinyurl.com/65nyeck

II. COMPONENT-BASED SYSTEM APPLICATION ARCHITECTURE IN SECOND LIFE®

Component-Based Systems (CBSs) are built using independently produced and tested components, offering a flexible alternative between standard and customised software [16]. The most common structure of client/server model in a system, assumes two discrete participants. This model is called “two-tier system”, which means the application logic resides within the client or server or shared between the two. If the application logic resides separately from the data and the user interface, the system turns into a “three-tier architecture”. According to Reference [8], in an ideal three-tier system, the user interface and the data reside separately from all the application logic. However, this does not happen frequently; usually select portions of the application logic are the responsibility of the client and/or server, and the bulk of the application logic is in the middle tier.

In the words of Reference [8], processes become more robust in the three-tier architecture, being a more advanced and flexible approach than the traditional two-tier model. New levels of autonomy are given to the application logic processes due to the separation of the application logic from the client and server. For example, in a standard web application following a three-tier system, the first tier is the user interface which reflects the interpretation of HTML by a browser. In the middle tier, resides the embedded components, such as: Java applets and ActiveXs, displayed by the browser. The final tear is represented by the data served from a web server. This is quite often a database driven system or groupware system.

Three-tier systems provide increased advantages, such as scalability: logic components can be shared across multiple clients. These systems are easier to maintain since the business logic is separate from the User Interface (UI). The UI can also be changed without the risk of altering by mistake the business logic. At the same time, the business logic can also be shared with applications with different UIs because it resides in its own tier.

In the Second Life® environment, the Second Life® client is installed on the user’s machine. The Second Life® client communicates with the Second Life® engine for catering the user responses and rendering the media assets for the user. The http Request call is established through Linden Scripting Language (LSL) from the Second Life® simulation environment in order to access the external web world. The LSL compiler takes the active role in validating the script statement before execution.

Figure 2 shows the three-tier-architecture implementation of web application for Imperial College virtual campus, interaction and call management between the Second Life® virtual world environment and the web world environment.

The web world environment, which host the web application for the Imperial College virtual campus consists of the three-tier architecture based on Model View Controller (MVC) design pattern. The MVC architecture allows for a clean separation of business logic, data, and presentation/interface logic. The model represents application data and the business rules that govern access and modification of this data. The model object notifies the views when it changes or its state is modified. A view presents the data represented by the model in a way that’s targeted at a specific type of client/interface. Views are decoupled from the business logic, so that these can be modified without any affects to the business logic or the model.

The controller performs all the authentication process, before providing a user access to the application. It is made up of many components responsible for taking data posted in an HTTP request or made by a function call and converting it into an event to update the model data. Controller is also responsible for sequencing the logical flow of actions required to extract relevant information from the model layer using one or more component invocation.

The MVC architecture is implemented through Struts Framework using Java 2 Platform Enterprise Edition (J2EE) technology. The core of the Struts framework is a flexible control layer based on standard technologies like Java Servlets, JavaBeans, Resource Bundles, and XML, as well as various open source packages. Following is a brief description of the various tiers in the 3-tier architecture of web application designed & developed for virtual medical campus:

**Tier 1 (web server):** static content such as HTMLs, media elements (JPEG, GIFs, JavaScript) are directly served from the web server. The web server forwards requests for server side components such as Java Servlets, JavaServer Pages (JSPs), and other Java classes (Action classes, Delegates, Service Locator) to the Servlet runner. Web application designed & developed for virtual medical campus uses Apache HTTP server, a well known web server which can serve HTML/ JPG and other static content but at the same time has bridge component for forwarding the JSP/Servlet request to relevant J2EE application server on a different port.

**Tier 2 (application server):** the application server is responsible for running the J2EE environment over which the Struts framework resides. It generally has a servlet container like tomcat at the minimum though commercial heavy weight J2EE application server like Websphere/Weblogic can be used. Application server is also responsible for deployment, object pooling (Activation and Passivation) of session beans, and transaction support to the session beans. The persistence layer is implemented on the application server.
Tier 3 (database): the third tier is the database, which is the central repository of all data that the system generates and queries to create the reports. Web application designed & developed for virtual medical campus uses MySQL 5.0 as database repository to store data tracked during various activities conducted by users in the virtual campus.

A. Web application development

A website service was developed as part of the web application development. The website aims to record the Second Life® activity produced by the user in the database external to Second Life® and then create a presentation layer for when the data is pulled into the different report formats. This website service helps academics and administrators keep track of the activity generated by users when accessing the virtual patients in the virtual hospital.

Figure 3 and 4 show an example of the Report module. This module offers several reporting options. For example, all the registrations to the virtual hospital till date or during specific dates can be displayed; the activities attempted by all users or specific users can be generated. This helps academics and administrators keep track of the progress made by the students when accessing the virtual patients. Investigations needed for the diagnosis of virtual patients have a cost in Linden Dollar (L$). This was designed purposely in order to ensure students think about their budgets when ordering investigations for their virtual patients. Detailed reports on all the money spent by all users or by specific users help manage the process of refunding these payments.

B. Virtual Patients’ Functionality

In order to provide a virtual environment that aims to simulate a learning process, it is important to offer all the functionality and the necessary tools and applications to its users in order to offer an efficient space for experimentation, communication and collaboration [3].

In the Respiratory Ward in Second Life®, users have the ability to interact with virtual patients suffering from different Respiratory conditions, such as: Asthma, Chronic Obstructive Pulmonary Disease, Lung Cancer, etc. These activities offer the requirements and steps that the learning process would offer in a real hospital ward scenario. Figure 5 shows a workflow with the steps required to complete a virtual patient.
(A) The user finds the ‘Virtual Patient Panel’ by the entrance of the virtual patient room. The user has to ask permission to see the patient (See Figure 6). Feedback is delivered via the Second Life® feedback panel (See Figure 7).

(B) The user must wash his/her hands before talking to the patient. For this, the user needs to ‘Touch’ the wash basin located in the room (See Figure 8). Feedback is delivered letting the user know his/her hands are clean (See Figure 9).

(C) The user can now access all the relevant information available by the patient, e.g. Patient Profile, breath sounds, etc. (See Figure 10). Patient Profile feedback is shown in Figure 11.

(D) After accessing the Patient Profile, the user can proceed to make a Differential Diagnosis (See Figure 12 and Figure 13).

(E) Then the Investigations required are purchased (See Figure 14 and Figure 15).
(F) The results of the Investigations purchased are then collected from the relevant departments which are adjacent to the virtual patient’s area in the Respiratory Ward (See Figure 16 and Figure 17).

(G) If the Investigations purchased are not sufficient to give a Final Diagnosis, the user will not be able to proceed and further Investigations will need to be obtained.

(H) Once, at least, one correct Investigation is purchased and collected for the Diagnosis of that condition, the user can then proceed with the Final Diagnosis (See Figure 18 and Figure 19).

(I) After receiving feedback about the Final Diagnosis, the user is invited to visit the Patient Management area where more information is provided about the management of that condition (See Figure 20).

C. Feedback provided via Heads-Up Display (HUD)

User performance can be greatly influenced by an active feedback system [2]. The authors recognised the need to maintain users informed of their actions with different levels of feedback, in order to provide a more rewarding user’s experience. It is extremely important to provide clear explanations that keep learners informed of their actions [9].

According to Reference [12] and [14], users have limitations in relation to memory, sometimes forgetting what they have done and not being able to perceive subtle differences. On the other hand, Reference [12] also highlights users’ strengths in relation to being able to retrieve relevant information rapidly by ways of storing
similar patterns, as well as being able to process visual information quickly.

Any CBS has different types of users at different stages during the life cycle of the application. In this particular CBS, three distinct categories have been identified according to the role they play within the application. The first user is the designer/programmer, who is in charge of the end-user application. The designer/programmer designs and develops the components and is also responsible for providing technical support. The second user is the learner for whom the application has been created. The last user is the academic, who is in charge of the learning experience, tracking learners’ responses.

The needs of each of these users are very different. Therefore, this CBS has been designed in order to accommodate the needs of these 3 levels of users:

The designer/programmer needs technical feedback from the application to record data pertaining to the user activities and present it in the form of reports. This is achieved in two parts viz. In-World feedback, and Over-Net feedback. The In-world feedback is gathered through listener object coded using LSL scripts and deposited in the virtual campus to listen In-world communication continuously on the Second Life®’s private communication channels. The listener once received the In-world feedback converts immediately into suitable Over-Net feedback. This Over-Net feedback then gets posted using http server request handler at the web service running at the web application developed for virtual campus. The web service secures the data received through Over-Net feedback into database repository for future usage and presentation.

The learner or end-user needs to receive feedback about their actions associated with the tasks being carried out. In order to provide this level of feedback to learners, a Heads-Up-Display (HUD) has been developed. Its functionality will be explained in detailed in this section.

The academic needs to keep track of the activities carried out by the learners. The Report Module explained before, provides this information to academics allowing them to produce reports about learners’ attempts per virtual patient, their actions on the patient, the money spent on investigations, their scores, etc.

“The goal of system design in many applications is to give operators sufficient information about the current status and activities, so that, when intervention is necessary, they have the knowledge and the capacity to perform correctly, even under partial failures.”

(Reference [9]. p.p 85)

The process of designing user interfaces for this CBS started with a task analysis and a detailed specification of the end users. A HUD or console was designed to keep learners informed of their progress when accessing the different virtual patients at the virtual hospital (See Figure 21).

At run time environment, the virtual patients HUD provides information, which is dynamically updated as the user accesses the virtual patients.

The list of patients available at the Respiratory Ward is presented on the left hand side. An icon with a tick ‘✓’ indicates the user has started treating that patient. An icon with a cross ‘X’ indicates the user has not attempted to treat the patient. The current progress indicates how far the user is in the evaluation of the patient.

The score section displays the score obtained by the user per virtual patient. The score is calculated depending on the correct answers obtained when giving a Differential Diagnosis and a Final Diagnosis. The top scorer section provides the name of the user who has obtained the best score for that virtual patient.

The HUD can be downloaded from the Respiratory Ward in the virtual hospital (See Figure 22). Once it has been downloaded, it is available in the inventory of the user. The user will need to access the HUD in her/his inventory and ‘wear’ it so it is available as an icon; not intruding, but always offering the possibility of obtaining feedback at any time (See Figure 23).
The HUD satisfies feedback requirements providing information about rewards, such as: rank, mechanical and victory rewards. Rank rewards let users know about their progress offering a sense of progression and completion. Mechanical rewards make users feel their actions have an effect; this is represented by the ‘Top Scorer’ section. The ‘Top Scorer’ section also offers the learner Victory rewards, giving the learner the opportunity to defeat other participants [20].

III. COMPARISON WITH PIVOTE

It is important to mention and discuss another web based authoring environment for virtual patients developed in Second Life® which provides similar functionality to the one developed at Imperial College London and discussed in this paper.

PIVOTE is an authoring system for virtual worlds that consists of 7 main elements: Exercise Definition, PIVOTE Editor, PIVOTE Player, Web Interface, Virtual World Interface, Virtual World Objects, and Student Performance Data [1]. Apart from the virtual world element the rest of the elements are developed for web using Perl CGI::Application framework.

‘CGI::Application aims to provide a framework for reusable code that is based on the run mode concept, but in a way that avoids a lot of spaghetti code. Because it is Object Oriented (OO), it can easily be extended and enhanced. CGI::Application encourages the adoption of a Model-View-Controller (MVC) framework. It includes the logic and rules that the application understands and enforces. The view is simply the user interface, and by default CGI::Application supports HTML::Template. Finally, the controller mediates between the model and the view. It takes input, passes it to the model components and invokes the view components as appropriate.’

(Reference [6], p.p 2)

The architecture of the virtual patients in the virtual Respiratory Ward in Second Life® also uses MVC architecture implemented through Struts Framework using Java 2 Platform Enterprise Edition (J2EE) technology. The core of the Struts framework is a flexible control layer based on standard technologies like Java Servlets, JavaBeans, Resource Bundles, and XML, as well as various open source packages. The main advantage of the Struts framework is its Centralized File-Based Configuration.

‘Struts values/mapping are represented in XML or property files. This loose coupling means that many changes can be made without modifying or recompiling Java code, and that wholesale changes can be made by editing a single file. This approach also lets Java and Web developers focus on their specific tasks (implementing business logic, presenting certain values to clients, etc.) without needing to know about the overall system layout.’

(Reference [17], p. 1)

The PIVOTE infrastructure uses the Medbiqitous Virtual Patient (MVP) XML format to store definition of the exercise [5].

‘The MVP specification also allows for the storage of meta-data including a description of the exercise and parameters that can be used to filter a set of exercise (e.g. in the medical case by age/sex/complaint of patient).’

(Reference [1], p.p 176-177)

However, this requires users to have knowledge of XML standards for authoring the virtual world exercise. Although the authoring of MVP cases is supported by PIVOTE text editor, a web-based application, the interface still demands the basic understanding of XML terminology from the author. The Editor also lets authors export the XML data to their hard-drive, and import XML from other authors and it supports user accounts, and sharing and editing privileges so that multiple authors can work through the same instance of the editor program.

The Imperial College virtual world web application has simple and user friendly GUI and provides an easy to use system even for the non-computer savvy users. However, the authoring environment only allows linear virtual patients to be authored.

A key advantage presented by PIVOTE in comparison to the Imperial College virtual application is evident in the functionality presented by the PIVOTE Editor. The PIVOTE editor can author branching cases allowing the creation of required nodes, linking them to asset nodes, assigning variables, etc. The Imperial College virtual application Editor only allows for linear virtual patients authoring always allowing the same path to be followed with the same links to asset nodes and variables.

The case and user tracking and performance data is stored by the Imperial College virtual application using MySQL RDBMS package. A Relational Database Management System (RDBMS) is simple and easy for users to understand and use. RDBMSs provide data access using a natural structure and organisation of the data. DBMSs feature maintenance utilities that provide database administrators with tools to easily maintain, test, repair and back up the databases housed in the system.
Database queries can search any column for matching entries using "Structured Query Language" (SQL). The SQL syntax is simple, and the use of standard English language keywords and phrases makes it easy to use [15].

The Imperial College virtual world web application provides a set of reports based on powerful SQL syntax to track the performance & usage data of the users captured from in-world activities. The data presented by the reports can be printed or exported into Microsoft Excel format for further analysis.

IV. CONCLUSION

Access to patients suffering from different respiratory conditions by undergraduate medical students is presently being challenged by time constraints as well as patients' availability during students' rotations. Feedback from consultants and clinicians is also limited. The Respiratory Ward developed in the virtual world of Second Life®, provides an interactive representation of the activities carried out in real Respiratory Wards offering medical students the opportunity to explore in a safe environment, the possibility of seeing and managing different respiratory conditions.

This paper has discussed the development of a CBS as a three-tier architecture, which accommodated the needs of the users identified within the CBS: designer/programmer, learner and academicians. The segmentation of the application into the three-tier architecture has proved to provide the functionality required to display the user interface and perform the main logic of the application and storage and retrieval of data in an effective and efficient manner.

The activities implemented have followed a game-based learning approach which has not been discussed in this paper but in other publications [18], [19], [20].

According to the different evaluations carried out as part of this study, assessing learners’ attitudes towards this type of learning using virtual patients in Second Life®, learners find the linear virtual patient activities not challenging enough [21]. Although a game-based learning approach was followed in the design of the virtual patient activities and interfaces [18], the development of more challenging 'emergent narratives' and 'responsive environment' [11], were not achieved. On the other hand, the PIVOTE authoring environment discussed in this paper allows the development of more challenging learning experiences using branching narratives which learners seem to enjoy and learn from [1].

The CBS model presented in this paper can still be recommended to simulate other learning experiences that fit a linear approach targeting low end Cognitive skills. The same level of users’ feedback can be replicated in other fields such as: business and engineering, where instead of virtual patients, other components relevant to the learning experience can be implemented. A similar data availability model enabling the sequencing and progressive disclosure of information may be implemented as well.

All the programming code used in this CBS has been released as open source, licensed under a Creative Commons Attribution-Non Commercial 3.0 License, in order to stimulate other interested parties in the development of similar applications in the virtual world of Second Life®.

ACKNOWLEDGMENT

The authors wish to thank the Faculty Education Office (Medicine) at Imperial College London for the support received during this study.

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DESIGNING GAME-BASED LEARNING ACTIVITIES FOR VIRTUAL PATIENTS IN SECOND LIFE

Maria Toro-Troconis1, Ulf Mellström 2, Martyn Partridge3, Karim Meeran4, Michael Barrett1, Jenny Higham1

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 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, 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-
ical 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 (Aarnaud, 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 pr 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 (Helmer 2007). Second Life has common community and collaborative features with recent contemporary developments such as Facebook, YouTube, Wikipedia, Moodle 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 - Cyclic 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. Cyclic 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://star.com/secondlife/Imperial%20College%20Loudon/150/8/6), 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>
<th>Learner specifications</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>
<td>• Third-year students. Average age 22 years.</td>
</tr>
<tr>
<td>• A module on respiratory medicine focused on pneumothorax will be embedded in Second Life using game-based learning activities.</td>
<td>• The game-based activities can be used by learners working singly or in groups.</td>
</tr>
<tr>
<td>• This module has already been embedded in the curriculum as part of the Year 3 e-lecture program.</td>
<td>• The virtual presence of the tutor is not required.</td>
</tr>
<tr>
<td>• Significant technical support and resources will be required during the first delivery of this module in Second Life.</td>
<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 seen in Figure 2.
**Table 2. Framework for the design of game-based learning activities – narrative and modes of representation.**

<table>
<thead>
<tr>
<th>Virtual patient section</th>
<th>Introductions</th>
<th>Scaffolding</th>
<th>Diagnostic capabilities</th>
<th>Assessment</th>
<th>Triggers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction</td>
<td>Notecards will be provided at the beginning of the case.</td>
<td>An introductory 'notebook' with the learning outcomes of the activity is provided in the reception area.</td>
<td>The time the case will be recorded as soon as the learner enters the case. All actions triggered by the learner will be recorded.</td>
<td>Assessment will not be provided in this section.</td>
<td>Introduction to the activity delivered as a 'notebook'.</td>
</tr>
<tr>
<td>Medical history</td>
<td>Audio and 'notecards' will be provided at the beginning of the case. Participants are not allowed to access patient information until they wash their hands.</td>
<td>No other diagnostic capability will be provided in this section, but the time will continue to be recorded.</td>
<td>A multiple-choice question on an interactive board is provided.</td>
<td>Assessment will not be provided in this section.</td>
<td>Handwash.</td>
</tr>
<tr>
<td>Differential diagnosis</td>
<td>Audio, diagrams and 'notecards' will be provided. As soon as the participant selects one investigation he/she will be prompted with a question about the differential diagnosis.</td>
<td>No other diagnostic capability will be provided in this section, but the time will continue to be recorded.</td>
<td>A multiple-choice question on an interactive board is provided.</td>
<td>Different signs by the patient's bed will trigger patient information in different formats.</td>
<td></td>
</tr>
<tr>
<td>Investigations</td>
<td>Audio and 'notecards' will prompt the learner to select the appropriate investigations. Learners' accounts will be credited with Linden dollars (L$). They will use those L$ to purchase the investigations required. They will be reminded to wash their hands when they go into the investigation area.</td>
<td>A series of objects that represent tests will be set at varying prices, which would relate to realistic real-life values. The correct set of tests will leave the avatar with some L$ spare from the initial amount given. If the avatar purchases all the tests this will cost them more than the amount of money they have been given (over budget).</td>
<td>Multiple-choice questions on an interactive board will be provided when the results are picked up from the different investigation areas.</td>
<td>By selecting the different investigations available they will be able to purchase them and move into the investigations area to find out the results.</td>
<td></td>
</tr>
<tr>
<td>Working diagnosis</td>
<td>Diagrams and 'notecards' will be provided. The participant will be able to click on the 'working diagnosis' sign by the patient's bed and a question about the final diagnosis will be presented.</td>
<td>No other diagnostic capability will be provided in this section, but the time will continue to be recorded.</td>
<td>A multiple-choice question on an interactive board is provided.</td>
<td>The 'working diagnosis' sign by the patient's bed will trigger this section.</td>
<td></td>
</tr>
<tr>
<td>Management plan</td>
<td>Notebooks will be provided. The participant can visit the Management Plan area and find out about how to manage the patient's condition.</td>
<td>Will be provided in this section, but the time will continue to be recorded.</td>
<td>Questions on an interactive board will be provided.</td>
<td>set-up for each condition within the Management Plan area. Interaction with the stations will trigger information in different formats.</td>
<td></td>
</tr>
</tbody>
</table>

**Methods**

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 Kommer (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.

<table>
<thead>
<tr>
<th>Second Life</th>
<th>Total number</th>
<th>Total (%)</th>
<th>Male (%)</th>
<th>Female (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low gamer</td>
<td>7</td>
<td>30</td>
<td>4</td>
<td>26</td>
</tr>
<tr>
<td>High gamer</td>
<td>16</td>
<td>70</td>
<td>48</td>
<td>22</td>
</tr>
<tr>
<td>Total</td>
<td>23</td>
<td>100</td>
<td>52</td>
<td>48</td>
</tr>
</tbody>
</table>

**Table 3.** Computer and videogame player categories by gender for Second Life group.

<table>
<thead>
<tr>
<th>e-module</th>
<th>Total number</th>
<th>Total (%)</th>
<th>Male (%)</th>
<th>Female (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low gamer</td>
<td>3</td>
<td>16</td>
<td>10</td>
<td>6</td>
</tr>
<tr>
<td>High gamer</td>
<td>16</td>
<td>84</td>
<td>53</td>
<td>31</td>
</tr>
<tr>
<td>Total</td>
<td>19</td>
<td>100</td>
<td>63</td>
<td>37</td>
</tr>
</tbody>
</table>

**Table 4.** Computer and videogame player categories by gender for e-module group.
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 variable scores, computed affective components, computed perceived use, 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 use, computed perceived control and computed behavioral components.

<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 hesitate to use an e-module/Second Life as a learning tool in case I look stupid.</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>P = 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'm 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.</td>
<td>P = 0.0001</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.</td>
<td>P = 0.0001</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-modules/Second Life make(s) it possible to learn more productively.</td>
<td>P = 0.0001</td>
</tr>
</tbody>
</table>
Table 6. Computed variables – Second Life group

<table>
<thead>
<tr>
<th></th>
<th>Second Life</th>
<th>Median (IQR) (females)</th>
<th>Standard Deviation (females)</th>
<th>Median (IQR) (males)</th>
<th>Standard Deviation (males)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computed Affective variable</td>
<td>0.925</td>
<td>20 (18-23)</td>
<td>2.34</td>
<td>20.5 (19-23)</td>
<td>3.73</td>
</tr>
<tr>
<td>Computed components for perceived use</td>
<td>0.0751</td>
<td>14 (12-15)</td>
<td>1.91</td>
<td>11.5 (10.5-13)</td>
<td>1.94</td>
</tr>
<tr>
<td>Computed components for perceived control</td>
<td>0.2878</td>
<td>20 (19-21)</td>
<td>1.43</td>
<td>21 (18-22)</td>
<td>2.45</td>
</tr>
<tr>
<td>Computed Behavioural components</td>
<td>0.6130</td>
<td>9 (6-10)</td>
<td>2.27</td>
<td>10 (8-10)</td>
<td>2.53</td>
</tr>
</tbody>
</table>

Table 7. Computed variables E-module group

<table>
<thead>
<tr>
<th></th>
<th>Second Life</th>
<th>Median (IQR) (females)</th>
<th>Standard Deviation (females)</th>
<th>Median (IQR) (males)</th>
<th>Standard Deviation (males)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computed Affective variable</td>
<td>0.3038</td>
<td>22 (20-24)</td>
<td>1.79</td>
<td>23.5 (21.5-25)</td>
<td>2.08</td>
</tr>
<tr>
<td>Computed components for perceived use</td>
<td>0.6988</td>
<td>14 (13-16)</td>
<td>1.60</td>
<td>15.5 (13.5-16.5)</td>
<td>2.02</td>
</tr>
<tr>
<td>Computed components for perceived control</td>
<td>0.2739</td>
<td>17 (16-18)</td>
<td>0.786</td>
<td>17 (16-18)</td>
<td>1.78</td>
</tr>
<tr>
<td>Computed Behavioural components</td>
<td>0.5472</td>
<td>8 (6-9)</td>
<td>1.79</td>
<td>7.5 (5-9)</td>
<td>1.99</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 (Q2: 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 (Q36: 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 entering 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 (Q6: P = 0.492). Such disposition should be exploited. Neither group agreed that learning either in Second Life or via e-module provides more interesting and imaginative ways for learning (Q17: P = 0.0001). During the focus group, the Second Life group discussed the fact that the delivery of virtual patients via a MUVE may replace contact with real patients, a situation that they found uncomfortable.

Regarding productivity (Q21: P < 0.0001), the Second Life group regarded learning in Second Life as a less efficient and less effective learning experience.

Perceived Control
Perceived control refers to one’s feelings and reactive behavior while manipulating technological tools. This includes the ability to self-teach task-related skills, acquiring control over Second Life, and the degree of reliance on others’ help to execute requested tasks.

The e-module group claimed more competence (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 (Q2: 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 behavior are manifested as willingness to use Second Life for learning. Negative behaviors 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 behavioural 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 found problems navigating in Second Life. It is important to keep in mind that the interface offered in Second Life is unique. The traditional navigational functions offered in current web browsers are very different from the ones available in Second Life.
- It is recommended 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 students' 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.

References


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Game-based learning in Second Life®. Do gender and age make a difference?

ABSTRACT
New learning technologies have changed the way teaching and learning is delivered. One of the technologies that offers great potential in helping to motivate and engage students is game-based learning. Social virtual worlds offer rich interactive three-dimensional collaborative spaces where users can meet and interact. One example of such an environment is Second Life (http://www.secondlife.com; henceforth ‘Second Life’). This article provides an overview of a recent trial carried out at Imperial College London aimed to explore gender-related attitudes towards game-based learning in Second Life. This article also draws on three recent studies to furthermore explore gender-related issues in computer and video game play. We here argue that the gender gap in gaming and learning is becoming less analytically significant, and in conjunction with this that game experiences have to be viewed from a more inclusive perspective in regard to game genre, gender and age.

KEYWORDS
games virtual worlds
Second Life
gender virtual patients
medicine
INTRODUCTION

In this article we explore the generally under-investigated terrain of gender- and age-related differences and similarities in studies of computer games and game-based learning. In doing so, we are addressing what has often been described as an exclusively masculine social space (Turkle 1984), although growing evidence shows that gaming and social Internet activities are becoming gender balanced to the degree that in the United States ‘[f]emale video game players now comprise 40 per cent of all players, and women over 18 make up more of the game-playing population than do males under 17’ (Williams et al. 2009: 700). However, surprisingly little research has paid attention to this ongoing gendered transformation of gaming and game-based learning. Analyses of gender in games and game-based learning are therefore in need of being both revised and updated in the light of new data, something we provide in this article by introducing the implementation of Second Life® in game-based learning in conjunction with other recent studies.1

This is also of outmost importance since new learning technologies need to be appreciated and evaluated beyond a game and learning culture made by men for men (Williams et al. 2009). It is also important to update previous images of the motivation and enjoyment in the psychology of learning in regard to a more gender-balanced use of and commitment to online and video games.

As Veugen and de Lange (2007) have pointed out, one of the key advantages of using computer games in education is the power to motivate. The British Educational Communications and Technology Agency (BECTA) highlighted the following statement: ‘A striking feature of games software is its power to motivate. Motivation or the will to continue the use of the software is the end product of a mixture of psychological effects’ (BECTA 2001: 2). The four features that motivate persistence and enjoyment of games are:

1. Challenge: when the learning environment is neither too simple nor too difficult.
2. Control: when the player feels actions have an effect on the outcomes of the game.
3. Curiosity: when exploratory opportunities are presented within the game leading to unpredictable outcomes.
4. Fantasy: when the player feels part of the game.

(Malone 1981; Malone and Lepper 1987)

From the motives identified as reasons for playing games, arousal is the one that appears to be most closely associated with enjoyment (Boyle and Connolly 2008). Performance is poor when an individual becomes bored and arousal decreases. In contrast, when arousal is optimal, performance will be at its best.

Flow Theory has become very significant in explaining the feelings of enjoyment, including while playing computer games (Sherry 2004). According to this theory, arousal will increase as a task becomes more challenging, but performance and enjoyment will depend on the level of skills. Csikszentmihalyi’s (1991) model of optimal flow describes the levels of enjoyment, immersion and involvement that people feel when taking part in favoured activities (Boyle and Connolly 2008). Flow is achieved when a gamer reaches an optimal match...
Game-based learning in Second Life®

between his or her skills and the challenges presented by the game. For example, when the skills become automated and require little attention, although the task may be challenging, the level of skills competence achieved by the gamer will allow a feeling of relaxation and a state of flow (Boyle and Connolly 2008).

The theories described above that focus on feelings when playing games contribute to our understanding of player enjoyment in computer games. However, games that over-emphasize educational requirements often underestimate the potential of play, game and story for creating memorable experiences (Hirumi and Stapleton 2008). The right balance should be achieved between the intended educational requirements and motivational factors in order to ensure an enjoyable and effective game-based learning experience.

In medical education, various forms of representative simulation have been developed to enhance clinical learning experiences and support the lack of real clinical student–patient encounters. This is due to the fact that managed health care has resulted in shorter patient stays with consequently fewer clinical learning opportunities (Olson et al. 2005; Ruiz et al. 2006). It is not possible for all trainees to gain the necessary skills at the bedside, in the operating theatre and through observation (Kneebone et al. 2006).

As technology advances and as the climate of clinical education places more emphasis on simulation as a safe substitute for practicing on real patients, the range of available simulations will inevitably increase.

(Kneebone 2005: 551)

Medical simulation is a wide term covering a wide range of skills, starting from using a block or resin or wood for future surgeons to get the feel of handling a drill to a sophisticated surgical simulation that reproduces a high-fidelity patient’s anatomy (Piturro 2008). Medical simulation also encompasses the use of mannequins and actors playing the role of patients, sometimes using simulated body parts (Kneebone et al. 2006). Another option is the use of virtual worlds, such as Second Life, to represent virtual hospitals, emergency departments, patients’ rooms and surgical suites (Piturro 2008).

Many high-quality e-learning materials are being produced by medical schools and health care organizations (Ruiz et al. 2006). ‘The virtual patient’ is one of the models developed to support the delivery of clinical teaching. Virtual patients are real-life clinical scenarios utilized for the purpose of medical education. Virtual patients support the delivery of traditional learning introducing problem-based scenarios focused on clinical or general/community practice. Virtual patients also allow learners to work independently, under the guidance of a tutor or in a collaborative setting with their peers.

It is important to highlight the fact that although virtual patients support and enhance the delivery of clinical and/or general practice, virtual patients are not supposed to replace real clinical experiences. The development of virtual patients has evolved starting from simple linear cases to more challenging branching scenarios, moving into immersive virtual worlds.

VIRTUAL WORLDS

According to the Joint Information Systems Committee (2007) the terms ‘game-based learning’ and ‘serious games’ have emerged as generic labels for the use of games for learning for educational purposes, including fully immersive
virtual environments in which learners represented by avatars can take on a virtual presence in virtual worlds. Virtual worlds represent rich interactive 3D collaborative spaces in which users can meet and interact (Livingstone 2007). Different users can access the virtual worlds at the same time, offering opportunities for synchronous collaborations within the 3D environment.

A series of virtual worlds characteristics were identified by De Freitas (2008), highlighting the potential of these worlds in education: learners can create a virtual representation of themselves, called avatars, and interact with the virtual world; there is a wide range of collaboration opportunities; content generated by users can be easily shared among online communities; and the great potential for immersion and interaction offers a wide range of highly immersed and interactive learning opportunities.

It becomes difficult to group together virtual worlds, games and social networking worlds. This is due to the fact that virtual worlds, games and social networking worlds offer similar capabilities for which boundaries are difficult to draw. Therefore, for the purpose of this article, we will focus only on open-ended social virtual worlds, which have been very popular among educational institutions in the United Kingdom (De Freitas 2008; Kirriemuir 2009), as well as many other universities across the world, particularly in the United States and Northern Europe (Molka-Danielsen and Deutschmann 2009; Wankel and Kingsley 2009). Examples of these worlds include Second Life, Active Worlds Educational Universe and There.com. These virtual worlds support social networking and live chat and offer authoring tools that allow users to collaborate in building three-dimensional virtual worlds.

Although Second Life has been identified as a social virtual world (De Freitas 2008; Kirriemuir 2009), it has great potential for delivering game-oriented scenarios. However, the openness of Second Life regions and therefore the lack of predefined goals and challenges within them make it difficult to classify Second Life as a game platform (Livingstone 2007). However, the potential for developing strategy-oriented games and game-based learning in Second Life is huge. The main challenge that academia may face when exploring the potential of developing game-based activities in Second Life is the lack of game-based authoring tools, which may make the development and use of game-based learning activities in Second Life more challenging and costly. Imperial College London realized the potential of developing game-based learning activities for the design of its virtual hospital and virtual patients, leading to the incorporation of pedagogical frameworks for the design of game-based learning activities within the virtual hospital (Toro-Troconis et al. 2010). This will be explained in more detail later in this article.

A large number of regions have been developed in Second Life in the area of medicine. The Heart Murmur Simulation implemented in Second Life was built by Jeremy Kemp, the host of SimTeach, a community for educators using virtual environments. This simulation was an early example of the potential of Second Life as a game-based learning platform, which very much inspired the work presented in this article. Another example in the medical field is Virtual Hallucinations from the University of California, which focused on the psychoses of actual patients. It was created by Dr Peter Yellowlees, Professor of Psychiatry, and colleagues at the School of Medicine to help medical students appreciate what it is like to have schizophrenia. The Sexual Health Region of the University of Plymouth is another example. It offers opportunities to test knowledge of sexual health through quizzes and games, web resources integrated within the virtual context and live seminars on sexual health topics. Indiana University’s School of Medicine developed a virtual clinic for medical
student training using chat-enabled patient simulations for learning medical microbiology and infectious disease medicine. The clinic provides training on diagnosis, laboratory medicine and problem solving. Students work in teams with simulated patients applying the skills of a practising physician as they organize information about infectious diseases.

There are other regions in Second Life worth mentioning that are mainly focused on the exploration and provision of information using the tools available in Second Life. The Gene Pool is a genetic educational region in Second Life that provides quizzes, animations and the possibility of wearing different chromosome textures. The Virtual Neurological Education Centre is another region developed as an experiential learning environment for an identified community and health care professionals.

GAME-BASED LEARNING IN SECOND LIFE

Second Life is a 3D world or ‘metaverse’ in which users are called ‘residents’ and can interact with content and other residents through a customizable avatar. Users can communicate using instant messages, voice chat or text-based ‘notecards’. Second Life provides simple tools for constructing three-dimensional objects and scripting tools for creating interactive content. There has been increasing investigation and trialling of the potential of Second Life for learning (Helmer 2007).

Second Life shares certain community and collaborative features with recent contemporary developments such as Facebook, YouTube, Wikipedia, Sloodle and Flickr, which places it in the Web 2.0 domain.

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. According to Holloway and Valentine (2003), learners in their 20s usually belong to the ‘game generation’, being native speakers of the digital language of computer, video games, DVD players, mobile phones, eBay, iPods and the Internet. According to Prensky (2001), they are ‘digital natives’, and 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 lack of immersion in current virtual patient delivery, as well as the recent debate about the familiarity of our digital natives with virtual and game-based environments, has been the motivation for this research. A Respiratory Ward was developed in Second Life with a series of virtual patients’ activities following a game-based learning model. The game-based learning process covered a wide range of activities and phases that were followed in order to ensure a pedagogically sound game-based learning implementation.

The framework for evaluating games and simulation-based education developed by De Freitas and Martin (2006) was adapted for this research (Toro-Troconis and Partridge 2010). The framework requires the consideration of four main dimensions in advance of using games and simulations. These focus on the following:

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.
User controls and interfaces were designed to accommodate the capabilities of Second Life. Notecards and on-screen text messages were used as the main user communication interface. A Heads-Up Display (HUD) was designed in order to keep the learner informed about his or her performance. HUD elements indicate player/learner status and show which direction the player/learner is going or where the player/learner ranks in the game (Figure 1). Gender differences in attitudes to game-based learning in Second Life have been looked at by the research team when evaluating high-level educational simulation models used with training professionals. The following section explains general findings in this area, followed by the research findings.

**GENDER DIFFERENCES IN COMPUTER AND VIDEO GAME ACTIVITIES**

Computers and gaming have, throughout the history of computing, been closely associated with masculinity, as have many Information and Communication Technologies (ICTs). The masculine nerdy and ‘boy’s room’ image was invoked early on by authors like Weizenbaum (1976) and Turkle (1984). The hacker stereotype became the standard gender association of computers and gaming, and has also been the long-lived dominant explanation for the gender gap in computing. Some authors claim that ‘the idea of a hegemonic “boy’s room competence” related to computers...’

Figure 1: Heads Up Display (HUD) – Imperial College London – virtual hospital.
seems to have affected the conduct of research into the issue’ (Gansmo et al. 2003). Although the gender gap is still a relevant and often used explanatory model, we can observe that a more complex and heterogeneous picture is emerging and that the masculine stereotypes have started to fade away. We can also observe that there is more space for negotiation of gender identity in relation to computers and ICT in general. In an investigation by Nordli (2003) she notes that the proportion of female enthusiasts seems to be growing markedly. In terms of access there are hardly any noticeable differences between boys and girls (Gansmo 2002). Many researchers claim that this gender difference is no longer analytically important, as has also been observed with mobile phones in terms of access and ownership (Gansmo et al. 2003); rather, it is other social categories such as class and age that are more important (Lie 2003). The latter is also indicated in studies of computer games and gaming using gender role theory as an explanatory framework (Williams et al. 2009).

However, according to early research such as the research carried out by Giacquinta et al. (1993), boys conceptualize computers differently from girls; they are more likely to play games and to see the computer as a playful recreational toy. However, none of the previous research has demonstrated that girls are less skilled at computer tasks than boys. On the contrary, continued exposure to computer games decreases pre-existing gender differences (Greenfield 1996). Game-based learning therefore ought to target more inclusive strategies rather than reinforce old stereotypes.

A large number of attempts to explain the gender gap in computer game involvement focus on the content and design of typical games (Cassell 2002). Some authors argue the main problems concerning gender and games are related to the absence of females as game developers, stating that if there were more females involved in the actual game creation, the games would have greater appeal to ‘feminine sensibilities’ (Kafai 1999). On the other hand, according to Hartmann and Klimmt (2006), at least four factors can account for the gender gap in game playing. Three factors are related to the content typically found in games, namely archaic gender role portrayals, violence and lack of social interaction; the fourth factor is mainly related to the competitive interactive tasks found in games.

Three recent studies show interesting findings in relation to the use of computer and video games among British, American and Finnish gamers (Pratchett 2005; Lenhart et al. 2008; Kallio et al. 2007). The studies were carried out between 2005 and 2008 among different age groups. Figure 2 shows an overview of these studies.

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Year of study</th>
<th>Age group</th>
</tr>
</thead>
<tbody>
<tr>
<td>British</td>
<td>3442</td>
<td>2005</td>
<td>6–65</td>
</tr>
<tr>
<td>American</td>
<td>1102</td>
<td>2007</td>
<td>12–17</td>
</tr>
<tr>
<td>Finnish</td>
<td>805</td>
<td>2007</td>
<td>15–75</td>
</tr>
</tbody>
</table>

Figure 2: Studies on Video Game Use and Users (Pratchett 2005; Lenhart et al. 2008; Kallio 2007).
### British Age group Males (%) Females (%)

<table>
<thead>
<tr>
<th>Age group</th>
<th>Males (%)</th>
<th>Females (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6–10</td>
<td>52</td>
<td>48</td>
</tr>
<tr>
<td>11–15</td>
<td>53</td>
<td>47</td>
</tr>
<tr>
<td><strong>16–24</strong></td>
<td><strong>56</strong></td>
<td><strong>44</strong></td>
</tr>
<tr>
<td>25–35</td>
<td>56</td>
<td>44</td>
</tr>
<tr>
<td>36–50</td>
<td>55</td>
<td>45</td>
</tr>
<tr>
<td>51–65</td>
<td>52</td>
<td>48</td>
</tr>
</tbody>
</table>

### American Age group Males (%) Females (%)

<table>
<thead>
<tr>
<th>Age group</th>
<th>Males (%)</th>
<th>Females (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>12–17</td>
<td>99</td>
<td>94</td>
</tr>
</tbody>
</table>

### Finnish Age group Males (%) Females (%)

<table>
<thead>
<tr>
<th>Age group</th>
<th>Males (%)</th>
<th>Females (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>15–24</td>
<td>13</td>
<td>14</td>
</tr>
<tr>
<td>25–34</td>
<td>18</td>
<td>15</td>
</tr>
<tr>
<td>35–44</td>
<td>13</td>
<td>15</td>
</tr>
<tr>
<td>45–4</td>
<td>18</td>
<td>23</td>
</tr>
<tr>
<td>55–64</td>
<td>24</td>
<td>19</td>
</tr>
<tr>
<td>65–75</td>
<td>13</td>
<td>13</td>
</tr>
</tbody>
</table>

---

**Figure 3: Age and gender distribution per study.**

**Figure 4: How often do you play games? (age group 6–65 years) (Pratchett 2005).**
Figure 3 shows age and gender distribution per study. The age groups relevant to the study that forms the body of this article are shown in bold type in this table.

The BBC study ‘Gamers in the UK: Digital Play, Digital Lifestyles’ (Pratchett 2005) suggested that 59 per cent of 6–65-year-olds in the United Kingdom are gamers; this is equivalent to 26.5 million people (Pratchett 2005). This study classified gamers under three categories: heavy, medium and light gamers. Figure 4 shows the proportion of gamers under the three categories classified by gender.

A much higher proportion of British online and console video gamers may be found currently due to the rapid penetration of console games such as the Nintendo Wii. In fact, the United Kingdom National Gamers Survey conducted in 2009 reveals that Britain has more online and console gamers than anywhere else in Europe (Barbour 2009). However, the discussion and comparisons in this article will concentrate only on the studies mentioned above.

A large number of ‘heavy’ gamers (81 per cent) are found in the 16–24 age group, as well as some ‘medium’ gamers (14 per cent) playing a few times a month. The lowest proportion of female gamers is found in this group (44 per cent) (Pratchett 2005). The most popular game genres played among the females in the age group of 11–65 years are puzzle/board games/quizzes (76 per cent), simulation (38 per cent) and action adventure (29 per cent). The most popular genres played among males were action adventure (56 per cent), racing (53 per cent) and puzzle/board games/quizzes (50 per cent). A very small percentage of males and females played Massive Multiplayer Online Games (MMOGs): males 8 per cent and females 7 per cent (Figure 5).

A recent American survey carried out by the Pew Internet & American Life Project, an initiative of the Pew Research Center, shows interesting findings in relation to diverse teens’ gaming experiences. This initiative involved the John D. and Catherine T. MacArthur Foundation (1978), which aims to defend human rights and understand how technology is affecting children and society. This survey shows that 97 per cent of American teenagers in the age range 12–17 play computer, web, portable or console games. The gender split between gamers is fairly even across all age groups in this study as well. In all 99 per cent of boys and 94 per cent of girls play video games. While almost all boys and girls play

<table>
<thead>
<tr>
<th>Genres/Percentages</th>
<th>Total (%)</th>
<th>Males (%)</th>
<th>Females (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Puzzle/Board games/Quizzes</td>
<td>63</td>
<td>50</td>
<td>76</td>
</tr>
<tr>
<td>Action adventure</td>
<td>43</td>
<td>56</td>
<td>29</td>
</tr>
<tr>
<td>Racing</td>
<td>40</td>
<td>53</td>
<td>25</td>
</tr>
<tr>
<td>Simulations</td>
<td>39</td>
<td>40</td>
<td>38</td>
</tr>
<tr>
<td>First person shooters</td>
<td>29</td>
<td>45</td>
<td>12</td>
</tr>
<tr>
<td>Sports</td>
<td>30</td>
<td>44</td>
<td>15</td>
</tr>
<tr>
<td>MMOGs</td>
<td>8</td>
<td>8</td>
<td>7</td>
</tr>
</tbody>
</table>

Figure 5: The most popular gaming genres played (age group 11–65 years) (Pratchett 2005).
video games, boys typically play games with greater frequency and duration than girls. Boys are more likely than girls to play games daily, with 39 per cent of boys reporting daily play and 22 per cent of girls reporting the same (Figure 6).

### Table: Frequency of play

<table>
<thead>
<tr>
<th>Frequency of play</th>
<th>All teen gamers (%)</th>
<th>Males (%)</th>
<th>Females (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Several times a day</td>
<td>13</td>
<td>19</td>
<td>6</td>
</tr>
<tr>
<td>About once a day</td>
<td>18</td>
<td>20</td>
<td>16</td>
</tr>
<tr>
<td>3–5 days a week</td>
<td>21</td>
<td>27</td>
<td>15</td>
</tr>
<tr>
<td>1–2 days a week</td>
<td>23</td>
<td>23</td>
<td>22</td>
</tr>
<tr>
<td>Every few weeks</td>
<td>15</td>
<td>8</td>
<td>23</td>
</tr>
<tr>
<td>Less often</td>
<td>10</td>
<td>4</td>
<td>17</td>
</tr>
</tbody>
</table>

*Figure 6: How often do you play games? (age group 12–17 years). Adapted from Pew Internet & American Life Project Teen & Parents Gaming and Civics Survey (Lenhart et al. 2008).*

### Table: Genres/Percentages

<table>
<thead>
<tr>
<th>Genres/Percentages</th>
<th>Males (%)</th>
<th>Females (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Action</td>
<td>84</td>
<td>48</td>
</tr>
<tr>
<td>Sports</td>
<td>80</td>
<td>55</td>
</tr>
<tr>
<td>Adventure</td>
<td>75</td>
<td>57</td>
</tr>
<tr>
<td>First person shooters</td>
<td>74</td>
<td>17</td>
</tr>
<tr>
<td>Fighting</td>
<td>67</td>
<td>29</td>
</tr>
<tr>
<td>Strategy</td>
<td>63</td>
<td>55</td>
</tr>
<tr>
<td>Role-playing</td>
<td>45</td>
<td>26</td>
</tr>
<tr>
<td>Survival horror</td>
<td>45</td>
<td>18</td>
</tr>
<tr>
<td>MMOGs</td>
<td>30</td>
<td>11</td>
</tr>
<tr>
<td>Puzzle</td>
<td>58</td>
<td>87</td>
</tr>
<tr>
<td>Racing</td>
<td>77</td>
<td>71</td>
</tr>
<tr>
<td>Rhythm</td>
<td>58</td>
<td>64</td>
</tr>
<tr>
<td>Simulations</td>
<td>46</td>
<td>52</td>
</tr>
<tr>
<td>Virtual worlds</td>
<td>11</td>
<td>10</td>
</tr>
</tbody>
</table>

*Figure 7: What kind of game do you play? (age group 12–17 years). Adapted from Pew Internet & American Life Project Teen & Parents Gaming and Civics Survey (Lenhart et al. 2008).*
In all 57 per cent of those who play games every day are aged 12–14 and the remaining 43 per cent of daily gamers are aged 15–17. Daily gamers are also more likely to report playing games as part of a guild or group (50 per cent of daily gamers fall under this category, compared with 38 per cent of less frequent gamers) (Lenhart et al. 2008).

This study has shown that American boys are more likely than girls to be intensive gamers, playing on a daily basis for long periods of time. Figure 7 shows similar tendencies between boys and girls among some of the genres played: 77 per cent of boys and 71 per cent of girls play racing games, 58 per cent of boys and 64 per cent of girls play rhythm games, and 46 per cent of boys and 52 per cent of girls play simulation games. Similar tendencies are also found among virtual worlds, with 11 per cent of boys and 10 per cent of girls playing some kind of virtual world. The most popular genres among boys are action games (84 per cent), sports (80 per cent) and racing games (77 per cent), whereas for girls the most popular genres are puzzle games (87 per cent), racing games (71 per cent) and rhythm games (64 per cent) (Lenhart et al. 2008). There is a large difference for MMOGs: boys 30 per cent and girls 11 per cent.

Boys play a wider variety of games than girls. Girls report playing an average of under six game genres, whereas boys play an average of eight genres (Lenhart et al. 2008).

In another survey carried out in Finland by the Hypermedia Laboratory of the University of Tampere, 48 per cent of women and 58 per cent of men were gamers (Kallio et al. 2007). The respondents were asked to identify their frequency of game play from ‘I play a few minutes a day’ to ‘I don’t play at all’ (Figure 8).

The participants who reported having played digital games in this study and continued answering the more detailed questions about gaming were classified as ‘Active Gamers’. This group represented 29 per cent of the respondents. The gender distribution in this group was 56 per cent male and 44 per cent female. However, only 23 per cent of women and 36 per cent of men filled in the digital gaming form. The ‘Active Gamers’ group was subdivided into three age groups, each containing about one third of them. The gender distribution among the 15–24 age group was 31 per cent male (n = 40) and 35 per cent female (n = 36).

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>I play a few minutes a day</td>
<td>4</td>
</tr>
<tr>
<td>I play a few hours a week</td>
<td>11</td>
</tr>
<tr>
<td>I spend a couple of days a month on playing</td>
<td>3</td>
</tr>
<tr>
<td>I play a few weeks per year</td>
<td>0.5</td>
</tr>
<tr>
<td>I play only occasionally</td>
<td>24</td>
</tr>
<tr>
<td>I don’t play at all</td>
<td>28</td>
</tr>
<tr>
<td>No response</td>
<td>31</td>
</tr>
</tbody>
</table>

*Figure 8: How often do you play games? (age group 15–75 years). Adapted from Kallio et al. (2007).*
<table>
<thead>
<tr>
<th>Genres/Percentages</th>
<th>Males (%)</th>
<th>Females (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Classic/Puzzle</td>
<td>17</td>
<td>12</td>
</tr>
<tr>
<td>Action</td>
<td>43</td>
<td>10</td>
</tr>
<tr>
<td>Strategy</td>
<td>17</td>
<td>0</td>
</tr>
<tr>
<td>Sports</td>
<td>13</td>
<td>3</td>
</tr>
<tr>
<td>Simulation</td>
<td>0</td>
<td>18</td>
</tr>
<tr>
<td>Racing</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>MMOGs</td>
<td>12</td>
<td>2</td>
</tr>
<tr>
<td>Role-playing</td>
<td>12</td>
<td>7</td>
</tr>
<tr>
<td>Money</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>Platform</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td>Party</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>Adventure</td>
<td>0</td>
<td>2</td>
</tr>
</tbody>
</table>

Figure 9: What kind of games do you play? (Age group 15–24 years). Adapted from Kallio et al. (2007).

The gamers assigned to this category ‘Active Gamers’ were, on average, much younger than the rest of the respondents with a clear lower proportion of women. ‘Active Women Gamers’ had less variation in their responses than men had in this group. On the whole, women reported 170 games (approximately 1.67 each) and 62 individual games or game series, whereas men reported 266 games (approximately 2.04 each) and 119 individual games or game series.

(Lenhart et al. 2008: 76)

The most popular genres among males aged 15–24 were action (43 per cent), classic/puzzle and strategy games (17 per cent) and sports (13 per cent) and among females aged 15–24 they were simulation (18 per cent), classic/puzzle (12 per cent) and action (10 per cent) (Figure 9).

Within the most popular games, *Solitaire* was the most popular game among both men and women. Other popular games among women were puzzle games. *The Sims* and *SingStar* were also popular among women. In contrast, the most popular games among men were first person or third person shooters (Kallio et al. 2007).

**VIRTUAL PATIENTS – A CASE STUDY**

This case study is focused on a piece of research carried out at Imperial College London. This research aims to identify game-based activities that can drive experiential, diagnostic and role-play learning activities within the 3D world, aiming to support patients’ diagnoses, investigations and treatment. Each virtual patient had a medical history, differential diagnosis, investigations,
working diagnosis and a management plan. Figure 10 shows this ward. The recent trial aimed to explore gender-related differences and attitude towards two e-learning delivery methods including the delivery of game-based learning for virtual patients in Second Life.

This research was carried out in 2008. It aimed to explore gender-related differences and attitudes towards two e-learning delivery methods including the delivery of game-based learning for virtual patients in Second Life (Toro-Troconis et al. 2010). The main investigation involved 42 undergraduate medical students (21 years old), and the gender distribution of the respondents was 43 per cent female (N=18) and 57 per cent male (N=24).

INSTRUMENTS

In this study, the survey ‘My feelings when playing games’, developed by Bonanno and Kommers (2008), was used. The survey instrument comprises 21 statements that describe behaviours while using games, and a five-point Likert scale is used to measure response. Six of the statements relate to the affective component, five to perceived usefulness, six to perceived control and four to behavioural components. The statements were adapted to two 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.

PROCEDURE

Gaming competence was addressed by identifying participants in two categories of computer and video game use: high gamers and low gamers.
High gamers includes all participants who reported having played computer or video games a few days ago or a few months ago.

Low gamers includes all participants who reported having played a few years ago or never.

The first step in the data collection for this project was a survey delivered via Blackboard, which sampled 347 full-time undergraduate medical students. Participants were asked to recall the genres of computer and video games they played (adventure, race games, model/simulation, sport, shooting/arcade games, other). From these 347 students 118 responded. Therefore, the sample analyzed included 118 full-time undergraduate medical students, whose average age was 22 years.

The majority of participants surveyed were classified as high gamers (70 per cent). The majority of male participants were high gamers (87 per cent of all males surveyed), while only about half of the female participants were high gamers (54 per cent). The majority of the participants had never heard of Second Life (66 per cent). However, 50 per cent of male participants had heard of Second Life, in comparison to only 13 per cent of female participants. The most popular computer or video game genre among female participants was adventure games, while sport games were the most popular choice for male participants.

From this group of 118 undergraduate medical students, a stratified sample (N=42) was selected according to gender and high- and low-gamer categories in order to give equal proportions. One group (N=23) was given access to the game-based learning activity in Second Life. 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, to be completed at the end of each 40-min session. The scores for the separate statements were coded in Stata version 10, using reverse scoring for unfavourable statements.

The Imperial College Research Ethics Committee approved the ethics of this research.

<table>
<thead>
<tr>
<th>Second Life</th>
<th>Total number</th>
<th>Total (%)</th>
<th>Male (%)</th>
<th>Females (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low gamer</td>
<td>7</td>
<td>30</td>
<td>4</td>
<td>26</td>
</tr>
<tr>
<td>High gamer</td>
<td>16</td>
<td>70</td>
<td>48</td>
<td>22</td>
</tr>
<tr>
<td>Total</td>
<td>23</td>
<td>100</td>
<td>52</td>
<td>48</td>
</tr>
</tbody>
</table>

Figure 11: Computer and video game player categories by gender for Second Life group.

<table>
<thead>
<tr>
<th>E-module</th>
<th>Total number</th>
<th>Total (%)</th>
<th>Male (%)</th>
<th>Females (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low gamer</td>
<td>3</td>
<td>16</td>
<td>10</td>
<td>6</td>
</tr>
<tr>
<td>High gamer</td>
<td>16</td>
<td>84</td>
<td>53</td>
<td>31</td>
</tr>
<tr>
<td>Total</td>
<td>19</td>
<td>100</td>
<td>63</td>
<td>37</td>
</tr>
</tbody>
</table>

Figure 12: Computer and video game player categories by gender for e-module group.
The breakdown of the groups is displayed in the following tables given the two different treatments. Computer and video game player categories by gender for the Second Life group are shown in Figure 11, and those for the e-module group in Figure 12.

The Second Life group was given an introduction (20 min) at the beginning of the session, which covered basic navigational techniques in Second Life, e.g., how to access notecards. A focus group interview was 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 other accessibility and usability issues not addressed in the survey.

RESULTS AND ANALYSIS

Data on 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 behavioural components.

The main results for the separate statements are given in Figure 13. 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 with reverse scoring are shaded.

<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 hesitate to use an e-module/Second Life as a learning tool in case I look stupid.</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 that 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>
</tbody>
</table>
The Mann–Whitney test was used to compare general attitude by gender for each group. The questions were combined into groups 1–3 (disagree) and 4–5 (agree).

Figures 14 and 15 show the computed variables for both groups.

<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>I don’t feel uneasy about using e-modules/Second Life®.</td>
<td></td>
<td>0.004</td>
</tr>
<tr>
<td></td>
<td></td>
<td>I can make the computer do what I want it to do while learning using e-modules/Second Life®.</td>
<td></td>
<td>P &lt; 0.0001</td>
</tr>
<tr>
<td></td>
<td></td>
<td>I would only use an e-module/Second Life for learning if I were told to.</td>
<td></td>
<td>All disagree</td>
</tr>
<tr>
<td></td>
<td></td>
<td>I need an experienced person nearby when I’m learning using an e-module/Second Life®.</td>
<td></td>
<td>0.105</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Learning using e-modules/Second Life does not scare me at all.</td>
<td></td>
<td>0.468</td>
</tr>
<tr>
<td></td>
<td></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></td>
<td>0.049</td>
</tr>
<tr>
<td></td>
<td></td>
<td>I would avoid learning a topic if it involved an e-module/Second Life®.</td>
<td></td>
<td>0.075</td>
</tr>
<tr>
<td></td>
<td></td>
<td>If I have problems using an e-module/Second Life®, I can usually solve them one way or the other.</td>
<td></td>
<td>P &lt; 0.0001</td>
</tr>
<tr>
<td></td>
<td></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></td>
<td>0.024</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Learning using e-modules/Second Life provides more interesting and imaginative ways of learning.</td>
<td></td>
<td>P &lt; 0.0001</td>
</tr>
<tr>
<td></td>
<td></td>
<td>I would access an e-module/Second Life regularly for learning.</td>
<td></td>
<td>1.000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>I do not need somebody telling me the best way to use an e-module/Second Life for learning.</td>
<td></td>
<td>0.014</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Using an e-module/Second Life makes me feel uncomfortable</td>
<td></td>
<td>0.011</td>
</tr>
<tr>
<td></td>
<td></td>
<td>E-modules/Second Life make(s) it possible to learn more productively.</td>
<td></td>
<td>P &lt; 0.0001</td>
</tr>
</tbody>
</table>

Figure 13: Statistical data for the 21 separate variables.
The discussion is organized around the four major attitudinal components, and the statistical significance of each statement 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 and via e-modules.

<table>
<thead>
<tr>
<th>Second Life P value</th>
<th>Median (IQR) (females)</th>
<th>Median (IQR) (males)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computed Affective variable</td>
<td>0.925</td>
<td>20 (18–23)</td>
</tr>
<tr>
<td>Computed components for perceived use</td>
<td>0.0751</td>
<td>14 (12–15)</td>
</tr>
<tr>
<td>Computed components for perceived control</td>
<td>0.2878</td>
<td>20 (19–21)</td>
</tr>
<tr>
<td>Computed behavioural components</td>
<td>0.6130</td>
<td>9 (6–10)</td>
</tr>
</tbody>
</table>

Figure 14: Computed variables – Second Life group (IQR: inter-quartile range).

<table>
<thead>
<tr>
<th>E-module P value</th>
<th>Median (IQR) (females)</th>
<th>Median (IQR) (males)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computed Affective variable</td>
<td>0.3038</td>
<td>22 (20–24)</td>
</tr>
<tr>
<td>Computed components for perceived use</td>
<td>0.6988</td>
<td>14 (13–16)</td>
</tr>
<tr>
<td>Computed components for perceived control</td>
<td>0.2739</td>
<td>17 (17–18)</td>
</tr>
<tr>
<td>Computed behavioural components</td>
<td>0.5472</td>
<td>8 (6–9)</td>
</tr>
</tbody>
</table>

Figure 15: Computed variables – e-module group.
Learning using the two different delivery modes is perceived by both males and females as an intelligent and socially accepted activity. Males, median 20.5 (interquartile range [IQR] 19–23), and females, median 20 (IQR 18–23), show nearly the same median values and manifest an overall positive attitude for the affective component. The e-module group shows nearly the same median values as well: males median 23.5 (IQR 21.5–25) and females median 22 (20–24).

The median values are higher in the e-module group. This could be explained by the fact that learning via e-modules is something the students are used to since e-modules are embedded in various undergraduate blended learning programmes in medicine.

**PERCEIVED USEFULNESS**

The Second Life group shows weak evidence of a difference in perceived usefulness between genders ($P = 0.0751$). Females show higher medians, 14 (12–15), than males, 11.5 (10.5–13), demonstrating a more positive attitude overall for the perceived usefulness component. This involves behaviours arising from perceptions about the advantages of using Second Life for learning. This is an interesting finding. Females generally perceive gaming not as a unique learning and entertaining experience, but as just another way to learn (Bonanno and Kommers 2008).

**PERCEIVED CONTROL**

Perceived control refers to the feelings and reactive behaviours the player may experience when manipulating technological tools (Bonanno and Kommers 2008). There is no evidence of a difference in perceived control between genders ($P = 0.2878$). The medians for both genders are very similar: females 20 (IQR 19–21) and males 21 (IQR 18–22). The Second Life group shows higher medians and thus a more positive attitude overall for the perceived control component. It is interesting to note that males and females had a very similar perceived control of the Second Life environment and felt confident interacting with the learning experience and manipulating the virtual world.

**BEHAVIOURAL COMPONENTS**

Positive behaviours are manifested as willingness to use Second Life or e-modules for learning. Negative behaviours involve avoidance tendencies. There is no difference in behavioural attitude between genders ($P = 0.6130$) in the Second Life group and the e-module group ($P = 0.5472$). The medians for both genders are very similar: females 9 (IQR 6–10) and males 10 (IQR 8–10) in the Second Life group, and females 8 (IQR 6–9) and males 7.5 (IQR 5–9) in the e-module group.

Although the four studies discussed in this article looked at fairly different age groups and different methodologies were implemented to classify ‘gamers’, we will attempt to compare and contrast the results of the 20- to 22-year age group studying at Imperial College London.
Table 1: Gender distribution, age group and classification of gamers by study.

<table>
<thead>
<tr>
<th>Gender distribution (%)</th>
<th>Age group</th>
<th>Classification of gamers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male</td>
<td>Female</td>
</tr>
<tr>
<td>Imperial College</td>
<td>87</td>
<td>54</td>
</tr>
<tr>
<td>Finnish</td>
<td>31</td>
<td>35</td>
</tr>
<tr>
<td>British</td>
<td>56</td>
<td>44</td>
</tr>
<tr>
<td>British</td>
<td>31</td>
<td>25</td>
</tr>
<tr>
<td>American</td>
<td>65</td>
<td>35</td>
</tr>
</tbody>
</table>

Figure 16: Gender distribution, age group and classification of gamers by study.

Figure 16 shows the gender distribution, age group and classification of gamers for the four studies discussed in this article.

Figure 17 shows a comparison of all the studies looked at in this article in relation to games genre and gender among the different age groups. The highlighted figures show the most popular games genres in the studies looked at in this article.

Table 2: Games genre according to gender among the different age groups.

<table>
<thead>
<tr>
<th>Games genre</th>
<th>Imperial (%) (18–22) Male</th>
<th>Finnish (%) (15–24) Male</th>
<th>Americans (%) (12–17) Male</th>
<th>Totals (%) Male</th>
</tr>
</thead>
<tbody>
<tr>
<td>Puzzle/Board games/Quizzes</td>
<td>–</td>
<td>–</td>
<td>17</td>
<td>58</td>
</tr>
<tr>
<td>Role-playing</td>
<td>–</td>
<td>–</td>
<td>12</td>
<td>45</td>
</tr>
<tr>
<td>Sports</td>
<td>68</td>
<td>4</td>
<td>13</td>
<td>80</td>
</tr>
<tr>
<td>First person shooters</td>
<td>48</td>
<td>–</td>
<td>74</td>
<td>67</td>
</tr>
<tr>
<td>MMOGs</td>
<td>–</td>
<td>–</td>
<td>12</td>
<td>30</td>
</tr>
</tbody>
</table>

Figure 17: Games genre according to gender among the different age groups.
DISCUSSION

The development of game-based learning in social virtual worlds such as Second Life offers engaging learning opportunities for students of both sexes. This article shows interesting findings in relation to gender-related attitudes when learning following a game-based learning approach in Second Life. Learning using this delivery mode is perceived by males and females as an enjoyable activity, with females demonstrating a more positive attitude overall for the perceived usefulness component. These results are also in accordance with what other research on gender, computing and games has concluded: that there is little empirical evidence today for the old stereotypes of gender and computers as an exclusive masculine social space or a 'boy's room' competence. However, the masculine hacker and nerd image is still considered to play a pervasive role in symbolic understandings of games and computing. What our results indicate is that this symbolic image is a bigger problem than the actual use by and attitudes of students of the two sexes.

It is important to mention that since the project carried out at Imperial was a pilot part of a research project, we have to be cautious about the conclusions that can be drawn on the basis of it. The different game studies discussed in this article also provide interesting findings in relation to gender attitude towards gaming.

In the British study, although the lowest proportion of female gamers (44 per cent) was found in the 15–24 age group, there was a fair gender split in this group among heavy, medium and light gamers. The Finnish group also shows a fair gender split among the 'Active Gamers' group in the 15–24 age range. In contrast, the American study and the study carried out at Imperial do not show a fair gender split between males and females that took part in these studies.

The studies discussed earlier gave details of the genre of game that had been used by the respondents. The British group aged 16–24 years was not included since the data about game genres for this age group were not available. By adding the percentages shown in Table 15, the most popular game genres among Imperial, Finnish and American males are sports (101 per cent), first person Shooters (67 per cent) and adventure (64 per cent). The most popular game genres among female players in these groups are adventure (78 per cent), simulations (110 per cent) and puzzle/board games/quizzes (34 per cent).

Interesting findings emerge from these figures. First, game play seems to vary significantly between male and female players not only in terms of game genre, but also in frequency of play. Therefore, one may construct several interpretations and even contradictory views of game play among this age group.

The main finding is that the current perception of gamers is limited to the view that gamers are younger in age, mainly male in gender and mainly 'hardcore' game players. Some of the studies looked at show a fair gender split between male and female gamers (British and Finnish gamers). However, gamers also include a significant number of older people. For example, in Finland older people represent a high percentage of the population who are occasional players of a familiar puzzle or card game like Solitaire, dedicating a couple of hours per week to digital play.

The studies looked at in this article give an indication of how current game studies are shaping game play research. However, before drawing conclusions about game play it is important to maintain a holistic view of game play, looking carefully at how game players are classified and how game genres are used by different genders and age groups. Attitude towards game-based learning
in virtual worlds might be driven by previous game experience. Game experience is a variable concept that ought to be more inclusive. Game experiences vary not only in relation to game genre, but also to gaming hardware. Opportunities for accessible and economic gaming experiences are widening out with the increased use of mobile phones. New technologies such as iPhone and iPod Touch Applications are expanding the way gaming experiences can be integrated into day-to-day activities. The way game consoles are evolving is also making gaming experiences more collaborative and family driven. For example, the Nintendo Wii, which can be used as a handheld pointing device to detect movement in three dimensions, offers great potential for family entertainment, with a large range of engaging family games bringing together males and females from a wide age group.

In this article we have seen the successful implementation of game-based learning in Second Life, which has been accepted and enjoyed by males and females. These initial findings show acceptance and enjoyment for this type of game-based activities in social virtual worlds. Other studies that focused on game play were also looked at and contrasted, providing interesting thoughts and reflections on gender tendencies and game play. More inclusive and holistic research in this field ought to be carried out in order to identify game play tendencies in professional-level simulation with adults at university level, which may counteract outdate perceptions about age and gender differences in game play.

REFERENCES


SUGGESTED CITATION


CONTRIBUTOR DETAILS

Maria Toro-Troconis is a Senior Learning Technologist at the Faculty of Medicine, Imperial College London. Her main role is to support the development and
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Virtual Worlds and Metaverse Platforms: New Communication and Identity Paradigms

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*University of Texas at Austin, USA*
Chapter 9

Students’ Perceptions about Delivery of Game-Based Learning for Virtual Patients in Second Life

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ABSTRACT

This chapter describes the use of the nominal group technique to assess students’ attitudes to game-based learning in the delivery of virtual patients in Second Life.

Two groups of undergraduate medical students (Yr 3, n=14) were invited to participate. The research question posed was: “In your opinion what are the advantages and disadvantages of learning in Second Life compared with other methods?” Thirty items were generated in each group, then reduced to 10 items. These were classified into 3 themes 1) learning experience, 2) clinical exposure, and 3) technical experience. Results from the first group focused on the learning experience highlighting its importance for clinical diagnosis and a structure for learning. The second group focused on the clinical exposure although they were ambivalent about the advantages of this type of delivery mode. Results show interesting findings highlighting the virtual patients developed follow a very linear approach which is not challenging enough for medical students at that level.

DOI: 10.4018/978-1-60960-854-5.ch009

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INTRODUCTION

Anecdotal evidence from teachers suggests that the impact of gaming on millions of learners, who grew up playing best-selling games such as SimCity is starting to be felt (Squire 2002). According to Prensky (2001), these learners or ‘digital natives’ are native speakers of the digital language of computers, video games, mobile phones and any other digital technology that easily become available. Some authors recognise the fact that these learners have a cognitive style characterised by multi-tasking while learning, with short attention span during learning and an exploratory and discovery approach to learning (Asakawa & Gilbert, 2003; Bain & Newton, 2003; Prensky, 2005). However, the term ‘digital native’ has been recently expanded by Prensky (2009) to fit a wider audience that has grown up in the era of digital technology. Prensky defines a new term ‘digital wisdom’ emphasizing that the use of digital technology in our everyday lives makes us wiser.

Digital tools already extend and enhance our cognitive capabilities in a number of ways. Digital technology enhances our memory, for example, via data input/output tools and electronic storage. Digital data-gathering and decision-making tools enhance judgment by allowing us to gather more data than we could on our own. (Prensky, 2009)

Video and computer games are in many ways a ‘perfect’ learning mechanism for this group (Prensky 2006). Learning by games results in the acquisition of new knowledge, the transfer of learning, the development of intellectual skills (abstraction, anticipation, strategy-building, problem-solving, spatial representation, function-movement relationship), and the development of behavior and attitudes (Whelan, 2005; Sauve et al, 2007).

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’, and includes fully immersive virtual worlds, in which learners cantake on virtual presence within these worlds (Joint Information Systems Committee 2007). Gee (2003) also observed how successful game play and experiential learning opportunities have been shown to share common aspects.

The game-based learning activities for the delivery of virtual patients were designed based on the four-dimensional framework developed by De Freitas and Oliver (2006) and discussed by the authors in other publications (Toro-Troconis et al, 2008), which provides a close relationship with the systems of Activity Theory (Kuutti, 1996). The learning types described by Helmer (2007): Demonstration, Experiential Learning, Diagnostic activities, Role-Play and Constructive Learning were also taken into account for the design. And finally, it is worth highlighting the last three influential factors taken into account in the design which were described by Begg (2005): Emergent Narrative, originally described by Murray’s (1997), The Responsive Environment and the Psycho-social Moratorium originally described by Gee (2003).

The framework focuses on four main dimensions in advance of using games and simulations (De Freitas & Oliver, 2006):

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

The Faculty of Medicine at Imperial College London developed a Respiratory Ward in Second Life with a series of virtual patients’ activities following the framework and modes of representation mentioned above. A range of game-based elements
were introduced and delivered to the learner via a Heads Up Display (HUD), which aims to keep the learner informed of his/her progress, showing the patients treated by the learner, how far the learner is in the diagnostic process, his/her scores and the top scores for each patient (Figure 1). A demo on YouTube can be accessed at: http://tinyurl.com/mwpn2r

The game-based learning activities aim to drive experiential, diagnostic and role-play learning activities within the 3-D world, aiming to support students as they select investigations and make diagnoses. The Respiratory Ward was developed with five virtual patients, each with a different respiratory condition, and each includes elements of medical history, differential diagnosis, investigations, working diagnosis and production of a management plan.

The delivery of virtual patients in Second Life benefit from target user input during development. Focus groups composed of undergraduate medical students have been organised to gather feedback about attitudes and barriers when accessing virtual patients in Second Life. As an alternative to the focus group, the Nominal Group Technique (NGT), originally developed by Delbecq, Van de Ven, and Gustafson for organizational decision making and problem solving was used. The NGT is a highly structured group process that is used to generate prioritised list of responses to a question or problem (Delbecq et al., 1975; IoM, 1985). A primary purpose of the NGT is to ensure

Figure 1. Virtual Patient at the Respiratory Ward – Imperial College London region in Second Life
Students’ Perceptions about Delivery of Game-Based Learning for Virtual Patients in Second Life

that opinions of all participants receive equal representation (Hall, 1983).

One of the criticisms of nonstructured focus groups is that there is often a tendency for discussions to become dominated by the opinions of the most self-assured personalities in any group. The NGT aims to limit this potential by offering and forcing equal opportunities for each participant to express their opinion (Carney, O. et al, 1996).

EXPERIMENTAL METHODOLOGY

Participants

This investigation focused on two groups of Year 3 undergraduate medical students. On average, participants were 21 years old (+/- 1.26). The gender distribution of the respondents was 7% female (n = 1) and 93% male (n = 13). Two sessions were held with 6 in one group, and 8 in the other.

Process

An introduction to the virtual hospital and the Virtual Respiratory Ward was given to each group of students. The students spent 30 minutes assessing five virtual patients at the Respiratory Ward in groups of two (Figure 2).

The moderation of the NGT was not researcher-led which avoided domination of the leader’s concerns rather than those of the participants. Three members of staff led the process and students were asked to consider the following question:
“In your opinion what are the advantages and what are the disadvantages of learning in Second Life compared with other methods?”

The NGT process consisted of 6 stages (Figure 3).

**Results**

The NGT was held at Imperial College, Sir Alexander Fleming building, London in April 2009. The results of the NGT include the items generated and the voting that gave the consensus opinion on important items for inclusion. Initially, 30 pos-

*Figure 3. The NGT process*
sible items that could be important in assessing the advantages and disadvantages of learning in Second Life, following a game-based learning model for virtual patients were generated by the two groups. The 30 items generated by participants during the silent phase and subsequently ranked during the voting phase can be seen in Tables 3 & 4. Table 1 & Table 2 only show the top 10 items selected in each group.

Following the first round of voting, participants had an opportunity to view the voting results and express their opinions or discuss queries if it was considered some items had been emphasized incorrectly in their opinion. The discussions that preceded the first round of voting clearly influenced how individuals ultimately voted. Ten items had received final votes in both groups resulting in greater consensus (Table 5).

The established items have been grouped into three main areas in Table 5:

1. Learning experience (L)
2. Clinical exposure (C)
3. Technical experience (T)

DISCUSSION

The results of this NGT process established ten items generated in each group to be taken into account for the design of game-based learning for virtual patients in Second Life. This process has determined content validity by assuring students agreement on the items to be evaluated further.

The final items generated by Group 1 were mainly focused on the Learning Experience with a total of 107 points. The second most popular item among Group 1 was focused on the Clinical experience with a total of 62 points leaving only 21 points to the Technical experience item.

There was great discussion about the advantages of learning the process of clinical diagnosis using this type of delivery mode. However, the fact that this way of learning may become mechanical was pointed out. Some discussion was based on the clinical disadvantages focused on the restrictions of tests available and the simplicity of the clinical cases. Similar approaches were found in both groups where they identified this type of delivery more suited for clinical years, highlighting the fact that this way of learning might help medical students structure clinical thinking. The group also pointed out how the delivery of virtual patients in this way would reduce doctor/patient contact and would not prepare them for experiences on the ward. The only item discussed around the technical experience area was the advantage of accessing virtual patients in their own time, anywhere.

The final items generated by Group 2 concentrated mainly on the Clinical exposure with a total of 282 points. This group highlighted the fact that this delivery method was too simple to teach diagnostic skills and more challenging scenarios were required. Few items related to the Learning experience were discussed mainly focused on the advantage of making students remember better bridging the gap between lectures and clinical work. A small amount of students did not see the advantage of learning in the virtual hospital over other forms of e-learning. This may be due to the fact students are used to a wide variety of interactive e-learning materials which are already embedded in the curriculum and they are already used to accessing and learning from.

The gender distribution of the respondents was not even with a high representation of males (93% n=13) in comparison to females (7% n=1). However, recent studies carried out at undergraduate medicine level at Imperial College London shows interest findings which do not highlight significant gender differences in attitude when learning following a game-based learning approach in Second Life (Toro-Troconis & Mellsström, U., 2010).
Table 1. Top ten items generated by nominal group technique that are important when learning in Second Life (Group 1).

<table>
<thead>
<tr>
<th>Suggested item (n=30)</th>
<th>Number of votes</th>
<th>Number of participants scoring item</th>
</tr>
</thead>
<tbody>
<tr>
<td>Predictability – removes thought process becoming mechanical process.</td>
<td>19</td>
<td>4</td>
</tr>
<tr>
<td>Gives opportunity to discuss issues in a safe environment.</td>
<td>8</td>
<td>2</td>
</tr>
<tr>
<td>Useful as reinforcement of other teaching.</td>
<td>27</td>
<td>4</td>
</tr>
<tr>
<td>Easier to validate learning by supervisor.</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Easy to organise structure for self learning.</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Restrictive choice of tests/no option to add new investigations (limited capacity to make mistakes).</td>
<td>16</td>
<td>3</td>
</tr>
<tr>
<td>Repeatable, go back to virtual patients.</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Focusing on passing exams not seeing the unusual “real life exposure” on the wards.</td>
<td>12</td>
<td>2</td>
</tr>
<tr>
<td>Difficult to cover all material needed to become a doctor – reinforcement aid.</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Extended Matching Questions (EMQs) where you can walk around given differential diagnosis.</td>
<td>6</td>
<td>1</td>
</tr>
</tbody>
</table>

Items generated by the nominal group technique with the question: “In your opinion what are the advantages and disadvantages of learning in Second Life compared with other methods?”

Table 2. Top ten items generated by nominal group technique that are important when learning in Second Life (Group 2).

<table>
<thead>
<tr>
<th>Suggested item (n=30)</th>
<th>Number of votes</th>
<th>Number of participants scoring item</th>
</tr>
</thead>
<tbody>
<tr>
<td>Second Life can be vandalized.</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Negative view about Second Life.</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Potential to become over dependant on e-learning methods.</td>
<td>12</td>
<td>3</td>
</tr>
<tr>
<td>Students may use Second Life too much stopping them from interacting in real world.</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Can’t ask specific questions during history taking.</td>
<td>24</td>
<td>4</td>
</tr>
<tr>
<td>Can’t see advantage over other forms of e-learning.</td>
<td>22</td>
<td>3</td>
</tr>
<tr>
<td>Bridges gaps between lecture and hospital – framework for years prior to clinical practice.</td>
<td>23</td>
<td>6</td>
</tr>
<tr>
<td>Too simple to teach diagnostic skills, more complicated scenarios needed, should allow you to make mistakes.</td>
<td>56</td>
<td>7</td>
</tr>
<tr>
<td>No control over spending money in Second Life.</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Potential to learn blood results.</td>
<td>6</td>
<td>1</td>
</tr>
</tbody>
</table>

Items generated by the nominal group technique with the question: “In your opinion what are the advantages and disadvantages of learning in Second Life compared with other methods?”
Table 3. Items generated by nominal group technique that are important when learning in Second Life (Group 1).

<table>
<thead>
<tr>
<th>Suggested item (n=30)</th>
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<th>Number of participants scoring item</th>
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<tbody>
<tr>
<td>Predictability – removes thought process becoming mechanised process.</td>
<td>19</td>
<td>4</td>
</tr>
<tr>
<td>Gives opportunity to discuss issues in a safe environment.</td>
<td>8</td>
<td>2</td>
</tr>
<tr>
<td>Useful as reinforcement of other teaching.</td>
<td>27</td>
<td>4</td>
</tr>
<tr>
<td>Easier to validate learning by supervision.</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Easy to organise structure for self learning.</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Restrictive choice of texts/no option to add new investigations (limited capacity to make mistakes).</td>
<td>16</td>
<td>3</td>
</tr>
<tr>
<td>Repeated, go back to virtual patients.</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Focusing on passing exams not seeing the unusual “real life exposure” on the wards.</td>
<td>12</td>
<td>2</td>
</tr>
<tr>
<td>Difficult to cover all material needed to become a doctor – reinforcement aid.</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Extended Matching Questions (EMQs) where you can walk around to make differential diagnosis.</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>Would be better for clinical beginners – helps structure thinking.</td>
<td>17</td>
<td>3</td>
</tr>
<tr>
<td>Distracted by emails in Second Life.</td>
<td>8</td>
<td>1</td>
</tr>
<tr>
<td>Missed out on practical stuff – only theory.</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Time taken away from learning - technical issues.</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Not designed for teamwork; no expert to ask unless they happened to be there.</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Too spoon fed for Seniors.</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Motivating for Junior levels.</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Very easy to use in own time, anywhere.</td>
<td>25</td>
<td>4</td>
</tr>
<tr>
<td>Students can work at their own speed.</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Break from other formats of learning.</td>
<td>20</td>
<td>3</td>
</tr>
<tr>
<td>6</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Metrics game, conditioned to enjoy games, making learning memorable.</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>More applicable to learning on the wards ties in with wards.</td>
<td>9</td>
<td>1</td>
</tr>
<tr>
<td>Integrates learning that is not covered in other ways, e.g. breath sounds and other things are always taught together as package.</td>
<td>22</td>
<td>3</td>
</tr>
<tr>
<td>Not a good learning tool. Couldn’t ask questions/insufficient information.</td>
<td>9</td>
<td>1</td>
</tr>
<tr>
<td>Structural way to learn – framework for learning.</td>
<td>19</td>
<td>4</td>
</tr>
<tr>
<td>Unrealistic presentation of symptoms.</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Reduces the doctor/patient relationship and associated skills - emotional.</td>
<td>15</td>
<td>2</td>
</tr>
<tr>
<td>Does not compare for experiences on the ward.</td>
<td>14</td>
<td>3</td>
</tr>
<tr>
<td>tendencies – may skip after the first patient.</td>
<td>6</td>
<td>0</td>
</tr>
</tbody>
</table>

Items generated by the nominal group technique with the question: “In your opinion what are the advantages and disadvantages of learning in Second Life compared with other methods?”
### Table 4. Items generated by nominal group technique that are important when learning in Second Life (Group 2).

<table>
<thead>
<tr>
<th>Suggested item (n=30)</th>
<th>Number of votes</th>
<th>Number of participants scoring item</th>
</tr>
</thead>
<tbody>
<tr>
<td>Second Life can be vandalised.</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Negative view about Second Life.</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Potential to become over dependent on e-learning methods.</td>
<td>12</td>
<td>3</td>
</tr>
<tr>
<td>Students may use Second Life too much stopping them from interacting in real world.</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Can’t ask specific questions during history taking.</td>
<td>24</td>
<td>4</td>
</tr>
<tr>
<td>Can’t use advantage over other forms of e-learning.</td>
<td>22</td>
<td>3</td>
</tr>
<tr>
<td>Bridges gaps between lecture and hospital – framework for years prior to clinical practice.</td>
<td>23</td>
<td>6</td>
</tr>
<tr>
<td>Too simple to teach diagnostic skills, more complicated scenarios needed, should allow you to make mistakes.</td>
<td>56</td>
<td>7</td>
</tr>
<tr>
<td>No control over spending money in Second Life.</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Potential to learn blood results.</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>Bugs in system, slow running of programme.</td>
<td>13</td>
<td>2</td>
</tr>
<tr>
<td>Useful for EMQs.</td>
<td>13</td>
<td>3</td>
</tr>
<tr>
<td>Useful for platform for older students to help.</td>
<td>9</td>
<td>2</td>
</tr>
<tr>
<td>Wider variety of cases – bank of cases abnormal presentation.</td>
<td>35</td>
<td>6</td>
</tr>
<tr>
<td>Easy to monitor what people do.</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Motivation when Imperial is exploring new methods of learning.</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Aliases can be confusing to find friends.</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Chance to encounter scenarios you wouldn’t encounter in the hospital.</td>
<td>47</td>
<td>7</td>
</tr>
<tr>
<td>Seems more fun and interactive like playing a game.</td>
<td>16</td>
<td>5</td>
</tr>
<tr>
<td>Makes you think about the tests you order.</td>
<td>43</td>
<td>7</td>
</tr>
<tr>
<td>Takes a lot to get used to the controls.</td>
<td>14</td>
<td>2</td>
</tr>
<tr>
<td>Only the person buying the tests sees the results. Results can’t be shared.</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Not realistic, don’t practice communication skills.</td>
<td>45</td>
<td>7</td>
</tr>
<tr>
<td>Don’t have to travel to hospital should make you more productive.</td>
<td>17</td>
<td>3</td>
</tr>
<tr>
<td>Scenarios make you remember / learn better.</td>
<td>25</td>
<td>3</td>
</tr>
<tr>
<td>Combines all the elements of diagnosis in one programme, history, exams, etc.</td>
<td>14</td>
<td>4</td>
</tr>
<tr>
<td>Sound bleed in different patients.</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Explanations about results are good.</td>
<td>32</td>
<td>3</td>
</tr>
<tr>
<td>Procrastination in team/group work.</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Can work in groups.</td>
<td>11</td>
<td>3</td>
</tr>
</tbody>
</table>

*Items generated by the nominal group technique with the question: “In your opinion what are the advantages and disadvantages of learning in Second Life compared with other methods?”*
Table 5. Final votes during NGT - Group 1 and Group 2.

<table>
<thead>
<tr>
<th>Suggested item (a=10)</th>
<th>Number of votes</th>
<th>Suggested item (a=10)</th>
<th>Number of votes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Useful as reinforcement of other teaching.</td>
<td>27 L</td>
<td>Too simple to teach diagnostic skills, more complicated scenarios needed, should allow you to make mistakes.</td>
<td>56 C</td>
</tr>
<tr>
<td>Integrates learning that is not covered in other way, e.g. breath sounds and other things not always taught together.</td>
<td>22 L</td>
<td>Chance to encounter scenarios you wouldn’t encounter in the hospital.</td>
<td>47 C</td>
</tr>
<tr>
<td>Very easy to use in own time, anywhere.</td>
<td>21 T</td>
<td>Not realistic, don’t practice communication skills.</td>
<td>45 C</td>
</tr>
<tr>
<td>Break from other formats of learning.</td>
<td>20 L</td>
<td>Makes you think about the tests you order.</td>
<td>43 C</td>
</tr>
<tr>
<td>Predictable – removes thought process, becomes mechanical process.</td>
<td>19 L</td>
<td>Wider variety of cases – back of cases, abnormal presentation.</td>
<td>35 C</td>
</tr>
<tr>
<td>Structured way to learn – Framework for learning.</td>
<td>19 L</td>
<td>Explanations about results – good.</td>
<td>32 C</td>
</tr>
<tr>
<td>Would be better for clinical beginners – helps structure thinking.</td>
<td>17 C</td>
<td>Scenarios – make you remember / learn better.</td>
<td>25 L</td>
</tr>
<tr>
<td>Restrictive choice of tests/no option to add new investigations (limited capacity to make mistakes).</td>
<td>16 C</td>
<td>Can’t ask specific questions during history taking.</td>
<td>24 L</td>
</tr>
<tr>
<td>Reduces the doctor/patient relationship and associated skills – antisocial.</td>
<td>15 C</td>
<td>Bridges gaps between lecture and hospital – framework for years prior to clinical practice.</td>
<td>23 L</td>
</tr>
<tr>
<td>Does not prepare for experiences on the ward.</td>
<td>14 C</td>
<td>Can’t see advantage over other forms of e-learning.</td>
<td>22 L</td>
</tr>
</tbody>
</table>

Items groups according to the following areas:
Learning Experience: L
Clinical Exposure: C
Technical Experience: T

CONCLUSION

Consensus of these student groups has established 20 items to be considered for the delivery of virtual patients following a game-based learning model in Second Life. With increased educational research investigating interventions to evaluate the educational advantages of virtual worlds, such an instrument will be critical for the non-biased qualitative analysis of these learning environments.

It is clear from the group items generated that there are mixed opinions about how useful they find learning in this way and no major technical issues were found. On the other hand, the clinical experience was found to be too simple for the delivery of virtual patients at Year 3 undergraduate medicine level, suggesting the delivery of this type of virtual patients should be aimed at earlier years in the undergraduate medical curriculum. More challenging scenarios following a branching model and a ‘responsive environment’ that does not necessarily follow one right path (Murray, 1997; Begg 2007), should be constructed to target higher level cognitive skills at more advanced clinical years. Further thought needs to be given to the type of clinical scenarios and skills acquisition best
suited to this form of learning. This may involve scenarios where students can select investigations or interventions which could cause harm in real life such that experience can be obtained without risk. Role-play - multi-user game-based learning activities may also be developed in which students could work together, with their responses affecting the overall learning experience of the group. This approach would challenge more advanced medical students in their diagnosis processes emphasizing communication and Inter professional skills. This model would also exploit the multi-user capacity presented in virtual worlds.

REFERENCES


Students’ Perceptions about Delivery of Game-Based Learning for Virtual Patients in Second Life


