UNIVERSITI PUTRA MALAYSIA

DESIGN AND DEVELOPMENT OF A MULTI-USER VIRTUAL LEARNING ENVIRONMENT USING SECOND LIFE AND EFFECTIVENESS IN IMPROVING RESIDENTS A CHIEVEMENT AND KNOWLEDGE RETENTION

RICHARD HARI CHANDRA PANY

FBSB 2012 44

DESIGN AND DEVELOPMENT OF A MULTI-USER VIRTUAL LEARNING ENVIRONMENT USING SECOND LIFE® AND EFFECTIVENESS IN IMPROVING RESIDENTS ACHIEVEMENT AND KNOWLEDGE RETENTION

By

RICHARD HARI CHANDRA PANY

Thesis Submitted to the School of Graduate Studies, University Putra Malaysia, in Fulfilment of the Requirement for the Degree of Doctor of Philosophy

January 2012

Abstract of thesis presented to Senate of University Putra Malaysia in fulfilment of the requirement for the degree of Doctor of Philosophy

DESIGN AND DEVELOPMENT OF A MULTI-USER VIRTUAL LEARNING ENVIRONMENT USING SECOND LIFE® AND EFFECTIVENESS IN IMPROVING RESIDENTS ACHIEVEMENT AND KNOWLEDGE RETENTION

By

RICHARD HARI CHANDRA PANY

JANUARY 2012

Chairman: Associate Professor Suhaimi bin Napis, PhD

Faculty: Biotechnology and Bimolecular Sciences

The recent development of digital tools has spurred educators to think differently about how they teach and how they can use computers in their classrooms. The concept of Multi-User Virtual Environments (MUVEs) has opened new avenues in the educational spectrum. The use of virtual worlds, in particular Second Life, in higher education has been the focus of study, in evaluating the value of Second Life in a hybrid implementation of forensic science course. This thesis is based on such an experiment carried out where students in an Introductory Forensic Science module use Second Life as their platform. Both quantitative and qualitative investigation processes provide the researcher with different ways of operationalizing and measuring theoretical constructs and practical concepts. Quantitative methods ensured high levels of reliability of gathered data on the students' achievement and knowledge retention. Qualitative research allowed for obtaining more in-depth information about how the students

engagement level using Second Life as a platform. The findings are based on data collected from student surveys, student interviews, test scores and observations collected over the course of the experiment. The majority of the students acknowledged the value of Multi-User Virtual Environment in Second Life and demonstrated improved engagement and learning in many instances through detailed experiences, higher achievement scores and retention of the subject matter. The conclusions of the study suggest that the combination of MUVEs' features and strengths will eventually influence the educators to accept the MUVE as an educational tool, although several areas of concern are identified. Future growth in the educational uses of MUVEs is examined, the implications and limitations of the study are discussed, and ideas for future research are elaborated on.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Doktor

DESIGN AND DEVELOPMENT OF A MULTI-USER VIRTUAL LEARNING ENVIRONMENT USING SECOND LIFE® AND EFFECTIVENESS IN IMPROVING RESIDENTS ACHIEVEMENT AND KNOWLEDGE RETENTION

Oleh

RICHARD HARI CHANDRA PANY

JANUARY 2012

Pengerusi: Profesor Madya Suhaimi bin Napis, PhD

Fakulti: Bioteknologi dan Sains Biomolekul

Pembangunan alat digital pada masa kini telah mendorong para pendidik untuk berfikir secara berbeza tentang bagaimana mereka mengajar dan bagaimana mereka boleh menggunakan komputer di dalam kelas. Konsep Multi-Pengguna Persekitaran Maya (MUVE) telah membuka peluang baru dalam spektrum pendidikan. Penggunaan dunia maya dengan "*Second Life*" dalam pendidikan tinggi telah menjadi tumpuan kajian, untuk menilai platform *'Second Life'* dalam pelaksanaan kursus hibrid sains forensik. Tesis ini adalah berdasarkan kepada satu eksperimen yang dijalankan bagi pelajar dalam modul Sains Forensik dengan memperkenalkan penggunaan "Second life" sebagai platform mereka. Kedua-dua proses penyiasatan kuantitatif dan kualitatif menyediakan pengkaji tentang cara yang berbeza operasinya dan mengukur pembinaan teori dan konsep yang praktikal.

Kajian kuantitatif memastikan tahap kebolehpercayaan yang tinggi bagi data yang dikumpulkan terhadap pencapaian pelajar dan pengekalan pengetahuan. Penyelidikan kualitatif digunakan menjadi asas untuk mendapatkan lebih maklumat yang mendalam tentang tahap penglibatan pelajar yang menggunakan Second Life. Penemuan ini adalah berdasarkan data yang dikumpul daripada kaji selidik pelajar, temubual pelajar, skor ujian dan pemerhatian yang dikutip sepanjang eksperimen. Majoriti pelajar mengakui nilai Pelbagai Pengguna Pembelajaran Maya dalam "Second Life" dan menunjukkan penglibatan dan pembelajaran yang baik dalam banyak contoh melalui pengalaman terperinci, skor pencapaian yang lebih tinggi dan pengekalan perkara subjek. Kesimpulan kajian menunjukkan bahawa kombinasi ciri-ciri dan kekuatan Pelbagai Pengguna Pembelajaran Maya akhirnya akan mempengaruhi pendidik menerima sebagai alat dalam pengajaran mereka dimana beberapa bidang telah dikenal pasti. Pertumbuhan masa depan dalam penggunaan pendidikan Pelbagai Pengguna Pembelajaran Maya diperiksa, implikasi dan batasan kajian dibincangkan, dan idea-idea untuk kajian akan datang akan diperkembangkan.

ACKNOWLEDGEMENTS

I would like to express my deepest gratitude and respect to my main supervisor, Assoc. Prof. Dr Suhaimi Bin Napis for his professional competence and guidance throughout the research period. My sincere appreciations are also extended to my supervisory committee members, Assoc. Prof Dr Sahandri Ghani and Dr Mohd Taufik Abdullah for your excellent advice and constructive suggestions in helping to shape my project and thesis. My thanks goes to Andrew Cezar, Yap Thiam Boon and Tan Kheng Tat for their assistance, support and suggestion in the design and development of Project CSI Second Life. My thanks to the participants in this research study for their participation and providing the relevant feedback and suggestion.

My special thanks also to my lovely wife, Asong Ngau for your expertise, inspiration, and time you gave to help complete this research project. You have been my pillar throughout this process. Your help has been tremendous and greatly appreciated. Thanks to my daughter, Esther Sonia Pany, my parents and my family for being so supportive and encouraging. Finally, my thanks to God Almighty for making this dream possible.

TABLE OF CONTENT

		Page
ABSTRACT		ii
ABSTRAK		iv
ACKNOWLEDGEMENTS		vi
APPROVAL		vii
DECLARATION		ix
TABLE OF CONTENT		x
LIST OF TABLE		xiv
LIST OF FIGURES		xvi
CHAPTER		
1	**INTRODUCTION**	1
	1.1 Overview	1
	1.1.1 Virtual worlds	5
	1.1.2 Integrating virtual worlds in biotechnology	7
	1.1.3 Project CSI: Second Life	9
	1.2 Background of the study	11
	1.3 Statement of the problem	13
	1.4 Objectives	14
	1.5 Research questions	15
	1.6 Hypothesis	16
	1.7 Significance of the study	17
	1.8 Limitations of the study	19
	1.9 Assumptions	20
	1.10 Definition of Terms	20
	1.11 Organisation of the thesis	22
2	**LITERATURE REVIEW**	25
	2.1 Overview	25
	2.2 Background	28
	2.3 Theoretical basis for the use of technology in education	32
	2.3.1 Learner autonomy	36
	2.3.2 Engaged learning model	41

	2.3.3 Theoretical approaches to learning	45
	2.3.4 Designing for engagement	48
2.4	Virtual communities	51
	2.4.1 Characteristics of virtual communities	51
	2.4.2 Types of virtual communities	53
2.5	Virtual worlds	54
	2.5.1 Virtual world designs	55
	2.5.2 The significance of using virtual worlds	58
	2.5.3 The virtual world solution in education	59
	2.5.4 Collaboration in virtual world	62
	2.5.5 Second Life as a learning environment	64
2.6	Forensic science & virtual world learning	68
	2.6.1 Diffusion of virtual worlds in education	70
	2.6.2 Innovation	71
	2.6.3 Theoretical Framework	73
	2.6.4 Conceptual Framework for Learning in Project CSI	76
2.7	Challenges of using virtual worlds in education	79
2.8	Conclusion	82
3	**RESEARCH METHODOLOGY**	84
3.1	Overview	84
3.2	Study Design	88
3.3	Introduction To Internal and External Validity	91
3.4	Selection of Samples	91
	3.4.1 Study location	91
	3.4.2 Participants of the study	92
	3.4.3 Duration of experiment	93
3.5	Field Work	95
	3.5.1 Pre test data collection	96
	3.5.2 Instrumentation	97
	3.5.3 The treatment	100

		3.5.4 Post test data collection	103
		3.5.5 Summary of study instruments	106
	3.6	Pilot study of Project CSI	109
	3.7	Data collection & analysis	110
		3.7.1 Quantitative analysis technique	112
		3.7.2 Qualitative analysis technique	114
	3.8	Conclusion	114
4	**PROJECT CSI SECOND LIFE**		117
	4.1	Overview	117
	4.2	Exploratory Study	118
		4.2.1 Data collection in exploratory study	119
		4.2.2 Participants and apparatus	123
		4.2.3 Procedure	123
		4.2.4 Analysis of exploratory study	125
		4.2.5 Interpretation according to activity theory	126
		4.2.6 Incidents caused by technical problems	128
		4.2.7 Incidents caused by observer intervention	129
		4.2.8 Incidents caused by system feedback	131
		4.2.9 Interpretation according to activity theory	133
		4.2.10 Summary	136
	4.3	The design and development of Project CSI	137
		4.3.1 Virtual world for biotechnology learning	140
		4.3.2 Design aims	142
		4.3.3 Description of the virtual environment	146
		4.3.4 Project CSI Second Life Development Model	146
		4.3.5 Technology and standards	168
		4.3.6 General specifications of Second Life	173
		4.3.7 The Evolution of Project CSI Second Life	178

5	**ANALYSIS OF DATA**		182
	5.1	Overview	182
	5.2	Method	182
		5.2.1. Method design	184
		5.2.2. Applied method	185
		5.2.3. Project CSI Second Life learning environment	186
		5.2.4. Procedure	186
	5.3	The Results	187
		5.3.1 Research Question 1	188
		5.3.2 Research Question 2	191
		5.3.3 Research Question 3	196
		5.3.4 Research Question 4	202
		5.3.5 Research Question 5	203
		5.3.6 Research Question 6	205
	5.4 Summary		209
6	**DISCUSSIONS, CONCLUSION & RECOMMENDATIONS**		211
	6.1	Overview	211
	6.2	The problem	212
	6.3	Importance of the study	213
	6.4	Main contributions	214
		6.4.1 Methodological Contributions	215
		6.4.2 Learning Contributions	217
		6.4.3 Practical Contributions	218
	6.5	Summary of the findings	220
	6.6	Further Research	222
	6.7	Concluding remarks	223
BIBLIOGRAPHY			225
APPENDICES			244
BIODATA OF STUDENT			482

LIST OF TABLES

Table		Page
1.1	Issues investigated in the study	11
2.1	The favourable and unfavourable of Using Second Life as a platform	65
3.1	Study Design	89
3.2	Sample Distributions of Students	93
3.3	K-chart of the treatment duration of the study	94
3.4	Reliability Statistics Using Cronbach Alpha	99
3.5	Study Instrument for Effectiveness Evaluation of Project CSI	106
4.1	Summary of Project CSI Second Life Development Phases	166
4.2	Project CSI Second Life supported standards and technologies	168
4.3	3rd Party Software Tools Used in the Development of Project CSI Second Life	169
5.1	Layout of the test procedure	184
5.2	Skills Selection by the user survey (Observed Frequencies)	189
5.3	Favorite Type of Computer Games as noted on the user survey	190
5.4	The Most Important Factors in Attitude towards Difficulty in Learning Biotechnology (Observed Frequencies)	191
5.5	The Most Important Factors in Attitude towards Project CSI Second Life (Observed Frequencies)	192
5.6	The Most Important Factors in Attitude towards Project CSI Second Life (Observed Frequencies)	194

5.7 The Most Important Factors in Attitude towards Project CSI Second Life (Observed Frequencies) 196

5.8 Comparison of the Test Scores between the Experiment Group and the Control Group Using Independent samples t-test (Pre-test vs Post-test) 203

5.9 Comparison of the Test Scores between the Experimental Group and the Control Group Using Independent samples t-test (Pre-test vs Delayed Post-test) 204

5.10 Comparison of the Test Scores between the Experimental Group and the Control Group Using Independent samples t-test (Post-test vs Delayed Post-test) 205

LIST OF FIGURES

Figure		Page
2.1	Students Engagement Model by Stevens & Robins (2009)	49
2.2	Four key functions of a virtual learning community	52
2.3	Teachable Moments by Leon & Fisher (2006)	57
2.4	Diffusion of innovation model	71
2.5	The essential elements of Activity Theory and their inter-relationships	75
2.6	Conceptual Framework	77
3.1	Workflow of the research methodology	115
4.1	The DNA Electrophoresis Process Storyboard	120
4.2	A general activity system diagram illustrating the relationship between subjects (S), subject (O) and Tool (T) for the exploratory study	127
4.3	A general activity system diagram extended to include the relationship between the three main components (S, O, T) and the Rules (R), C(the observer in this exploratory study) and Division of Labour (DL)	128
4.4	An activity system illustrating the observer's intervention in resolving the contradiction	129
4.5	Activity theory: A problem between the Subject's understanding of the Rules and the use of a different rules set (Ro – rules old; Rn – rules new)	130
4.6	Activity theory-S2 understands of the Rules (R1) and self-reassessment (R2)	132
4.7	Project CSI Second Life Conceptual Model	138
4.8	Project CSI Second Life Development Framework	151
4.9	Project CSI Second Life Lifecycle Model: Analysis Phase	152
4.10	Project CSI Second Life Lifecycle Model: Design Phase	156

4.11	Project CSI Second Life Lifecycle: Development Phase	161
4.12	Project CSI Second Life Lifecycle Model: Implementation Phase	164
4.13	Project CSI Second Life Lifecycle Model: Evaluation Phase	165
4.14	Second Life Viewer 1 interface	170
4.15	Second Life Viewer 2 interface	171
4.16	The development tool box in Second Life Viewer 2	171
4.17	The compiler of Second Life Viewer 2	172
4.18	System Framework of Project CSI Second Life	181
4.19	Pie Chart of Computer Games Skills of Project CSI Students	189

CHAPTER ONE

INTRODUCTION

1.1 Overview

The rapid growth and evolution of technology has seen many institutions of higher learning in Malaysia enhance the student learning experience by integrating technology in their teaching methods. Raja Maznah (2004) commented that most public universities in Malaysia have some form of strategic plan for implementing pure electronic university. During the last few years, many important changes have occurred in the education systems in Malaysia, which require educators to upgrade and refine their technology skills (Nurhizan Abdul Manab and Azman Othman, 1999). Some of these changes are due to changes in government policies related to the use of information technology (IT) while others are due to developments in state of the art pedagogical practices. Others are due to the continual advancements in technological products and systems themselves, both the hardware and the software. Malaysia has been working hard for the last few years to develop policies and strategies for education institution of higher learning and schools to infuse technology into their learning content. The reasons for these efforts are not difficult to understand: a nation's economic success in the 21st century will be linked to how well it can adopt and thrive in a global IT environment. The need for knowledge workers and the need to become a developed nation place tremendous responsibilities onto institutions of learning and educators to prepare their children to meet global technological changes. In preparing students for their role in society, the Malaysian Ministry of Education and Higher Education has identified

technology along with literacy and communication, problem solving and human relations as a foundation skill area to be developed in every subject (Abdul Rahim, 2001). Some technology-minded lecturers have been using technology in the form of computer-aided learning presentation systems, or as a research tool. Given the rapid pace of technological innovation, however, others may lack the necessary skills and training to transfer the use of technology to learning outcomes (Antonnaci and Modaress, 2008). With the current advancement of integrated circuits and chipsets, computers today are far more interactive than they once were (Kristof and Satran, 1995). A decade ago, technologies available to classroom teachers included slides, tapes, videos, and multi-image presentation equipment (Jonassen, Peck and Wilson, 1999), but these media have evolved and are now available digitally. Computers are now used as a compulsory teaching tool and as an instructional medium. According to Jonassen et al. (1999), the computer now has the ability to capture, synthesise and manipulate multimedia effects and integrate them into a single presentation that will better engage students.

The emergence of new technologies, such as three-dimensional (henceforth 3D) virtual worlds (i.e., *Second Life* or *Active World*), creates new opportunities for teaching and learning. In addition, these virtual worlds reinforce the wider strategic drive in education towards a more personalised style of learning, which is tailored to the individual learner's needs (De Freitas and Roberts, 2005; West-Burnham, 2005) and greater learner autonomy. Since learning depends on the way technologies are used, and so much not the technologies themselves (Clayon, Horn and Johnson, 2008), educationalists must design lessons that integrate technologies into the learning environment, in such a way that it exploits all instructional innovations available at the time. It is the powerful visual,

auditory and tactile (haptic) impact of "multimodal virtual environments" (Garcia-Ruiz et al., 2003) like Second Life that can aid learning, in terms of programming behaviours into objects (Esteves, Fonseca, Morgado and Martins, 2009). In addition, Garcia-Ruiz, Edwards and Santos (2007) stated that the use of simulation technology in these virtual worlds for educational purposes can also offer the following benefits:

i. The reification of abstract concepts to make them more explicit and concrete (Winn, 1993);

ii. The transduction of information present in more than one sensory channel (Winn, 1993; Garcia-Ruiz et al., 2003);

iii. Manipulating the scale of scientific information, so that micro- and macroscopic concepts can be better explained (Winn, 1993); and

iv. Allowing the user intrinsic and extrinsic views of the virtual environment, to obtain extra details while inspecting a problem space (Dede and Ketelhut, 1998).

With virtual simulation, an area of the physical classroom or training area can be transformed to resemble an actual target environment (i.e., a crime scene or a laboratory), with materials similar to what one would find in that setting; but at present, few resources exist to provide such simulations (Wall and Ahmed, 2007). To combat this insufficiency, a more recent development in the area of simulated interactions utilises classroom or home computers to deliver learning that simulates these real-life learning environments, such as Virtual World or Multiple User Virtual Environment (MUVE).

Scholarly research to date about using virtual worlds as an educational tool in higher education has primarily consisted of qualitative case studies and instructional essays (Antonnaci and Modaress, 2005; Calogne and Hiles, 2008; Cheal, 2007; Childress and Braswell, 2006; Mannes, 2006; Conklin, 2008). A review of the literature suggests that only a handful of quantitative research studies have been conducted regarding how educators of higher learning use Second Life. In a survey study comparing identical courses taught using traditional face-to-face methods versus Second Life, Lester and King (2006) found that, overall, students in both courses reported that "they enjoyed the experience, and they appeared to learn the information on a comparable basis" (p. 22). A content analysis by Jennings and Collins (2007), focusing on post-secondary institutions as the unit of analysis, provided descriptive insights into the population of Second Life by higher education institutions, as well as the various ways virtual land is used by these institutions of higher learning. It also provided the beginnings for applying Rogers's diffusion of innovations theory to the use of Second Life as an education tool. This study expands the application of diffusion theory by tying its theoretical constructs to specific survey measurements from individual respondents. A project by New Media Consortium (NMC) completed in 2007, provided a great deal of raw data collected on demographics, experience levels using Second Life and other technologies, uses of Second Life, and personal and professional satisfaction with Second Life (NMC, 2008). However, the NMC study provides no analysis or interpretation of its data, and it includes among its respondents students, administrators, librarians, and instructors. In contrast, the study concentrates only on post-secondary instructors as the unit of analysis, and moves beyond raw data to provide a detailed analysis of the findings based on Rogers's theory. Moreover, whereas the NMC survey is conducted by means of an

greater autonomy over their learning. With the current ubiquity of these virtual world environments, research in this area is necessary to understand its dimensions. What also warrants study is the inevitable merging of virtual worlds with the discipline of Information Systems (IS), which offers valuable insights on the design, development and management of a multi-user environment, in both corporate and consumer contexts. As Mennecke et al. (2008) states that the time is at hand for scholars and professionals to begin systematic research on virtual worlds, since it represents the best way to ignite interest in virtual world environments.

In addition, virtual worlds are also gaining in popularity amongst the general public, especially the younger generation, which is evident in the hundreds of publicly accessible virtual worlds already in existence. Virtual worlds exist for all age groups—while *Second Life* is primarily built for adults, Disney's *Virtual Magic Kingdom* is targeted to those aged 8 to 14. These virtual worlds are classified in the domain of online multiplayer games called Massively Multiplayer Online Role-Playing Games (MMORPGs). The game known as *Second Life* is a subtype of MMORPG, effectively tagged MUVE. The growth of MMORPGs has been phenomenal over the last decade—as of 2008, there are almost 12 million unique avatar (in-game representation) accounts for *Second Life* (Mennecke et al., 2008). Besides visual animation, 3D MUVEs also provide users with simulation and role playing opportunities and even social communities such as Facebook and MySpace, which enable users to interact with each other. In short, virtual worlds have the features and functions of an interactive game environment, where one's avatar engages in or responds to a myriad of activities. Yee (2006) states that users usually react to the spatial settings of the virtual environment

positively due to the manner it imitate the real world. He also notes that research on spatial issues—i.e., tele-presence and haptic interface links to virtual worlds—has been ongoing over the last two decades, primarily focused on issues related to user interface, perception and learning. Knoll (2007) meanwhile, adds that there is literature focusing on user experience in virtual worlds.

Second Life do not only provide information on user experience or network-based infrastructures, but also on social, economic and organisational issues that extend beyond the individual user, such as in the areas of public policy, economics and law—so much so that a number of studies have begun to address legal, ethical, taxation and economic issues pertaining to virtual worlds (Castronova 2001, 2006; McInnis et al., 2000; Malaby, 2006; Mennecke et al., 2008). MUVEs can thus be seen to open up a great deal of research opportunities in the social sciences. Castronova (2006) implied large multiplayer online games as "social science research tools on the scale of the super colliders use by physicists." Thus, it will provide researchers with information and knowledge on MUVE behaviours, economics, social dynamics, legal, government policies and a host of other research areas. The number of these research areas is growing rapidly, since the evolution of these virtual worlds involves embedding with more and more systems, which will only expand its capabilities.

1.1.2 Integrating virtual worlds in biotechnology

Technologies associated with biotechnology and biomolecular science, such as recombinant DNA technology, have proven to be a crucial aspect of scientific

revolutions in this decade. Biotechnology can undoubtedly improve the quality of human life, but it does present some ethical problems. As such, it is important that people understand the concepts behind recombinant DNA technologies - not just its practitioners for the purposes of career advancement, nor just the general public, for the impact of these technologies on their daily lives, but also tertiary level students, who will be called upon in the future to resolve challenges associated with biotechnology. A number of studies show that tertiary students do not possess a consistent analysis dealing with biotechnology theories (Stencel, 1995; Eckdahl, 1999), such as 'DNA, 'central dogma' and 'DNA manipulation, as well as the students' interactions during the study of molecular biology according to researchers such as Jenkins (1987); Malacinski and Zell (1996); Bohrer (1997); Wagner (1998); Kirkpatrick et al.,(2002). Tertiary students are familiar with the term 'biotechnology' or 'recombinant DNA', but have difficulties expressing the difference between the two. The students also encounter problems when faced with certain issues, such as visualising DNA structures, replication, central dogma, protein synthesis, and the techniques of DNA cloning. Lectures with no pedagogical applications resulted in unsatisfactory results – students lacked the motivation to learn as they find the classroom environment inadequate as an active learning process (Melmed and Glennan, 1995). This contradicts current cognitive theories which regard students as playing an active role in the learning process. New learning methods, such as cooperative learning, will assist tertiary students in overcoming their learning problems and be independent learners (Khairiyah Mohd.Yusof and Mimi Haryani Hassim, 2003). Integrating methods such as these into virtual world environments for educational purposes, in effect turning them into what Wehmeyer (1999) terms "assistive technologies," where interaction with technology increases individual participation, can

be the answer to this inadequacy. However, merely making virtual world technologies available to both lecturers and students will neither ensure that students will learn more nor that the technology will be used effectively; Cuban (2001), for instance, states that poor technology implementation has not produced the desired effects on learning.

This does not mean, of course, that research in virtual world environments should cease altogether, as their theories are important in the field of instructional learning; yet there remains a dearth of research in the successful implementation of virtual world environments in education (Hew and Brush, 2007). This is unfortunate because it is clearly evident what technology has in store for the education community, and ceasing research on virtual world technology will be done as the expense of meeting the changing needs of students. Seeing as student-centred learning is still a major criteria in the design of teaching methods, research on different virtual world environments should ideally be carried out to support various pedagogies (Roush, 2007). A number of frameworks and structures for designing and developing a multimedia system already exist, but not so for virtual world environments in education. Thus, more research is required to provide more direction on the effective use of virtual worlds in developing learning materials for the laboratory and classroom, particularly, with regards to the present study, in the field of forensic science.

1.1.3 Project CSI: Second Life

In response to the deficiency of 3D Multi-User Virtual Environment training materials and barriers of successful integration of ICT as noted by Bimgimlas (2007), the School of Biotechnology of INTI International University, Malaysia, with the support and

professional advice of Kimia Malaysia, agreed that the researcher to develop a MUVE using *Second Life* as a platform, known as *Project CSI: Second Life.* This instructional MUVE was designed to teach and equip individuals with skills required to engage in the basics of forensic science successfully, as well as the skills needed for possible employment as a CSI Investigator. *Project CSI* begins with an introduction by an avatar, which is intended to gain the attention of students and to provide video anchors or machinima for later skills training. They depict a fictional crime scene investigator, whose goal is to uncover evidence during the investigation phase. They are then required to analyse their findings and reveal the suspect. *Project CSI Second Life* is designed in the style of an interactive investigation phase in a virtual world, where learners can progress through the story of a crime scene investigation, and the study guide storyline is interspersed with multiple examples that demonstrate the skills required for a successful solving of a case. These examples address the areas of DNA, nucleic acids, literacy, investigation skills, and the job skills needed to work as a crime scene investigator. In addition to these models, simulated activities contained in the virtual learning environment enable users to practice the aforementioned skills in highly graphic realistic settings. While engaged in these virtual activities, the learners receive feedback and guidance from the virtual support group. *Project CSI Second Life* was designed and developed by the researcher in the field of biotechnology and uses instructional pedagogy. Recommendations of using a virtual learning environment has been suggested for INTI International University but questions remained on whether the implementation can be successfully carried out by lecturers and other involved in this field. Table 1.1 summarises the issues investigated in this study:

Table 1.1: Issues investigated in the study

Issues	*Criteria*
Development	Advantages of multi-user virtual learning
	Disadvantages of multi-user virtual learning
	Pedagogical considerations
	Delivering virtual learning
	Designing virtual learning (*Project CSI: Second Life*)
	Implementation of virtual learning
	Issues surrounding tests and feedback from students
Research	Subject preferences of learners
	Literature and methodology review
	Issues regarding traditional lectures
	Issues regarding laboratory practicals
	Issues regarding static multimedia computer presentations
	The use of the virtual learning in *Second Life*
	Learner suggestions
	Learner profiles
	Suggestions for the presentation of a full virtual learning course

1.2 Background of the study

According to Young (1998), students have a strong desire of the need to study and thereby understand the natural world environment, but conversely, many of them often consider science to be something which is not important in their daily living. Being instructors, great effort should be undertaken to connect students in their scientific

exploration. This is done so that students can identify with concepts as well as understand the value of the nature of science at work. Forensic science is one domain that engages students in the scientific environment and assists those students to think like a scientist and be good in problem solving skills (Williams, Ebert-May, Luckie, Hodder and Koptur, 2004). Technology development has now evolved tremendously and the implementation of forensic science is of extreme importance to the criminal justice system (Asplen, 1999; Freedman, 1997). Television series such as *CSI: Crime Scene Investigation* (henceforth CSI) have popularised and catapult the importance of this branch of science among the general public. Although this newfound popularity tends to romanticise the science itself (Willing, 2005; Deutsch, 2006), it nevertheless provides educators with an opportunity to tap into students' interest in science.

Seeing as forensic science is gaining in popularity, many institutions of higher learning such as University Technology Malaysia, University Sains Malaysia, Management & Science University, Taylors University, UCSI University, INTI International University and others now offer courses in forensic science and biotechnology, with new curricula being swiftly drawn up to lure students into these institutions. Virtual world environments are ideally suited to be integrated into these new curricula, even if studies concerning its applications are still in its infancy. Engaging students in a virtual world environment has its advantages, as Hansen (2008) noted that students are able to dynamically inter-relate with the content and role playing skills related to their profession. Hansen (2008) also stated that in presenting students with time to interact with other avatars, a secured, simulative environment, a reduction in anxiety and apprehension, increase in proficiency in learning, acquisition of new skills and ability to cooperate and collaborate and to resolve conflicts is possible. She also stated that

learners can actively interact with the content and role-playing skills associated with their profession, in a safe and stimulating environment, which encourages not only self-reflection, but also cooperation, conflict resolution, and the learning of new skills. With regards to the present study, the gaming component of MUVEs, as well as the fact that it is easily accessible via web browsing, will motivate students to log in and to engage in collective intelligence.

1.3 Statement of the problem

The implementation of community-based instruction for sciences, however, can be costly (Gardner et al. 1999). The amount of time required to work with each student may be too much for the teacher and staff. Just as overwhelming can be the complicated logistics and scheduling necessary to transport the students to the instructional setting on a frequent enough basis to meet their learning needs. Finally, the cost of transportation, staff, and other materials needed for learning may be more than the school's budget allows. One potential solution to these problems is classroom simulations of community interactions. In this type of learning, an area of the physical classroom or learning area is transformed to resemble the actual target environment (such as a forensic science laboratory) with equipments that are realistic to what students would find in that setting (Antonacci and Modaress, 2005). Although this training allows students to practice valuable real-life skills, unfortunately few resources exist to provide such classroom or laboratory simulations (Langford et al, 2006). To combat this problem, a more recent development in the area of simulated community interactions utilizes the web (Multi-User Virtual Learning Environment) to deliver learning that simulates these real-life

learning environments (Kim et al., 2008; Richter, 2007; Anderson and Elloumi, 2004). With virtual world environments, users are able to participate in real-world experiential learning activities that consist of synchronous and rich media elements. Multi-User Virtual Environment allows for an increased number of meaningful trials for each skill, while reducing the number of trips required to the actual target environment (such as the Forensic Science Laboratory). Hansen (2008) stated that the features of the virtual worlds are captivating, role-playing opportunities, simulation, personal interaction with technology and the power it possess on formative and cumulative learning all of which are areas that require further investigation.

Although the literature on using virtual world technologies to teach in the classroom is limited, literature has begun to show that the 3D MUVE technology can indeed be a supplement for traditional community-based instruction curriculum for sciences (McInnis, James and Hartley, 2000; Pham et al., 2008 Moore, Fowler and Watson, 2007; Collins and Jennings, 2007; Lester and King, 2008; Roberts, Kelly and Medlin, 2007). Even so, additional research is needed to judge the effectiveness and efficiency of implementing interactive Multi-User Virtual Learning technology activities with individuals that would enable them to increase their engagement level and thus, improve their achievement scores and knowledge retention.

1.4 Objectives

In order to explore the potential of using Second Life in Introductory Forensic Science education as a tool for teaching and learning, the following study has been developed to investigate how a small group of students can use Second Life as a computer-mediated tool for communication with their tutor and peers in a Second Life platform. The study

was produced out of a real learning situation – the Second Life 3D Multi-User Virtual Environment possesses high perceptual qualities obtained from the spatial attributes that give the sense of being 'in a place' and provides a rich context of the activities that take place in it. It presents an opportunity for teaching and learning to be engaged remotely via both text-based and interactive 3D simulative graphics. Communication in 3D MUVE's environments can also be better for some students who participate more actively while not being observed by their tutors or peers. Avatars, controlled by students in real time, contribute a human dimension to the creation of a sense of a 'real' rich learning environment in Second Life. This is meant to simulate the process of learning and provide students with a sense of realism and allow for maximum engagement with the entire learning process. Accordingly, the main objective of this study is to explore the use of Second Life in engaging a learning situation in forensic science to improve their achievement scores and knowledge retention of the subject matter.

1.5 Research questions

The guiding research questions for this study are as follows:

Q1: What are the participants' preferences, experiences and attitudes toward the Project CSI: Second Life virtual environment?

i. What did the results of the user survey reveal about the gaming experience of this sample of graduate student users?

ii. What did the results of the user survey reveal pertaining to the students' satisfaction of *Project CSI: Second Life* application?

iii. What information was revealed about the preferences, experiences, and attitudes about *Project CSI: Second Life* by the participants in the study during the focus group discussions?

Q2: Will the *Project CSI: Second Life* virtual learning application help biotechnology students improve their scores?

i. Do students' scores improve with the usage of the *Project CSI: Second Life* application?

ii. Will the *Project CSI: Second Life* Virtual Learning application help forensic science students recall information after four weeks of instruction?

iii. Was the primary intent of the selection of *Project CSI: Second Life* successfully integrated into the learning process of the students?

1.6 Hypothesis

In order to answer research question 2 (Q2, see previous section), the following null hypotheses were generated:

Hypothesis 1 ($H_0$1): There are no significant differences between the scores of Experimental Group Students and Control Group Students (Pretest□Post-test)

Hypothesis 2 ($H_0$2): There are no significant differences between the scores of Experimental Group Students and Control Group Students (Pretest□Delayed Post-test)

1.7 Significance of the study

Barab and Dede (2007) noted this view: "3D MUVE provide an important experiential space for supporting meaningful learning, and....it might behave educators to understand and leverage this powerful medium" (p. 26). Ang and Wang (2006) noted that when they develop a MUVE using Virtual Worlds, the pupils in a primary school were totally attracted, engrossed and also very quiet. They behaved quite differently compared to how they performed in traditional classes where they were very disruptive, talkative and showed no interest in lessons.

Project CSI Second Life is a unique, relevant and innovative MUVE, provides an appropriate research context for investigation in this area and a follow-up from Ang and Wang (2006). It is a learning and teaching project that uses a 3D multi-user environment to immerse students in a tertiary education in educational tasks specifically in the field of forensic science. This study was conducted as an attempt to answer the above research challenges by providing an in-depth look at how tertiary students would express themselves in an educational MUVE and to see whether there is a significant impact in improving their scores. It is hoped that there will be reports of personal experiences, with teachers and students reporting increased levels of engagement and interest in pursuing the forensic science issues outside of university. Students and teachers would conduct rich inquiry-based forensic science explorations through which they learn particular standards-based content, and at the same time develop pro-social attitudes regarding significant environmental and crime scene processing issues. Rather than just placing

work and play side-by-side, Project CSI Second Life strives to make learning fun and to show students how they can make a difference.

At the core of student activity with Project CSI is the completion of the CSI investigation. The CSI investigation is an engaging curricular task designed to be educational and entertaining. In completing the CSI investigation, students are required to participate in simulated and real world activities that are socially and academically meaningful, such as laboratory processing, researching crime scene investigation process, interviewing techniques, and developing investigative skills. Through these activities, it is hoped that the students will not only learn to use technology, but will also develop standards-based academic and communication skills as well. All of the academic activities are embedded in a secure online Second Life environment context where students explore the Project CSI 3D virtual environment, "chat" online with other students and teachers, and take part in the laboratory process – analyzing DNA, analyzing fingerprints and analyzing traces. Building on strategies from online role-playing games, Project CSI Second Life combines features used in the gaming environment with lessons from educational research on learning and motivation.

Although MUVEs have a great potential to be utilized in educational environments, the successful implementation of a MUVE is heavily reliant on the educator. Their perceptions of MUVEs will influence their acceptance decisions, as well as their teaching practice when using a MUVE. Furthermore, as the methods for educational uses of MUVEs are increasingly supported and promoted by educational and software tools providers, the outcomes of this research are relevant to current and future practice. The outcome of this study could also be used as a basis for a broader examination of educator

perceptions around the use of MUVEs in teaching; for example, a quantitative and qualitative study that would involve a group of respondents.

1.8 Limitations of the study

This project has a number of limitations that can be divided into practical limitations and research limitations. Practical limitations encompass the development, implementation and use of Second Life, and information gathered by the instruments, while the research limitations include the accuracy and interpretation of the findings. With regards to the former, it needs to be stated that this thesis is not supplementary to, but an integral part of the academic programme— because the project covered only the first four weeks of the basic biotechnology course, there was no time to repeat any topic if Project CSI: Second Life had turned out to be unsatisfactory. Therefore, the learners could not be forced to use the virtual learning environment solely, as this could be used as an excuse if they underperformed during the test. Also, it cannot be overlooked that because the students' responses to the surveys and discussion forums could be traced back to their personal records, the answers that they provided to the questions may have not been completely honest, possibly out of fear of being victimised. In addition, the study is limited to only one institution, INTI International University; if the study were conducted in more universities in different countries, the results may have varied. Results may also vary if the study were repeated with a different group of students at a later time, because every new group of students will have different levels of computer literacy, particularly in terms of familiarity with the usage of computers as a study aid, or virtual world environments.

1.9 Assumptions

The following are the assumptions underlying this study:

i. The students used in this study are undergraduate students from the School of Biotechnology at INTI International University, a private institution of higher learning in Malaysia;

ii. Instructors involved in *Project CSI: Second Life* followed the guidelines and procedures implemented in this study; and

iii. Uncontrollable variables, which include socioeconomic status, intelligence, creativity and computer literacy are equally distributed across all groups and had equal effect on treatment group scores.

1.10 Definitions Of Terms

The following are definitions of a number of terms used throughout this study:

1. *Knowledge Retention:* Knowledge retention means recalling or remembering pieces of knowledge, processes, or skills that were learned earlier in time (Semb and Ellis, 1994). In this study, it refers to the retention of knowledge that the students acquired through Project CSI Second Life where a post-test is given four weeks after Project CSI Second Life has been introduced to the students.

2. *Achievement*: Achievement is defined as success in bringing about a desired end. It is also defined as the degree of level of success in some specified or in general area (Dictionary of Behavioral Science, 1973). In this study, achievement refers to academic achievement in terms of the total scores obtained in the pre-test and post-test.

3. *Attitude:* Attitude refers to an evaluative reaction to some referent or attitude object, inferred on the basis of the individual's beliefs or opinions about the referent (Gardner, 1985). In this study, attitude refers to the degree of affect associated with Project CSI Second Life; i.e. attitude is the emotional disposition towards Project CSI Second Life (the value of various components of Project CSI Second Life).

4. Satisfaction: Kotler and Clarke (1987) define satisfaction as a state felt by a person who has experience performance or an outcome that fulfill his or her expectation. Satisfaction is a function of relative level of expectations and perceives performance. Tough (1982) defined student satisfaction as the following: student satisfaction refers to the student's perception or attitude towards the learning activities. Where the student is happy with his/her studies or adopts an aggressive learning attitude, student is deemed to be "satisfied"; where the student is unhappy or adopts negative or passive attitude, student is deemed to be "dissatisfied". In this study, student satisfaction can be perceived as the student's positive feelings or attitude towards his/her learning activities. The term

"student satisfaction" in this study is based on the scores responded by surveying students in the "Student Survey", a self-developed instrument to achieve the research purposes

5. Student engagement: Student engagement refers to a student's willingness, need, desire and compulsion to participate in, and be successful in, the learning process (Schelecty, 1994). In this study, student engagement refers to the extent of an individual's or student's involvement with activities in Project CSI Second Life that are instrumental to their learning. The indicators of student engagement in this study are effort (the amount of time spent engaging with Project CSI Second Life), attitude (the value of various components of Project CSI Second Life), purpose (the approach used to engage with Project CSI Second Life) and activity (the integration of Project CSI Second Life into the learning environment).

1.11 Organisation of the thesis

The thesis is divided into six chapters. Chapter one, the Introduction, presents an overview and outlines the background of the current study, and by extension, reveals gaps in existing research. This leads to the rationale and justification of the research and identification of the problem, which includes examining the interaction between the user and the 3D virtual learning environment to determine the effectiveness of 3D MUVEs. In Chapter Two, the Literature Review, the relevant literatures are reviewed to identify the theoretical frameworks through which the research problem is approached. This chapter discusses the research literature on the use of virtual worlds in education, the

communication aspects of a MUVE, research into the interactive use of virtual worlds and usability studies, including their limitations. This literature review also examines the theoretical approaches for using virtual world technology in education, and in doing so, develops the theoretical frameworks through which the research problem is to be approached. The approach is discussed in terms of how it will be applied in the research. Chapter Three, the Research Methodology, evaluates the instruments used to analyse the lesson plans and graphics displays of results, which are included in full in the Appendix 2, 3, 4, 5 and 6. Methodology describes sampling, methods of data collection and methods of analysis employed in the current research. This chapter will detail the development of an integrated approach for analysing *Project CSI: Second Life* interactions, and shows how this will be applied to the case study used by the faculty of biotechnology in INTI International University. The chapter also elaborates the types of data to be collected, the sample, and the pilot testing. All the methods described in this chapter are justified in terms of the research questions, as well as the strengths and weaknesses of each method are also investigated. The integrated approach is linked to its relevance to the investigation and in examining the effectiveness of *Project CSI: Second Life*. In Chapter Four, *Project CSI: Second Life* is discussed, wherein details of *Second Life* will be elaborated upon, the opportunities made available by the application, and how to leverage *Second Life* in education. It also entails the design and development of *Project CSI: Second Life* with the relevant workflow found in the appendices. In Chapter Five, the Analysis of Data, the results generated from quantitative and qualitative data analysis will be discussed. It is an analytic approach to data obtained from sample users' interactions with *Project CSI: Second Life*. This investigation is divided into two sections: the first examines the limitations of usability criteria in investigating the

effectiveness of *Project CSI Second Life* on achievement and knowledge retention, while the second applies the integrated approach to investigate potential users' responses in their surveys and interviews. In the final chapter, Chapter Six, Discussion and Recommendations, discussions based on the findings of the study and conclusions are presented. It includes research findings with results of the investigation, and sheds light on the effectiveness of *Project CSI Second Life* on achievement and retention. It also evaluates the strengths and the limitations of *Project CSI Second Life*, and the implications of this approach from theoretical and practical perspectives. It also discusses recommendations for further research into understanding perspectives on 3D MUVEs.

UNIVERSITI PUTRA MALAYSIA

STATUS CONFIRMATION FOR THESIS / PROJECT REPORT AND COPYRIGHT

ACADEMIC SESSION : _____

TITLE OF THESIS / PROJECT REPORT :

_____

_____

_____

NAME OF STUDENT : _____

I acknowledge that the copyright and other intellectual property in the thesis/project report belonged to Universiti Putra Malaysia and I agree to allow this thesis/project report to be placed at the library under the following terms:

1. This thesis/project report is the property of Universiti Putra Malaysia.
2. The library of Universiti Putra Malaysia has the right to make copies for educational purposes only.
3. The library of Universiti Putra Malaysia is allowed to make copies of this thesis for academic exchange.

I declare that this thesis is classified as :

*Please tick (√)

☐	**CONFIDENTIAL**	(Contain confidential information under Official Secret Act 1972).
☐	**RESTRICTED**	(Contains restricted information as specified by the organization/institution where research was done).
☐	**OPEN ACCESS**	I agree that my thesis/project report to be published as hard copy or online open access.

This thesis is submitted for :

☐	**PATENT**	Embargo from_____ until _____ (date) (date)

Approved by:

_____	_____
(Signature of Student)	(Signature of Chairman of Supervisory Committee)
New IC No/ Passport No.:	Name:
Date :	Date :

[Note : If the thesis is CONFIDENTIAL or RESTRICTED, please attach with the letter from the organization/institution with period and reasons for confidentially or restricted.]