THE AFFORDANCES OF VIRTUAL WORLD TECHNOLOGIES TO EMPOWER THE VISUALISATION OF COMPLEX THEORY CONCEPTS IN COMPUTER SCIENCE: ENHANCING SUCCESS AND EXPERIENCE IN HIGHER EDUCATION

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Dedication

I dedicate this thesis to

my family, my husband, Kalid Alayash,

and my beloved son, Joseph Alayash

for their constant support and unconditional love.

I love you all dearly.

I also dedicate this thesis to the loving memory of

my beloved father and mother

who have successfully made me the person I am becoming.

'You will always be remembered'

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Abstract

This research targeted complex abstract concepts in Computer Science and focused on bringing about the visualisation of such concepts using virtual world technologies. The research proposed the use of virtual world elements to support the understanding and learning of six computer science subjects having difficult theory concepts at the Higher Education level.

The researcher decided to choose Higher Education as the platform for this research, due to the significant need to understand and learn complex abstract concepts of Computer Science at this level. The framework of the research is Higher Education within Further Education, which was chosen for its challenging nature with regards to students' background and the level of additional support required for their success.

The Second Life virtual world was selected and utilised to build purposely designed and scripted scenarios to empower the visualisation of complex theory concepts of the selected computer science subjects. These scenarios were embedded, in a pre-determined order, within the curriculum delivery of a number of selected Computer Science modules from a Foundation Degree and a BSc (Hons) in Computing Programmes in a FE college in England. The research activities were carried out in two academic years, 2012/2013 and 2013/2014, in order to involve more students and obtain additional data to effectively, and more accurately, answer the research questions.

The research aimed at identifying the extent to which using virtual world technologies to visualise difficult theory concepts in Computer Science subjects, might enhance students' learning and achievement. The research outcomes provided positive answers to the four research questions, which pursued the extent to which the visualisation of such concepts using Second life virtual world might, 1) facilitate students' understanding of the complex abstract concepts in their HE Computer Science subjects, 2) increase students' engagement in their HE Computer Science sessions, 3) enhance affective quality (to include elements such as appeal, enjoyment, interest and appreciation), and 4) improve student's achievement (i.e. grades) in the targeted modules.

In answer to these questions, the research outcomes showed that subject difficulty was reduced by 25% and around three quarters of students acknowledged enhanced learning in the virtual environment. Seventy percent of students acknowledged becoming more engaged in their study sessions that were carried out in virtual worlds, and more than three quarters of students acknowledged enhanced affective quality. Finally, around 85% of the modules covered by the research witnessed improved students' achievement (i.e. higher grades).

The researcher explained potential use, advantages and limitations of employing Second Life in Higher Education in general and HE Computer Science in particular, and provided recommendations to academic institutions that are interested in applying such virtual world technologies to overcome the challenges involved.

Introduction

This research was carried out to address complex abstract concepts in Computer Science. Investigation was carried out on tools and techniques to facilitate the understanding and learning of such concepts, for which a thorough literature review was carried out.

A visualisation technique using virtual world technologies was adopted by the researcher following the literature review process, which resulted in achieving an innovative approach to the understanding of these complex theory subjects and to the acquiring of their skills.

The researcher decided to choose Higher Education as the platform for this research, due to the significant need to understand and learn complex abstract concepts of Computer Science at this level.

The framework of Higher Education (HE) within Further Education (FE) was then selected for its challenging nature with regards to students' background and the level of support required for their success. This research investigated a number of academic and governmental sources to obtain statistical information on the educational circumstances, personal environments and progression options of students selecting a FE college for their HE studies. The outcomes of this investigation confirmed the need for additional support for such HE students in order to enhance their understanding, learning experience and success.

The research aimed at identifying the extent to which using virtual world technologies to visualise complex abstract concepts in Computer Science subjects, might enhance students' learning and achievement.

'Second Life' was chosen as the virtual world environment for the research activities. The researcher's specialist skills in Computer Science were employed effectively within Second Life to design and script visualisation scenarios to achieve the targets of this research. This has majorly contributed to the success of the research activities.

The research activities were carried out in a FE college in England. The different modules of the selected HE in Computing Programmes were examined carefully to judge the degree of difficulty involved. This research covered extensive literature review to investigate what educationists observed about these Computer Science subjects in terms of the degree of complexity experienced by students and the impact of this on their learning and achievement, and consequently on the retention rate. The outcome of this investigation determined the specific computer science modules to be considered for this research.

Being an HE Lecturer in Computing at the chosen college enabled a direct supervision and monitoring of the research activities. The scenarios that were designed and scripted by the researcher in virtual worlds aimed at visualising the complex theory concepts of the selected Computer Science subjects for HE students to enhance their understanding and learning. The students' feedback was recorded and analysed as a significant input to the process of determining whether virtual worlds provide a suitable environment to achieve this visualisation. In addition to this, other factors were also considered as a vital contribution to this research, e.g. lecturers' observations and students' final grades.

The visualisation scenarios designed in Second Life virtual world, as part of this research, could well be achieved (or exported) to other virtual worlds of choice.

Chapter One: Literature Review – Part 1; Research rationale, framework and the selected Computer Science subjects

1.1 Research rationale, questions and contribution to knowledge

This research was focused on bringing about the visualisation of complex abstract concepts in Computer Science subjects using virtual world technologies. The research proposed the use of virtual world elements to support the understanding and learning of such concepts in the Computer Science field at the HE level.

Purposely designed and scripted visualisation scenarios in the Second Life virtual world were planned to be embedded, in a pre-determined order, within the curriculum delivery of a number of selected HE Computer Science modules from a Foundation Degree and a BSc (Hons) in Computing Programmes in a FE college in England. The research activities were carried out in two academic years, 2012/2013 and 2013/2014, in order to involve more students and obtain additional data to effectively, and more accurately, answer the research questions.

A total of 57 students participated in this research throughout both academic years. According to statistics obtained from Skills and Funding Agency (SFA) (2015), the total number of students attending HE in FE courses that have the word 'Computer' or 'Computing' in their course title, in both academic years 2012/2013 and 2013/2014, was 550 students (230 students in year 2012/2013, and 320 students in year 2013/2014). This indicates that the cohort participated in this research (the sample) forms 10.36% of the population, which is appropriate to claim that the outcomes of this research are deemed valid for other HE in Computer Science students within the said framework.

As indicated in Section 1.3 below, six Computer Science subjects were selected for this research, the first three of which were identified as having a high degree of complexity in their theory concepts (relevant literature review is provided as part of this Chapter), while the last three were identified as having an indirect degree of difficulty, which are explained in Chapter Four.

The research questions were built around identifying the extent to which using virtual world technologies to visualise complex theory concepts in Computer Science subjects might enhance students' learning and achievement.

The research was intended to answer the following four questions:

1- **To what extent might the application of virtual world technologies in the above mentioned context facilitate students' understanding of complex theory concepts in Computer Science subjects at the HE level?**

2- **To what extent might the application of virtual world technologies in the above mentioned context increase students' engagement in their HE Computing sessions?**

3- **To what extent might the application of virtual world technologies in the above mentioned context enhance affective quality (to include elements such as appeal, enjoyment, interest and appreciation)?**

4- **To what extent might the application of virtual world technologies in the above mentioned context improve student's achievement (i.e. grades) in the targeted modules?**

It is worth highlighting here that all the questionnaires that were used to capture students' feedback for this research were fully designed by the researcher (and not outsourced), as they were intended to obtain information relevant to the research questions.

1.2 Selecting the HE in FE framework

Research to-date shows that the majority of students joining HE in FE colleges usually progress from the diploma (vocational) courses delivered by FE colleges, and that these students would not have considered HE otherwise.

According to the Association of Colleges (2012):

- More than half of the HE in FE applicants applied to one choice only, i.e. selecting a FE college for their HE studies.
- More than 70% of those doing HE in FE live within 25 miles of the college they study in.
- More than 80% of those doing HE in FE have qualifications other than A-Levels.

In a comparison between the acknowledged entry requirements of HE in FE qualification (i.e. a Foundation Degree) and the university academic one, and as indicated in the UCAS official site, the majority of universities in the UK require fewer UCAS points for the admission to their HE programmes at 'Partner Colleges' compared to that of the academic courses within the universities themselves. According to UCAS (2014), "*formal qualifications are not always necessary for entry onto a foundation degree*".

The Higher Education Academy states that "*Colleges are well aware that they have a key role in widening participation by offering flexible HE to non-traditional learners (i.e. those that prefer a familiar college environment and local students who otherwise would not consider HE)*". They also expresses that an increased emphasis is placed on the provision of HE within the FE context in accordance with the Government's agenda of 'Widening Participation'. They also highlights that higher education within this framework needs to be flexible in terms of allowing these 'non-traditional learners' the choice about the modes of study. In the same regard, King *et al.* (2009) indicated that it is crucial that HE within the FE environment provides high-quality and relevant learning in their qualifications that is valued by their students. They also clarified that the experience of HE within FE is different to that of a 'traditional undergraduate' in many respects.

It is important that we understand the aspects involved in, and the cause of, the gap between the level of achievement and retention data of the HE in FE students, who attend vocational courses, and that of university students, who attend the traditional academic courses, in order to accurately judge the level of extra support required for the so called 'non-traditional learners'. Following the disclosure of statistical data by the Higher Education Statistics Agency (HESA) for the academic years 2002/3 to 2007/8, Round *et al.* (2012) explained that the results of the quantitative data analysis showed the complexity of the relationship between the entry profile and the retention rate of vocational students, who are more likely drawn from the lowest socio-economic groups. In terms of the comparison between the retention data of HE in FE students and that of traditional university students (progressing from A-Levels), Round *et al.* (2012) clarified that the results confirmed the outcomes of the study carried out by the Higher Education Policy Institute (HEPI), which showed that the retention rate of vocational students is indeed lower than that of academic ones. This was 4.9% withdrawal rate of vocational (Year-1) learners, due to academic reasons, compared to 1.9% for non-vocational learners.

In addition, and as indicated by Bailey *et al.* (2008), the National Research published by the HEPI in 2008 argued, following a statistical study, that the number of vocational students discontinuing their degree programmes is greater than that of university students with a traditional A-Level entry profile, and that the final degree classifications of the former were lower than those of the latter. In support of this, Lipsett (2008) stated that while the government was encouraging more students at the age of 14 years to take vocational subjects, a new report by the HEPI postulates that students with vocational backgrounds are less likely to attend a leading university, do less well academically and are more likely to drop out compared to those with traditional academic A-Levels.

The above, therefore, dictates that the learning tools, mechanisms and technologies should be researched and investigated further in the HE in FE framework in order to develop the learning techniques required for these 'non-traditional learners' with the aim to facilitate their learning and achievement in their programmes.

Some supporting statistics were provided by Round *et al.* (2012), which emphasised indirectly the level of additional support required for the HE in FE students. They also clearly highlighted the importance of the vocational route into Higher Education for the 'poorest learners' and its significance as a vehicle for widening participation:

- The vocational students are approximately twice as likely as academic students to be drawn from the 20% most deprived communities (30% compared to 17%).

- Almost half of the vocational students (48%) are drawn from the 40% most disadvantaged communities compared to a third of academic (A-Level) students. These communities form the target area to widen access to Higher Education.

- In the wealthiest communities, the number of academic (A-Level) students is twice the number of vocational students.

According to the above, and as Computer Science is such a varied subject with a number of complex scientific areas, this research targeted the HE in FE framework to facilitate its students' understanding and learning of difficult theory concepts at this level.

1.3 Selecting the HE Computer Science modules

The researcher carried out comprehensive literature review to investigate what other researchers and educators recognised and/or observed about the difficulty in certain Computer Science subjects in order to confirm their suitability for this research. Sections 1.4 – 1.6 below discuss the literature review carried out per subject.

The conference held by the British Computer Society (BCS) in Newcastle on 30-31 March 2004, titled 'Grand Challenges in Computing Education', to identify and discuss problems in Computing Education, stated that "*There are problems of retaining students within Computing programmes, the study of the discipline seems to be difficult and complex*" (McGettrick *et al.*, 2004, p.1). In his speech for the Conference, Peter Denning drew attention to some important issues and views by students on computing programmes. He clarified that learners consider that the curriculum is very complex and too packed. He highlighted that the high percentage of 30-50 percent drop-out rate is clear evidence on this. (McGettrick *et al.*, 2004)

Following a careful examination of all modules in the selected HE Computing programmes, the following subjects were chosen so that elements of virtual worlds were to be embedded in their curriculum delivery in order to enhance students' learning:

<u>A) Primary modules having a high degree of complexity in their theory concepts:</u>

1. Computer Programming – Part of the 'Introduction to Programming / Software Design and Development module', Year 1, and, Part of the 'Object Oriented Software Development module', Year 2 of the Foundation Degree in Computing Programme.

2. Database Normalisation – Part of the 'Systems Analysis and Databases module', Year 1 of the Foundation Degree in Computing.

3. Multithreading Techniques (Concurrency and Parallelism) – including multithreading programming, Part of the 'Multi-Tasking Systems module', BSc (Hons) in Computing.

<u>B) Secondary modules having an indirect degree of difficulty in their concepts:</u>

4. Helpdesk Support – Part of the 'ICT Service Support module', Year 2 of the Foundation Degree in Computing.

5. Multimedia Technologies, Year 2 of the Foundation Degree in Computing.

6. Research Methods for Computing Projects – Part of the 'Research Methods module', BSc (Hons) in Computing.

In the process of investigating the degree of complexity in the abstract concepts of the first three modules, this research placed particular emphasis on the literature indicating issues of concern in the understanding and learning of these subjects by HE students. This was important to assess the benefits of and the need to this research, not only for the quality of learning achieved by HE students, but also for the lecturers in opening new horizons for the delivery of these modules.

With regards to the last three modules (having an indirect degree of complexity), the explanation of their different areas of difficulty is provided in Chapter Four, Sections 4.3 – 4.5.

1.4 Computer Programming

McGettrick *et al.* (2004, p.11) defined Programming as "*a central element of the discipline of computing, an important practical skill for computing, and an essential component of the undergraduate curriculum*". They clarified that despite the developments within the other computer science subjects; students still believe that their computing courses are dominated by programming.

The 'Grand Challenges in Computing Education Conference', hosted by the British Computer Society (BCS) in 2004, explained some major concerns within the academic community internationally as being the teaching and learning of computer programming. They clarified that viewing this subject as 'dry' and 'boring' rather than 'enjoyable' and 'creative' has discouraged people to apply for Computer Science studies, which was accompanied by poor achievement and retention data in Computing degree programmes. This has caused the opinion that, even after graduation, students from Computer Science courses clearly expressing their dislike of programming and their reluctance to undertake it. (McGettrick *et al.*, 2004)

There is significant research acknowledging the level of complexity in the computer programming subject at the HE level, and how this issue forms a cause of students' withdrawal from their HE Computing courses. Sajjanhar *et al.* (2014) stated that high-level programming skills require in-depth understanding of the theory concepts within this subject, which are recognised to be difficult to grasp by students due to lack of real life representation. They clarified that students who struggle in understanding and learning the abstract concepts of computer programming are likely to either withdraw from their course or choose another career path that does not involve programming.

In the same regard, Morgado *et al.* (2011) clarified that computer programming is a fundamental subject that all students in computer science courses are required to learn. They added that programming languages have extensive and complex syntaxes, resulting in great learning difficulties for beginners and the highest dropout rates.

Miliszewska *et al.* (2007) highlighted that computer programming forms a common issue of concern amongst many universities due to the problems faced by the HE students in this subject in their first year of studies. They confirmed that, being an important and essential component of the Computer Science curriculum, this subject is a compulsory module in Computing studies. In addition, they clarified that many novice Computing students often drop out from their course due to either failing or performing poorly in a programming unit, which is usually considered one of the most hated and feared units in a Computing course. In stressing the difficulty of this subject, Miliszewska *et al.* (2007) explained that programming techniques and skills are also difficult to teach, not only because the traditional teaching methods are not very effective in the areas of coding and problem solving, but also because these skills are best learned through experience. The difficulty in teaching this subject, they added, becomes even more challenging when trying to teach object-oriented programming to beginning learners.

As indicated by Lahtinen *et al.* (2005), computer programming is a very common unit in several fields of technology that are taught by a large number of universities, although certain courses deliver only the basics of it. They added that, unfortunately, students often face difficulties in learning this subject even in the basic courses. They also highlighted that the difficulty in the programming studies is not only because of the abstract concepts, but also in the different issues related to program construction. These difficulties led to a decrease in students' retention rate. Kaasbøll *et al.* (2004) clarified that the difficulty in learning and teaching the computer programming subject is confirmed by the high rate of failure and withdrawal in the introductory programming modules at universities.

In the same regard, Huggard (2004) confirmed that the major cause of non-completion in Computer Science degree programmes, when students transition from FE to HE, is the difficulties faced by students in this transition, with many of them having either little or no confidence in their programming skills. Therefore, one of the significant challenges in HE Computing education is to have an effective learning platform in order to achieve major enhancements in students' approach, learning and achievement in the programming subjects.

Esteves *et al.* (2008) supported the above by saying that the teachers of computer programming continuously looked for new methods to overcome the difficulties faced by beginning learners at the start of Computer Science programmes when studying this difficult and demanding subject. They confirmed that the skills needed by students to become good programmers are far beyond the syntax and semantics of a programming language. They reiterated that the difficulty in learning this subject results in high levels of failure at the beginning of Computer Science studies, because students claim that they do not understand even the most basic concepts of the subject due to their abstract nature, which has no similar representation in real life.

Regarding the use of virtual worlds for teaching computer programming, a paper published by Fonseca *et al.* (2009) explained the attempt, which involved Computer Science students from the University of Trás-os-Montes e Alto Douro (UTAD), in Vila Real, Portugal, and the Higher School of Technology and Management (ESTG – Portuguese-language acronym) of the Polytechnic Institute of Leiria, Portugal. This paper was referred to a number of times within this thesis for its relevant research work and activities in virtual worlds. The paper indicated that although the main target of that research work was to investigate the possibility of using the Second Life virtual world as a platform for the teaching and learning of an imperative computer programming language, the research focused primarily on investigating the potential problems that could be faced by both teachers and students in this environment, and whether such problems could be solved and how. Fonseca *et al.* (2009) acknowledged that a high number of students fail when starting a computer programming study, and consequently withdraw from their courses due to the various difficulties they face when trying to understand the computer programming subject. They also confirmed that although research has identified the challenges faced by students in this subject, researchers are still struggling to develop effective guidance to support practitioners in this field. They added that their students considered computer programming as a traditional theoretical subject, similar to history, which is based on reading rather than practicing. They added that their students felt discouraged and did not get involved in the learning process as they did not understand the programming concepts or achieve positive results.

Moreover, and in recognition of the difficulties faced by learners to understand the complex theory concepts of this subject, certain visualisation tools were created by software developers to facilitate the learning of computer programming, amongst which are ‘jGRASP’ and ‘Jeliot’; however, both of these tools present a static visualisation of the program execution unlike the scenario designed in virtual worlds for this research. Another tool to this regard was the ‘ViRPlay3D / ViRPlay3D2’, which featured some aspects of the virtual world platform (students represented by avatars and exercising programming in a sandbox); however, this environment was only limited to the coding process and lacked aspects of collaborative learning, which virtual worlds strongly support. Sorva *et al.* (2013) explained the features and applications of these tools and a number of other similar program visualisation software; however, they clarified that virtual worlds were not handled by such systems.

1.5 Database Normalisation

Alappanavar *et al.* (2013) explained how difficult it is to motivate students to learn database normalisation because they consider this subject to be dry and purely theory-based. They clarified that the more the database grows, the more difficult it becomes to manually handle the normalisation process.

Research revealed that a number of tools were designed to support the learning and teaching of database normalisation, regardless of which, the subject remained an issue of concern to Computing educationists. A number of researchers, yet, acknowledged the need for visualisation in this field. Patwardhan *et al.* (2010) clarified that certain web-based normalisation tools, e.g. NORMIT, are specifically designed for the teaching and learning of the database normalisation process, as it is theoretical and difficult to understand, which makes it difficult to motivate students. However, they added, such tools do not provide visual aid for the normalisation process.

In the same regard, Wingenious (2005) confirmed that besides being a complex subject to learn, database normalisation is a critical part of an effective database design, which is vital in guaranteeing data integrity and eliminating data redundancy in a database.

In a study carried out on the engineering students of Szent István University, Hungary, Czenky (2014) defined the process of database normalisation as being a principal database design method. However, she added, the students found the understanding and application of this method problematic and challenging. She explained the outcomes of the survey carried out for this in the university in 2008, where 54 students participated. The survey revealed that 69.6% of students found database normalisation as the most difficult subject. She also compared the outcomes of this survey to a similar one carried out at the University of Ulster, Northern Ireland, where the students were given the opportunity to select from (very difficult, difficult, easy and very easy) options. The summation of ‘very difficult’ and ‘difficult’ choices for the database normalisation subject was 84.6% of the students.

Folorunso *et al.* (2010) also stressed the complexity of the database normalisation subject by describing how certain students in Nigeria found it difficult to learn the subject of database design theory, and in particular, the database normalisation process. They also clarified that researchers and educators in this field emphasised the complexity of this process throughout the years since the introduction of Codd’s (1970) seminal work on database normal forms. They highlighted that the database normalisation process is not only a cause of poor designer performance, but it is also a challenging subject to teach.

The difficulty of the theory concepts in the database normalisation subject was also confirmed by Kung *et al.* (2006), which suggested designing a web-based tool to provide the learners with an interactive hands-on experience to improve the understanding and learning of the database normalisation process. They explained the difficulty they faced in motivating their students, who see it as such a dry and theoretical subject, to learn the process. They added that the results of the survey carried out, in a junior level ‘Systems Analysis and Design’ course, to record students’ feedback, confirmed that the learners generally viewed the web-based tool more positively than the database normalisation techniques in the textbook.

The above clearly indicate that researchers and educators in the computer database field confirmed the need for a new technique and/or a platform to enhance the learning of the complex theory concepts of database normalisation.

1.6 Multithreading Techniques (Concurrency and Parallelism)

This area is considered one of the challenging subjects in Computer Science studies, due to the high degree of complexity in its theory concepts related to the threading mechanism that is applied by the computer operating system in the processor and memory units, which accordingly, makes the programming of it even more difficult.

Cui *et al.* (2011) supported this by saying that the different executions of a multithreaded program may present different sets of results based on the structure of the threads and the way they communicate with each other within the program. This non-deterministic situation makes a multithreaded programme difficult to write, test and debug.

A number of researchers and educators confirmed the complexity of the theory concepts in this subject. Yang *et al.* (2014) reinforced this by saying that multithreaded programs are not only extremely difficult to write, but they are also very difficult to analyse, debug, and verify; these processes are much harder than those in a sequential program. They emphasised the impacts of the non-deterministic situation in the multithreading process by saying that conventional wisdom has assigned the difficulties of understanding this process to non-determinism, as repeated executions of the same program given the same input value(s) could well show different behaviours.

Rick *et al.* (2001) explained the complexity of the multithreading concepts by clarifying the process of having multiple threads within one program. They stated that each thread is performing a task that works separately from the rest of the program, which makes the concept difficult to understand by many programmers. They added that in sequential programs, the lines of code written by programmers are executed sequentially, which is the reason behind not understanding the situation of having a number of little programs (i.e. multiple threads), each of which has its own execution sequence, running inside one large program.

Huisman *et al.* (2007) highlighted that due to the increased requirements on maximising computer performance and productivity, multithreading nowadays is unavoidable for programmers. However, they added, multithreaded programs are particularly difficult to write and debug correctly, and they are much more demanding and challenging than writing and verifying a sequential program.

Lee (2006) confirmed this by saying that the complexity of multithreading programming is widely acknowledged; however, the necessity of it has become more urgent. He added that people are quickly overwhelmed by the concept of concurrency, as they find it much more difficult to understand and learn compared to sequential code. He clarified that the partially ordered operations could well make even careful people miss possible thread overlaps.

In the same regard, Duranton *et al.* (2012) stated that parallelism caused the computer applications to become more complex resulting in increased difficulties in their design, implementation, verification, and maintenance, which has become widely acknowledged by developers.

For more information on the degree of complexity experienced in this module, see Appendix-1 (page 202) for sample communication (email messages) between the researcher and HE lecturers teaching this module in other colleges, who expressed their views in this regard.

Chapter two: Literature Review – Part 2; The employment of Virtual worlds and similar technologies to achieve visualisation in science fields

2.1 Virtual worlds and the selection of Second Life

Girvan *et al.* (2010, p.342) defined virtual worlds as "*a three-dimensional online environment populated by multiple users who are represented through the use of avatars and can communicate with each other*". A more detailed definition was provided by Cheung *et al.* (2010, p.33), who indicated that "*3-D virtual worlds are richly immersive and highly scalable 3-D environments; where people enter these worlds via an avatar which is their representation in that space… Virtual worlds are open-ended environments in which people design and create the world, its objects and their behaviours. Consequently, virtual worlds can be applied to any context*".

For educational use, Calongne (2008, p.36) defined virtual worlds as "*engaging, stimulating spaces where students can meet online for normal class activities, including lectures, discussions, case studies, projects, papers, exams, and labs*". She added that the virtual worlds' class is a three dimensional graphical setting with the use of avatars to represent the class participants, and the feel of presence that immerse the learner within the scene. While Cheung *et al.* (2010) highlighted that virtual worlds provide replication of real universities, Girvan *et al.* (2010) confirmed that virtual worlds offer a flexible learning environment for both learners and educators. Falconer (2013) highlighted that the use of virtual worlds in general, and for education and training in particular, has increased significantly during the last 6-10 years.

Sansom (2014) highlighted that there are tens of virtual worlds and virtual world engines in the market nowadays. However, there are very few that are well-known and used in the education field. She confirmed that Second Life is by far the most popular and best known virtual world, which was developed by Linden Lab (a San Francisco-based Internet company), and launched in 2003. She added that millions of users created avatars in this virtual world, and it was recorded that around 50,000-60,000 users worldwide are using it at any given time. Harle (2015) stated that Second Life, which is a 3D computer-based virtual world, is not a game or a social media application, but it is a digital version of real life.

Open Simulator, more generally known as ‘OpenSim’, is another well-known type of virtual worlds indicated by Sansom (2014). She described this open-source virtual platform as being a server to create virtual worlds rather than being a single, standalone world like Second Life, although they share some of the same protocols. The other name mentioned by the source was ‘Unity 3D’, which is not a virtual world as such, but it is an ‘engine’, which is used to build standalone virtual environments. Harle (2015) highlighted some other relatively newer virtual worlds, e.g. Blue Mars (an open beta 3D multiplayer virtual world used to create virtual environments), InWorldz (a free virtual reality world), Twinity (a free 3D world and 3D chat community), Onverse (a game-based 3D virtual world) and OS Grid (allows connecting own OpenSim server into a grid that hosts multiple servers – currently facing problems).

In a comparison between the two virtual worlds, Second Life and OpenSim, Sansom (2014) clarified that OpenSim was criticised for a learning curve for developers that is steeper than that of Second Life, and that it has less users than Second Life, which means that the overall users’ experience is less rich, in addition to having less experienced developers for OpenSim to advise beginning users. The advantage of OpenSim over Second Life, however, is that OpenSim is an open-source application (and therefore free), while Linden Lab is a commercial organisation (although educational discounts were always made available).

There is significant research indicating the increase in using virtual world technologies in education worldwide. Rapanotti *et al.* (2010) justified this by saying that these technologies have the ability to induce a strong sense of presence for participants, and increase their social awareness and communication. In addition, this environment is able to foster online communities and constructivists, and situated learning. Fonseca *et al.* (2009) confirmed this by explaining that regardless of the fact that the 3D virtual world environment is considered relatively new, it has already been used as a pedagogical platform. They added that constructivists and educators involved in constructionist learning might be able to recognise the potential in this environment, as it provides them with an accessible means for the creation of rich, immersive and appealing 3D framework for situated learning and also communication tools to support dialogue and collaborative learning.

In the selection of Second Life as the chosen virtual world for education, Rapanotti *et al.* (2010) explained that Second Life has become exceptionally popular amongst educators in the UK. They reiterated that Second Life is the virtual world of choice for both FE and HE, due to its advanced graphical features that support both 3D simulation and social networking within a free-to-access platform. Baker *et al.* (2009) highlighted that Second Life is considered the most active virtual world in higher education. In the same regard, Singh *et al.* (2009) clarified that Second Life is a computer-based simulated virtual environment that has gained attention from educators worldwide as a medium to offer all or some of their course's interactive activities to students. Sansom (2014) supported this by saying that it is not a surprise that Second Life is still believed to be the predominant virtual world of use in higher education, and by a considerable margin.

In the same regard, Alenezi *et al.* (2015) confirmed that Second Life has currently emerged into one of the most popular multiuser 3D virtual platforms with daily increasing practises. They added that a large number of leading universities and colleges around the world preferred using Second Life for educational purposes. They also highlighted that this environment offers researchers a range of opportunities due to its collaboration and connection features.

According to Ryan (2008), researchers at Lancaster University, UK, were investigating the use of virtual worlds as an educational tool in several disciplines. She highlighted that Second Life was viewed as a developing technology that is surrounded by both publicity and rising educational prospects. Kirriemuir (2012) confirmed that while Second Life has been in the UK education world for over half a decade, it still appears to be the most widely used virtual world.

Due to the fact that Second Life enables the advantages of immersion, ease of use, broad availability and low barriers to entry, educators used this 3D virtual world to conduct courses and/or educational discussions with their students. Second Life has been emerging in teaching and learning because it provides students with illustrations, animations, role playing situations, and social communities. Huang *et al.* (2010) supported this by saying that Second Life provides the students with a new opportunity to have the experience of interactive education in an environment that facilitates achieving the objectives of collaboration, engagement and experimentation. In addition, this environment promotes idea generation and developing interactivity. Huang *et al.* (2010) also highlighted that as educators started realising the different possible applications and abilities of Second Life, many academic institutions have started investing substantially to use this virtual world as a pedagogical environment to enhance the learning experience of their students. In 2011, Linden Lab recorded that over 700 educational institutions from all over the world have representations in Second Life (Linden Research Inc., 2011).

2.2 Virtual worlds in Computer Science education

Sajjanhar *et al.* (2014) carried out a study in Deakin University and Monash University, Australia, regarding the learning of computer programming in virtual worlds. They investigated the affordances of Second Life for 'experiential problem-based learning pedagogies', and the potentials and limitations of this platform for learning the programming subject. They confirmed that collaborative environments offer significant support to students in computer programming activities, which is an effective approach for learning this subject. The study, in which 12 post-graduate students participated, generated very positive answers in terms of the advantages of Second Life virtual world for learning computer programming.

Beltrán Sierra *et al.* (2012) discussed the practical study carried out in the University of La Sabana, Chia, Colombia, in the Computing Engineering (INF) and Agroindustrial Production Engineering (IPA) academic programmes, which addressed the question of whether Second Life forms an attractive tool for the students that increases their motivation, promotes participation, and facilitates their learning of electronic related subjects within the Engineering degree qualifications.

Crellin *et al.* (2009) explained an application of Second Life in the computing courses of the School of Computing, University of Portsmouth, UK. He described that Second Life was used in two areas: 1) Human Computer Interaction (HCI) Unit, and 2) Computer Engineering Projects Unit. However, the application of virtual worlds in both units was not carried out to visualise complex theory concepts in these subjects; it was mainly aimed at developing interactive systems as part of the first unit, and larger scale developments of systems as part of the second unit.

Chen *et al.* (2009) also studied the application of Second Life to engage and motivate the HE Computing students of the Computer Information Systems Department at Borough of Manhattan Community College, New York, USA. They explained that a teaching and learning platform was designed in Second Life to assist the students in overcoming the difficulties in their study. They clarified that the designed platform included a lecture area, group study rooms and interactive teaching and learning activities, which aimed at better engagement of students and the improvement of the retention data within the Computer Science programme. However, this paper did not provide any background information on the academic level of students and/or their qualification, which could be used to judge whether this context is similar to that of the HE in FE in the UK.

Following investigating the above, it was concluded that no information could be found so far of any previous research or studies that addressed the visualisation of complex theory concepts within Computer Science subjects for HE in FE framework in the UK to facilitate students' learning and achievement. This clearly justified the need for this research and its novelty.

2.3 Visual learning

Fleetham (2014) stated that the 'Dual-Coding' theory confirmed that knowledge is stored as images and linguistically, and that such images include mental pictures in addition to physical sensations. He added that 80-90% of the information obtained by a human brain arrives visually. He highlighted that although certain students may have non-visual learning preferences, it seems sensible to develop the visual learning capacity of all learners. He added that the visual representation of knowledge makes it more memorable and meaningful.

In the same regard, Brown (2015) confirmed that technological innovations have resulted in excluding the aspects of neuronal development that support non-visual learning and memory.

Esteves et al. (2008) indicated that visualisation has been introduced as an approach to reduce students' difficulties in learning. They added that visualisation tools in education help students to better understand the concepts due to the fact that physical, spatial or visual representations are easier to manipulate and retain.

2.4 Scientific visualisation in virtual worlds

The following review of literature on the employment of virtual worlds and similar technologies to achieve visualisation in different science fields has strongly inspired this research. Ryan (2008) clarified that, from a teaching point of view, Second Life has made it possible to demonstrate ideas in a visual form due to the advanced graphical features of the software. She confirmed that providing an additional visual element within the teaching process can be achieved in several ways in the virtual world environment, e.g. the visualisation of otherwise theory concepts and data visualisation. The advantages of visualisation within virtual worlds were also handled by Monahan *et al.* (2008), who explained that virtual worlds have been used significantly for visualising complex data and simulations. They added that scientists are increasingly employing these technologies to achieve visualisation as a teaching aid.

Koutek (2003), who studied scientific visualisation in virtual environments, highlighted that researchers were considering this technique back in the 1980's. He quoted McCormick *et al.* (1987, p.63) in defining scientific visualisation as being "*the use of computer graphics to create visual images which aid in the understanding of complex, often massive numerical representations of scientific concepts or results*".

Looking at a more modern definition, Zyga (2009) indicated that the virtual world platform allows new possibilities for scientific visualisation, which is also known as 'visual analytics'. She added that in the case of large and more complex data sets, visualisation enables researchers to better understand different phenomena. She highlighted that as virtual worlds offer visualisation and allow researchers to immerse in data and simulations, this helps scientists to think in a different way about data and patterns.

A recent definition of scientific visualisation is found in Cioc (2013), who indicated that in today's generation of 'big data' sciences, the real challenge does not lie in the sheer volume of the data obtained but rather in its degree of complexity. He added that the visualisation process of such data sets, which is key to their analysis, is not a simple task to achieve. He also clarified that as human beings are 'optimised' to interact within a 3D world, a virtual world environment such as Second Life or OpenSim enables scientists to walk into a representation of their data, while collaborating and interacting with each other within the same virtual space. He added that such virtual platforms allow up to nine dimensions of a data space to be encoded using XYZ coordinates, transparency, RGB colours, size, and shape of 3D data objects.

2.5 Virtual visualisation techniques in different science fields

There is significant research investigating the utilisation of virtual worlds to visualise some 'unseen' elements of a number of science fields, where users are enabled to interact with their data and with each other in an immersive environment. In her publication, 'Seeing data in Second Life', Polack-Wahl (2009) confirmed that although there is a number of conventional ways in which data could be visualised, the world today requires more than a basic bar chart to communicate the data message. She added that Second Life is able to provide a clear visualisation in most of the applications, which makes the visualised information attractive and interesting and, consequently, promotes further study and investigation.

Although researchers in the education field mainly knew and/or used virtual worlds and similar technologies during the last 10 years, actual attempts of using virtual worlds to achieve scientific visualisation were recorded as early as mid to late 1990s. Orford *et al.* (1999) discussed the utilisation of virtual world technologies to attain visualisation in Geographical Information Systems (GIS). They highlighted the four different developments in computer visualisation within the 1990's in support of social sciences, which were computer graphics, multimedia, the World Wide Web, and Virtual Reality (VR). They confirmed that virtual worlds are a cheaper and less complicated alternative of VR, as they link images in order to produce a navigable landscape. In addition, virtual worlds do not require a certain interface device, e.g. a VR helmet, compared to a specialised '3D model of reality' that needs to be built in VR. In addition, they added, virtual world environments could be displayed on most of the recent personal computers. With regards to visualisation, they stressed the fact that the flexibility offered by virtual worlds in designing cities and streets has paved the way towards a new archetype of urban design. They clarified that this new visualisation technology enabled the displaying of pictures in a GIS and the running of animation based on abstract maps, in addition to video clips and photorealistic VR panoramas, which are linked to a number of data fields and functions of the GIS.

Ohno *et al.* (2007) explained that simulation within science fields is supported by two main technologies; computation and visualisation. They clarified that unlike the computation technology (computer systems), which is maintaining an exponential growth; the developments within the visualisation technology do not catch-up with its counterpart. They indicated the early use of virtual world technologies to visualise maths grids with the size of $O(100^3)$ in the beginning of 1990's. They described that this was achieved via a combination of visualisation software and graphic workstations (GWS), which facilitated the visualisation of 100^3 grid points. They clarified that they were able to zoom in, colour the objects, rotate, and change the levels of 'isosurface' through the use of a mouse in a graphical user interface. They added that this visualised interactive manipulation using the GWS enabled them to achieve a 3D structure of the numerical data.

In an experiment in using virtual worlds to achieve scientific visualisation of Self-Gravitating Systems, Farr et al. (2009) explained their visualisation system, NEO, designed to simulate N-body gravitational dynamics, which was built in the virtual world of OpenSim. They clarified that their users were allowed to connect to the OpenSim server to assign objects as ‘physical’ within the virtual environment. They added that physical objects interact gravitationally with each other as point masses; therefore, a small code modification in the OpenSim physics engine pursues the movement of physical objects under their joint gravitational forces.

In a different science field, Lang *et al.* (2009) explained the scientific visualisation achieved in Second Life in the Chemistry field. They described the interactive and collaborative visualisation of data from molecules and proteins within the virtual environment, and how these visualisation processes could be scripted to achieve immersive educational activities and real-life collaborative research.

Terrill et al. (2009) explained the extending of the measurement science to interactive visualisation environments. They described three classes of tools utilised within a visual laboratory in order to interactively measure and analyse scientific data. They clarified that the traditional laboratory experiments are increasingly being replaced by computational experiments, as the former is rather expensive, time-consuming or sometimes impossible or very difficult to achieve. They added that such interactive and visualised environments provide unique capabilities for the measurement and analyses process.

In another application of virtual world technologies to achieve visualisation in the geography education field, DeMers (2010) explained how students visualised flat maps, globes, and each of the three families of map projections (planar, conical and cylindrical) in Second Life, showing how the earth’s shape and grid change after projection. He added that this virtual environment enabled students to, first, create their needed visualisations, and then walk among and explore their creations.

Clifford (2012) indicated that the Human Interface Technology Lab (HITLAB), University of Washington, has explored recent educational applications of virtual worlds. She highlighted the best practices in Christine Youngblut’s research paper for the Institute for Defense Analysis, who explained that virtual spaces can be best applied to visualise abstract concepts. “*Unique capabilities of VR technology include allowing* *students to see the effect…, visualize abstract concepts, and visit environments and interact with events that distance, time, or safety factors normally preclude*.” (Youngblut, 1998, p.95).

The visualisation of elements within Astrophysics science was also carried out by using a virtual world environment. A project to this regard was implemented by the Meta-Institute for Computational Astrophysics (MICA), which lasted between 2008-2012. This is a professional scientific and educational, non-profit organisation based in virtual worlds (Second Life and OpenSim). Djorgovski *et al.* (2012), who discussed MICA’s experiment, highlighted that as the human visual awareness system is naturally optimised for 3D, virtual worlds offer fascinating new possibilities for scientific visualisation, or the so called ‘visual analytics’.

In another scientific field, Nykl *et al.* (2012) explained the visualisation tool of the Joint Precision and Landing System (JPALS) by using virtual world technologies. They clarified that this system is intended to work on all-weather and to integrate remote sensor data with databases of terrain imagery, elevation, and surveyed aviation locations, and that this visualisation tool enabled users to collaborate simultaneously in real-time during test flights.

In Paleontology, Cunningham *et al.* (2014) indicated their novel application of a computer-aided tool for the visualisation and analysis of fossils that has revolutionised their study of extinct organisms. In their publication, ‘A virtual world of paleontology’, they clarified that this tool allowed fossils to appear in a 3D format and in unprecedented detail, which enabled paleontologists to develop important insights into their anatomy, preservation and development.

Brewer *et al.* (2015) explained the virtual world-based cardiac rehabilitation program to encourage healthy lifestyle choices among cardiac patients. This program was designed in Second Life and it aimed at achieving healthy behavioural change among patients having post-acute coronary syndrome (ACS) or post-percutaneous coronary intervention (PCI).

2.6 Virtual visualisation techniques in Computer Science

Bernava *et al.* (2015) explained their designed application in Second Life, which supported user annotation of graphical objects and graphical visualisation of concept ontologies. They clarified that this application offered a platform that provides a representation of graphical knowledge.

McCaffery *et al.* (2010) introduced the visualisation of network routing algorithms by using virtual worlds. They described the routing algorithms as a difficult subject to understand and also to visualise. They highlighted the unique, simple and intuitive features of virtual world technologies in this regard, which provided multiple students with a platform to experiment with the network routing theory, learn from each other's changes/results and test how changes to network topology would affect routing algorithms.

In the computer programming area, Esteves *et al.* (2008) highlighted that traditional teaching methods, which depend on physical lectures that explain the syntax of the programming language taught, fail most of the time in motivating the students to get involved in relevant programming activities. They confirmed that the use of visualisation in the learning process helps the students to better understand the challenging concepts because visual representations are easier to retain and handle, and that having an instant visualisation of instruction results enables the students to directly judge whether their idea was right or wrong. They explained the application of Second Life in the learning of computer programming in two higher education academic institutions in Portugal, as explained earlier in Section 1.4. They clarified that they used the 3D environment of Second Life in their study to visualise and contextualise the learning of this computing subject. They added that Second Life users are able to create avatars and 3D objects, and to program their behaviour using the Linden Scripting Language (LSL), the syntax of which is close to that of the well-known C++ programming language. They also confirmed that the benefit of this is the students' ability to execute the programming code concurrently and that several students are able to simultaneously work over the same code and/or object. This process, they added, provides the advantage of immediate presentation of program execution. Moreover, they clarified that the project was introduced to the students during the first session, after which the students were divided into two groups and started developing their projects collaboratively in Second Life. They added that teachers met with their students in-world for about two hours, once a week, to follow-up their progression, make suggestions and exchange ideas. They reiterated that face-to-face meetings were not carried out due to the fact that the teachers/researchers were in a different city to the students.

Contrary to the approach adopted by this research, i.e. the presence of the lecturer was deemed necessary during each session to answer students' questions and to observe achieving the learning outcomes of individual sessions, Esteves *et al.* (2008) clarified that outside the weekly guided sessions, the students were working on their own throughout the whole week, and were only able to explain their achievement, concerns and mistakes once they met with their lecturer in the following week. Esteves *et al.* (2008) also confirmed that it would have been useful to have a mechanism to provide a better guidance by the lecturers.

With regards to the database normalisation subject, Folorunso *et al.* (2010) highlighted the need for visualisation to support the understanding and learning of this process. They clarified their adopted visualisation method, which was designed through a computer program built using C# programming language, in which learners enter the database field titles and their properties in textboxes and press the buttons available to produce the normalisation form associated with each stage. However, using this program did not enable the students to immerse in the process and generate the normalisation forms themselves. Although this technique was not implemented in a virtual world environment, Folorunso *et al.* (2010) still confirmed that the visualisation idea of this complex theory process caused the students to view this experience more positively than the textbook technique.

Ochs (2010) explained another visualisation attempt for this subject in USA that was carried out in virtual worlds. However, this attempt was to use the 3D virtual world environment to teach an introductory database course to Master of Science in Database Technology students in order to reduce the time needed to learn database concepts. The 3D model built for this purpose handled preliminary database aspects to enable students to create a Microsoft Access inventory database. It did not particularly focus on visualising the difficult theory concepts of the database normalisation process. The virtual model was a purposely furnished house in Second Life with descriptions and notecards attached to different furniture objects to provide the students with information on the fields required per database table. The inventory database for this house was rather simple and did not require a major normalisation process. Ochs (2010) clarified that students' feedback showed that 75% of them agreed that this model reduced the time needed to learn these concepts.

Regarding the multithreading techniques area, the researcher carried out intensive investigation to trace visualisation attempts using virtual worlds; however no evidence could be obtained.

Chapter Three: Methodology; Relevant literature review on research methods and learning theories

3.1 Rationale for 'Action Research' methodology

Alidou *et al.* (2015, p.33) defined Action Research as the methodology that "*builds on basic problem-solving processes and turns them into systematic, conscious action to improve practice*".

Laycock *et al.* (2010) indicated that 'Action Research' is the answer to the following questions:

- Have you tried a new strategy in your classroom lately?
- Have you planned your lessons differently?
- Are you looking for an alternative approach to dealing with a problem in your classroom?

These questions clearly reflect the need to a developed approach in education to enhance students' learning and achievement. Laycock *et al.* (2010, p.2) clarified that we can achieve an effective Action Research by formalising the education process through "*careful planning, acting and evaluating*". They emphasised the fact that Action Research is a systematic process that allows the researcher to practice different ways of doing things in the classroom until reaching a method that really works for both the teacher and the students.

According to Dick (2002), the researcher in Action Research is acting and researching at the same time. This is the process of doing a task, checking if it worked as anticipated, and if not, an analysis is carried out as to why it did not, what went wrong and what could have been done differently. If necessary, the process will then be repeated. This is the cycle in which Action Research is applied to achieve its outcomes.

Action Research involves people in both the planning and the action phases. It should be flexible and responsive to the research situation and the opinion of the participants.

An analysis stage should be planned to follow each of its phases in order to evaluate the outcomes and assess the suitability of the following phase.

Action Research is also known as:

- Participatory Action Research (PAR) (Koshy *et al.* 2010)
- Community-based Study (Koshy *et al.* 2010)
- Co-operative Enquiry (Koshy *et al.* 2010)
- Action Learning (Koshy *et al.* 2010)
- Exploratory Teaching and Learning (Allwright and Bailey, 1991)
- Educational Action Research (Carr *et al.*, 1986)
- Classroom Research (Hopkins, 1985)
- Self-reflective Enquiry (Kemmis *et al.*, 1982)

As there are various different schools of Action Research, four different definitions were selected to identify this methodology and its application in the education field. These definitions were chosen from different periods and by different researchers in order to demonstrate the development of its concepts throughout the years:

According to Adelman *et al.* (1982), Action Research is the process of making judgements on the value and effectiveness of the educational processes, their outcomes, learning resources, and their planning and implementation frameworks.

Zeni (1998) defined Action Research as the process in which practitioners examine their own professional practice and specify their own questions, as their research has immediate targets to evaluate in order to improve and/or develop their practice.

Into more details, Brown (2002) described Action Research as the process where educational practitioners work collaboratively to investigate and follow-up practical problems in their teaching practice. She clarified that such practitioners are required to improve their educational procedures, due to which they need to review and examine the literature related to their questions, and then choose (or design) a solution that would solve their problems and enhance their teaching practice.

A more recent definition of Action Research was provided by Bleach (2013, p.3): "*The process of identifying a problem, planning an intervention, implementing the intervention and evaluating the outcome*". It is "*an enquiry, undertaken with rigour and understanding so as to constantly refine practice. Unlike traditional research, it does not aim for the final answer, but provides a structure that enables the continuous evaluation and improvement of the project, both formally and informally.*"

All the above definitions reflect that Action Research is a valid methodology for the education field. It could well be applied when a lecturer identifies an area of concern within their practice and try to find solutions to enhance the learning process and experience of their students. Therefore, the Action Research methodology was selected for this research to examine the problems faced by HE in FE students in understanding the complex theory concepts in Computer Science subjects, and investigating whether the suggested solution (of utilising virtual worlds to achieve this visualisation) is appropriate/valid to solve the identified problem.

The above definitions also showed that the main concepts and the application framework of this methodology, when applied in the education field, have not changed dramatically throughout the years. However, it is also valid to say that the technology-based educational solutions that have been applied under this methodology by different researchers/educators over the years could well vary due to the technological developments within the time period.

Figure 3.1 summarises the Action Research stages and how it works:

Laycock *et al.* (2010).

(used with permission)

Figure 3.1: Action Research stages

However, a more detailed guide to carry out all the stages of Action Research is shown in the Figure 3.2:

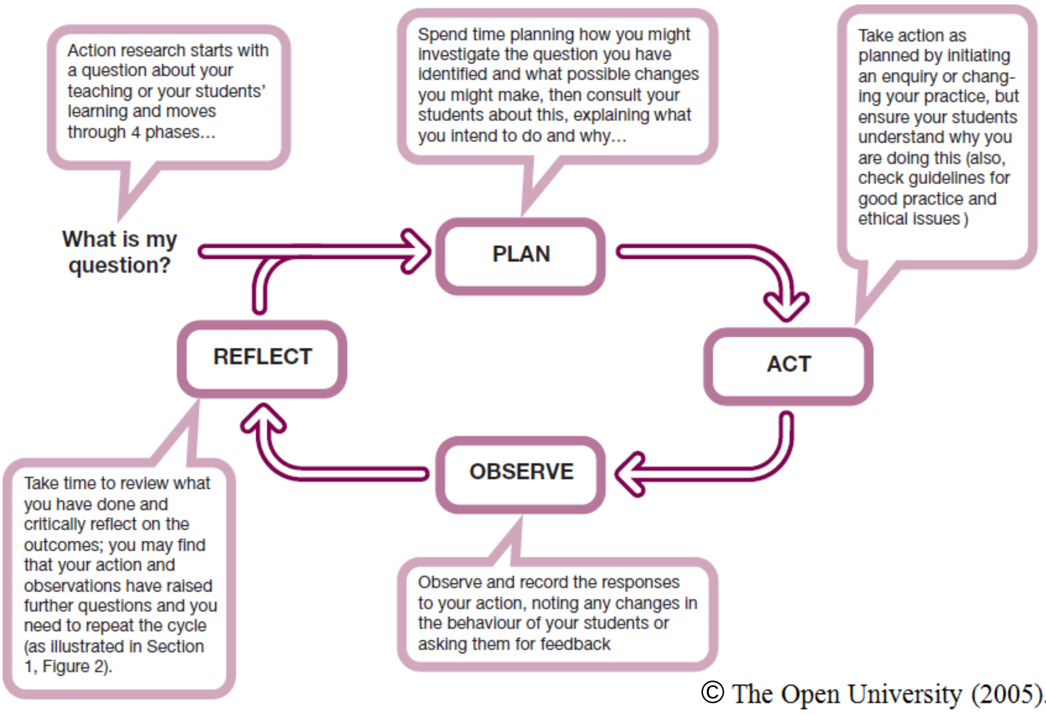

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Figure 3.2: A guide to Action Research stages

3.2 The differences between Action Research and other methodologies

Kemmis *et al.* (1982) highlighted the differences between the Action Research practice and other methodologies through the following points:

a. Action Research is not the usual thinking or method, which the teachers follow when they plan their teaching. It is a more systematic and collaborative approach in collecting information and evidence on which to base their reflection.

b. Action Research involves problem-posing, not just problem-solving. The process of Action Research does not begin with an interpretation of the problem as pathology, but it is encouraged by the aim to enhance the situation via making changes and then learning how to make the best improvements from the impacts of the changes made.

c. Action Research is not the research done on other people. It is the research carried out by certain people on their own work in order to enhance the way they carry out their activities and their deliverables for their clients.

The above clearly shows the important features of the Action Research methodology and its suitability for this research. In light of the current developments in the educational resources, facilities and environments, enhancing the teaching practice is one of the most important issues within the education field, and finding an appropriate and valid research methodology is vital to achieve effective teaching and learning solutions.

Alidou *et al.* (2015, p.32) stated that "*traditional research methodologies were criticized for their lack of support for improving practice. Action research made this link by inviting practitioners to participate in or conduct research relevant to their concerns*". Wabwoba *et al.* (2011), who investigated research methodologies for the Information Technology fields, clarified that a large number of specialists in the Information Technology field, most of whom have a computer science background, often find it difficult to select the best research methodologies to use. They added that the multidisciplinary nature of this field makes the situation even more complicated. The following is a comparison between a number of research methodologies and their application in the Computer Science/Information Technology (IT) fields. This clearly confirms the suitability of the Action Research methodology for the situation addressed by this research.

Action Research:

This is the preferred methodology by computer specialists for a long time. The main intention behind applying this methodology is solving a current important problem in the local setting. It aims to intervene in the studied circumstances by improving the situation. It forms an interactive process, the main interest of which is in developing an innovation to practically solve a problem in the selected society, which is of value to the people or organisations with whom the researcher is working. The majority of the ideas related to software applications are developed via collaborative work between the researchers and the beneficiaries. (Wabwoba *et al.*, 2011).

In this research, the researcher applied this methodology following the observation of the difficulties faced by the HE in Computer Science students in understanding the complex theory concepts in this field, which negatively impacted their learning experience and achievement. The research aimed at finding and applying an appropriate solution to this problem via the employment of virtual worlds in the curriculum delivery of the modules that include such concepts. As this process was based on 'trial and error' basis until the researcher finds the most suitable solution, Action Research was the best methodology to choose for this situation.

Ethnography:

This methodology places more emphasis on sociology of meaning via the use of observation, interviews and the examination of documents. Its main aim is to study a community of people in order to understand how they make sense of the social interactions. It enables IT researchers to have insight into social, human and organisational aspects of Information Technology innovations and applications. (Wabwoba *et al.*, 2011).

This methodology was inappropriate for this research, as the research aimed at solving a current problem in the workplace via achieving visualisation in virtual worlds, which is not focused on social interactions of people in the virtual environment.

Grounded Theory:

This methodology is used in Information Technology to develop theory that is based on systematically gathered and analysed data. It is a discovery method that enables researchers to develop theoretical accounts based on categories, concepts and prepositions. It is used to develop theoretical context for conceptualising the organisational issues around the use of Information Technology innovations and applications. (Wabwoba *et al.*, 2011).

Similar to Ethnography, this methodology was inappropriate for this research, as the investigated solution to the problem was of a practical and visual nature, where theory concepts are visualised and role-played. Therefore, a methodology that is focused on developing theoretical context was not relevant.

Case Study:

This is a thorough investigation of an individual/institutional situation within its real-life framework. This approach offers an in-depth analysis and understanding of a certain phenomena, as it discusses the mechanism by which cause, effect and relationship occur. The main aim of the case study approach is to determine factors and relationships that caused the behaviour under study. It involves purposeful sampling in the process of selecting the case for the study. (Wabwoba *et al.*, 2011).

Another inappropriate methodology, as the aim of this research was to apply and measure the effectiveness of the solution proposed to solve the problem. Therefore, this research does not handle an individual phenomena and its relevant factors.

3.3 Applying Action Research in virtual worlds

Research demonstrated that a number of education researchers, who applied the Action Research methodology in virtual worlds, obtained positive outcomes. Kirriemuir (2012) stated that a lecturer in Post-registration Nursing, School of Health, Glasgow Caledonian University, carried out Action Research in Second Life between 2009–2011, in which he described the use of virtual worlds in education as 'mostly positive'. He clarified that the students were a bit confused at the start, however, after getting more involved they conveyed their satisfaction, as they really felt they were learning and that the experience was enjoyable, which was evident in the results of their exam.

Esteves *et al.* (2008) explained the Action Research carried out in two higher education academic institutions in Portugal, when Second Life was applied in the learning of computer programming. They clarified that they chose the Action Research methodology due to being a 'cyclical process approach', which incorporates four stages: Planning, Action, Observation and Reflection on outcomes. They added that the decision of selecting this methodology was mainly based on its two key advantages: 1) The researcher being able to continue studying the problem while the changes are presented in order to enhance the teaching and learning practices, and 2) The researcher being able to achieve a high degree of flexibility, which is vital especially when dealing with an information technology project with little background information.

In the same regard, Blessinger *et al.* (2013) indicated that the proceedings of the 2013 International Higher Education Teaching and Learning Association Conference: Exploring Spaces for Learning, explained the action research they carried out when they redeveloped their courses to improve students' understanding, consolidation, involvement and achievement. This conference handled the issue of engaging and retaining HE students using 'cutting-edge' technologies and innovative pedagogies, one of the major areas of which was: 'Collaboration and immersion discover best practices in a virtual world of Second Life'.

Christopoulos (2013) explained the action research project carried out in the Institute of Research in Applicable Computing, University of Bedfordshire, on the use of Second

Life and OpenSim for educational practices. He highlighted that the majority of the comments received during the research period were positive. He confirmed that the self-assessment of the group work that was carried out before the end of the module showed that the students believed that this ‘in-world’ project helped them to improve.

The flexibility offered by virtual worlds makes this environment ideal to carry out Action Research. Breaking the boundaries of a physical classroom and allowing the students the freedom of expression and taking more responsibility of their own learning would encourage more positive outcomes of the Action Research carried out within this environment. While the Action Research process is based on the ‘Trial and error’ method, this makes virtual worlds an ideal environment to carry out its tasks due to being cost and risk free. This factor is very important, as it allows an increased number of attempts with different variables, which could consequently lead to more effective outcomes.

The above clearly shows the advantages of applying the Action Research methodology in educational research within the virtual world environment. Virtual worlds are relatively a new technology that offered the education field, amongst many other fields, huge benefits to enhance teaching practices and to add another dimension to the learning process and experience.

3.4 Rationale for mixed method research (quantitative and qualitative)

Within the Action Research methodology, both qualitative and quantitative methods were decided to be applied in this research to analyse the data obtained.

There is significant research that investigated the area of combining the two research methods, qualitative and quantitative, to achieve high standard outcomes of research with well analysed supporting evidence. Menon *et al.* (2010) indicated three advantages of integrating qualitative and quantitative methods in social work research: 1) Offering increased validity due to the triangulation of methods, 2) Providing an opportunity to make use of the strengths of each approach, and 3) Allowing correspondence with the principles of social work to study things comprehensively.

In support of this, Bronstein *et al.* (2013, p.354) stated that "*Despite being a combination of qualitative and quantitative approaches, mixed methods research has developed into a separate methodological orientation with its own worldview, vocabulary, and techniques*". They also referred to the increased number of books and information sources acknowledging this trend and providing support to researchers pursuing this approach. This was also indicated in the onset of the Journal of Mixed Methods Research and the International Journal of Multiple Research Approaches, 2007.

In addition to the above advantages of mixed methods research, Royce *et al.* (2010) highlighted that this approach offers a unique capacity for synergy, breadth, and depth otherwise difficult to achieve with single methods. Moreover, Creswell (2009) clarified that mixed methods are useful when there is a need to both, explore and explain, and when either qualitative or quantitative method alone appears to be inadequate for the complexity of the research questions and topics.

This mixture of research methods enriched the outcomes of this research and increased its validity, accuracy and usability.

With regards to the analysis of qualitative data in this research, the approach of 'themed matrices' was followed, which targeted the qualitative data within the quantitative analysis to enable more synthesising of the data analysis outcomes. According to Jansen (2010), this approach focuses on the 'diversity' of certain behaviours or cognitions within a given dataset. Matrices were constructed from the quantitative data, in order to use them in identifying themes, trends and comparisons in support of the research questions. He clarified that the qualitative type of survey aims at "*determining the diversity of some topic of interest within a given population. This type of survey does not count the number of people with the same characteristic (value of variable) but it establishes the meaningful variation (relevant dimensions and values) within that population*". Therefore, he added, "*the qualitative survey is the study of diversity (not distribution) in a population*".

3.5 Learning theories and the design of activities in virtual worlds

Investigating relevant learning theories and effective curriculum design in virtual worlds was vital to the success of the visualisation scenarios planned as part of this research. Sköld (2012) stated that learning activities must be designed in order to ensure that students acquire the skills needed to make use of the modes of multimodal communication available within the virtual environment.

As the long known learning theories were subject to continuous change and development over the years, in view of the evolving educational technologies, the 'Learning by doing' philosophy and the 'student-centric learning environment' approaches were listed within the most important teaching methods/styles by educators in order to meet the demands of an innovative practice at the HE level.

There is significant pedagogic research suggesting that the 'constructivist paradigm' is prevalent for teaching in virtual worlds. This is represented in its 'Experiential Learning' method. According to Woolfolk *et al.* (2008), constructivism is generally described as a view that emphasises the active role of learners in building, understanding and making sense of information. They added that the main characteristics of the constructivism theory that are applicable to learning in virtual worlds are:

- The learning is embedded in the framework of a realistic and relevant platform.
- Social collaboration and joint responsibility are provided as part of the learning process.
- Providing support for multiple views and using different representations of content.
- A platform that raises self-awareness and promotes the understanding that knowledge is constructed.
- A platform that encourages learners to take ownership of their learning.

According to Farrell (2005), the 'Experiential Learning' approach caused the teacher-centred paradigm to be replaced by a more dynamic learning strategy, where students benefit from the opportunity to apply the theoretical information they study into a replication of real life situations. Alternatively, the ‘Experiential Learning’ pedagogy promotes the student-centred approach in learning. Fitzsimons (2012) stated that student-centred styles promote and develop students' skills and knowledge, which enables them to reason from their own experience. She also suggested that, being part of the ‘Constructivist Paradigm’, this is prevalent for teaching in virtual worlds. Duncan *et al.* (2012) supported this by saying that virtual worlds enable students to construct knowledge by themselves and learn by doing experiments rather than passively receive what they are taught.

Based on the above, the researcher decided that in order to engage students in virtual worlds' experiential learning, both ‘Simulation’ and ‘Role Play’ were planned to be applied in the activities of this research under the umbrella of ‘Collaborative Learning’, where students work together within the virtual scenarios designed for this research to achieve the learning outcomes.

Woolfolk *et al.* (2008) defined ‘Collaborative Learning’ as an effective teaching and learning approach that is focused on adding value to students’ understanding via interacting with others, where they are encouraged to share ideas and talks. Duncan *et al.* (2012) highlighted that collaborative simulation activities form around half of the reviewed education literature in virtual worlds (over 100 academic papers), while Fitzsimons (2012) confirmed that educators have long employed role-playing as a pedagogic tool in the education sector. In addition, Duncan *et al.* (2012) indicated that constructivist activities or problem-based learning, e.g. in computer science simulations of network routing algorithms, form the strongest examples of the use of virtual tools. They added that virtual worlds provide a strong support for collaborative work and learner interaction.

Another term that lends itself well to virtual worlds is ‘Situated Learning’, which was first proposed by Lave and Wenger (1991). According to Falconer (2012), despite the fact that Lave and Wenger did not indicate that Situated Learning is a pedagogical strategy as such, it has been successfully applied in many subject settings including adult computer education. She described Situated Learning as the type of learning that takes place within the same framework as that in practice. She explained how this approach is an appealing prospect for HE in virtual worlds by clarifying that situated learners learn through simulation, visualisation and socialisation, which is particularly valid for HE, as it is widely acknowledged that the social framework is one of the key elements of learning at this level.

Chapter Four: Research Background

4.1 Research framework and activities

The Foundation Degree and the BSc (Hons) in Computing Programmes in a FE college in England were chosen as the infrastructure for this research, which was carried out in the academic years 2012/2013 and 2013/2014.

The research did not suggest that the whole learning process of the selected HE Computer Science modules to take place in virtual worlds; instead, the research proposed to bring about the visualisation of complex theory concepts of the selected computer science subjects in Second Life virtual world as part of the curriculum delivery. In addition, the presence of the lecturer was deemed necessary in the virtual sessions to provide additional support and clarifications to students in order to best achieve the learning outcomes of each session. Chapter One includes literature review on the first three Computer Science subjects (having a high degree of complexity in their abstract concepts), while the last three subject, which were identified as having an indirect degree of difficulty, are explained in sections 4.3 – 4.5 below.

The research activities included learning tasks carried out, on the selected subjects, in both the physical classroom and virtual worlds, following which the students' feedback and views were captured and recoded in the format of questionnaires, discussions, observations, email messages and written text (within their formative and summative assessments), in addition to the element of their module grades for both academic years.

It is worth mentioning here that the two modules (at the MA Level), which the researcher completed as part of the requirements for this PhD qualification, during the academic year 2012/2013, helped much in designing successful and effective visualisation scenarios in virtual worlds for the HE students. The modules, which are part of the 'MA Education in Virtual Worlds Programme', The University of the West of England, were:

1- Designing Curricula in Virtual Worlds Module.

2- Scripting and Building Learning Environments Module.

The skills developed as a result of completing these modules and the practical experience acquired following the design and implementation of the virtual scenarios during the academic year 2012/2013, led to a more developed approach and highly specialised visualisation scenarios designed and scripted for the HE students in the following academic year, 2013/2014.

As the aim of this research was to identify the extent to which using virtual world technologies to visualise complex theory concepts in Computer Science subjects might enhance their understanding, the HE provision was selected due to the crucial need to understand and learn such concepts at this level. However, the HE in FE framework was chosen due to the level of additional support required for students' learning and success, since a high percentage of them is drawn from 'socially disadvantaged' communities, as indicated in Chapter One. Duncan *et al.* (2012) said that an area of concern in the use of virtual worlds for education is revealed by the research in the use of these technologies for the socially disadvantaged learners, which is lagging behind other areas of research in this field.

4.2 Ethical Considerations

The application of Technology-Enhanced Learning (TEL) tools in Higher Education was a college policy that was dictated to all HE provisions within the selected college. Therefore, the application of virtual world technologies in the curriculum delivery of the selected HE Computing programmes was not originally decided for the sake of this research.

However, all the students were informed of the research aim and potential activities at the start of each academic year, and that providing feedback on the application of virtual world technologies, e.g. filling questionnaires, is totally optional. To this regard, students who agreed to provide feedback were required to sign an 'Informed Consent' form at the start of the academic year to authorise the researcher to use the data they provide as part of this research.

The Informed Consent form clearly stated that all data, comments and discussions will be kept anonymous, and that students have the right to remove their data from the project at any time.

When completing any questionnaire, students were given the option that they either write their name on it or a number. Those who chose to use a number were asked to remember it and use it on all the questionnaires they complete. This was used in the qualitative data analysis and in mapping the learning modes of students to the outcomes of their feedback. Importantly, students were informed clearly of the fact that their contribution to this research will have no impact on their grades of the modules involved.

Being the researcher and the HE Lecturer in Computing at the selected FE College where the research activities took place, i.e. being an insider-researcher, provided a number of advantages as well as limitations. The most important advantage was enabling a continuous monitoring and observations of students' attitude towards the application of virtual world technologies, their learning progress and levels of achievement. Another advantage was allowing the examination of all the factors involved in this process in the college and their impacts, e.g. availability of resources, the structure of the HE Computing programmes and their regulations, the relevant college policies and feedback from the other HE lecturers teaching on some of the modules selected for this research. One of the limitations, however, was due to the researcher's familiarity with the research field. This issue is highlighted by a large number of researchers in different fields. For example, Yu Tonia (2015) clarified that it is common that an insider-researcher overlooks certain aspects of the research data which an outsider-researcher would have acknowledged. In addition, she added, this high familiarity with the research context and circumstances is likely to encourage an insider-researcher to take things for granted in terms of observation. These issues were continuously addressed by the researcher in this research through regular discussions with other HE lecturers teaching on the same HE in Computing programmes and also with the Director of Studies. In addition, the researcher focused on obtaining and considering data from a variety of sources, e.g. questionnaires, group discussions, observations, email messages, students' feedback and grades. This has majorly contributed to achieving unbiased answers to the research questions.

4.3 The difficult concepts of the Helpdesk Support module

It is well known that the complexity of certain computer systems' problems and methods of communication with clients make the helpdesk job difficult to handle even for well-trained and experienced staff members. The HE students studying this module were required to practice the theory concepts they learned in a helpdesk project that is designed for them within the college library, in which they provide helpdesk support for the college students and staff.

According to Beisse (2004, p.71), helpdesk personnel may deal with different types of difficult clients, who require special strategies to handle, especially when they exhibit angry or hard-to-manage attitudes. He further clarified that "*excellent communications and interpersonal skills are often more challenging for new user support workers to learn than technical skills or business skills*". He explained that training is needed on how to apply the skills effectively, as senior/experienced helpdesk staff and also their managers confirm that there is a strong correlation between client's satisfaction and how well the helpdesk staff deal with them and understand their technical problems.

In this module, the HE students found the element of communicating computer hardware and software technical aspects to clients with no (or little) computing background difficult to achieve. In addition, they faced difficulties in the process of analysing the technical faults described by the clients while they are under pressure by them, especially when they need some further support from a colleague in certain cases, where their knowledge is lacking. The students expressed that these aspects made the application of the theory concepts they learned in this module difficult to achieve in the real-life helpdesk situation, and that they need further training in a replication of a helpdesk environment with real customers, in which they can avoid (or reduce) the impacts of these factors and focus more on the technical problem to solve and also on developing their skills in dealing with such situations.

The researcher observed that more than half of the students were reluctant to exercise their duties within the helpdesk project because of these concerns, which not only affected them in gaining the practical experience required for a successful helpdesk personnel, but also in meeting the requirements of their module assessments, as they were required to build a portfolio of evidence showcasing the helpdesk support duties they carried out within the project, customer feedback/satisfaction, and their reflection on the overall experience.

Due to the above, the virtual world environment appeared as an appealing prospect to accommodate students' training for this module, in order to address all the concerns raised within the real-life helpdesk project, which had their clear negative impacts on students' learning and achievement.

Providers of helpdesk training in the UK appear to have started to consider virtual worlds for their learners to learn and practice the various skills required for this job. For example, Skillsoft, UK, a provider of IT training and cloud-based learning solutions for customers worldwide, announced in June 2013 the availability of 'Skillsoft Virtual Practice-Labs' in response to customers' demand for virtual lab training. In their website, the Director of Product Management said that Skillsoft Virtual Practice Labs provide a safe (virtual) environment for the IT professionals to build their critical technology skills. He added that these labs are able to mirror almost any hardware or software configuration for this purpose, enabling the experimentation with live applications, which allows learners to retain valuable skills and be able to deliver maximum value to their organisations. (Skillsoft, 2013)

4.4 The difficult concepts of the Research Methods module

The students considered this module as 100% theoretical, which they found very dry and challenging as they were used to a large percentage of practical activities within each Computing module. They expressed their desire to have a different approach to studying this subject.

Although the core information on research is the same in both situations, the researcher suggested the use of a research observatory in virtual worlds for this module, as it provides a visual and interactive environment for students to exercise their research activities compared to the textual and subdued traditional method.

As the ability to extend methods of research increases the potential of success to a Computing project, the module lecturer decided to introduce the virtual world environment for students to carry out their research activates in order to investigate whether this environment is going to facilitate better outcomes.

The main focus behind selecting this module was exposing the students to research within multiple environments, one of which is visual, and to check whether this is going to increase their vision of how their Computing project should develop.

Visualising computing research activities was an entirely new experience for the students, which they found interesting to explore. It was planned to investigate whether the use of an observatory metaphor for research methods is able to aid the students in visualising a clear structure for research methods, understanding the activities involved, engaging more in this process and focusing clearly on their Computing projects.

4.5 The difficult concepts of the Multimedia Technologies module

The decision to include this module, although it does not include difficult concepts to visualise, was made in an attempt to broaden students' views on the potential use of virtual worlds in HE.

The researcher introduced virtual worlds to be used by students to obtain live feedback from an audience of different cultures, backgrounds and age groups on their multimedia projects (before being finally submitted for marking as a major component of their overall assessment for this module).

During the past academic years, students were only able to upload their work to Youtube and wait for offline comments. However, the majority of them only managed to obtain very little useful feedback due to time restrictions and the nature of comments given offline.

The use of virtual worlds facilitated receiving live feedback from a broad range of audience, which the students were able to discuss instantly with their visitors. The students were also able to obtain suggestions from the audience in addition to recommended links to look at in order to develop certain features of their multimedia objects. The majority of students found this activity very useful and realised the massive difference between this type of feedback and the offline comments obtained via other internet services. The researcher also observed that students' grades for this module were enhanced. Even those students who very much liked Youtube and used it daily, acknowledged the great advantage of using virtual worlds in this module.

Although the process of obtaining live feedback from broad audience does not contain difficult theory concepts to visualise (similar to the other computer science subjects in this research), it could well be considered a difficult aspect to achieve in the physical classroom environment. Given the wide benefits of this activity to students' success in this module, and the amount of additional learning they managed to achieve as a result of discussing the various aspects of their work and exchanging ideas with different people, the researcher decided that adding this module to those selected for this research is a correct decision to make.

4.6 Recording students' views and feedback

As it was the first time virtual world technologies were planned to be applied within the studies of the selected HE in Computing programmes, it was important that before introducing virtual worlds to students (in the academic year 2012/2013), relevant learning theories and learning preferences (the VARK questionnaire explained in

Chapter Five) were clarified and students' questions were answered. The majority of the students were interested in knowing what 'Learning Preferences' are, and to link them to the information discussed on learning theories. This process formed a good introduction to what 'Enhanced Learning' means, and to the need for the application of virtual worlds in their studies.

The following planned activity was recording and analysing students' views and background information on the use of virtual worlds in their HE subjects. This process was crucial to identify any pre-judgment or negative opinions prior to the start of the research activities. This was also of great benefit to monitor students' progression and acceptance of these technologies, and possible changes in their behaviour and views (either positively or negatively) following practicing in the virtual scenarios. The researcher also carried out the same recording of views at the end of the academic year, following all the activities carried out in virtual worlds, which was also of significant benefit in comparing the initial and final impression of students. This was one of the important factors in judging the success and effectiveness of applying such technologies in HE Computing for that academic year.

In addition to the researcher's personal observations, students' views, suggestions and feedback were also recorded (during the two academic years 2012/2013 and 2013/2014) in a number of different formats to ensure accurate outcomes for this research:

1. Detailed questionnaires:

   A number of activities were carried out in Second Life, on which questionnaires were designed to record students' feedback. Certain questionnaires included a text area for students to write their views whenever applicable. This data was gathered and analysed, and the outcomes were discussed within the overall framework of students' input. It is worth mentioning here that the feedback of a number of students was affected, in a considerable number of cases, by the technical challenges they faced during the sessions in virtual worlds, e.g. sound configuration and specification of the graphics adapter (see Chapter Seven for full description).

2. <u>Tasks within module assessments:</u>

Purposely designed tasks were added to the formative and summative assessments of the selected modules in order to capture a different format of students' views and reflection. This was intended to take the students out of the questionnaire framework (with dictated questions) and to allow them the freedom of expression and reflection on the advantages and limitations of their experience in virtual worlds. Particular emphasis was placed on asking neutral questions, where the students were assessed based on their reflection on the overall experience of learning in the virtual environment, their analysis of the factors involved and whether anything could have been done differently to improve the outcomes.

As certain summative assessments were carried out in teams, this enabled and encouraged the students to discuss their individual experiences with each other and come to a mutual outcome for their assessment. It was also noted that when there was a disagreement in the team's views, comments were added to the assessment task highlighting this. This activity was very important in assessing a number of crucial aspects, one of which is the validity of students' feedback, as their reflection in the assessment tasks was compared to their answers in the questionnaires. The formative assessments were also very beneficial in monitoring the improvement in students' learning before and after carrying out the activities in virtual worlds.

3. <u>Lecturers' observations:</u>

The learning curve of students was monitored closely by their lecturers (including the researcher), to assess the impacts of the visualised learning in virtual worlds. The changes in students' attitude and level of achievement were mapped towards the information obtained from the questionnaires they completed following each activity in virtual worlds in order to accurately evaluate the benefits of this experience to their understanding and learning.

4. Observation of other virtual world activities by a different lecturer (as part of the Secondary Research):

   The researcher observed activities in virtual worlds that were carried out by another HE lecturer in Computing, following which the researcher also distributed questionnaires to students to record their feedback on their learning experience. These observations provided an additional advantage for this research, as the accumulative experience of individual students in virtual worlds could well affect their engagement in future activities within this environment, especially that the activities carried out by the other lecturer were of a different nature. Delivering presentations in virtual worlds was one of the activities that the majority of students enjoyed and valued.

4.7 The 'Learning Archetypes' and the pedagogic domains applied

The 'Learning Archetypes' contains four domains as shown in Figure 4.1 below, two of which were applied within this research, the Cognitive and Dextrous Domains.

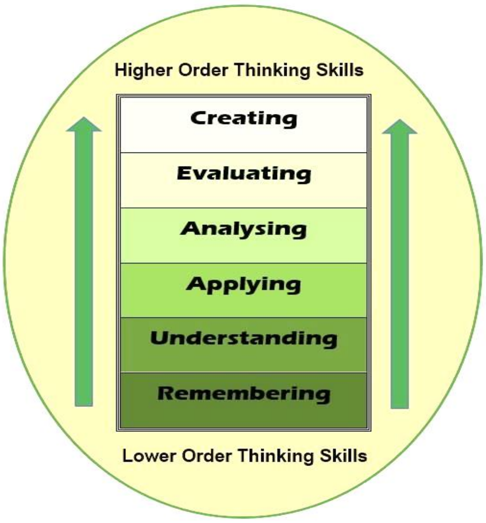
(Scopes, 2009)

(used with permission)

Figure 4.1: Learning Archetypes

Cognitive Domain (Bloom's Taxonomy) - processing information, knowledge and mental skills:

"*This categorized and ordered thinking skills and objectives*" (Churches, 2008). This taxonomy follows the natural thinking process, i.e. people cannot apply knowledge and concepts before understanding them, and obviously remembering them first. Figure 4.2 shows how Bloom orders the thinking skills:



(Idea from: (Churches, 2008))

Figure 4.2: Bloom's Revised Taxonomy

The virtual visualisation scenarios designed for this research were planned to help the students in remembering the background information and knowledge about their subject (Level 1), better understanding the complex theory concepts in their Computing curriculum and how they work (Level 2), applying the theory knowledge within different contexts (Level 3), analysing and comparing the outcomes of multiple cases – as a result of interacting with others (Level 4), evaluating the outcomes of their experiments (Level 5) and finally creating/designing/planning further activities based on their learning experience and outcomes (Level 6).

Dextrous Domain:

This domain "*was initially inspired by Bloom's incomplete psychomotor domain re-engineered to accommodate requirements that provide dexterity at the interface with the virtual world and also within it.*" (Scopes, 2011, p.11).

The levels within this domain are:

Level 1 – Imitating
Level 2 – Manipulating
Level 3 – Developing precision
Level 4 – Articulating
Level 5 – Naturalising
Level 6 – Mastering

The virtual visualisation scenarios designed for this research were planned so that the students acquire knowledge in the Cognitive domain and acquire skills in the Dextrous domain.

The following explains how the two domains were needed and applied together by the researcher in this research. The students were required to both interact with the virtual world user interface and apply their theory knowledge within the visualisation scenarios designed for them in this environment. Each student was required to imitate the instructions explained by the lecturer with the support of text and/or visual information (Level 1, Dextrous Domain). However, in order to accomplish this level of the Dextrous Domain, tasks within the Cognitive domain needed to be achieved first, i.e. Levels 1, 2 and 3 of the Cognitive Domain as explained above (Remembering, Understanding and Applying the theory information). (Chase *et al.* 2012).

Following imitating the lecturer's instructions, the learner manipulates the learning objects within the virtual scenario to visualise and compare execution results (Level 2, Dextrous Domain), continues manipulating the objects until achieving the correct results/outcomes (Level 3, Dextrous Domain) and articulates their interpretation of the amendments and their outcomes (Level 4, Dextrous Domain). This is then followed by understanding and accepting the results achieved (Level 5, Dextrous Domain) and finally, establishing ways/techniques to stretch and develop their acquired knowledge (Level 6, Dextrous Domain).

Chapter Five: The virtual learning scenarios and data analysis

The following sections discuss the analysis of the data gathered for this research in both academic years 2012/2013 and 2013/2014, with detailed information on the visualisation scenarios designed for the individual modules considered. Appendix-2 (page 210) has additional screenshots of the scenarios for all modules.

5.1 Data collection and analysis background

The data analysis covered both quantitative statistics (including students' grades) along with qualitative information for all HE levels. This was topped-up with observation-based comments from the module lecturers and the researcher.

Students' grades were checked for both academic years, 2012/2013 and 2013/2014, when virtual world technologies were applied (grades appearing in green within this Chapter). This was then compared to students' grades in the previous academic year (2011/2012), when these technologies were not used (grades appearing in red within this Chapter). In order to get as accurate indication as possible, the average mark of students' grades for each module was compared to the average mark of all the other Computer Science modules in their course year (for the same group of students). This is calculated as follows:

= (Average mark of the module / Average mark of all Computing modules * 100)

For example, when the value displayed under the module grade is above 100, this means that the average mark of the module was higher than the average mark of all the Computing modules for that course year (for the same group of students). Same applies when the value appearing under the module grade is less than a 100, i.e. the average mark of that module was lower than the average mark of all Computing modules.

In addition, only the grades of Computing modules were considered in this equation in accordance with the focus of this research. Non-Computing modules, e.g. Work-Based

Learning, Managing Marketing Activities and Developing Professional Skills were deemed irrelevant in this situation.

In each of the two academic years, a different approach to collecting students' feedback was adopted in order to add another dimension to data validity and reliability. A more general approach was followed in the academic year 2012/2013 in terms of asking the students, in questionnaires, to reflect on their experience of using Second Life to visualise complex theory concepts in their Computer Science subjects. This, however, was followed by a more focused approach in the academic year 2013/2014 when students were required to record their views before and after the application of virtual world technologies in order to achieve a more meaningful comparison between the two situations.

On top of the above, observations by the researcher of students' attitude, engagement and approach to their learning was sought and recorded, in order to be analysed along with students' feedback and the other data gathered for a more accurate picture of whether virtual worlds form an appropriate platform to visualise difficult abstract concepts in order to enhance students' learning and achievement in this field.

All the questionnaires distributed to collect students' feedback on their learning within virtual worlds included a number of questions, which were then mapped towards four main categories:

1. Is the subject and its theory concepts considered difficult to understand and learn?
2. Has the application of virtual world technologies enhanced the understanding and learning of the complex theory concepts of the subject?
3. Has the application of virtual world technologies enhanced affective quality (to include elements such as appeal, enjoyment, interest and appreciation)?
4. Has the application of virtual world technologies increased students' engagement?

The questionnaire(s) for each module was/were distributed following a session (or more) in virtual worlds (per individual visualisation scenarios), which was preceded by a number of sessions delivered using the traditional method in the physical world.

See Appendix-3 (page 227) for all the questionnaires and data analysis sheets for both academic years 2012/2013 and 2013/2014.

In order to ensure that students are providing accurate feedback and that they are reading the questions carefully before answering them, certain questions were reversed in the questionnaires and others were re-phrased and repeated elsewhere. Students' answers were compared during the analysis phase to make sure that the outcomes provide as true as possible answer to whether the application of virtual worlds enhanced students' learning of the complex theory concepts in their HE Computing studies.

In certain subjects, e.g. computer programming, it was planned that the module is introduced to students using the traditional method, where the challenging abstract concepts are delivered in the physical world, which is then followed by the application of the virtual world visualisation scenario to investigate whether this type of visualisation enhanced students' learning and achievement.

In other subjects, e.g. database normalisation, the researcher decided to adopt a different approach in the process of gathering students' feedback, which focused on dividing the group into two parts, one to learn in the physical world and the other in the virtual world. These groups were then swapped to enable them to compare the advantages and limitations of learning within each environment.

The reason behind the above decision of adopting a different approach to gathering feedback was in situations where more than one computing subject (handled by this research) are studied by the same group of students, e.g. computer programming and database normalisation are both studied at Year-1 of the course. The researcher tried to apply different ways of investigating students' views on the application of virtual world technologies in their studies, in order to achieve as accurate feedback as possible.

With regards to students' grades, the following approaches were followed in order to enable an accurate judgement of students' benefits from the application of virtual world technologies and to avoid including irrelevant data:

1- Where one (or more) of the assessments included in the calculation of grades does not involve the application of students' understanding of the complex theory concepts that they learned in virtual worlds, their grades for such an assessment were not included.

2- Where one (or more) of the assessments included in the calculation of grades was carried out before using virtual worlds, their grades were also excluded.

With regards to students' reflection on their experience within virtual worlds in their assessment work, all the assessments submitted by students that included such elements were gathered and the relevant paragraphs were highlighted for further analysis and comparison with the outcomes of the questionnaires.

While the software used for analysing the quantitative data in this research was Microsoft Excel 2013, the analysis of the qualitative data was carried out using the 'themed matrices' approach as indicated in Section 3.4 above. The qualitative data analysis covered the diversity of students' learning within the same virtual scenario while having different learning modes (according to VARK classifications below).

5.2 The 'Learning Modes' of students

In order to analyse and understand students' feedback and the data obtained in both academic years, the researcher carried out further investigation into the learning modes of students. This was investigated through using the VARK Questionnaire, which all the students were asked to complete at the start of their academic year. This online questionnaire is found in the following URL and it forms a well-known tool in education to judge preferred learning modes of students, i.e. the way(s) that students prefer to take-in and give-out information in their learning process:

http://vark-learn.com/the-vark-questionnaire/

VARK identifies four learning modes:

- Visual (see it)
- Aural (hear it)
- Read/Write (read it)
- Kinesthetic (do it)

According to Fleming (2011), the designer of the VARK Questionnaire: "*Asking some people to engage in a role-play will appeal to those who have a Kinesthetic preference while discussion in lectures will be more suited to those who have stronger scores for Aural in their profile*". He added that when students exercise their preferred modes, it is more likely that they become more motivated compared to the situation when they use those modes where their preference is weak.

In comments on the 'Multimodal' learning preference, Fleming (2011) clarified that although the advantage of this preference is students being flexible about the acceptable ways in which they give and receive information in their learning process (compared to other students with a single preference), there is also the disadvantage that students having the multimodal preference need to involve all of their preferred learning modes before they become satisfied with the information they gave or received in their learning process. For example, a student with a bimodal (Read/write and Aural) profile would want to read the information and discuss it with their lecturer and/or peers (and perhaps write some notes about it) before they can trust the information received. In comparison, a student with a single preference is able to learn from having (giving and receiving) information using their one preferred mode (assuming that this mode is made available).

According to Morris (2012, p.55), the VARK questionnaire includes 16 multiple-choice questions. The learning preferences are calculated according to 'VARK learning preference guidelines', which are shown in Table 5.1 below. There are 4 options to each question in the VARK questionnaire, and the students are not limited to one answer per question. Therefore, the options selected per student could be anything between 16 – 64 answers. The number of answers per student will impact the predominance of any of the 4 learning preferences.

Total No. of Responses	**Very Strong Preference** indicated by a difference of	**Strong Preference** indicated by a difference of	**Mild Preference** indicated by a difference of
Up to 16	4+	3	2
17 – 22	5+	4	3
23 – 30	6+	5	4
31+	7+	6	5

Table 5.1: VARK preference guidelines

This is calculated by adding all the values of the VARK results and then using the guidelines table to judge which row forms the category of the answer. For example, the total score of Student-1 in Table 5.2 below is 44. This places it in the responses category ‘31+’. The next step will be selecting the highest VARK score from (V, A, R, or K) and then eliminating any of the other scores that differs from that one by an amount equal to or greater than the number indicated in the "Mild Preference" column (in that row). In the above example, Student-1’s preferences are (Visual, Aural, Kinesthetic).

Academic Year 2012/2013:

The VARK results of the 7 students in Year-1 were as in Table 5.2 below – this will be referred to as ‘Group-A’ in the later analysis:

Seq.	Student	Visual	Aural	Read/ Write	Kinesthetic	Learning Mode (questionnaire result)
1-	Student-1	15	14	4	11	(multi-modal) Visual, Aural, Kinesthetic

2-	Student-2	6	3	3	9	Kinesthetic
3-	Student-3	4	8	7	9	(multi-modal) Aural, Read/Write, Kinesthetic
4-	Student-4	6	8	7	11	(multi-modal) Aural, Read/Write, Kinesthetic
5-	Student-5	9	11	8	7	(multi-modal) Visual, Aural, Read/Write, Kinesthetic
6-	Student-6	6	5	4	6	(multi-modal) Visual, Aural, Read/Write, Kinesthetic
7-	Student-7	3	7	4	9	(multi-modal) (Aural, Kinesthetic

Table 5.2: VARK results, Year-1 (Group-A)

The VARK results of the 13 students in Year-2 were as in Table 5.3 below (only 12 students completed the questionnaire) – this will be referred to as 'Group-B' in the later analysis:

Seq.	**Student**	**Visual**	**Aural**	**Read/ Write**	**Kinesthetic**	**Learning Mode (questionnaire result)**
1-	Student-1	12	9	12	10	(multi-modal) Visual, Aural, Read/Write, Kinesthetic
2-	Student-2	14	9	5	11	(multi-modal) Visual, Kinesthetic
3-	Student-3	5	6	7	2	(multi-modal) (Visual, Aural, Read/Write)

4-	Student-4	11	13	12	12	(multi-modal) Visual, Aural, Read/Write, Kinesthetic
5-	Student-5	4	9	13	12	(multi-modal) (Aural, Read/Write, Kinesthetic)
6-	Student-6	3	8	4	13	Kinesthetic
7-	Student-7	8	11	10	11	(multi-modal) Visual, Aural, Read/Write, Kinesthetic
8-	Student-8	12	11	4	11	(multi-modal) (Visual, Aural, Kinesthetic)
9-	Student-9	4	6	3	3	Aural
10-	Student-10	13	10	11	12	(multi-modal) Visual, Aural, Read/Write, Kinesthetic
11-	Student-11	5	2	7	2	Read/Write
12-	Student-12	10	3	0	3	Visual
13-	Student-13	-	-	-	-	-

Note: This questionnaire was completed under the supervision of another HE Computing Lecturer – a copy was obtained for this research.

Table 5.3: VARK results, Year-2 (Group-B)

The VARK results of the 7 students in Year-3 (BSc (Hons)) were as in Table 5.4 below – this will be referred to as 'Group-C' in the later analysis:

Seq.	**Student**	**Visual**	**Aural**	**Read/ Write**	**Kinesthetic**	**Learning Mode (questionnaire result)**
1-	Student-1	10	4	9	7	(multi-modal) Visual, Read/Write, Kinesthetic
2-	Student-2	13	11	13	14	(multi-modal) Visual, Aural, Read/Write, Kinesthetic
3-	Student-3	3	3	5	5	(multi-modal) Read/Write, Kinesthetic
4-	Student-4	9	7	11	5	(multi-modal) Visual, Aural, Read/Write
5-	Student-5	5	4	2	5	(multi-modal) Visual, Aural, Kinesthetic
6-	Student-6	14	3	6	11	(multi-modal) Visual, Kinesthetic
7-	Student-7	9	6	5	10	(multi-modal) Visual, Kinesthetic

Note: This questionnaire was completed under the supervision of another HE Computing Lecturer – a copy was obtained for this research.

Table 5.4: VARK results, Year-3 (Group-C)

Academic Year 2013/2014:

The VARK results of the 17 students in Year-1 (newly joined the HE programme) were as in Table 5.5 below – this will be referred to as 'Group-D' in the later analysis:

Seq.	Student	Visual	Aural	Read/ Write	Kinesthetic	Learning Mode (questionnaire result)
1-	Student-1	7	8	10	3	(multi-modal) Visual, Aural, Read/Write
2-	Student-2	2	4	4	8	Kinesthetic
3-	Student-3	9	5	11	10	(multi-modal) Visual, Read/Write, Kinesthetic
4-	Student-4	12	11	13	12	(multi-modal) Visual, Aural, Read/Write, Kinesthetic
5-	Student-5	5	4	9	8	(multi-modal) Read/Write, Kinesthetic
6-	Student-6	3	6	5	2	(multi-modal) Aural, Read/Write
7-	Student-7	7	5	7	11	Kinesthetic
8-	Student-8	1	6	7	9	(multi-modal) Aural, Read/Write, Kinesthetic
9-	Student-9	15	16	15	16	(multi-modal) Visual, Aural, Read/Write, Kinesthetic
10-	Student-10	4	7	4	7	(multi-modal) Aural, Kinesthetic
11-	Student-11	9	6	7	6	(multi-modal) Visual, Aural, Read/Write, Kinesthetic

12-	Student-12	2	4	7	7	(multi-modal) Read/Write, Kinesthetic
13-	Student-13	9	5	6	8	(multi-modal) Visual, Read/Write, Kinesthetic
14-	Student-14	8	12	8	11	(multi-modal) Visual, Aural, Read/Write, Kinesthetic
15-	Student-15	8	3	11	9	(multi-modal) Visual, Read/Write, Kinesthetic
16-	Student-16	4	4	8	13	Kinesthetic
17-	Student-17	2	6	4	11	Kinesthetic

Table 5.5: VARK results, Year-1 (Group-D)

The VARK results of the 6 students in Year-2 (which is the same group having their Year-1 in the academic year 2012/2013 - one student was withdrawn) were as in Table 5.6 below – this will be referred to as 'Group-E' in the later analysis:

Seq.	**Student**	**Visual**	**Aural**	**Read/Write**	**Kinesthetic**	**Learning Mode (questionnaire result)**
1-	Student-1	15	14	4	11	(multi-modal) Visual, Aural, Kinesthetic
2-	Student-2	6	3	3	9	Kinesthetic
3-	Student-3	6	8	7	11	(multi-modal) Aural, Read/Write, Kinesthetic
4-	Student-4	9	11	8	7	(multi-modal) Visual, Aural, Read/Write, Kinesthetic

5-	Student-5	6	5	4	6	(multi-modal) Visual, Aural, Read/Write, Kinesthetic
6-	Student-6	3	7	4	9	(multi-modal) (Aural, Kinesthetic

Table 5.6: VARK results, Year-2 (Group-E)

The VARK results of the 7 students in Year-3 (BSc (Hons)) (which is the same group having their Year-2 in the academic year 2012/2013 - six students did not join the BSc programme) were as in Table 5.7 below – this will be referred to as 'Group-F' in the later analysis:

Seq.	Student	Visual	Aural	Read/Write	Kinesthetic	Learning Mode (questionnaire result)
1-	Student-1	12	9	12	10	(multi-modal) Visual, Aural, Read/Write, Kinesthetic
2-	Student-2	14	9	5	11	(multi-modal) Visual, Kinesthetic
3-	Student-3	12	11	4	11	(multi-modal) (Visual, Aural, Kinesthetic)
4-	Student-4	4	6	3	3	Aural
5-	Student-5	13	10	11	12	(multi-modal) Visual, Aural, Read/Write, Kinesthetic
6-	Student-6	5	2	7	2	Read/Write
7-	Student-7	10	3	0	3	Visual

Note: This questionnaire was completed under the supervision of another HE Computing Lecturer – a copy was obtained for this research.

Table 5.7: VARK results, Year-3 (Group-F)

Having the majority of the students with ‘Multimodal’ learning preference could well be linked to the level of additional support required for the type of HE students within the FE framework, which was addressed in Chapter One. This also suggested that the application of virtual worlds and students’ acceptance of such technologies will not be an easy task, as the majority of these students would still require the other learning modes for their success and achievement. The following section looks into indicators on the technology acceptance by the above HE students.

5.3 Investigation into technology acceptance

In an attempt to gather students’ views with regards to their background information on virtual world technologies and their use in FE and/or HE, general questionnaires were distributed to HE students at all levels at the very start of the academic year 2012/2013. This, however, was not distributed in the academic year 2013/2014, as the same students progressed to the following level, except the new Year-1 students, who were also informed (prior to joining the HE programme) of the application of virtual world technologies in the HE Computing studies, as part of the promotional events for HE.

The outcomes of these general questionnaires were compared, at the end of the academic year, with the outcomes of another set of general questionnaires distributed at the end of the year to judge the development in students’ acceptance of virtual world technologies in the HE studies following practicing in the virtual visualisation scenarios of all the selected modules throughout the year. The outcomes of the questionnaires revealed the following:

Hundred percent of Year-1 (Group-A) students agreed that they are open to new technologies and that they are ready to investigate and exercise them in their Computing studies, while as high as 77% of them confirmed that they have not previously heard about the Second Life virtual world in FE/HE (in Computing and other fields). However, only 62% of the students believed that applying virtual worlds in education will enhance their learning experience, although 94% of them understood the two terms, simulation and social computing (see Figure 5.1 below).

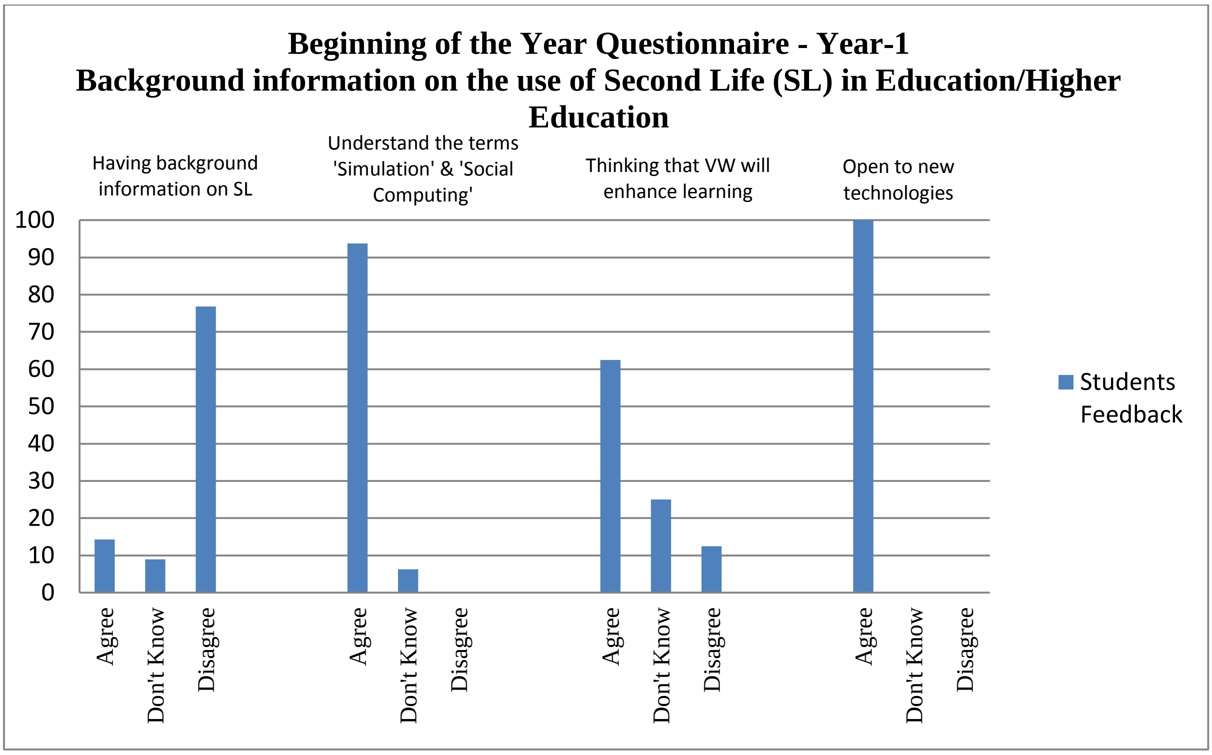


Figure 5.1: Background Information on Second Life, Year-1 (2012/2013)

The results of Year-2 (Group-B) questionnaire were a bit different. The same students' proportion of 100% agreed that they are open to new technologies and that they are ready to investigate and exercise them in their Computing studies. However, as low as less than half of the students confirmed that they previously heard about the Second Life virtual world in FE/HE (in Computing and other fields). In addition, the percentage was even lower in answer to the question whether the application of virtual worlds in education will enhance students' learning experience, even though the questionnaire was distributed following a presentation (delivered for all levels), which introduced Second Life, its features and its different applications in education and other fields. This low percentage was also regardless of the fact that 86% of the students confirmed that they understood the two terms, simulation and social computing (see Figure 5.2 below).

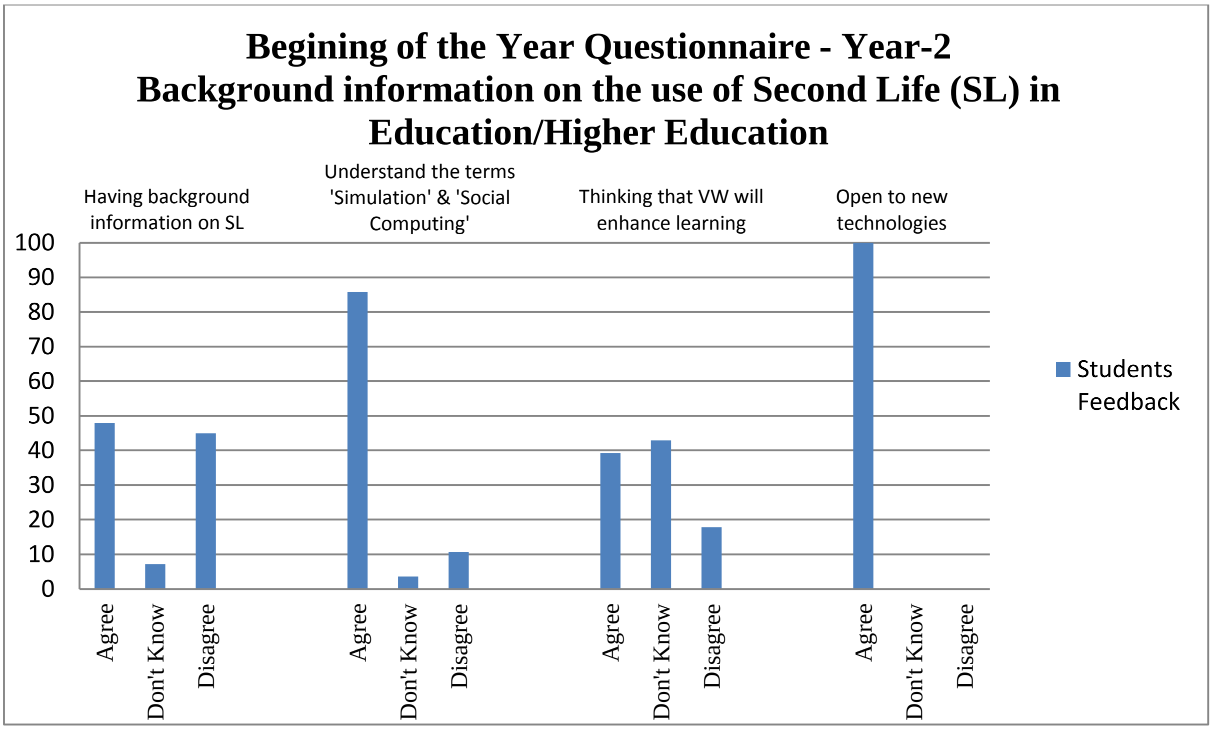


Figure 5.2: Background Information on Second Life, Year-2 (2012/2013)

With regards to the BSc (Hons) – Year-3 (Group-C), the same ratio of 100% agreed that they are open to new technologies and that they are ready to investigate and exercise them in their Computing studies. Just over half of the students confirmed that they had background knowledge on Second Life in FE/HE (in Computing and other fields). Fifty percent of the students believed that the application of virtual worlds in education will enhance their learning experience, and 79% of them confirmed that they understood the two terms, simulation and social computing (see Figure 5.3 below).

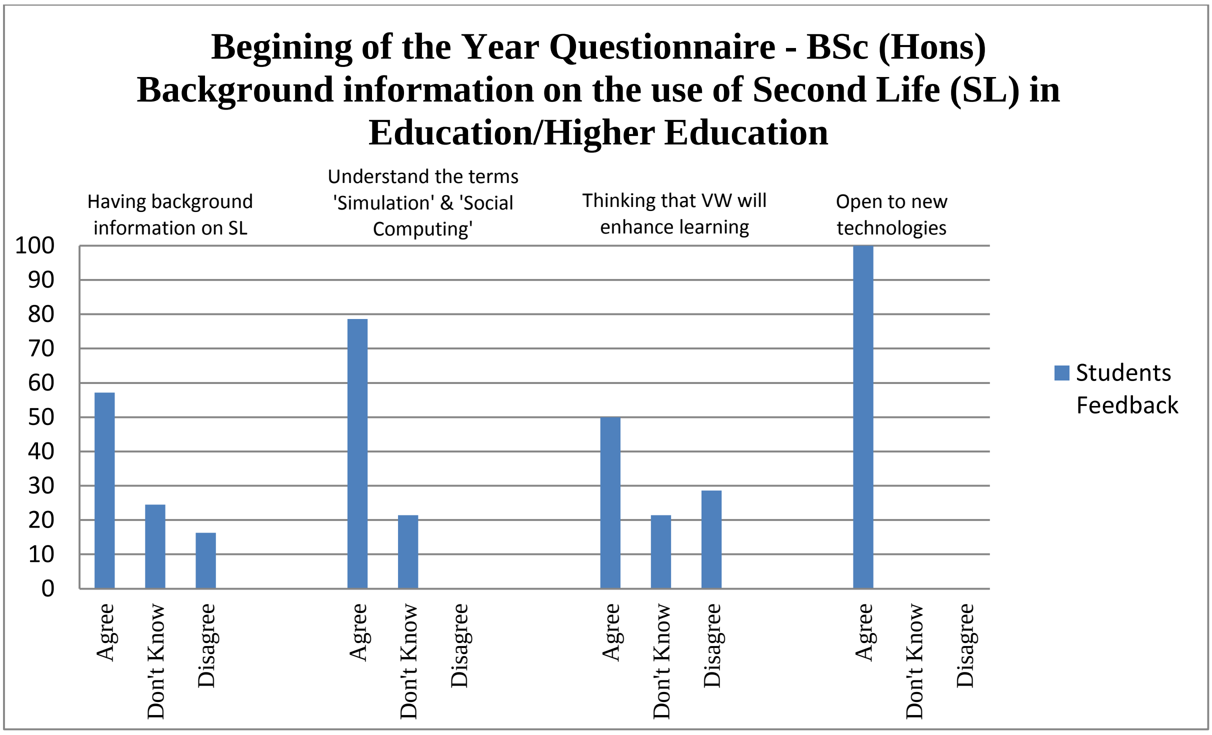


Figure 5.3: Background Information on Second Life, Year-3 (2012/2013)

The outcomes of the above questionnaires, especially for the questions related to whether the application of virtual worlds will enhance learning, led to the conclusion that opinions were divided on the likely affordances of virtual world technologies. In addition, the answers to the questions related to having background information on Second Life dictated the need to investigate students' acceptance of this technology at the end of the academic year following the number of visualisation activities that they carried out in virtual worlds. It was expected that the students would use their actual experience of learning within the virtual world environment and the level of understanding they managed to achieve in judging the effectiveness of this platform in their HE Computing studies.

For a copy of all the general questionnaires in the start of the academic year 2012/2013, see Appendix-3, Section A3.1 (page 227).

Accordingly, another set of three general questionnaires were distributed at the end of the academic year 2012/2013 to investigate possible changes in students' views following their virtual experience. The outcomes were as follows:

In the results of Year-1 (Group-A) questionnaire, it was interesting to see that the percentage of students who believed that the application of virtual world technologies will enhance their learning experience (both at the start and end of the academic year) were very close. Moreover, 67% of the students agreed that learning in virtual worlds changed their previous negative views and/or confirmed their positive views on the benefits of this technology in their HE Computing studies. The same percentage was also recorded for enhanced affective quality. The results of this questionnaire are shown in Figure 5.4 below.

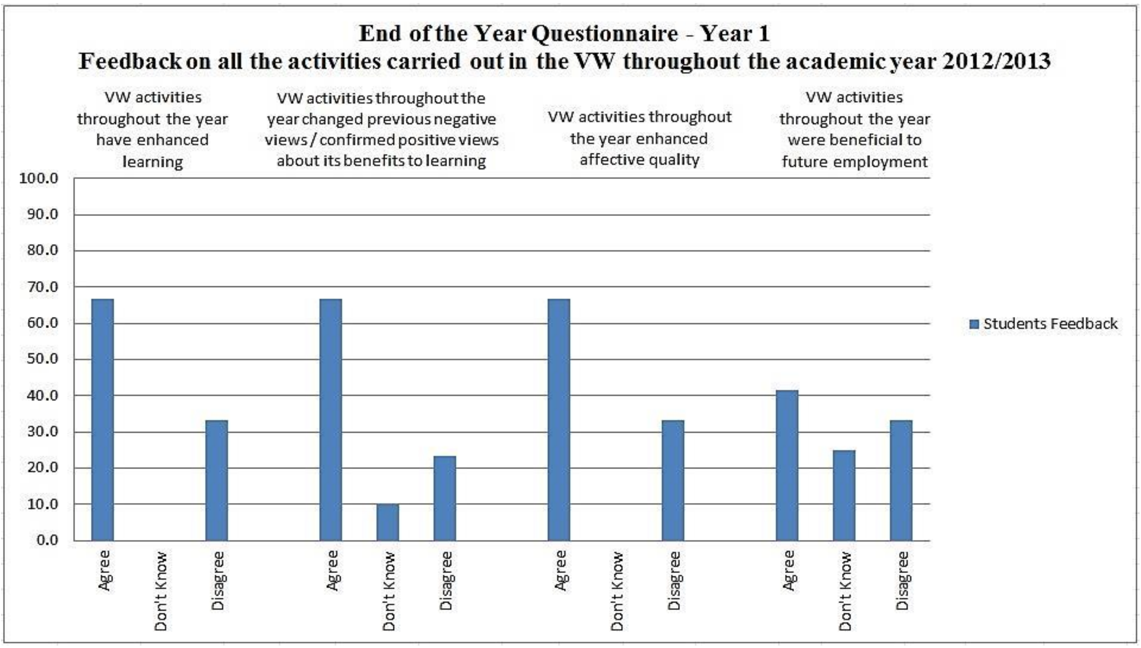


Figure 5.4: End of the year questionnaire, Year-1 (2012/2013)

The results of Year-2 (Group-B) questionnaire revealed a greater change than in Group-A. The percentage of students who believed that the application of virtual world technologies would enhance their learning experience was 20% higher at the end of the academic year compared to that at the start of the year. A high percentage of enhanced affective quality was recorded here (73%), and another high percentage of students agreed that learning in virtual worlds had changed their previous negative views and/or confirmed their positive views on the benefits of this technology in their HE Computing studies (64%) (see Figure 5.5 below).

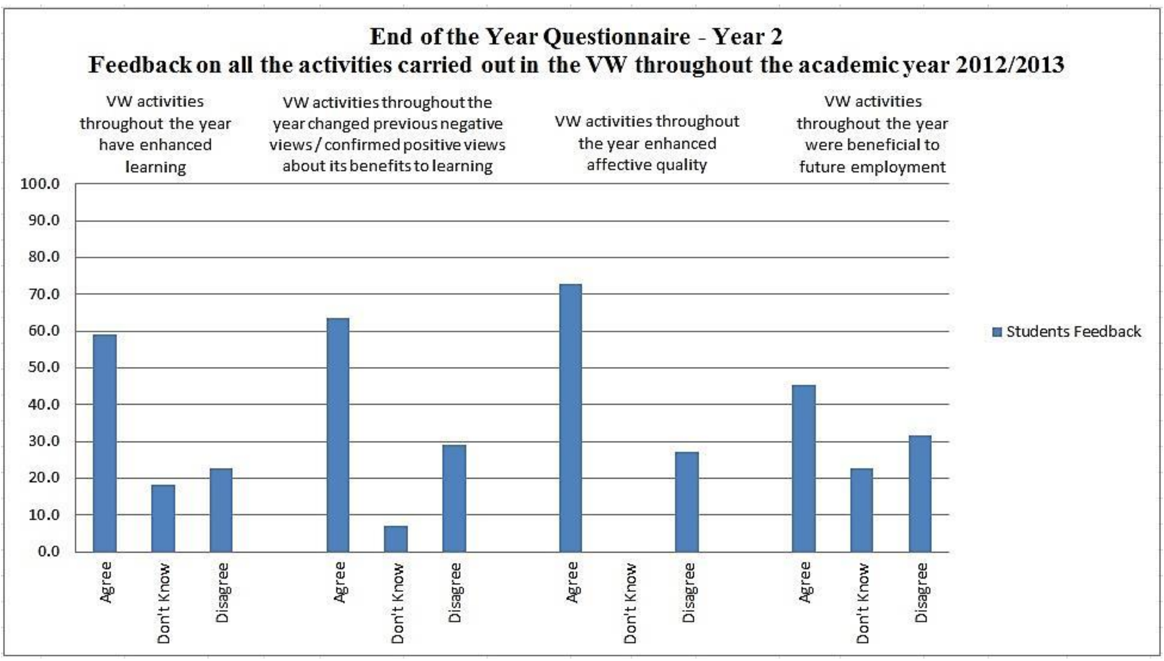


Figure 5.5: End of the year questionnaire, Year-2 (2012/2013)

Finally, the results of the BSc (Hons) – Year-3 (Group-C) questionnaire showed that the percentage of students who believed that the application of virtual world technologies would enhance their learning experience was 14% higher at the end of the academic year compared to the start of the year. However, the positive change this time was in the percentage of students who agreed that learning in virtual worlds had changed their previous negative views and/or confirmed their positive views on the benefits of this technology in their HE Computing studies (80%). Another high percentage recorded here for enhanced affective quality (71%). (see Figure 5.6 below).

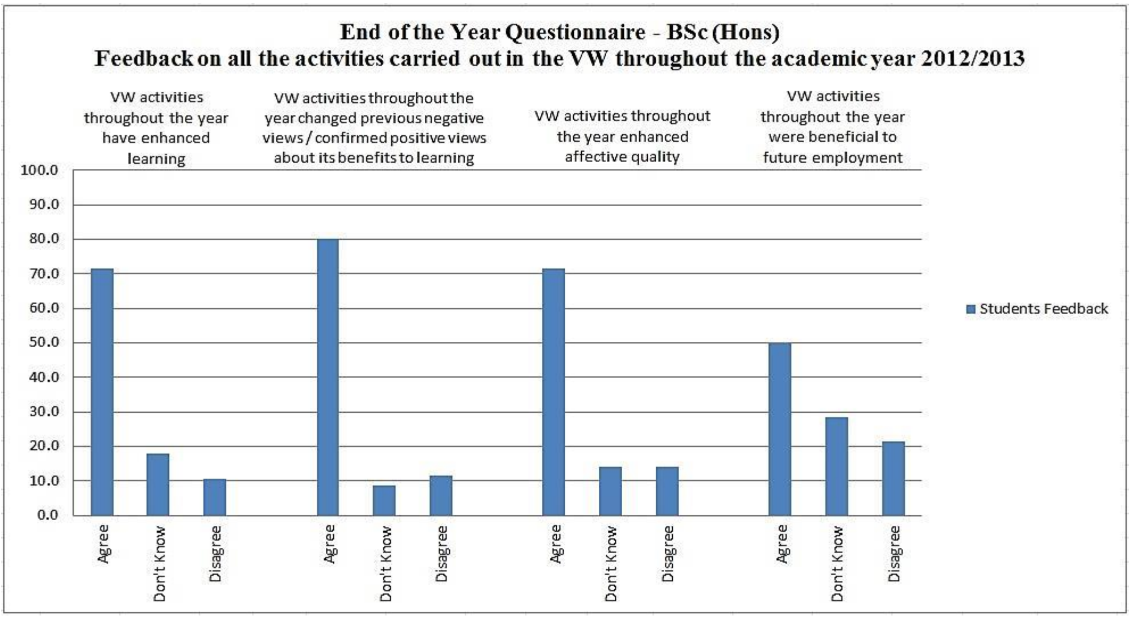


Figure 5.6: End of the year questionnaire, Year-3 (2012/2013)

For a copy of all the general questionnaires in the end of the academic year 2012/2013, see Appendix-3, Section A3.2 (page 242).

The above statistics indicated that the academic year 2012/2013, which was the first year of applying virtual worlds, demonstrated an improvement in student's acceptance of this technology and its benefits in enhancing their understanding and learning. This paved the way to a more focused approach of involving this platform in students' learning and course work in the following academic year, 2013/2014, in order to investigate further advantages and potential enhancements to students' learning and achievement.

The following sections explain in detail the outcomes of the different virtual activities carried out in both academic years 2012/2013 and 2013/2014 and the analysis of their results per module.

5.4 Computer Programming

Visualisation scenarios were designed in Second Life to support the understanding of the programming challenging concepts as part of the HE Computing Year-1 and Year-2 programming modules in both academic years 2012/2013 and 2013/2014. Students' questionnaires and the outcomes of their virtual experience were later used to monitor the development of their understanding and application of programming concepts in their following year of studies, i.e. observing Year-2 students' learning and achievement in the academic year 2013/2014 (who progressed from Year-1) and BSc (Hons) students (who progressed from Year-2).

The visualisation scenarios designed for this subject utilised the programming language embedded within Second Life, which is called 'Linden Labs Scripting Language (LSL)'. This language is considered, by many educationists and researchers, as being very similar to the C++ programming language, which the HE Computing students in the selected college were studying using the traditional method. Fonseca *et al.* (2009) confirmed this similarity by saying that programming in Second Life is carried out with the LSL scripting language, the syntax and keywords of which is similar to that in C-Language. Gomez (2012) reiterated that declaration of variables in the LSL language is similar to that in C++, and that in LSL "*there are several ways to create a loop. These are ripped almost straight out of C++*". Moldenhauer *et al.* (2007) also said that the basic syntax and operators of the LSL language are expressive of those in popular languages like C++ or Java. They added that Second Life includes C++ source code, which implements a compiler for the LSL language.

Some attractive 3D objects, e.g. Pokémon, were selected to be programmed by students in Second Life to enable them to visualise the execution of certain challenging programming instructions in order to enhance their understanding and learning of how these instructions are executed. Such 3D objects were chosen to add interest and make the learning process enjoyable (as part of the affective quality aspect).

This visualisation scenario was designed to enable the students to see the immediate effects of code changes on the 3D object, i.e. visualising program execution, which allows students to understand how each programming instruction works. The researcher placed particular emphasis on the loops and functions instructions (for the Introduction to Programming subject), and on the classes and objects (for the Object-Oriented Programming subject). See Figures 5.7 and 5.8 below.

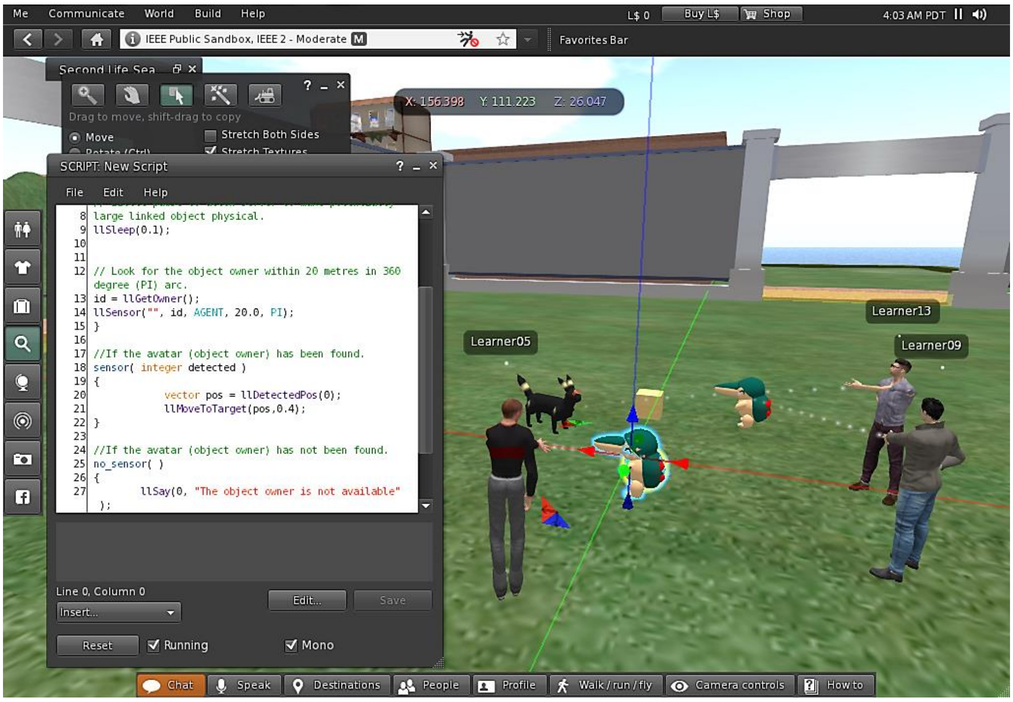


Figure 5.7: The Introduction to Programming virtual scenario

Figure 5.8: The Object Oriented Programming virtual scenario

More screenshots could be found in Appendix-2, section A2.1 (page 210).

Within the Introduction to Programming virtual scenario, each student got their own 3D object to program; however, working with other students in the same virtual space enabled the students to communicate their ideas and code changes to each other, see the impacts on the objects of their peers, compare this with the behaviour of their own object and modify their code accordingly. Collaborative learning was strongly achieved and evident in this situation. According to Fonseca *et al.* (2009, p.12), Second Life "*enables synchronous collaboration among students because the system permits two or more avatars to edit the same object and share the same code while programming it*". Examples of the coding tasks that were performed by students in virtual worlds are available in Appendix-4 (page 396).

Fonseca *et al.* (2009) also clarified that research demonstrated that collaborative learning is considered an effective pedagogical feature for preliminary programming courses, as programming with peers is particularly appropriate for learning how to code a program. They added that the environment that promotes collaboration is able to offer important support for the activities to learn computer programming, as students need to communicate within their group, argue and give opinions, which encourages the type of reflection needed for effective learning.

In this research, one of the examples that the students found very interesting when learning in the virtual environment was a question directed to them by the researcher before they started programming their objects in virtual worlds and following completing the programming sessions on the ‘For Loop’ in the physical world (using traditional learning in a classroom) –The question was:

Which of the following two pieces of code makes the object move five steps towards the X-axis?

```
For (i=0; i<5; i++)
    llSetPos(llGetPos()+<i,0,0>);
```

Or

```
For (i=0; i<5; i++)
    llSetPos(llGetPos()+<1,0,0>);
```

The students who were not 100% sure of the answer were allowed to guess based on their background knowledge in programming concepts so far.

It was a surprise to see that all the students who said that they are 100% sure of their answer gave the wrong one, where around half of the students who guessed gave the correct answer, however, they failed to justify it (they said we think this is the correct answer but we are not sure why).

When the students worked on moving their ‘Pokémons’ in the virtual platform, they saw the difference in the moving steps between the two code samples, after which they were able to fully explain what each ‘For Loop’ of the above performs. All of them confirmed that explaining/drawing this on the whiteboard (in a physical classroom) would not have facilitated the understanding and learning of this programming instruction like the way they visualised the object moves.

This simple code was just one example of how confused Computing students could become when they study the challenging concepts of this theory subject.

The object-oriented programming virtual scenario, on the other hand, focussed on using certain metaphors and sculptures to visualise the challenging abstract concepts of classes and objects in order to convey the understanding of their need and application within an object-oriented program. The students were able to compare, for example, between a portrait of a flower hung on the wall and a sculpture of the same flower planted in the ground (as a reference to a class and its object in an object-oriented program).

The lecturer needed to be present in the virtual environment, especially for those students who were not very familiar, comfortable or confident with the features of virtual worlds.

In the academic year 2012/2013, both of the above visualisation scenarios were applied in the curriculum delivery of the HE Computing Year-1 (Group-A). The outcomes of the Introduction to Programming questionnaire showed that 67% of the students considered computer programming as a difficult subject, however, 81% of them confirmed that learning this subject in the virtual world environment enhanced their learning and understanding of its difficult theory concepts, while 100% of them agreed to enhanced affective quality and 58% found this learning process more engaging (see Figure 5.9 below).

With regards to the Object-Oriented Programming questionnaire, which was designed by another HE Computing lecturer, the outcomes revealed that, although less than half of the group considered the object-oriented programming as a difficult subject, 71% of them confirmed that learning this subject in the virtual world environment enhanced their understanding of its difficult theory concepts, while 67% of them agreed to enhanced affective quality and 58% found this learning process more engaging. This gave a clear indication that some of the students who did not originally consider the subject to be difficult have, nevertheless, agreed that learning in virtual worlds enhanced their understanding and learning of the subject (see Figure 5.9 below).

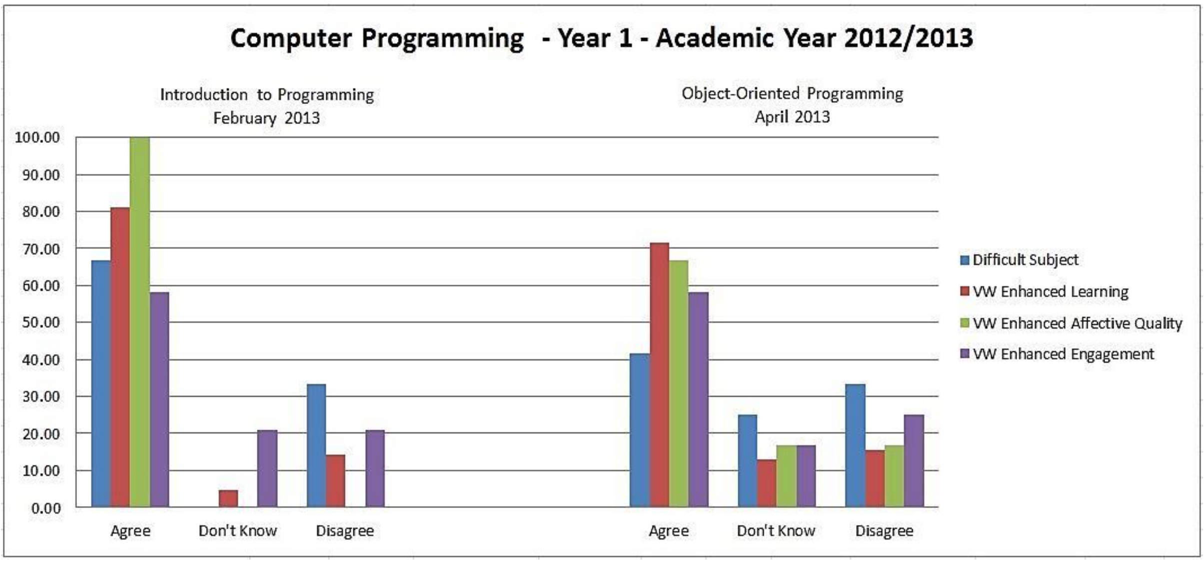


Figure 5.9: Computer Programming questionnaire, Year-1 (2012/2013)

In comparison, the questionnaire on the Object-Oriented Programming virtual scenario, that was designed by the same other HE Computing lecturer for Year-2 (Group-B), showed that more than three quarters of the students confirmed that the Object-Oriented Programming is a difficult subject. In addition, a slightly higher percentage of the students agreed that the virtual environment improved their understanding and learning of the complex theory concepts of the subject, while 90% of them agreed to enhanced affective quality and 64% found this learning process more engaging (see Figure 5.10 below).

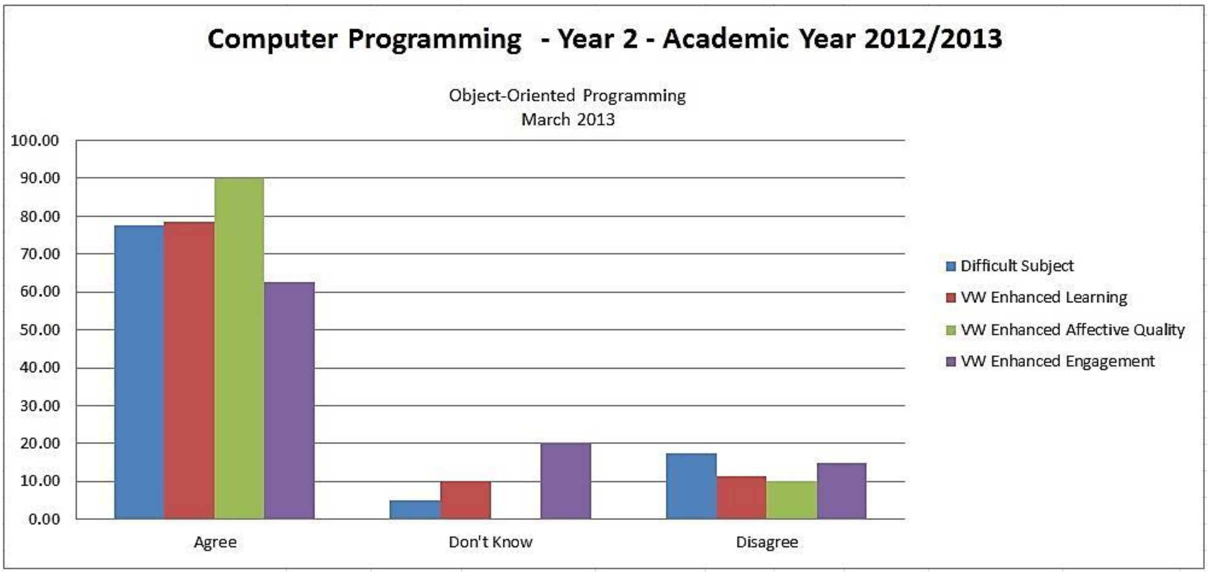


Figure 5.10: Computer Programming questionnaire, Year-2 (2012/2013)

It is worth clarifying here that Object-Oriented Programming is a more complex subject compared to normal programming (as indicated in section 1.4 earlier). The HE Computing curriculum aimed at introducing the object-oriented concepts towards the end of Year-1, to be fully taught in Year-2. Although it was expected that students at a higher level, i.e. Year-2, would show more confidence in the understanding and learning of this programming subject than Year-1 students (as they already studied the introduction to it and the ground information in their Year-1), but the results of this questionnaire revealed that as high as 77% of Year-2 students still consider the subject difficult. This confirmed that the programming subject is an area of concern to HE students in Computer Science courses at all levels. Fonseca *et al.* (2009) confirmed this by saying that the highest complexity faced by students in learning programming is not only the understanding of the basic concepts, but also in the process of applying these concepts correctly in more advanced constructs. They added that although some students understand the syntax and semantics of a programming language, they fail to use it correctly to create a program.

For a copy of all the questionnaires for the academic year 2012/2013 and their data analysis, see Appendix-3, Section A3.3 (page 257).

Moving to the academic year 2013/2014, a new Year-1 (Group-D), the same two virtual visualisation scenarios were introduced. However, in this year, the researcher carried out a separate and more detailed initial investigation into subject difficulty in order to explore how many of the students considered computer programming to be a difficult subject and whether they think that visualising the programming process would facilitate its learning and improve the understanding of its difficult theory concepts.

The outcomes of the questionnaire showed that slightly fewer than half of the group confirmed that computer programming is a difficult subject, and 73% of them believed that visualisation might enhance the understanding and learning of its difficult theory concepts (see Figure 5.11 below).

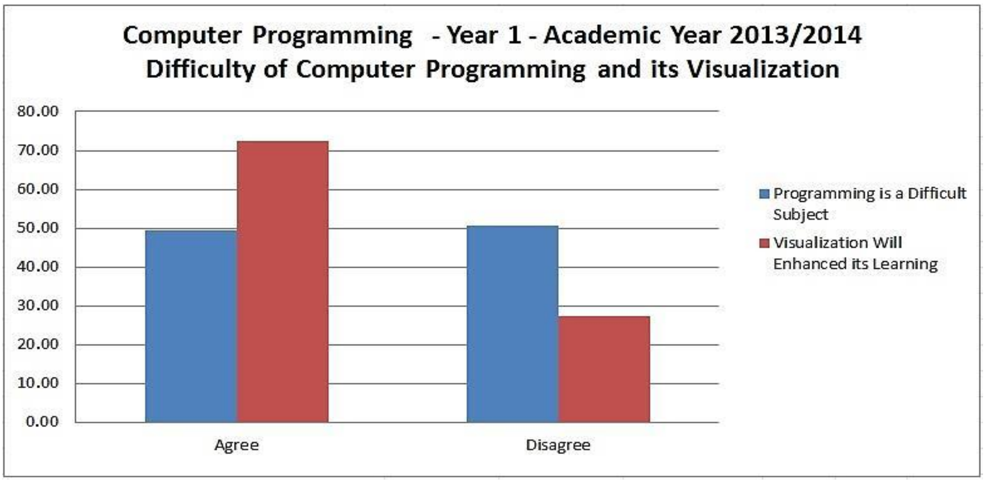


Figure 5.11: Computer Programming difficulty questionnaire, Year-1 (2013/2014)

Although the percentage of students who declared that they find the subject difficult is only around half of the group, a number of formative assessments were carried out to judge students' level of understanding and learning. The outcomes of these assessments were poor for the majority of the students, not only in the programming module but also in all the other modules considered to having challenging theory concepts (selected for this research). It was realised that students, especially the weak ones, did not feel comfortable declaring their difficulties in the questionnaires, which was an understandable situation. Due to this, all the percentages of similar declarations by students in the questionnaires were considered to be the minimum value (with the reality being a higher value) for all the modules. This issue and its impacts are discussed in Chapter Six, section 6.2 (page 164).

As previously indicated, a different approach was adopted in the academic year 2013/2014 compared to that in the previous year, as students' feedback was captured and recorded before and after the application of virtual world technologies in their studies.

The questionnaire on the introduction to programming virtual activities in 2013/2014, Year-1 (Group-D), produced the following outcomes (see Figure 5.12 below):

- Slightly more than half of the students who originally agreed that this subject is deemed difficult changed their minds following the virtual world exercise.

- Twenty-one percent more students agreed that effective learning of the subject took place in virtual worlds, which facilitated their understanding of the complex theory concepts.

- Ninety-four percent of the students agreed that affective quality was enhanced. That was close to double the percentage indicated for the physical world.

- Thirty-seven percent more students found learning within virtual worlds more engaging.

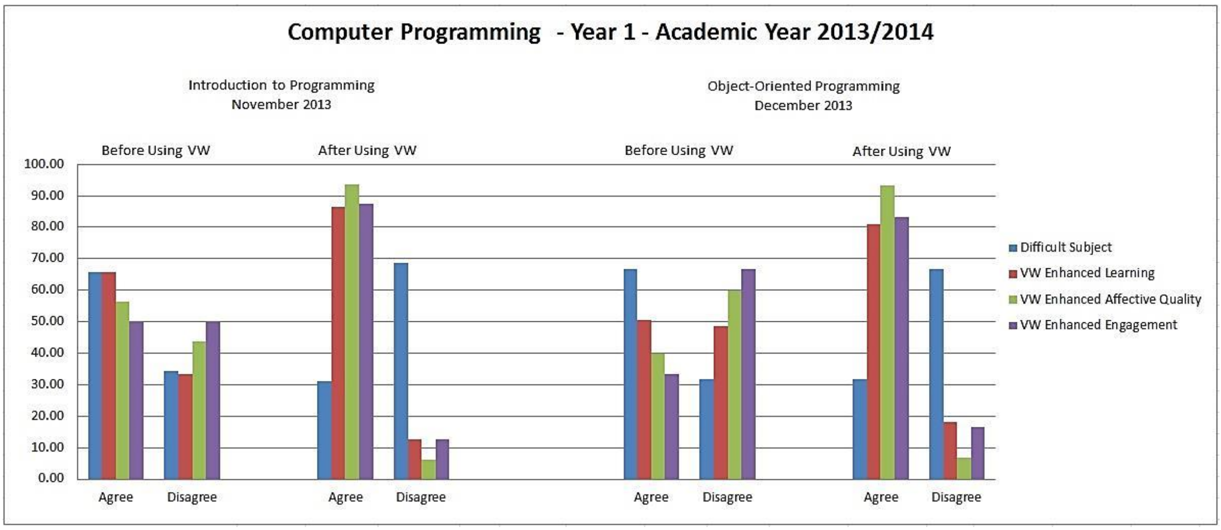


Figure 5.12: Computer programming questionnaire, Year-1 (2013/2014)

The last question asked in this questionnaire required the students to state their preferred environment for learning the computer programming subject (the real world, the virtual world, or both). Out of 16 students, who completed the questionnaire, the outcome was: ‘Real World’ (2 students), ‘Virtual World’ (6 students), and ‘Both’ (8 students).

With regards to the introduction to object-oriented programming virtual scenario, and as can be seen in Figure 5.12 above, the questionnaire revealed that the acceptance of virtual world technologies was risen, and that the students started to realise the advantages of embedding elements of virtual worlds in their curriculum delivery to enhance the learning of challenging abstract concepts.

The results of the questionnaire showed that:

- Similar to the outcomes of the introduction to programming virtual scenario, slightly more than half of the students who originally agreed that this subject is deemed difficult had changed their minds following the virtual world exercise.

- Thirty-one percent more students agreed that effective learning of the subject took place in virtual worlds, which facilitated their understanding of the complex theory concepts.

- Ninety-three percent of the students agreed that affective quality was enhanced. That was a lot higher than double the percentage indicated for the physical world.

- Eighty-three percent of the students found learning within virtual worlds more engaging. Again, that was a lot higher than double the percentage recorded for the physical world.

For a copy of all the questionnaires for the academic year 2013/2014 and their data analysis, see Appendix-3, Section A3.4 (page 313).

Correlation of the data obtained:

Looking into the analysis achieved above in the academic year 2012/2013 for Year-1 (Group-A), the researcher carried out further investigation to answer the questions in Table 5.8 below.

Question	Using the 1st virtual scenario	Using the 2nd virtual scenario
1. What is the number/percentage of students who found the subject difficult but their learning was enhanced after the application of virtual worlds?	100%	100%
2. What is the number/percentage of students who found the subject difficult but their affective quality was enhanced after the application of virtual worlds?	100%	100%
3. What is the number/percentage of students who found the subject difficult but their engagement was enhanced after the application of virtual worlds?	100%	100%
4. What is the number/percentage of students who found the subject difficult but their learning was not enhanced after the application of virtual worlds?	0%	0%
5. What is the number/percentage of students who did not find the subject difficult but their learning was enhanced after the application of virtual worlds?	50%	67%

Table 5.8: Data correlation of Computer Programming, Year-1 (2012/2013)

The resulted percentages of the first three questions for both scenarios confirmed the positive outcomes stated earlier for this virtual activity. The percentage of students in the 4th question indicated that the learning of all the students who found the subject difficult was enhanced as a result of the virtual world exercise. The percentage of students in the 5th question reflected the potential of using these technologies even for students who are not facing difficulties in learning the subject using the traditional method.

With regards to the further investigation into the analysis achieved for Year-2 (Group-B) to answer the questions in Table 5.9 below, the outcomes were also positive in terms of the benefits of virtual worlds in facilitating students' understanding and learning of difficult theory concepts in the computer programming subject.

	Question	Using the 1st virtual scenario
1.	What is the number/percentage of students who found the subject difficult but their learning was enhanced after the application of virtual worlds?	100%
2.	What is the number/percentage of students who found the subject difficult but their affective quality was enhanced after the application of virtual worlds?	100%
3.	What is the number/percentage of students who found the subject difficult but their engagement was enhanced after the application of virtual worlds?	88%
4.	What is the number/percentage of students who found the subject difficult but their learning was not enhanced after the application of virtual worlds?	0%
5.	What is the number/percentage of students who did not find the subject difficult but their learning was enhanced after the application of virtual worlds?	50%

Table 5.9: Statistics of Computer Programming, Year-2 (2012/2013)

Moving to the academic year 2013/2014, Year-1 (Group-D), the five questions were rephrased in order to reflect the additional element of before and after the application of virtual world technologies that was added to the questionnaires in this academic year. The outcomes were as in Table 5.10 below.

Question	Using the 1st virtual scenario	Using the 2nd virtual scenario
1. What is the number/percentage of students who found the subject difficult (before the application of virtual worlds), but their learning was enhanced (after the application of virtual worlds)?	92%	91%
2. What is the number/percentage of students who found the subject difficult (before the application of virtual worlds), but their affective quality was enhanced (after the application of virtual worlds)?	92%	91%
3. What is the number/percentage of students who found the subject difficult (before the application of virtual worlds), but their engagement was enhanced (after the application of virtual worlds)?	83%	91%
4. What is the number/percentage of students who found the subject difficult (before the application of virtual worlds), but their learning was not enhanced (after the application of virtual worlds)?	8%	9%
5. What is the number/percentage of students who did not find the subject difficult (before the application of virtual worlds), but their learning was enhanced (after the application of virtual worlds)?	100%	100%

Table 5.10: Data correlation of Computer Programming, Year-1 (2013/2014)

For a copy of all the data correlation and further analysis sheets, see Appendix-3, Sections A3.5 (page 345) and A3.6 (page 373).

Students' grades and links to learning modes:

Following the completion of the data analysis for this module, students' grades were then checked for the academic years, 2011/2012 (no virtual world activities), 2012/2013 and 2013/2014 (with virtual world activities) as in Tables 5.11 and 5.12 below:

Academic Year / Subject Name	2011 / 2012 (15 students)	2012 / 2013 (7 students)	2013 / 2014 (17 students)
Computer Programming, Year-1 (all assessments)	**102.51** StDev. = 7.6	**93.57** StDev. = 6.3	**104.56** StDev. = 9.9

Note: Grade = (Average mark of the module / Average mark of all Computing modules * 100)

Table 5.11: Grades of the Computer Programming module, Year-1

Academic Year / Subject Name	2011 / 2012 (11 students)	2012 / 2013 (13 students)	2013 / 2014 (8 students)
Object Oriented Programming, Year-2 (second assessment)	**101.56** StDev. = 9.4	**102.15** StDev. = 9.8	**109.89** StDev. = 8.9

Note: Grade = (Average mark of the module / Average mark of all Computing modules * 100)

Table 5.12: Grades of the Computer Programming module, Year-2

The grades of Year-1 (Group-A) students in the first year of applying virtual world technologies, i.e. 2012/2013, did not reflect the positive feedback obtained from the students' questionnaires. The following points were investigated further to pursue the reasons behind that:

1) This module was delivered by another HE Computing lecturer (who is also the designer of the Object-Oriented Programming virtual scenario). A permission was obtained by the researcher to provide the Introduction to Programming virtual scenario for the students on pre-planned dates and to be personally available to supervise/monitor the students' learning, attitude and achievement, and also to answer their questions. This situation, i.e. pre-determined dates for the virtual sessions in a module that is delivered by a different lecturer, did not facilitate having a large number of sessions with the students, which, in case happened, could have had a better impact on the level of their learning and consequently obtaining higher grades.

   However, this situation was unavoidable, as each lecturer has their own planned 'Scheme of Work' for the module they teach, which they need to follow rather strictly in order to ensure that they complete the syllabus within the allocated study weeks. This issue is indicated as one of the suggested areas for future research (section 6.4) to investigate whether having more sessions in virtual worlds would bring added enhancement to students' learning, and also ways to go about the delivery structure of HE programmes within the FE framework.

2) In the academic year 2012/2013, the programming module in Year-1 was a one-semester unit (short-fat) and was only delivered in Semester-1. It may be that the students were unable to reflect fully on their understanding and learning of the programming complex theory concepts that they developed using virtual worlds in this short period, especially as the assessments were carried out shortly after the application of the virtual scenarios. The programming module in the academic year 2013/2014, however, was a whole-year module (long-thin) with a greater spread of assessments throughout the academic year, which may have allowed the students to better reflect on their understanding and learning.

Gale (2012), University of Wolverhampton, stated that a long-thin module allows the opportunity to use the time for skills that need to be developed over a longer period of time, while Manchester Metropolitan University (2015) indicated that long-thin modules are ideal for students to spend time on developing skills and ideas in addition to analysis, reflection and synthesis, which are fundamental elements of higher education.

Evidence to support this suggestion is the grade of the Web Technologies (long-thin) module, in which the students need to program their website using the PHP programming language, which is similar in its structure and syntax to the C++ language learned in the programming module. In the Web Technologies module, students also apply their understanding of databases in their design of the online database needed for their website project.

The programming and databases concepts taught on the Web Technologies module were applied towards the end of the academic year in the web practical project, which is the final assessment in the module. The marks of this practical assessment may be used as a more accurate indicator of the development in the understanding and learning of both the programming and databases complex theory concepts within each academic year, as students are required to re-apply the skills they achieved earlier in both modules within a different context in the Web Technologies' project. The grades were as in Table 5.13 below:

Academic Year / Subject Name	2011 / 2012 (15 students)	2012 / 2013 (7 students)	2013 / 2014 (17 students)
Web Technologies, Year-1 (Assessment 2 – practical web project)	**99.69**	**109.66**	**115.51**

Note: Grade = (Average mark of the module / Average mark of all Computing modules * 100)

Table 5.13: Grades of the Web Technologies module, Year-1

3) The main learning mode applicable to both virtual scenarios that were designed for this subject is ‘Visual’, as students were expected to understand the execution of individual programming instructions after they visualise the execution of the code and its outcomes in virtual worlds (and to understand classes and objects through visualising the need for and the application of item portrait and their actual sculpture in the object-oriented virtual scenario). There is also a partial application to the ‘Kinesthetic’ learning mode, as students will be doing the code changes, based on the previous outcomes to alter the behaviour of their objects.

The VARK results of the three students’ groups involved did not reflect a high percentage of the ‘Visual’ learning mode preference. For Year-1, the results showed that the percentage of students having the ‘Visual’ preference for Group-A was 43% (3 out of 7) and for Group-D was 47% (8 out of 17). The percentage of the ‘Kinesthetic’ learning mode, however, was much higher, 100% (7 out of 7) for Group-A, and 88% (15 out of 17) for Group-D. This high percentage of the ‘Kinesthetic’ learning mode may account for the better grades of students in the databases module, as its virtual scenario is mainly based on this learning mode. For Year-2 (Group-B), VARK results showed that the percentage of students having the ‘Visual’ preference is the same as that for the ‘Kinesthetic’ learning mode. Both recorded 58% (8 out of 12).

The ‘enhanced learning’ percentages that were obtained from the questionnaires of this module in both academic years were mapped towards the learning mode of individual students; however, and although the above statistics suggest some relation between the grades of this module and the low percentage of the ‘Visual’ learning mode, it was clearly noted that there was no strong correlation between the two aspects. For the academic year 2012/2013, see Figures 5.13 and 5.14 for Year-1(Group-A), and Figure 5.15 for Year-2 (Group-B) below. For the academic year 2013/2014, see Figures 5.16 and 5.17 for Year-1 (Group-D) below.

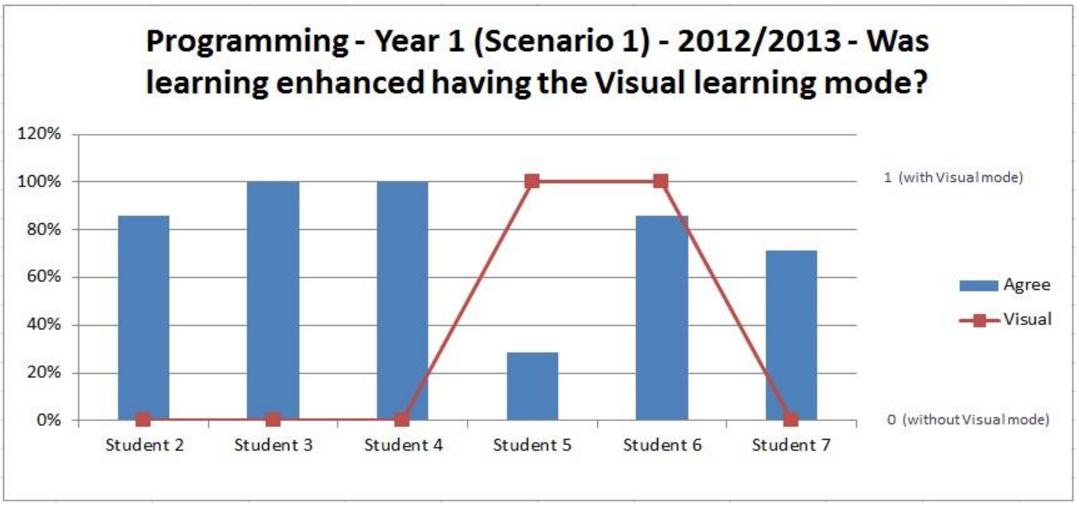


Figure 5.13: Link between enhanced learning and Visual learning mode in Computer Programming, Year-1 (Scenario 1, 2012/2013)

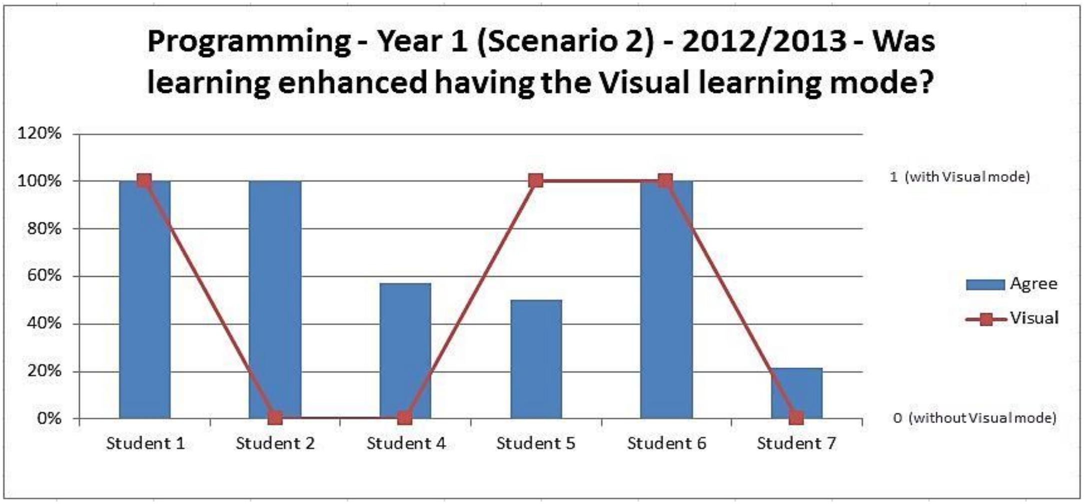


Figure 5.14: Link between enhanced learning and Visual learning mode in Computer Programming, Year-1 (Scenario 2, 2012/2013)

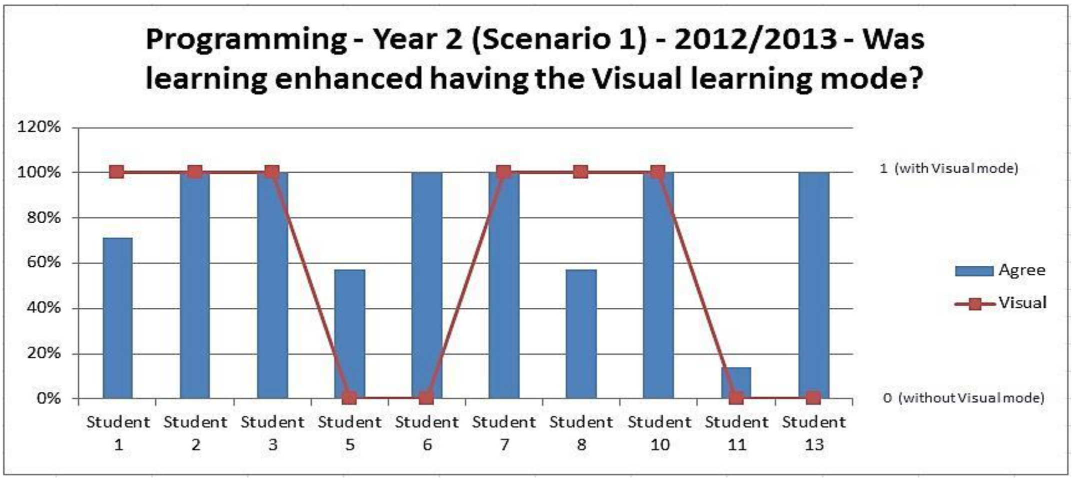


Figure 5.15: Link between enhanced learning and Visual learning mode in Computer Programming, Year-2 (Scenario 1, 2012/2013)

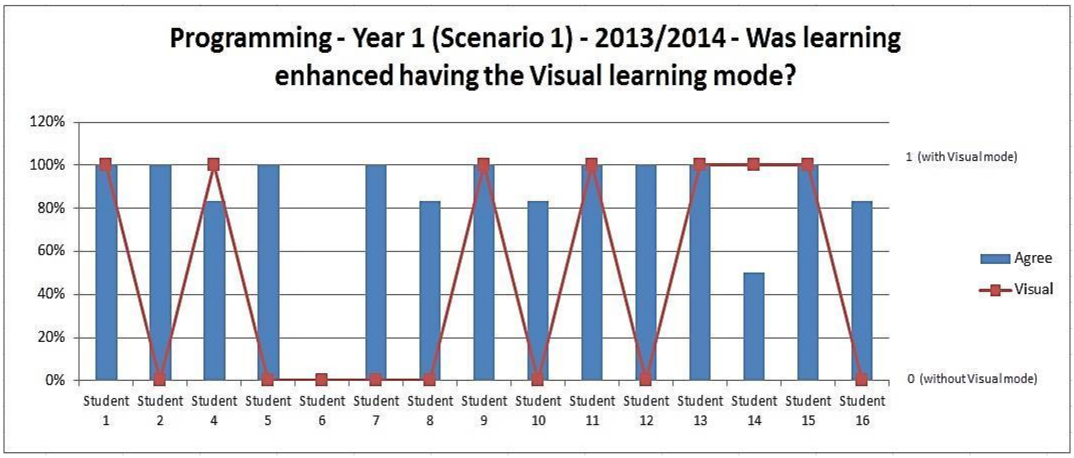


Figure 5.16: Link between enhanced learning and Visual learning mode in Computer Programming, Year-1 (Scenario 1, 2013/2014)

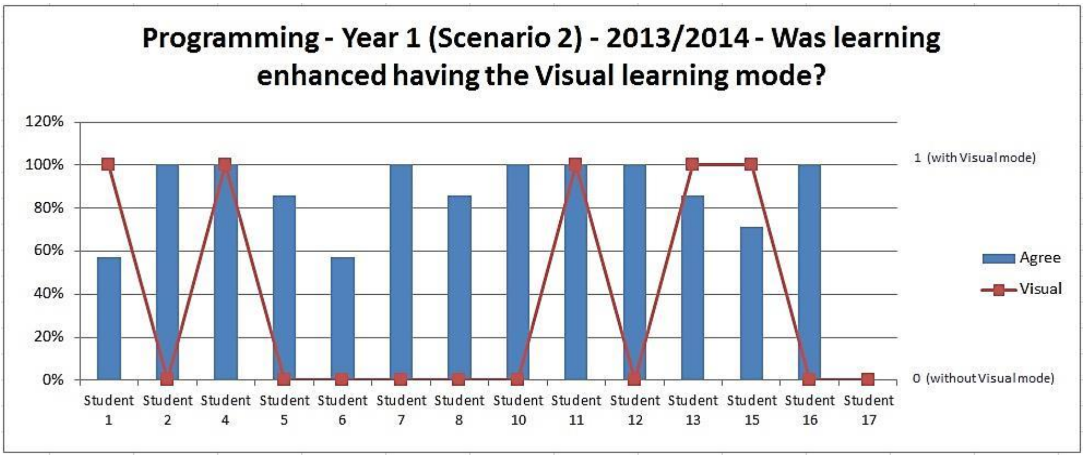


Figure 5.17: Link between enhanced learning and Visual learning mode in Computer Programming, Year-1 (Scenario 2, 2013/2014)

The reason for choosing a secondary vertical axis for the learning preference values in the above charts was due to having mixed types of data which vary widely, i.e. percentages of 'Enhanced Learning' and '0/1' values of the 'Learning Preference'. The Microsoft Office online support site indicated that the secondary axis style works well in a chart that shows a combination of column and line charts. (Microsoft Office, 2015).

On the other hand, the analysis of the calculated values of Standard Deviation (StDev), stated above, did not suggest any systematic increase or decrease in the differentiation in students' grades for this module over the three academic years.

For a copy of all students' grades before and after the application of virtual worlds, see Appendix-3, Section A3.7 (page 386).

5.5 Database Normalisation

The virtual scenario designed for the Database Normalisation subject was also applied in both academic years 2012/2013 and 2013/2014. In order to visualise the complex theory concepts of the database normalisation process, a clear real-life example, which requires a large database system, was chosen for the virtual scenario. This was a hospital that requires a database system to store and manage patients' diagnosis and treatment records.

Although the type of stored information on patients in a real-life hospital is obviously intuitive, the aim was, when the researcher designed the virtual scenario, to put the students, virtually, in the atmosphere of a real hospital situation. This was intended to inspire the students to investigate the certain departments (within the hospital) that need to be referred to for information on the database system in hand, and the correct approach to data exploration and gathering.

A sample hospital of two storeys was designed in Second Life. The first floor included the reception area, the pharmacy department and a couple of consultant rooms, while the second floor contained two patient wards of two different departments. There was a number of sign boards distributed within the scenario displaying information on each department, and also some metaphors of information givers, e.g. a telephone figure titled ‘Call for help’, which gives a notecard when clicked explaining how the patient’s data is linked to that of the ward, and also a drug bottle title ‘Click for information’ which provides a notecard explaining the information recorded for drugs in the pharmacy department. These explanations represented the fields required in the patient, ward and drug tables within the hospital database system. In addition, a number of ‘clues’ were distributed randomly within the scenario, e.g. signs and title of objects, to encourage the students to explore all the areas of the virtual hospital investigating and seeking data in order to get all the information they need to design the database system. Another type of information was embedded in a bookshelf titled ‘Hospital Files’ having a couple of books with URL links to published webpages, which were purposely designed and scripted to provide further information on the relationships between the data of different tables within the database system. See Figures 5.18 and 5.19 below.

Figure 5.18: The Database Normalisation virtual scenario (Weston Hospital)

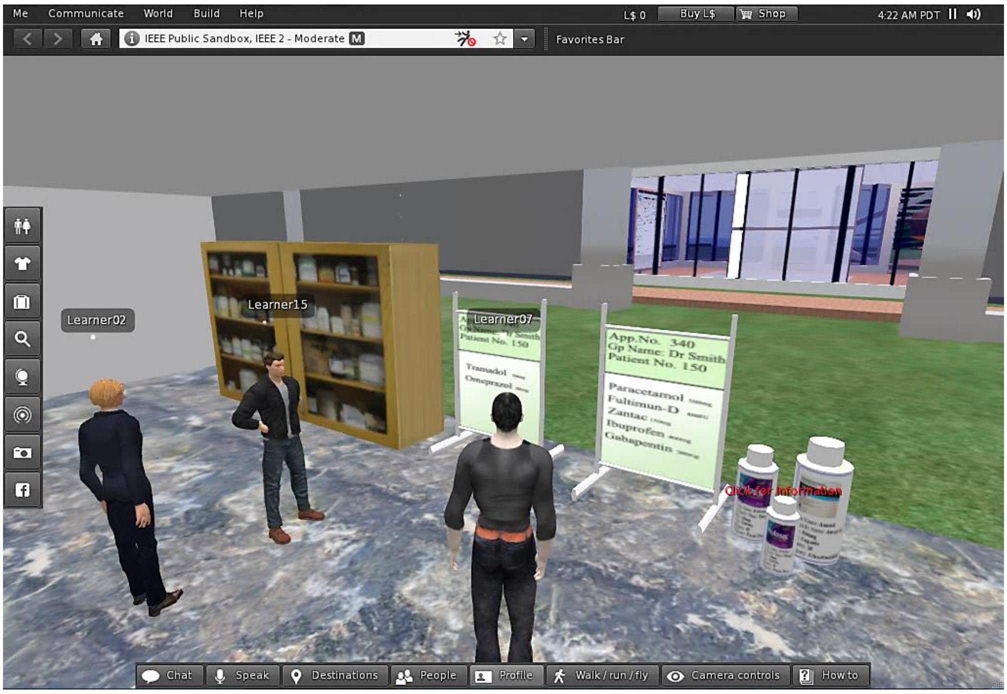


Figure 5.19: The Database Normalisation virtual scenario (Pharmacy Department)

More screenshots could be found in Appendix-2, section A2.2 (page 213).

This virtual scenario was designed to mirror the actual procedure that the students need to follow when visiting a real hospital, i.e. visiting all the departments involved, investigating sources of information, e.g. hospital records and staff members, and writing their comments based on their own observation of the hospital procedures and how the patients' data is processed.

Following collecting all the information needed for the hospital database example, the students were provided with virtual sculptures of the database components so that they use them to design a 3D visual representation of the database system. These sculptures represented the fields of tables within the database, which students were required to use in order to form the individual tables starting from the '1st Normal Form' and proceeding to the '3rd Normal Form'. See Figures 5.20 and 5.21 below.

Figure 5.20: The Database Normalisation virtual scenario (sculptures representing table fields)

Figure 5.21: The Database Normalisation virtual scenario (students normalising database tables visually)

More screenshots could be found in Appendix-2, section A2.2 (page 213).

The observations by the researcher confirmed that the students found the scenario extremely useful in visualising why the three 'Normal Forms' are necessary to improve data integrity within the tables and to eliminate unnecessary duplication(s) and repetition within the data. This visualisation enabled the understanding of why the normalisation process is vital for the success of a relational database system and the critical need to an effective and logical design of its data tables. As students were seeing the immediate outcomes of their structuring process of the database tables and fields, they were able to see the impacts of certain aspects, e.g. data duplication and repetition, and consequently were able to do the correct changes to the design of their tables to successfully achieve a fully normalised database.

These observations were then approved by the outcomes of the questionnaire completed by the students following the virtual exercise regarding the enhancement to their learning and understanding of this complex theory process.

It is worth mentioning here that using the sculpture section of the scenario as metaphors to represent the table fields for the database was only added to the scenario in the academic year 2013/2014. This was due to the researcher's observations made when the scenario was applied in the academic year 2012/2013 and the analysis of its strengths and weaknesses, after which, the sculpture section was added as an enhancement to extend the utilisation of virtual worlds in achieving a full visualisation of the database normalisation process.

With regards to the method of applying virtual world technologies in the academic year 2013/2014, and as stated at the start of this Chapter, the researcher decided to adopt a different approach to that of the Computer Programming module. This approach focused on dividing the students into two groups, where both groups receive a basic introduction to the module using the traditional method in the physical world. This was then followed by delivering the whole subject to the first group using the traditional method, and the whole subject to the second group using the virtual scenario. The two groups were then swapped to have the same subject delivered (in the following session) using the other method to enable them to have a strong background to compare between the amount of learning achieved within each platform, and also to reflect more on the advantages and limitations of each environment, e.g. engagement and affective quality.

The outcomes of the questionnaires distributed to Year-1 students to capture and record their feedback on both academic years are explained below. In the academic year 2012/2013 (Group-A), the results of the questionnaire showed that 53% of the students considered database normalisation as a difficult subject, however, only 49% of them agreed that learning this subject in the virtual world environment enhanced their learning and understanding of its complex theory concepts, while 57% of them agreed to enhanced affective quality and 57% found this learning process more engaging (see Figure 5.22 below).

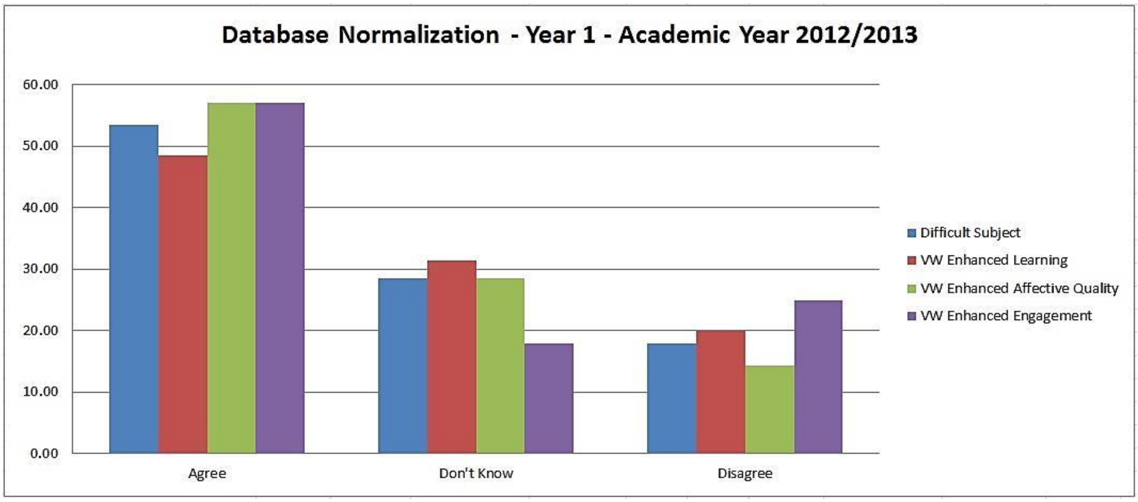


Figure 5.22: Statistics of Database Normalisation, Year-1 (2012/2013)

In this academic year, the students were unable to fully realise the affordances of virtual world technologies to achieve visualisation in this subject, as the second part of the database normalisation learning scenario, i.e. using sculptures to represent table fields to fully visualise the database normalisation process, was only made available in the academic year 2013/2014. This matter could well suggest the reason behind these weak percentages in year 2012/2013.

For a copy of all the questionnaires for the academic year 2012/2013 and their data analysis, see Appendix-3, Section A3.3 (page 257).

Moving to the academic year 2013/2014 (Group-D), and as previously indicated, a different approach to recording students' feedback was adopted in this academic year compared to that in the previous year. Students' feedback was captured and recorded before and after the application of virtual world technologies in their studies.

The questionnaire on the database normalisation virtual activities produced the following outcomes (see Figure 5.23 below):

- Slightly more than half of the students who originally agreed that this subject is deemed difficult changed their minds following practicing in the virtual world scenario.

- Twenty-two percent more students agreed that effective learning of the subject took place in virtual worlds, which facilitated their understanding of the complex theory concepts.

- Sixteen percent more students agreed that affective quality was enhanced.

- Twenty-three percent more students found learning within virtual worlds more engaging.

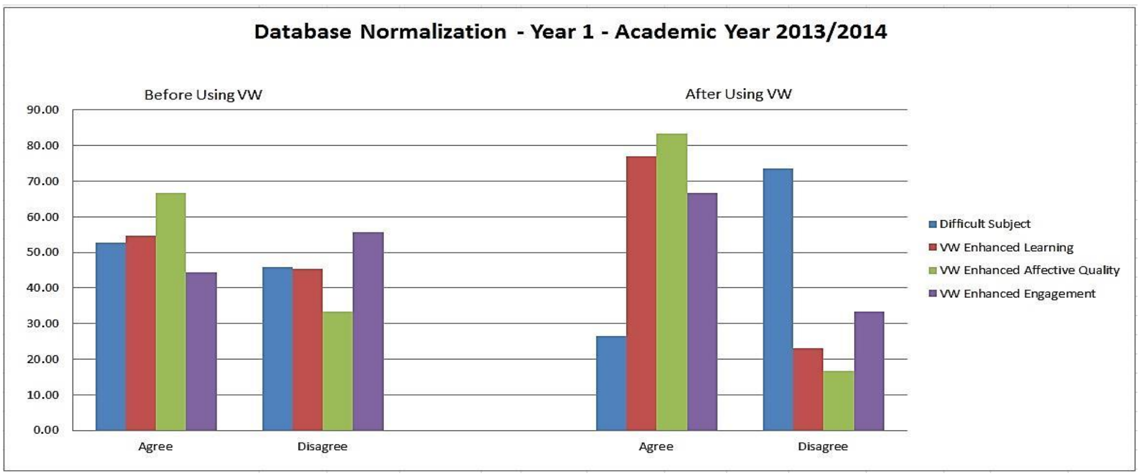


Figure 5.23: Statistics of Database Normalisation, Year-1 (2013/2014)

The last question asked in this questionnaire required the students to state their preferred environment for learning the database normalisation subject (the real world, the virtual world, or both). Out of 18 students the outcome was: ‘Real World’ (6 students), ‘Virtual World’ (2 students), and ‘Both’ (10 students).

For a copy of all the questionnaires for the academic year 2013/2014 and their data analysis, see Appendix-3, Section A3.4 (page 313).

Correlation of the data obtained:

Looking into the analysis achieved above for the academic year 2012/2013 (Group-A), the researcher carried out further investigation to answer the questions in Table 5.14 below:

	Question	Percentage
1.	What is the number/percentage of students who found the subject difficult but their learning was enhanced after the application of virtual worlds?	50%
2.	What is the number/percentage of students who found the subject difficult but their affective quality was enhanced after the application of virtual worlds?	67%
3.	What is the number/percentage of students who found the subject difficult but their engagement was enhanced after the application of virtual worlds?	83%
4.	What is the number/percentage of students who found the subject difficult but their learning was not enhanced after the application of virtual worlds?	50%
5.	What is the number/percentage of students who did not find the subject difficult but their learning was enhanced after the application of virtual worlds?	0%

Table 5.14: Data correlation of Database Normalisation, Year-1 (2012/2013)

The circumstances that suggest the reason behind these not strong percentages in this academic year are explained below (following the discussion of module grades).

Moving to the academic year 2013/2014 (Group-D), the five questions were rephrased in order to reflect the additional element of before and after the application of virtual world technologies that was added to the questionnaire in this academic year. The outcomes were as in Table 5.15 below:

Question	Percentage
1. What is the number/percentage of students who found the subject difficult (before the application of virtual worlds), but their learning was enhanced (after the application of virtual worlds)?	100%
2. What is the number/percentage of students who found the subject difficult (before the application of virtual worlds), but their affective quality was enhanced (after the application of virtual worlds)?	100%
3. What is the number/percentage of students who found the subject difficult (before the application of virtual worlds), but their engagement was enhanced (after the application of virtual worlds)?	70%
4. What is the number/percentage of students who found the subject difficult (before the application of virtual worlds), but their learning was not enhanced (after the application of virtual worlds)?	0%
5. What is the number/percentage of students who did not find the subject difficult (before the application of virtual worlds), but their learning was enhanced (after the application of virtual worlds)?	67%

Table 5.15: Data correlation of Database Normalisation, Year-1 (2013/2014)

The above strong percentages were confirmed by the high module grades in this academic year as shown in the following paragraphs.

For a copy of all the data correlation and further analysis sheets, see Appendix-3, Sections A3.5 (page 345) and A3.6 (page 373).

Students' grades and links to learning modes:

Following the completion of the data analysis for this module, students' grades were then checked for the academic years, 2011/2012 (no virtual world activities), 2012/2013 and 2013/2014 (with virtual world activities) as in Table 5.16 below:

Academic Year / Subject Name	2011 / 2012 (15 students)	2012 / 2013 (7 students)	2013 / 2014 (17 students)
Database Normalisation, Year-1 (all assessments for 2011/12 & 2012/13) (second assessment for 2013/14)	**97.16** StDev. = 7.7	**99.12** StDev. = 5.4	**106.58** StDev. = 11.2

Note: Grade = (Average mark of the module / Average mark of all Computing modules * 100)

Table 5.16: Grades of the Databases module, Year-1

There are two factors that may form the reasons behind the noticeably higher achievement in the academic year 2013/2014. First, and as explained earlier within this section, enhancements were added to the virtual learning scenario in this academic year. Second, and similar to the Computer Programming module, the Databases module in the academic year 2012/2013 was a one-semester module and was only delivered in Semester-2, while in the academic year 2013/2014, it was a whole-year module. It could well be suggested that in 2012/2013, the students were unable to reflect fully on their understanding and learning of the database normalisation complex theory concepts that they developed using the virtual world platform in this short period, especially that the assessments were carried out shortly after the application of the virtual world scenario, while in the following year, there was a greater spread of assessments throughout the academic year, which resulted in a better reflection of students' understanding and learning. Praising was made by a number of universities to the advantages of the 'long-thin' module approach to students' understanding and learning as indicated within the Computer Programming section of this Chapter.

The Web Technologies module could form another strong evidence to support this. Within this 'long-thin' module, students need to program their website and also apply their understanding of databases in their design of the online database needed for their website. The database normalisation skills needed in this module were applied towards the end of the academic year in the web practical project, which is the final assessment in the module. The grades of this practical assessment clearly show the development in students' understanding and learning of both the programming and databases complex theory concepts, which were re-applied as part of this module. The grades were as in Table 5.17 below:

Academic Year / Subject Name	2011 / 2012 (15 students)	2012 / 2013 (7 students)	2013 / 2014 (17 students)
Web Technologies, Year-1 (Assessment 2 – practical web project)	**99.69**	**109.66**	**115.51**

Note: Grade = (Average mark of the module / Average mark of all Computing modules * 100)

Table 5.17: Grades of the Web Technologies module, Year-1

As the students were required to move the sculptures (the data fields within the database) and re-arrange them in rows (patients' records) and columns (table fields) and keep adding, removing, restructuring and separating sculptures throughout the Normal Forms, the main learning mode applicable to this scenario is 'Kinesthetic', while the secondary learning mode is 'Visual'.

The VARK results revealed that 100% of the students in the academic year 2012/2013 (Group-A) had the 'Kinesthetic' learning mode, compared to 88% in the academic year 2013/2014 (Group-D). The 'enhanced learning' percentages that were obtained from the questionnaires of this module in both academic years were mapped towards the learning mode of individual students; however, it was clearly noted that there was no strong correlation between the two aspects (see Figures 5.24 and 5.25 below).

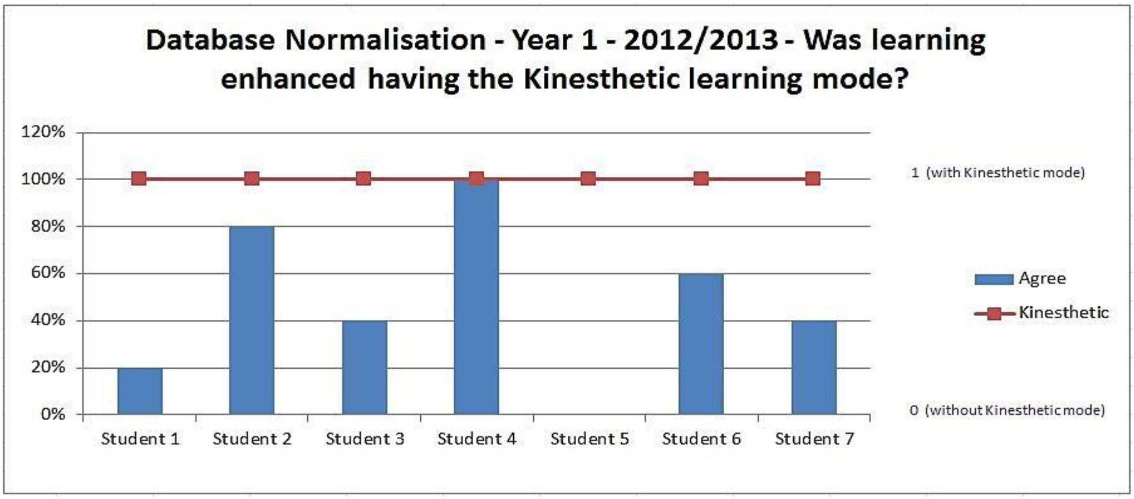


Figure 5.24: Link between enhanced learning and Kinesthetic learning mode in Database Normalisation, Year-1 (2012/2013)

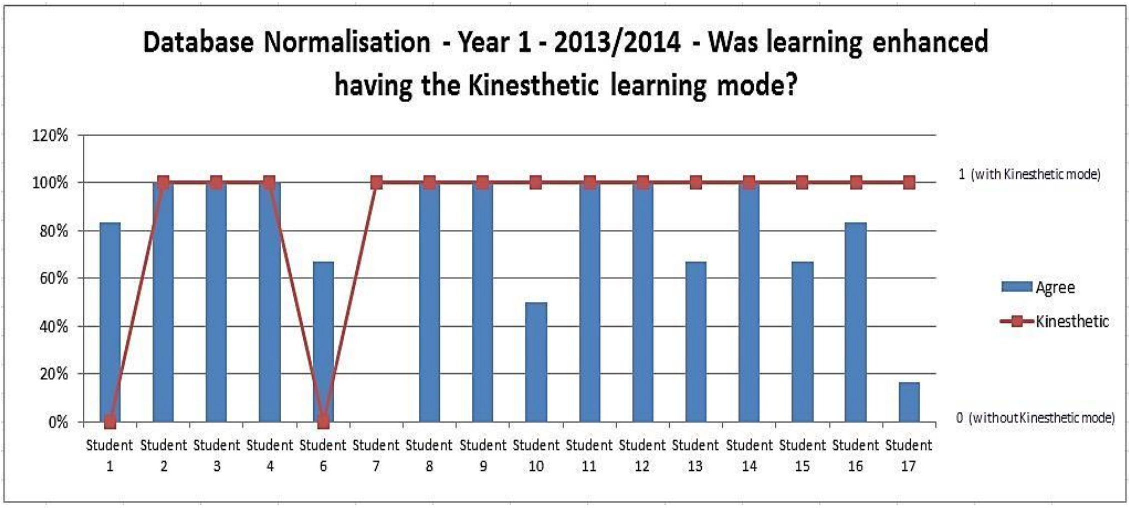


Figure 5.25: Link between enhanced learning and Kinesthetic learning mode in Database Normalisation, Year-1 (2013/2014)

As stated earlier in this Chapter, the reason for choosing a secondary vertical axis for the learning preference values in the above charts was due to having mixed types of data which vary widely, i.e. percentages of ‘Enhanced Learning’ and ‘0/1’ values of the ‘Learning Preference’.

On the other hand, the analysis of the calculated values of Standard Deviation (StDev), stated above, did not suggest any systematic increase or decrease in the differentiation in students’ grades for this module over the three academic years.

For a copy of all students’ grades before and after the application of virtual worlds, see Appendix-3, Section A3.7 (page 386).

5.6 Multithreading Techniques (Concurrency and Parallelism)

The virtual scenario designed to visualise the complex theory concepts of multithreading techniques (Concurrency and Parallelism), as part of the Multi-Tasking Systems module, was applied on the BSc (Hons) in Computing students in both academic years 2012/2013 (Group-C) and 2013/2014 (Group-F) using Second Life virtual world. The students found this module to be the most challenging amongst all the other modules, not only in the said academic years, but also throughout the seven years of the researcher’s teaching of this subject at this HE level.

Before using virtual worlds to visualise the multithreading techniques, the researcher was used to drawing a number of sketches on the whiteboard for students to represent the computer Random Access Memory (RAM) and processor with a number of arrows representing the data flow between these two components (for individual examples). More drawings and arrows were then added to show how the operating system controls the swapping and priority of tasks (threads) inside a computer and the time slots allocated to them within the processor. However, these sketches on the whiteboard could get very crowded and confusing for students, especially when more components are added (drawn on the board), e.g. the input/output devices and virtual memory. In addition, there was no clear representation of the sequence of actions and their individual consequences.

In order to visualise the multithreading techniques, the researcher carried out a thorough investigation for a comparable real-life example that requires a similar queuing process to receive the service (i.e. the queuing of threads in RAM by the operating system), and how the structure of the queue is affected by a higher priority arrival. The intension was to build the virtual scenario on the selected real-life example, in order to achieve a clearer and intuitive illustration for the students to enable them to compare the situation to that inside a computer system.

The outcome of the investigation was to choose a buffet restaurant example with a single restaurant keeper/waiter, where customers need to queue to get food, ice cream and drinks. The comparison between this real-life example and the multithreading techniques was as follows: The customers' queue represents the queue of tasks/threads within the computer RAM waiting to be served by the processor, while the food buffet, ice cream counter and the drink machine represent different resources/cores within the computer processor. The single restaurant keeper, who coordinates the providing of services, represents the operating system, while the restaurant tables and chairs represents the computer virtual memory having stand-by tasks (seated customers in the restaurant example) waiting for a space to join the queue in order to get served. Finally, the counter on the side having plates and cups, where the customer needs to go out of the queue to get a plate, represents the input/output devices in a computer system, where a task in RAM needing an input value cannot be served by the processor until it gets it. The screenshots in Figures 5.26 and 5.27 show the virtual restaurant designed in Second Life to visualise the multithreading techniques.

Figure 5.26: The Multithreading Techniques virtual scenario (queauing technique in RAM with tasks in the virtual memory)

Figure 5.27: The Multithreading Techniques virtual scenario (swapping of tasks between the RAM and virtual memory)

More screenshots could be found in Appendix-2, section A2.3 (page 217).

In the virtual restaurant scenario, some students were required to act the role of customers queuing to get food, desserts or a dink (representing computer tasks queuing in RAM), while other students were required to sit down around the tables when the queue was full (representing tasks stored in the computer virtual memory) waiting for any of the queuing customers to finish, then the restaurant keeper (another student representing the role of the computer operating system) would ask them, one by one, to join the queue. Throughout this process another student is asked to act the role of a VIP customer who arrived to a busy restaurant having a full queue and a number of other seated customers waiting to be served (representing a high priority task joining a full RAM).

Within this virtual scenario, a number of different multithreading situations were explained to the students, using the above restaurant metaphors, with their impacts and outcomes, e.g. when a higher priority task is placed by the operating system at the start of the queue in RAM changing the order of execution for all the remaining tasks, having a full queue with or without tasks in the virtual memory, and having a single core (Concurrency) or multiple cores/processors (Parallelism).

Being part of this number of different situations and their visual impacts facilitated students' understanding of the complex abstract concepts of the multithreading process and the various factors affecting the execution of tasks in a computer system. In addition, the situation of role-playing the different computer components contributed greatly to this enhanced learning.

The observations by the researcher confirmed that the students found this virtual scenario extremely useful in understanding the different aspects of the multithreading process and the need for it. This was based on students' answers to well-selected questions (during and after the virtual exercise) to test their level of understanding and learning.

In both academic years, the outcomes of the questionnaires distributed to the students to capture and record their feedback on this virtual scenario are explained below. In the academic year 2012/2013 (Group-C), the results of the questionnaire showed that 57% of the students considered multithreading techniques as a difficult subject. However, 64% agreed that learning this subject in the virtual world environment had enhanced their learning and understanding of its difficult theory concepts, while 43% of them agreed to enhanced affective quality and 72% found this learning process more engaging (see Figure 5.28 below).

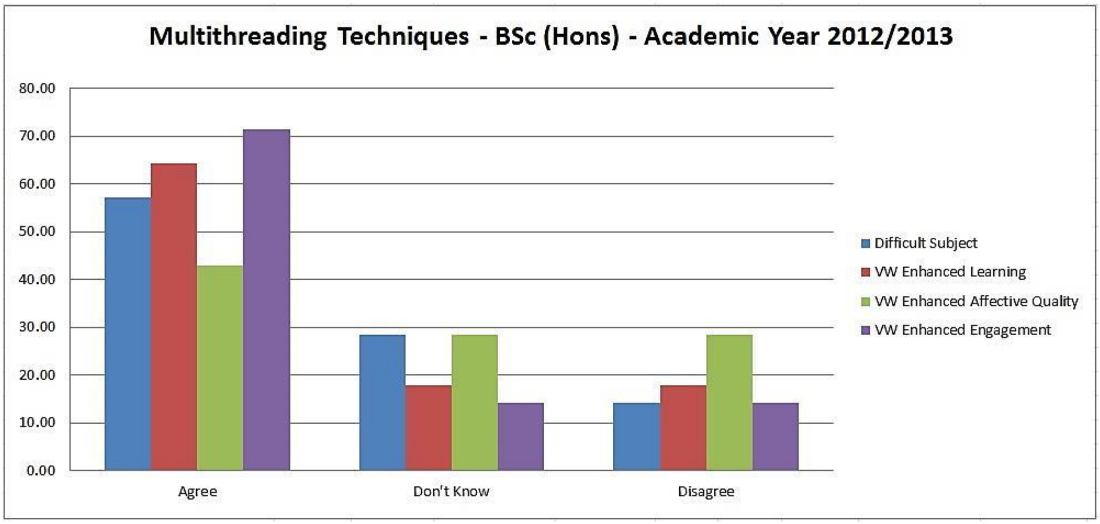


Figure 5.28: Statistics of Multithreading Techniques, Year-3 (2012/2013)

The observations by the researcher also confirmed that this virtual exercise was successful in enhancing students' understanding and learning of Concurrency and Parallelism's complex theory concepts. Therefore, in an attempt to know the reason(s) behind the low percentage of affective quality, the researcher carried out an open discussion session in-class in the following week, in which the students expressed concerns regarding the technical issues faced during the virtual session, as a number of them were unable to communicate via voice at the start of the session (the students were attending the virtual session from home). Other students experienced issues with the graphics rendering on their machines due to low specification of the graphics adapter. In addition to the above, few students expressed that the long time and the large number of different multithreading situations and possibilities, which were practiced in the virtual scenario, along with the number of wrong judgements made and corrected, were the reasons behind this relatively low percentage of affective quality.

With regards to subject difficulty, the percentage of students who declared that they found the subject difficult was slightly more than half of the group. A number of formative assessments were carried out to judge students' level of understanding and learning in this module, the outcomes of which were poor for around three quarters of the students. As indicated earlier, it was understandable that students of weaker academic backgrounds found it difficult (or embarrassing) to acknowledge facing complications in a subject either to their lecturer or peers. Therefore, and as previously explained in the Computer Programming section in this Chapter, all the percentages of similar declarations by students in the questionnaires were considered to be the minimum value (with the reality being a higher value) for all the modules. This issue and its impacts are discussed in Chapter Six, section 6.2 (page 164).

It is worth mentioning here that following the application of this virtual world scenario in the academic year 2012/2013 and obtaining students' feedback (Group-C), another short questionnaire was distributed, after few weeks, to capture students' views on a couple of more in-depth issues. As high as 86% of the students agreed that learning in virtual worlds facilitated their learning and understanding of the difficult concepts of parallelism in a dual core/multi-processor computer system, while slightly fewer than half of the students acknowledged that practicing in virtual worlds helped them in correcting one or more wrong concepts that they had following the traditional theory sessions, and that Second Life is a useful tool to enhance the learning and achievement of students in this Module. In addition, as students were required to undertake a written exam at the end of the module, 57% of them agreed that they would be able to remember the simulation of different multithreading situations in Second Life more than the information delivered in the traditional theory sessions.

For a copy of all the questionnaires for the academic year 2012/2013 and their data analysis, see Appendix-3, Section A3.3 (page 257).

Moving to the academic year 2013/2014 (Group-F), and as previously indicated, a different approach to recording feedback was adopted in this academic year compared to that in the previous year. Students' feedback was captured and recorded before and after the application of virtual world technologies in their studies.

It is worth mentioning here that this group was previously introduced to virtual worlds in a number of modules in their Year-2 of the Foundation Degree in Computing programme (in the academic year 2012/2013). This could suggest one of the reasons behind the very high achievement they made using the virtual platform in their Year-3 (BSc (Hons)).

The questionnaire on the multithreading techniques' virtual activities produced the following outcomes (see Figure 5.29 below):

- Slightly more than half of the students who originally agreed that this subject is deemed difficult changed their minds following exercising the virtual world scenario.

- As high as 96% of the students agreed that effective learning of the subject took place in virtual worlds, which facilitated their understanding of the complex theory concepts. This was almost double the percentage recorded for the physical world.

- Hundred percent of the students agreed that affective quality was enhanced compared to 62% for the physical world.

- Another 100% of the students found learning within virtual worlds more engaging compared to 57% for the physical world.

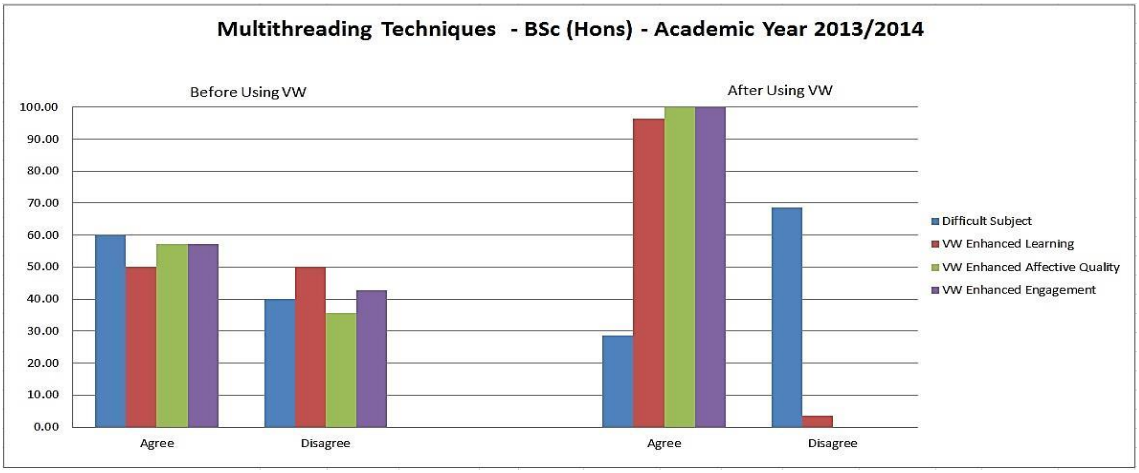


Figure 5.29: Statistics of Multithreading Techniques, Year-3 (2013/2014)

For a copy of all the questionnaires for the academic year 2013/2014 and their data analysis, see Appendix-3, Section A3.4 (page 313).

Correlation of the data obtained:

Further investigation was made into the analysis achieved above, for the academic year 2012/2013 (Group-C) to answer the questions in Table 5.18 below.

	Question	Percentage
1.	What is the number/percentage of students who found the subject difficult but their learning was enhanced after the application of virtual worlds?	100%
2.	What is the number/percentage of students who found the subject difficult but their affective quality was enhanced after the application of virtual worlds?	75%
3.	What is the number/percentage of students who found the subject difficult but their engagement was enhanced after the application of virtual worlds?	50%
4.	What is the number/percentage of students who found the subject difficult but their learning was not enhanced after the application of virtual worlds?	0%
5.	What is the number/percentage of students who did not find the subject difficult but their learning was enhanced after the application of virtual worlds?	67%

Table 5.18: Data correlation of Multithreading Techniques, Year-3 (2012/2013)

Moving to the academic year 2013/2014 (Group-F), the five questions were rephrased in order to reflect the additional element of before and after the application of virtual world technologies, which was added to the questionnaire in this academic year. The outcomes were as in Table 5.19 below:

Question	Percentage
1. What is the number/percentage of students who found the subject difficult (before the application of virtual worlds), but their learning was enhanced (after the application of virtual worlds)?	100%
2. What is the number/percentage of students who found the subject difficult (before the application of virtual worlds), but their affective quality was enhanced (after the application of virtual worlds)?	100%
3. What is the number/percentage of students who found the subject difficult (before the application of virtual worlds), but their engagement was enhanced (after the application of virtual worlds)?	100%
4. What is the number/percentage of students who found the subject difficult (before the application of virtual worlds), but their learning was not enhanced (after the application of virtual worlds)?	0%
5. What is the number/percentage of students who did not find the subject difficult (before the application of virtual worlds), but their learning was enhanced (after the application of virtual worlds)?	100%

Table 5.19: Data correlation of Multithreading Techniques, Year-3 (2013/2014)

For a copy of all the data correlation and further analysis sheets, see Appendix-3, Sections A3.5 (page 345) and A3.6 (page 373).

Students' grades and links to learning modes:

Following the completion of the data analysis for this module, students' grades were then checked for the academic years, 2011/2012 (no virtual world activities), 2012/2013 and 2013/2014 (with virtual world activities) as in Table 5.20 below:

Academic Year / Subject Name	2011 / 2012 (10 students)	2012 / 2013 (7 students)	2013 / 2014 (6 students)
Multithreading techniques, BSc (Hons) (all assessments)	**93.25** StDev. = 7.7	**93.45** StDev. = 4.7	**106.90** StDev. = 9.4

Note: Grade = (Average mark of the module / Average mark of all Computing modules * 100)

Table 5.20: Grades of the Multitasking Systems module, Year-3

The grades of the BSc (Hons) students in the first year of applying virtual world technologies, i.e. 2012/2013 (Group-C), did not reflect the positive feedback obtained from the students' questionnaire. As explained in Section 5.3 above regarding students' acceptance of virtual world technologies, the outcomes of the beginning of the year questionnaire for this group demonstrated that half of the students did not support using virtual worlds in their studies. This negative prejudgment by the students, who were not previously introduced to the application of these technologies in HE, could suggest one of the reasons behind the no improvement in achievement within this academic year compared to that in 2011/2012, when virtual world technologies were not applied.

In the same regard, the analysis of the calculated values of Standard Deviation (StDev), stated in Table 5.20 above, did not suggest a strong systematic increase or decrease in the differentiation in students' grades for this module. However, the Standard deviation value for the academic year 2012/2013 (when virtual world technologies were applied) was noticeably lower than that for the academic year 2011/2012 (when virtual world technologies were not applied), while students' average grades for both years were almost identical. This could suggest that students' achievement was slightly better in the academic year 2012/2013 (all students achieved well with a reduced spread of grades) compared to the students' achievement in the previous year. In 2013/2014 (when virtual world technologies were applied), the very high grades of students reflected the higher achievement in this academic year compared to both of the previous years.

As students were role-playing in the virtual restaurant, the main learning mode applicable to this scenario is 'Kinesthetic', while the secondary learning mode is 'Visual'. The VARK results revealed that 86% of the students in the academic year 2012/2013 (Group-C) had the 'Kinesthetic' learning mode, compared to 67% in the academic year 2013/2014 (Group-F). The 'enhanced learning' percentages that were obtained from the questionnaires of this module in both academic years were mapped towards the learning mode of individual students; however, it was clearly noted that there was no strong correlation between the two aspects (see Figures 5.30 and 5.31 below)

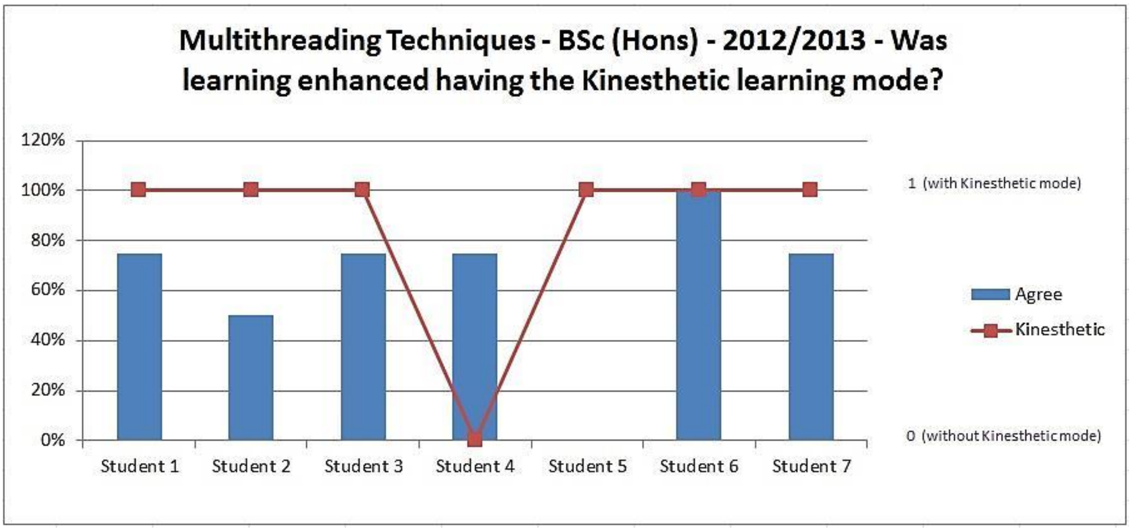


Figure 5.30: Link between enhanced learning and Kinesthetic learning mode in Multithreading Techniques, Year-3 (2012/2013)

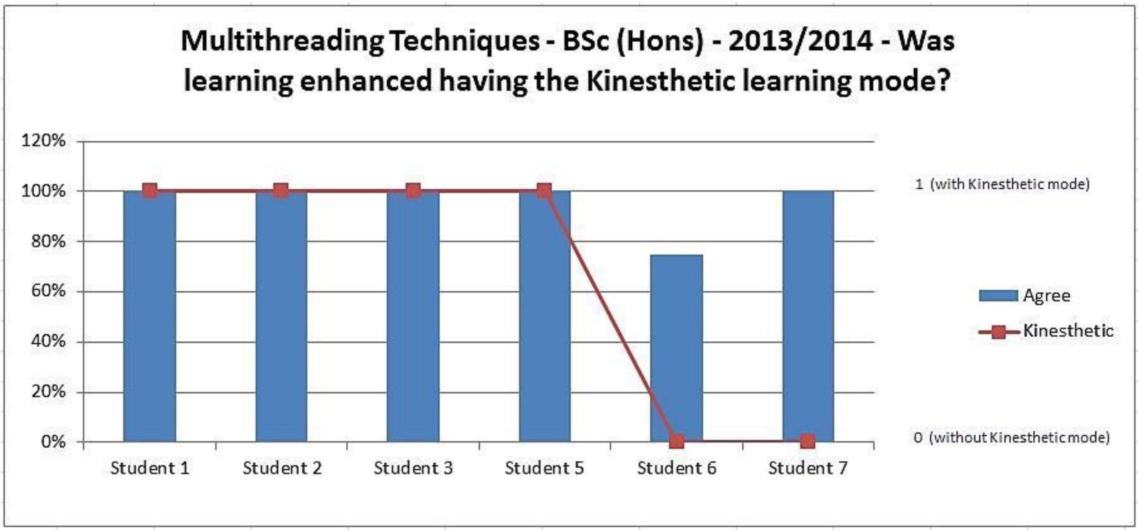


Figure 5.31: Link between enhanced learning and Kinesthetic learning mode in Multithreading Techniques, Year-3 (2013/2014)

As stated earlier in this Chapter, the reason for choosing a secondary vertical axis for the learning preference values in the above charts was due to having mixed types of data which vary widely, i.e. percentages of ‘Enhanced Learning’ and ‘0/1’ values of the ‘Learning Preference’.

For a copy of all students’ grades before and after the application of virtual worlds, see Appendix-3, Section A3.7 (page 386).

Quotes from students’ feedback:

As indicated in the other modules, the technical difficulties faced by the students when using Second Life formed the main cause of negative feedback. The following are some quotes from students’ emails, following the application of the virtual scenarios, highlighting both positive and negative experiences:

Student-6 of Group-C (2012/2013) said: “*I think there might be issues with second life in terms of the sound because my headset worked well during the last session. I just couldn't figure out what was wrong today. I would also like to confirm that I find other students behavior distracting as well. Overall I think these simulations are good so I* *think it was a great idea to use them. I'm benefiting from them maybe because it suits my preferred learning style (visual)*".

Student-2 of Group-C said: "*Although the session today went on than originally planned, I think we all learnt a lot from the session especially the complex understanding of higher and lower priorities. I know for a fact that I learnt a better understanding of the process in which a multi-tasking system takes… I still benefited a lot from the session(s) and I am grateful for you being 100% dedicated to the class by writing with injuries. I however think that the laptop I am using is not 100% suitable for Second Life software and thats why the sound and graphics are not working correctly. I will still purchase or borrow a headset for the session on the 8th November*".

A student in the academic year 2013/2014 (withdrawn later due to personal circumstances) said: "*First of all I would like to thank you for todays second life experience, this was invaluable for me especially as I had a hard time understanding that concept in class…It was also much easier to understand in that environment, I wish all lessons could be through second life at the moment.*"

5.7 Helpdesk Support

As explained in Chapter One, this module does not include complex theory concepts as such in its subject. The difficulty targeted by this research was the confrontation with real customers on the helpdesk, the way in which information is investigated on the hardware/software faults and how solutions (fixing recommendations) are communicated to the customers.

In a large part of the module assessments, the Foundation Degree in Computing, Year-2 students were required to join a physical helpdesk (for the first time), in which they can record their practical experience. All the students were reluctant to attend a real-life helpdesk, where they face actual customers without previous training which enables them to be well-prepared to handle different situations and some challenging personality traits of customers, especially when the student is unable to reach a satisfying technical solution to the problem. In addition, the students needed to physically apply their taught methods of investigating hardware and software faults within a computer system on real-life scenarios in order to judge their effectiveness in reaching the correct diagnosis and fixing in different situations. However, and at the same time, the students did not want this training to take place with actual customers at the start in order to avoid any issues or escalations, as mistakes are very common in such a stage.

In previous academic years, when virtual world technologies were not applied, the procedure that was followed to provide the students with the required helpdesk training prior to their physical experience was achieved by dividing them, in their lecture hall, into two groups, one represented the helpdesk staff, and the other represented customers. Each helpdesk staff investigated the computing problem(s) of their customer and applied their taught methods to find the appropriate solution to fix them. However this process had a number of drawbacks. First, the group representing customers came up with fake problems, which in the majority of situations had a number of weakness points. This had a negative impact on the diagnosis and fixing options reached by the student representing the helpdesk staff. Second, as the students knew each other, it was difficult for them to take this process seriously enough and follow the taught theory procedures carefully to reach their target. This had always affected the achievement of the learning outcomes for this part of the curriculum.

The virtual scenario provided for this module in Second Life, which was applied in both academic years 2012/2013 and 2013/2014, included designing and scripting a virtual helpdesk for the students to join, where they meet with actual customers and practice their taught theory procedures. The students approached this with little reluctance, as they were not doing the helpdesk process physically face-to-face. The virtual world platform provided the students with the advantage of being in a replication of a real-life situation without the need to be physically there, and benefitting from the training possibilities that this environment provides without facing consequences of making mistakes during their learning process. This environment had actually encouraged the students to get involved and learn from their mistakes, which enhanced their learning and achievement in this module.

As shown in Figures 5.32 and 5.33 below, the designed virtual helpdesk utilised a large hall, which was purposely furnished to provide means to meet with customers and to offer them with different types of support. In addition to the reception area, a virtual mailbox was also added to the scenario to enable customers to leave messages for the helpdesk staff if they were not available when the customer visited the helpdesk. The various types of support embedded within this virtual helpdesk included a bookshelf having a number of books, each of which is linked to a well-selected website providing tutorials on the common software and operating systems and also a FAQ webpage answering maintenance and problem solving questions. This facility was used by the helpdesk staff, while being busy with other customers, to direct newly arriving customers to read relevant information on their problem rather than just waiting till a member of helpdesk staff is free. Another facility was two large white boards located in each side of the hall, which the helpdesk staff used to display selected webpages, images or a slide show to provide their customers with information, e.g. tips of the day and recent news or events.

Figure 5.32: The Helpdesk Support virtual scenario (Tech Genius virtual helpdesk)

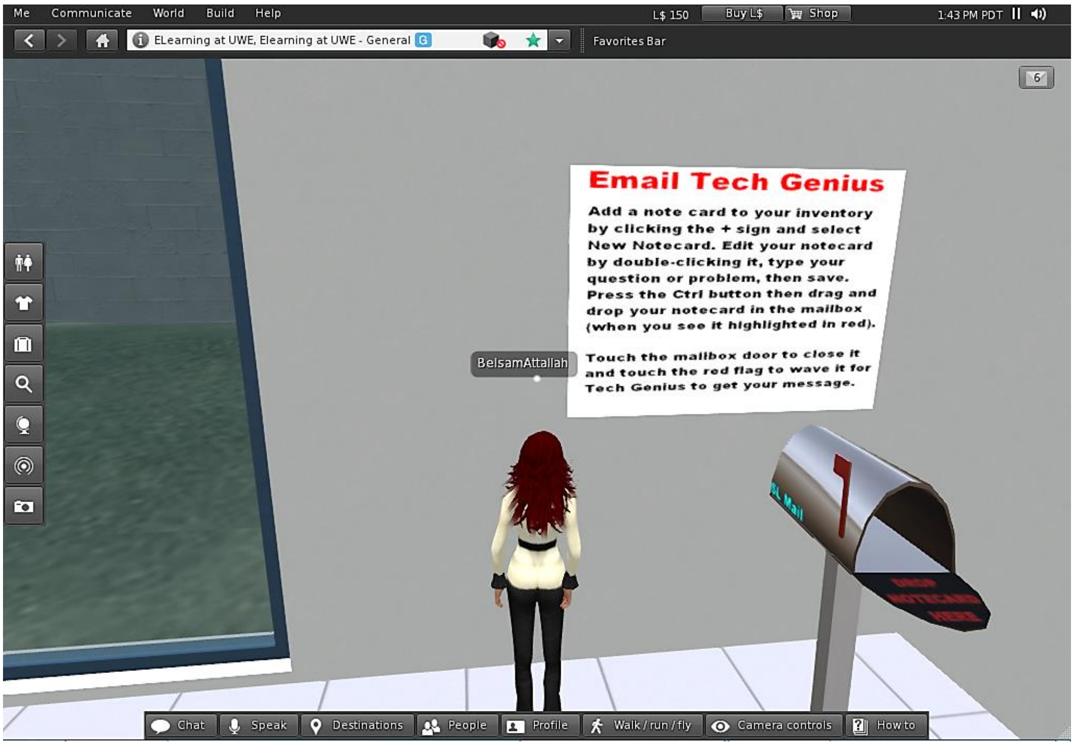


Figure 5.33: The Helpdesk Support virtual scenario (Tech Genius customer mailbox)

More screenshots could be found in Appendix-2, section A2.4 (page 220).

The students found this virtual helpdesk very useful in providing them with a genuine experience, which well-prepared them to effectively join the physical helpdesk. They chose to produce a digital story on their experience in this virtual helpdesk as part of their multimedia project designed for the practical assessment of the Multimedia Technologies module.

It is worth mentioning here that this virtual scenario was applied shortly following the start of the module in both academic years, as the students were expected to start their physical helpdesk placement before the end of the first semester; therefore, students were introduced to the virtual scenario at a very early stage to allow them enough time to benefit from its facilities before they started their actual experience. This situation, however, had also a negative impact. In the academic year 2012/2013, a high percentage of students selected the option ‘I don’t know’ in the questionnaires distributed to capture their feedback following the application of the virtual scenario. That was an understandable situation, as many students were unable to clearly judge, at that stage, the requirements and challenges of a physical helpdesk and the affordances of virtual worlds in this field. However, when analysing the other responses to the questionnaires, they appeared to respond positively to the virtual helpdesk as explained below.

Another issue that was concluded following the analysis of the questionnaires for both academic years was the greater acceptance of virtual world technologies in the academic year 2013/2014 compared to that of the previous year, given the fact that the virtual scenario was applied around middle of October in both years. The circumstances that could suggest the reason behind that is the students, in the academic year 2013/2014, were previously introduced to virtual worlds in a number of modules in the previous year (their Year-1 of the HE Computing course in the academic year 2012/2013). This issue is discussed in the following chapter, as it reoccurred in other modules as well.

The outcomes of the questionnaires distributed to the students to capture and record their feedback in the academic year 2012/2013 (Group-B) showed that:

- Thirty-seven percent of the students considered the helpdesk support as a difficult subject, compared to 27% who disagreed, while 36% answered ‘I don’t know’.

- Forty-three percent of the students agreed that learning this subject in the virtual world environment enhanced their learning and understanding of its difficult concepts, compared to 40% who disagreed, while 17% selected ‘I don’t know’.

- As high as 82% of the students agreed that affective quality was enhanced.

- Forty-one percent of the students found learning within virtual worlds more engaging compared to 46% who disagreed, while 13% answered ‘I don’t know’.

As a large percentage of students could not judge whether they face any difficulties in this module, at the time of the questionnaire, and whether virtual worlds offer any advantage to their learning, the researcher decided to distribute another questionnaire to the students following a number of more sessions to the module, when students started appreciating the challenging aspects of a physical helpdesk, and after more application of the virtual scenario. The students' feedback (Group-B) was as follows (see Figure 5.34 below):

- Eighty percent of the students confirmed that before using Second Life they were not sure about the context in which this environment could be used to assist their learning in this module.

- Sixty percent of the students agreed that learning this subject in the virtual world environment enhanced their learning and understanding of its difficult concepts, compared to 21% who disagreed, while 19% selected 'I don't know'.

- Fifty-two percent of the students agreed that affective quality was enhanced compared to 30% who disagreed, while 18% answered 'I don't know'.

- Fifty percent of the students found learning within virtual worlds more engaging compared to 30% who disagreed, while 20% answered 'I don't know'.

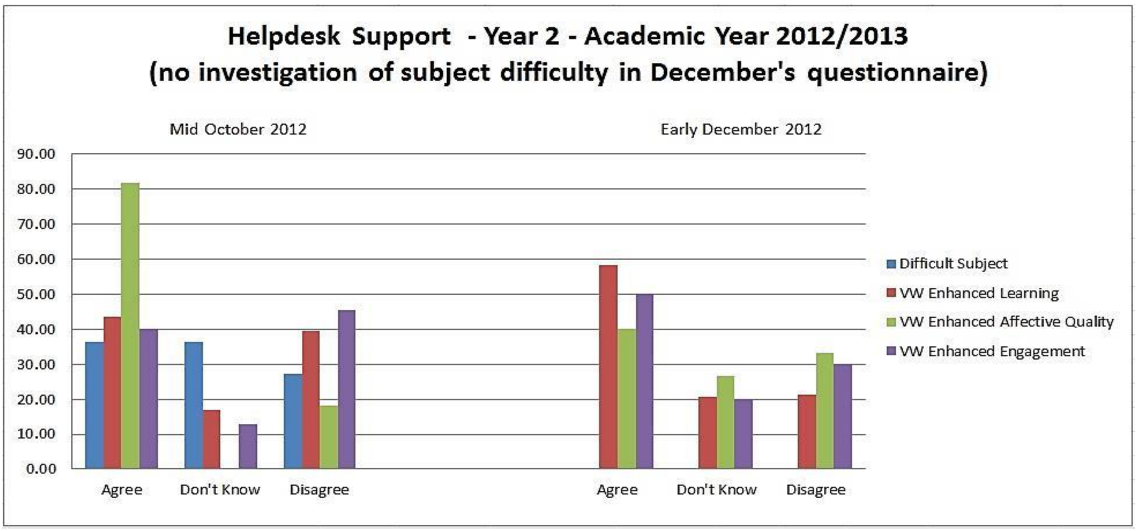


Figure 5.34: Statistics of Helpdesk Support, Year-2 (2012/2013)

Although there was no direct investigation into subject difficulty in the later questionnaire, there was a significant change in students' responses regarding their enhanced learning, affective quality and engagement in their learning process in virtual worlds. It is worth mentioning here that this module was delivered by another HE lecturer, and as previously explained in the Computer Programming module, the dates of applying the virtual scenario were not subject to discussion/negotiation in both academic years.

For a copy of all the questionnaires for the academic year 2012/2013 and their data analysis, see Appendix-3, Section A3.3 (page 257).

Moving to the academic year 2013/2014 (Group-E), and as previously indicated, a different approach to recording feedback was adopted in this academic year compared to that in the previous year. Students' feedback was captured and recorded before and after the application of virtual world technologies in their studies.

The questionnaire on the helpdesk support virtual activities produced the following outcomes (see Figure 5.35 below):

- Eleven percent more students agreed that the subject became less difficult following the application of the virtual scenario.

- Fourteen percent more students agreed that effective learning of the subject took place in virtual worlds.

- As high as 100% of the students agreed that affective quality was enhanced.

- Eighty-six percent of the students found learning within virtual worlds more engaging.

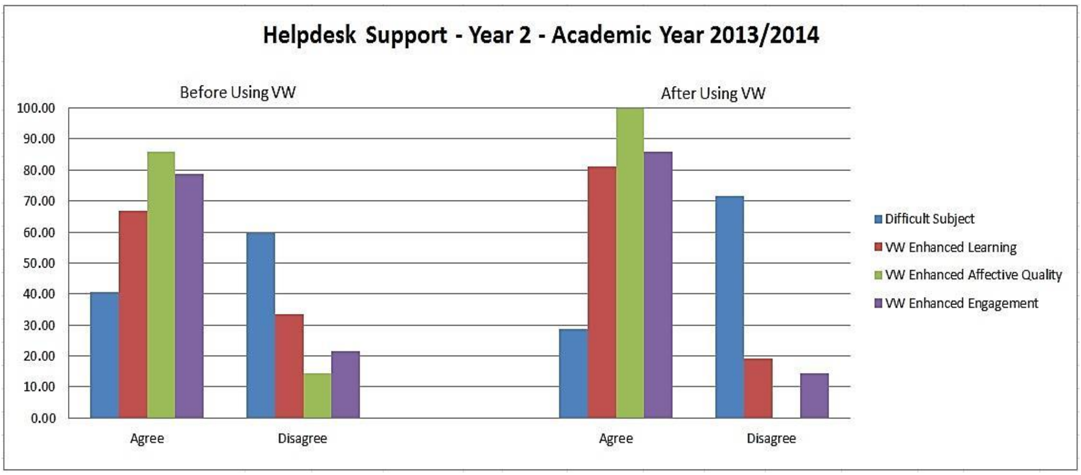


Figure 5.35: Statistics of Helpdesk Support, Year-2 (2013/2014)

For a copy of all the questionnaires for the academic year 2013/2014 and their data analysis, see Appendix-3, Section A3.4 (page 313).

Correlation of the data obtained:

Looking into the outcomes of the data analysis achieved above, and following further investigation by the researcher in the academic year 2012/2013 (Group-B), answers to the questions in Table 5.21 below were achieved.

	Question	Percentage (Using the 1st questionnaire)
1.	What is the number/percentage of students who found the subject difficult but their learning was enhanced after the application of virtual worlds?	57%
2.	What is the number/percentage of students who found the subject difficult but their affective quality was enhanced after the application of virtual worlds?	71%
3.	What is the number/percentage of students who found the subject difficult but their engagement was enhanced after the application of virtual worlds?	57%
4.	What is the number/percentage of students who found the subject difficult but their learning was not enhanced after the application of virtual worlds?	43%
5.	What is the number/percentage of students who did not find the subject difficult but their learning was enhanced after the application of virtual worlds?	0%

Table 5.21: Data correlation of Helpdesk Support, Year-2 (2012/2013)

Moving to the academic year 2013/2014 (Group-E), the above five questions were rephrased in order to emphasise the additional element of before and after the application of virtual world technologies, which was added to the questionnaire in this academic year. The outcomes were as in Table 5.22 below:

Question	Percentage
1. What is the number/percentage of students who found the subject difficult (before the application of virtual worlds), but their learning was enhanced (after the application of virtual worlds)?	50%*
2. What is the number/percentage of students who found the subject difficult (before the application of virtual worlds), but their affective quality was enhanced (after the application of virtual worlds)?	100%
3. What is the number/percentage of students who found the subject difficult (before the application of virtual worlds), but their engagement was enhanced (after the application of virtual worlds)?	100%
4. What is the number/percentage of students who found the subject difficult (before the application of virtual worlds), but their learning was not enhanced (after the application of virtual worlds)?	50%
5. What is the number/percentage of students who did not find the subject difficult (before the application of virtual worlds), but their learning was enhanced (after the application of virtual worlds)?	75%

* Explanations on the reduced acknowledgement of subject difficulty by students is explained in section 6.2 of Chapter Six (page 164).

Table 5.22: Data correlation of Helpdesk Support, Year-2 (2013/2014)

For a copy of all the data correlation and further analysis sheets, see Appendix-3, Sections A3.5 (page 345) and A3.6 (page 373).

Students' grades and links to learning modes:

Following the completion of the data analysis for this module, students' grades were then checked for the academic years, 2010/2011 (no virtual world activities), 2012/2013 and 2013/2014 (with virtual world activities) as in Table 5.23 below:

Academic Year / Subject Name	2010 / 2011 (10 students) (*module not taught in 2011/2012*)	2012 / 2013 (13 students)	2013 / 2014 (8 students)
Helpdesk Support, Year-2 (the practical assessment)	**90. 57** StDev. = 19.3	**105.89** StDev. = 11.5	**101.07** StDev. = 10.0

Note: Grade = (Average mark of the module / Average mark of all Computing modules * 100)

Table 5.23: Grades of the Helpdesk Support module, Year-2

The above shows a much higher achievement in the academic years 2012/2013 and 2013/2014 (with the application of virtual world technologies). However, the grades of the academic year 2013/2014 did not strongly reflect the positive feedback obtained from students' questionnaire, as it was lower than that for the academic year 2012/2013 (although students' feedback in this academic year, i.e. 2013/2014, reflected more acceptance of the technologies and more enhanced learning). There was no suggested reason behind this situation; however, the impact of the number of students in each academic year could form an area of further investigation in future research.

In addition, the Standard Deviation (StDev) values for the academic years 2012/2013 and 2013/2014 were noticeably lower than that for the academic year 2010/2011. This could suggest that students' achievement was better with the application of virtual worlds in the two recent academic years, as all students achieved well (with a reduced spread of grades) compared to students' achievement in 2010/2011.

As students were role-playing in the virtual helpdesk, the main learning mode applicable to this scenario was ‘Kinesthetic’, while the secondary learning mode was ‘Visual’. The VARK results revealed that 64% of the students in the academic year 2012/2013 (Group-B) had the ‘Kinesthetic’ learning mode, compared to 100% in the academic year 2013/2014 (Group-E). The ‘enhanced learning’ percentages that were obtained from the questionnaires of this module in both academic years were mapped towards the learning mode of individual students; however, it was clearly noted that there was no strong correlation between the two aspects. For the academic year 2012/2013, see Figures 5.36 and 5.37 below, and for the academic year 2013/2014, see Figure 5.38 below.

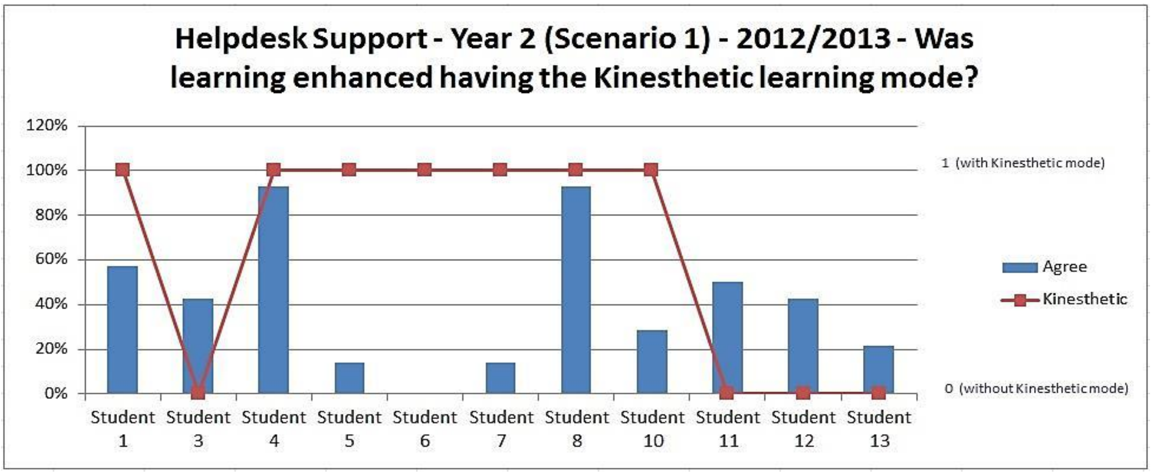


Figure 5.36: Link between enhanced learning and Kinesthetic learning mode in Helpdesk Support, Year-2 (Scenario 1, 2012/2013)

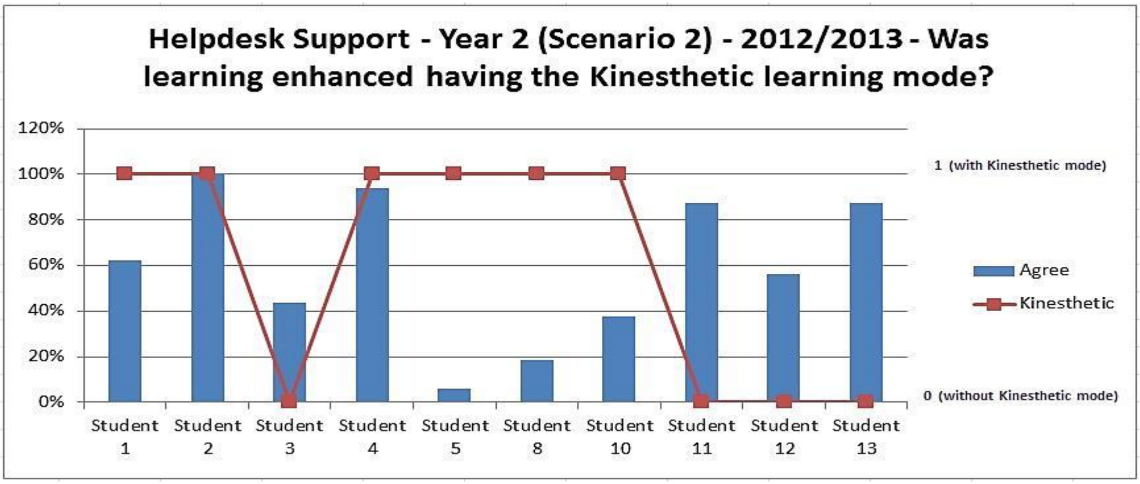


Figure 5.37: Link between enhanced learning and Kinesthetic learning mode in Helpdesk Support, Year-2 (Scenario 2, 2012/2013)

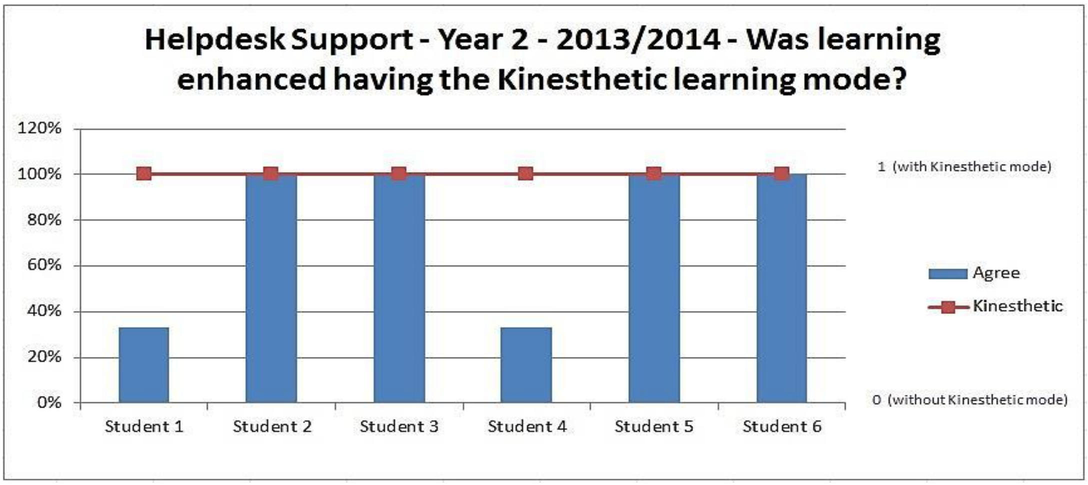


Figure 5.38: Link between enhanced learning and Kinesthetic learning mode in Helpdesk Support, Year-2 (2013/2014)

As stated earlier in this Chapter, the reason for choosing a secondary vertical axis for the learning preference values in the above charts was due to having mixed types of data which vary widely, i.e. percentages of 'Enhanced Learning' and '0/1' values of the 'Learning Preference'.

Quotes from students' feedback:

The following are some quotes from students' reflection on their experience in the virtual helpdesk, in the academic year 2012/2013 (Group-B):

"*…The initial provision of a virtual helpdesk in Second Life, where simulations were performed, allowed us to perform a reflection upon the experience from various points of view… Working on a virtual helpdesk removed ourselves from the physical helpdesk, which meant that whilst we could not physically inspect customers' equipment other benefits were yielded. Such benefits included: 1) Being able to research a customer's problem alongside talking to them, whilst not giving the appearance of not listening… 2)Metric gathering was found to be easier to gather, as the calls could be recorded for analysis later, or the exact time taken for a call to be processed could be recorded more in depth… This virtual environment opens a new way for IT Service delivery. Creating a virtual helpdesk has its own benefits with the most important fact - everyone can access it from everywhere and anytime… The downsides from this method of support were: it was not possible to look at the customers' computer for some scenarios, meaning that* *we were reliant on the customers' description of the problem, which can often be unintentionally misleading or wrong*".

See Appendix-5 (page 404), section A5.1 for more quotes.

For a copy of all students' grades before and after the application of virtual worlds, see Appendix-3, Section A3.7 (page 386).

5.8 Research Methods for Computing Projects

In this module, virtual world technologies were applied in one academic year only, 2013/2014 (Group-F). This module is very important for the students in their final year, BSc (Hons) in Computing, as they need the skills to research their Computing graduation project, which is allocated a large number of credits. In such a practical course, having a 100% theoretical module like Research Methods is not usually welcomed or appreciated by students.

Recent research demonstrates that researchers are looking to replace traditional 'paper-and-pencil' research methods and adopting a range of online methodological options (Silva, 2012).

Ideas were investigated to bring about visualisation in this fully theoretical module in order to enhance students' experience and achievement. As the researcher was introduced to research methods in virtual worlds as part of a number of modules undertaken in the MA Education in Virtual Worlds Programme at the University of the West of England (UWE), the idea of applying virtual world technologies in the Research Methods module was developed.

The BSc (Hons) students utilised the 'Research Observatory' site in Second Life, which is part of the UWE virtual island, to practice their research activities. The intention was to allow the students to benefit from the facilities provided in this virtual site to synthesise a range of underpinning research methodologies, based on their taught sessions, and to recommend/select the appropriate methodology for their projects.

The multiple layers of the virtual research observatory mirror the research map provided on the UWE research observatory website (http://ro.uwe.ac.uk), see Figures 5.39 and 5.40 below. The process of going up through the levels of the virtual research observatory helped the students to better understand the research phases and appreciate the need for them to achieve a successful research project. The peer discussion of research ideas and methods of investigating information was one of the strength areas of this virtual site.

The transposition of this metaphoric context from a 2D environment, i.e. the University website, and the 3D immersive platform of Second Life assisted the students in comprehending the process of progressing through the different stages of an actual research. Students were inviting each other to the different levels of the virtual site to showcase their progression and obtain peer views and evaluation, which resulted in a strong collaborative learning situation.

Figure 5.39: The Research Methods virtual scenario (the research facilities provided by the virtual observatory – multiple levels within the building)

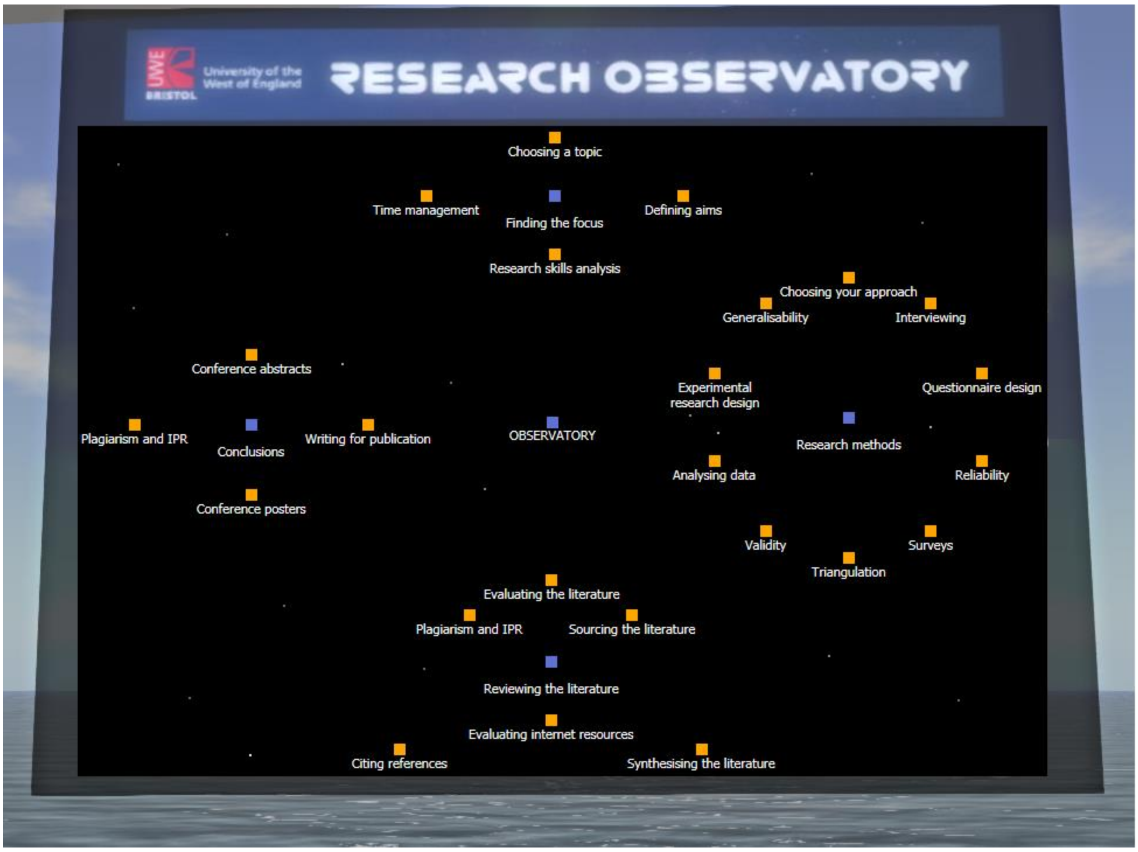


Figure 5.40: The Research Methods virtual scenario (The Research Map from the online research onservatory – one of the information/explanation signs within the virtual building)

More screenshots could be found in Appendix-2, section A2.5 (page 223).

As previously indicated, students' feedback in the academic year 2013/2014 was captured and recorded before and after the application of virtual world technologies in their studies. The outcomes of the questionnaires (Group-F) revealed the following (see Figure 5.41 below):

- Ten percent of the students who originally agreed that this subject has difficult theory concepts changed their minds following exercising the virtual world scenario.

- As high as 90% of the students agreed that effective learning of the subject took place in virtual worlds, which facilitated their understanding of the theory concepts.

- Fifteen percent more students found learning within virtual worlds more engaging.

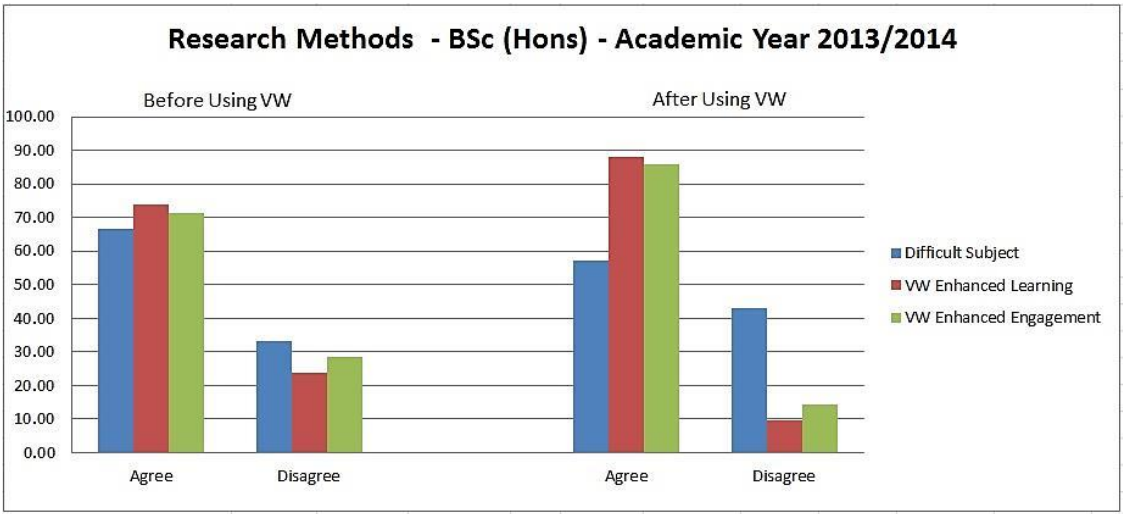


Figure 5.41: Statistics of the Research Methods module, Year-3 (2013/2014)

The last question asked in this questionnaire required the students to state their preferred environment for learning the research methods subject (the real world, the virtual world, or both). Out of 7 students the outcome was: 'Real World' (2 students), 'Virtual World' (0 students), and 'Both' (5 students).

For a copy of all the questionnaires for the academic year 2013/2014 and their data analysis, see Appendix-3, Section A3.4 (page 313).

Correlation of the data obtained:

Looking into the outcomes of the data analysis achieved above, further investigation was carried out by the researcher, in the academic year 2013/2014 (Group-F), to answers the four questions in Table 5.24 below. The questions utilised the element of before and after the application of virtual world technologies, which was added to the questionnaire in this year.

Question	Percentage
1. What is the number/percentage of students who found the subject difficult (before the application of virtual worlds), but their learning was enhanced (after the application of virtual worlds)?	100%
2. What is the number/percentage of students who found the subject difficult (before the application of virtual worlds), but their engagement was enhanced (after the application of virtual worlds)?	100%
3. What is the number/percentage of students who found the subject difficult (before the application of virtual worlds), but their learning was not enhanced (after the application of virtual worlds)?	0%
4. What is the number/percentage of students who did not find the subject difficult (before the application of virtual worlds), but their learning was enhanced (after the application of virtual worlds)?	100%

Table 5.24: Data correlation of the Research Methods module, Year-3 (2013/2014)

For a copy of all the data correlation and further analysis sheets, see Appendix-3, Sections A3.5 (page 345) and A3.6 (page 373).

<u>Students' grades and links to learning modes:</u>

Following the completion of the data analysis for this module, students' grades were then checked for the academic years, 2011/2012 and 2012/2013 (no virtual world activities), and 2013/2014 (with virtual world activities) as in Table 5.25 below:

Academic Year / Subject Name	2011 / 2012 (10 students)	2012 / 2013 (7 students)	2013 / 2014 (6 students)
Research Methods, BSc (Hons) (all assessments)	**95.82** StDev. = 7.1	**101.60**** StDev. = 7.4	**97.09** StDev. = 8.7

<u>Note:</u> Grade = (Average mark of the module / Average mark of all Computing modules * 100)

** Virtual world technologies were not applied in the academic year 2012/2013

Table 5.25: Grades of the Research Methods module, Year-3

The grades of the BSc (Hons) students in the academic year 2013/2014 (Group-F), when virtual world technologies were applied, did not reflect the positive feedback obtained from the students' questionnaire. An issue that could strongly suggest the reason behind that is the type and structure of the assessments in this module, and the scope for applying research methods in virtual worlds on the process of researching the requirements of students' graduation projects. This purely theoretical module is structured to include the employment of traditional research methods in the physical environment in order to achieve a full investigation of project factors and infrastructure. The assessments of this module are built to show students' achievement using the traditional research methods. Therefore, the above grades do not form a strong indicator on the successful application of virtual world technologies in this module. The factor of the type and structure of module assessments is discussed in detail within the following chapter.

As students were visualising the different levels/stages of their research in the virtual Research Observatory site, the main learning mode applicable to this scenario is 'Visual', while the secondary learning mode is 'Kinesthetic'. The VARK results revealed that 71% of the students in the academic year 2013/2014 had the 'Visual' mode within their learning preferences. The 'enhanced learning' percentages that were obtained from the questionnaire of this module in this academic year were mapped towards the learning mode of individual students; however, it was clearly noted that there was no strong correlation between the two aspects (see Figure 5.42 below).

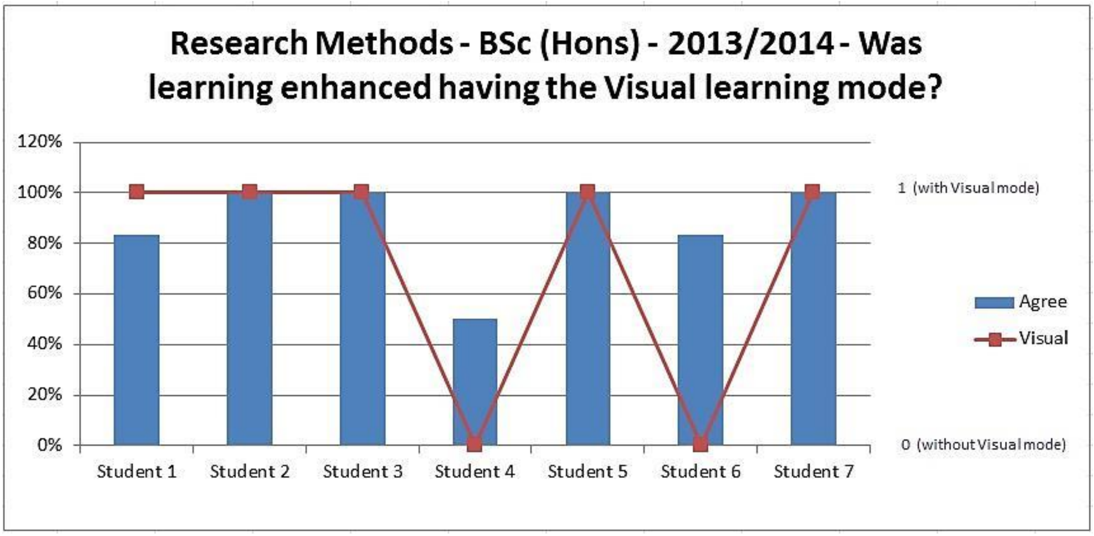


Figure 5.42: Link between enhanced learning and Visual learning mode in the Research Methods module, Year-3 (2013/2014)

As stated earlier in this Chapter, the reason for choosing a secondary vertical axis for the learning preference values in the above chart was due to having mixed types of data which vary widely, i.e. percentages of 'Enhanced Learning' and '0/1' values of the 'Learning Preference'.

On the other hand, the analysis of the calculated values of Standard Deviation (StDev), stated above, did not suggest any systematic increase or decrease in the differentiation in students' grades for this module over the three academic years.

For a copy of all students' grades before and after the application of virtual worlds, see Appendix-3, Section A3.7 (page 386).

5.9 Multimedia Technologies

Similar to the Helpdesk Support module, and as explained in Chapter One, the Multimedia Technologies module does not include complex theory concepts as such in its subject. The difficulty pursued by this research was in the process of obtaining live feedback from an audience of different cultures, backgrounds and age groups on their multimedia projects (before being submitted as a major part of the assessments for this module).

In this Year-2 module of the Foundation Degree in Computing, virtual world technologies were applied in both academic years 2012/2013 (Group-B) and 2013/2014 (Group-E).

To enable the process of obtaining live feedback, the hall that was designed for the virtual helpdesk was utilised to invite broad audience to watch the demonstration of the multimedia objects designed by students for their projects, which were displayed on the large whiteboards located on both sides of the hall. These whiteboards were configured to allow the displaying of videos (for the digital stories and interviews) and the websites published with advanced multimedia designs and tools to promote the projects.

Taking into account the size of the virtual hall and the number of students, 5-7 guests of different origins, age groups and backgrounds were invited to the hall (in Second Life) in multiple sessions in order to facilitate receiving a considerable number of different opinions and comments by the students on their work. Some of these sessions resulted in further follow-up and communication between the visitors and students, where members of the audience decided to provide the students with additional support in terms of URLs to websites having successful digital stories to enable them to enhance the features of their designed objects, in addition to links to relevant online tutorials of some advanced multimedia tools and techniques.

This experience was extremely useful for the students in enhancing the quality of their final multimedia products, especially those who were stretched and challenged by the audience and decided to utilise the additional support provided by them in advancing the features of their projects.

Although there were a number of technical issues that accompanied this virtual experience, e.g. the configuration required to display videos on the white boards, the different useful facilities provided by Second Life, e.g. the private chatting enabled some further one-to-one discussions and comments between individual students and members of the audience without affecting the rest of the group. Moreover, the virtual world environment facilitated inviting broad audience, who attended the hall from their workplace or home and from different cities and countries as well (a couple of audience members were attending from New Zealand and Greece). This enriched the feedback obtained by the students with the international experience of those people.

It is worth mentioning here that in the academic year 2012/2013 slightly more than half of the group attended the activity in Second Life. However, the students who did not attend were required to attend a briefing, in the following session, on the virtual activity, its outcomes and students' feedback. This was delivered by the students who attended the activity using a video recording to demonstrate the event. The researcher, who is also the HE lecturer of this module, carried out this activity to extend the virtual experience to the whole of the group, not only to judge the advantages and limitations of applying virtual world technologies in the curriculum delivery of this module, but also because Second Life is a 3D graphical environment, which includes protocols for embedding sound, videos and animation, which all fall under the category of multimedia technologies. The successful mixture of this large number of different multimedia objects in the Second Life environment was a strong example on the compatibility between different multimedia formats and the other supporting software needed for their display/running, e.g. plug-ins.

In addition, the students' feedback in the academic year 2013/2014 was not captured in terms of a questionnaire, as the students chose to produce a number of multimedia objects on the application of virtual world technologies in their studies as part of their multimedia project, e.g. a digital story on their experience in the virtual helpdesk. This project formed a significant part of their overall assessments for the module, and the students evaluated their experience of receiving live feedback as part of their project.

The screenshots in Figures 5.43 and 5.44 below show parts of the sessions held in the virtual hall in Second Life.

Figure 5.43: The Multimedia Technologies virtual scenario (session-1)

Figure 5.44: The Multimedia Technologies virtual scenario (session-2)

More screenshots could be found in Appendix-2, section A2.6 (page 225).

The outcomes of the questionnaire distributed to the students (who attended the virtual activity) in the academic year 2012/2013 (Group-B) showed that 100% of the students appreciated the need to obtain live feedback to their achievement in this module (i.e. the difficult element of this subject). Eighty-eight percent of the students believed that the virtual scenario in Second Life enhanced their learning and facilitated higher achievement, while 86% of them agreed that affective quality was enhanced and 71% found this learning process more engaging.

With regards to the students who had not attended the virtual activity, their feedback following the briefing by the students who attended the activity showed that 75% appreciated obtaining live feedback to their achievement in this module, while 79% of them agreed that this virtual activity could have had enhanced their learning and achievement, 75% of them agreed that affective quality was enhanced and 75% found this learning process more engaging (see Figure 5.45 below).

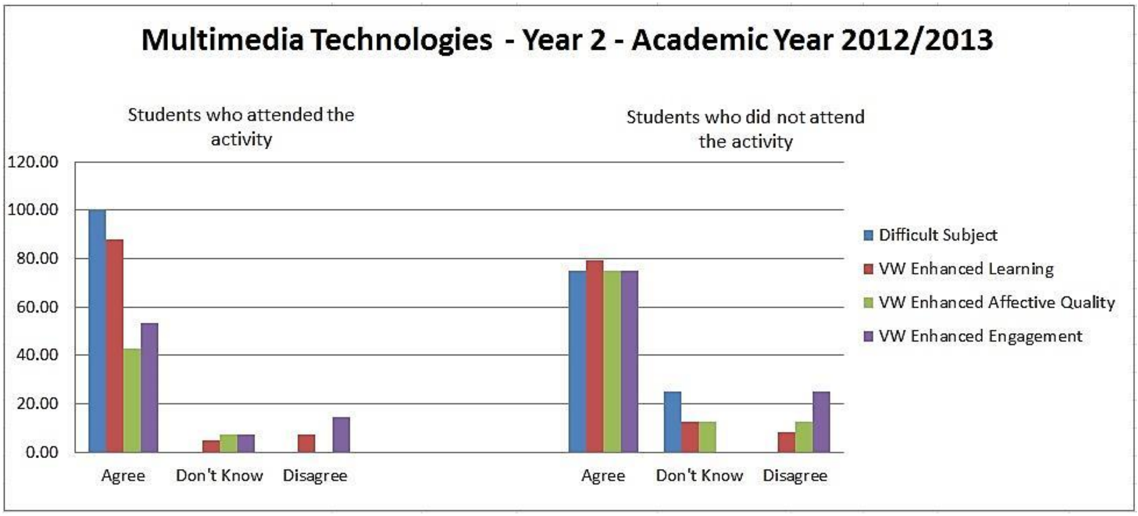


Figure 5.45: Statistics of Multimedia Technologies, Year-2 (2012/2013)

For a copy of all the questionnaires for the academic year 2012/2013 and their data analysis, see Appendix-3, Section A3.3 (page 257).

Moving to the academic year 2013/2014 (Group-E), the last part of this section includes some quotes by the students on the process of receiving live feedback as part of their multimedia projects.

<u>Correlation of the data obtained:</u>

Looking into the data analysis achieved above for the academic year 2012/2013 (Group-B), the researcher carried out further investigation to answer the questions in Tables 5.26 and 5.27 below.

For the students, who attended the Multimedia Technologies' virtual activity:

	Question	Percentage
1.	What is the number/percentage of students who found the subject difficult but their learning was enhanced after the application of virtual worlds?	100%
2.	What is the number/percentage of students who found the subject difficult but their affective quality was enhanced after the application of virtual worlds?	86%
3.	What is the number/percentage of students who found the subject difficult but their engagement was enhanced after the application of virtual worlds?	71%
4.	What is the number/percentage of students who found the subject difficult but their learning was not enhanced after the application of virtual worlds?	0%
5.	What is the number/percentage of students who did not find the subject difficult but their learning was enhanced after the application of virtual worlds?	0%

Table 5.26: Data correlation of Multimedia Technologies (students who attended the virtual activity, Year-2 (2012/2013)

Moving to the group of students who did not attend the Multimedia Technologies' virtual activity, but they attended the demonstrated briefing by their peers who attended the activity:

Question		Percentage
1.	What is the number/percentage of students who found the subject difficult but their learning was enhanced after the application of virtual worlds?	67%
2.	What is the number/percentage of students who found the subject difficult but their affective quality was enhanced after the application of virtual worlds?	100%
3.	What is the number/percentage of students who found the subject difficult but their engagement was enhanced after the application of virtual worlds?	67%
4.	What is the number/percentage of students who found the subject difficult but their learning was not enhanced after the application of virtual worlds?	33%*
5.	What is the number/percentage of students who did not find the subject difficult but their learning was enhanced after the application of virtual worlds?	100%

* This group of students did not actually attend the virtual scenario, they saw a recording of the activity and received a briefing by the students who attended, hence they were unable to accurately judge this point.

Table 5.27: Data correlation of Multimedia Technologies (students who did not attend the virtual activity, Year-2 (2012/2013)

For a copy of all the data correlation and further analysis sheets, see Appendix-3, Sections A3.5 (page 345) and A3.6 (page 373).

Students' grades and links to learning modes:

Following the completion of the data analysis for this module, students' grades were then checked for the academic years, 2010/2011 (no virtual world activities), 2012/2013 and 2013/2014 (with virtual world activities) as in Table 5.28 below:

Academic Year / Subject Name	2010 / 2011 (10 students) (*module not taught in 2011/2012*)	2012 / 2013 (13 students)	2013 / 2014 (8 students)
Multimedia Technologies, Year-2 (the practical assessment)	**99.75** StDev. = 13.9	**99.89** StDev. = 5.0	**124.81** StDev. = 5.4

Note: Grade = (Average mark of the module / Average mark of all Computing modules * 100)

Table 5.28: Grades of the Multimedia Technologies module, Year-2

The grades of Year-2 students in the first year of applying virtual world technologies, i.e. 2012/2013 (Group-B), did not reflect the positive feedback obtained from their questionnaires. The issue that may suggest the reason behind the slightly higher students' achievement in this academic year compared to that in the previous year (with no application of virtual worlds) is the overall grade profile of students (for all the Computing modules) in each of the academic years. The grade profile of the academic year 2010/2011 was 56.64% compared to 62.80% for the academic year 2012/2013. This clearly indicates that the overall achievement of students in the academic year 2012/2013 is higher than that in the academic year 2010/2011, and based on the fact that the above module grades were calculated by dividing the average grade of the module by the overall average grade for all the Computing modules in that academic year, the achievement of students using virtual world technologies was a lot better.

In addition to the above, the Standard Deviation (StDev) values for the academic years 2012/2013 and 2013/2014 were noticeably lower than that for the academic year

2010/2011. This could suggest that students' achievement was better with the application of virtual worlds in the two recent academic years, as all students achieved well (with a reduced spread of grades) compared to students' achievement in 2010/2011.

The main learning mode applicable to this scenario is 'Visual', while the secondary learning mode is 'Kinesthetic'. The VARK results for the group, who attended the virtual activity, revealed that 86% of the students in the academic year 2012/2013 had the 'Visual' learning mode, compared to 0% for the group who did not attend the virtual activity. The 'enhanced learning' percentages that were obtained from the questionnaires of this module in this academic year were mapped towards the learning mode of individual students; however, it was clearly noted that there was no strong correlation between the two aspects (see Figures 5.46 and 5.47 below).

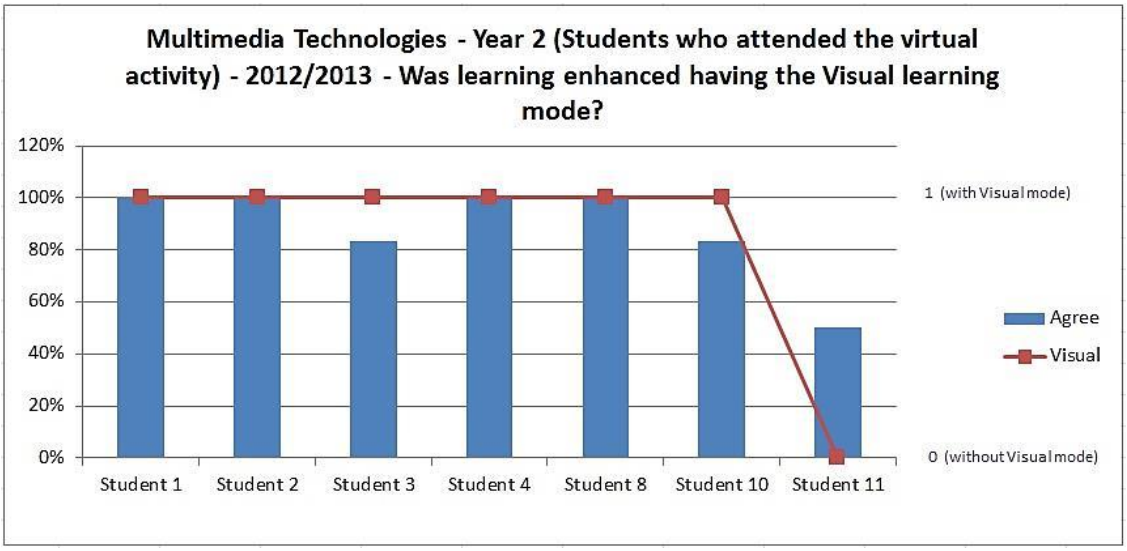


Figure 5.46: Link between enhanced learning and Visual learning mode in Multimedia Technologies (students who attended the virtual activity), Year-2 (2012/2013)

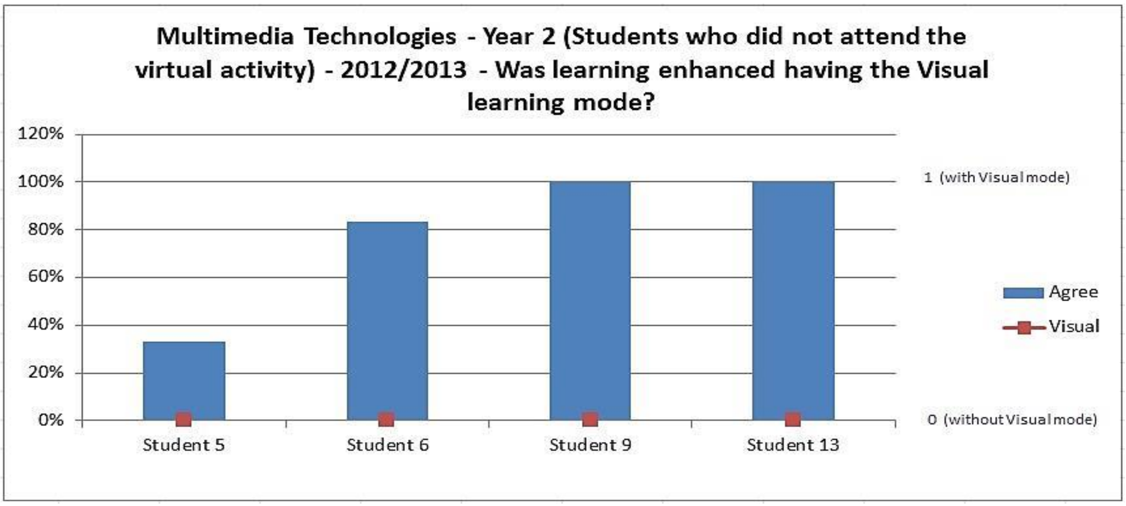


Figure 5.47: Link between enhanced learning and Visual learning mode in Multimedia Technologies (students who did not attend the virtual activity), Year-2 (2012/2013)

As stated earlier in this Chapter, the reason for choosing a secondary vertical axis for the learning preference values in the above charts was due to having mixed types of data which vary widely, i.e. percentages of 'Enhanced Learning' and '0/1' values of the 'Learning Preference'.

For a copy of all students' grades before and after the application of virtual worlds, see Appendix-3, Section A3.7 (page 386).

Quotes from students' feedback:

The course representative of Year-2 (Group-B) in the academic year 2012/2013 (Student-1) emailed the following in his response to the follow-up messages sent by the audience, who attended the virtual activity in Second Life to provide the students with their feedback on their multimedia projects: "*Thank you very much for the feedback, it was much appreciated and will be useful to improve the future iterations of our video - The conversational part of the feedback was well received as it allowed our group to converse with everyone for better feedback. Also, thank you for finding a selection of videos that you like/dislike, they will help us to further understand how we can improve our video.*"

In the academic year 2013/2014, the following are some quotes from students' reflection on their experience in virtual worlds (Group-E):

"…*After undertaking two meetings, one formally in person and the other informally on Second Life, the group found the feedback was more truthful and honest because the audience felt more comfortable and confident in a familiar environment. Due to the familiar environment in which the audience were attending, the meeting in the virtual world of SecondLife became more informal which reflected in the feedback that was obtained. Both the presenter and audience felt more confident and therefore the overall potential and feedback were a lot more detailed than that of a formal meeting*".

See Appendix-5 (page 404), section A5.2 for more quotes.

Chapter Six: Discussion of results

6.1 The justified answers to the research questions

The research was intended to answer the following four questions. The answers, which are explained and justified within this section, will not only base on the outcomes of the data analysis process, but will also include the personal observations by the researcher throughout the process of monitoring the impacts of visualisation using virtual world technologies on students' learning of complex abstract complex in Computer Science in both academic years 2012/2013 and 2013/2014.

It is worth reminding here that the technical challenges faced by students, the researcher and other HE lecturers in Second Life virtual world caused a level of frustration to certain students, and consequently, they negatively impacted the feedback provided by these students in the questionnaires.

The research questions were:

1- **To what extent might the application of virtual world technologies in the above mentioned context facilitate students' understanding of complex theory concepts in Computer Science subjects at the HE level?**

The researcher's observations throughout both academic years demonstrated that the students benefitted from, and also liked, the aspect of observing each other's activities in virtual worlds, especially the shy students or those with a lower academic level watching the better students working actively and creatively in virtual worlds. This promoted a number of vital factors of enhanced learning, e.g. peer evaluation and feedback, learning from each other, motivation and taking initiative.

Following the application of virtual worlds in the above academic years, a number of graduated HE Computing students, who were interviewed by reporters, praised the application of such technologies in their curriculum, which enhanced their learning and achievement. Student-5 of Group-C said: "*Tutors make each lesson intuitive and adopt evolving technologies to provide the best education to prepare you for the workplace. We received a high level of tuition and vast resources to support our learning*". Student-6 of Group-C said: "*I benefited from the variety of teaching methods the course offered and the workplace helped me understand the demands of the industry at an early stage*". More evidence on enhanced learning was obtained from students' statements and email messages (as indicated in Chapter Five).

Another clear evidence of students' enhanced learning following the application of virtual world technologies was recorded in the academic year 2012/2013, which was the noticeable change in students' views throughout the year. The outcomes of the general questionnaires distributed at the start of this academic year to investigate students' acceptance of virtual world technologies and whether they think that these technologies would be of benefit to their learning were not strongly supportive. In total, only half of the HE students provided positive answers as indicated in Table 6.1 below. However, following the application of activities in virtual worlds in all the selected modules, the students started providing positive to strongly positive feedback in the similar set of general questionnaires that was distributed at the end of the academic year. As high as 70.33% of students acknowledged that these virtual activities managed to either confirm their initial positive views or change their negative views on the advantages of virtual world technologies to their learning process.

Before applying virtual worlds in all modules Positive (predicted|) views on enhanced learning Start of 2012/2013	After applying virtual worlds in all modules Positive (actual) views on enhanced learning End of 2012/2013	After applying virtual worlds in all modules Confirmed positive views or changed negative views End of 2012/2013
50.33%	65.66%	70.33%

Table 6.1: Students' general feedback on the acceptance of virtual world technologies and their advantages to enhance learning

The External Examiner at the university that validates the selected HE Computing programmes (for the FE college) commented on the positive impacts of the application of virtual world technologies in the curriculum delivery on students' achievement. Regarding the virtual scenario designed for the 'Systems Analysis and Databases' module, where different representations of 'clues' were embedded within the scenario to provide the students with visualised information on the database normalisation process and the relationship between the database tables, the External Examiner mentioned the following point under the 'Collaborative Provision Comments' section of their report (academic year 2013/2014): "*The introduction of a playful element to the assessment process, and in particular, the creative use of Second Life to plant clues to assist students.*"

In addition to the above, the comments by the other HE lecturer teaching part of the modules selected for this research reinforced the fact that students' understanding and learning of the complex theory concepts in their HE Computing curriculum were noticeably, if not greatly, enhanced. This lecturer managed to observe students' learning and attitude before and after the application of virtual worlds in the modules she taught. Regarding her observations in the programming module she said: *"…The virtual scenarios had a positive impact on areas of particular difficulty… The visualisation reinforced some of the more challenging concepts… Scenario ideas are a useful addition to learning aids… The virtual world is a powerful tool that can be used to make the constructs more memorable… Initial suspicion and some reluctance were gradually replaced by interest and then acknowledgement of the value of this addition to their curriculum*".

Part of her comments on her observations in the databases module was: "…*Many of our students are visual learners, and therefore, the virtual scenario helped them to understand the rules more fully and see the outcome of the reduction of duplication that normalisation brings… Students felt more able to attempt the normalisation process… It made a positive impact, and students were interested to see the change in the objects following each stage of the normalisation process... Objects and situations are always much more interesting than raw data*".

The full communication is available in Appendix-6 (page 406).

With regards to the outcomes of the data analysis, Chapter Five resulted in the conclusion that the learning of Computing complex theory concepts was significantly enhanced following the visualisation achieved using virtual world technologies in both academic years 2012/2013 and 2013/2014. This was also confirmed by the acknowledged decrease in subject difficulty in the selected modules across different HE levels. Tables 6.2 – 6.5 below provide a summary of the achievement made in both aspects.

Table 6.2 below shows the original number of questionnaires, which investigated subject difficulty and the number of questionnaires (out of that) reporting a difficult subject with above 50% score:

Original number of questionnaires at all HE levels which investigated subject difficulty	Number of questionnaires resulting in a percentage above 50% for subject difficulty	Average percentage of subject difficulty 2012/2013 & 2013/2014	
		In all questionnaires	In questionnaires scoring above 50%
15	12	61.60%	67.08%

Table 6.2: Number and score of questionnaires reporting a difficult subject

In the academic year 2013/2014 (with the structure of before and after the application of virtual world technologies in the questionnaires), Table 6.3 below shows the recorded average percentage of subject difficulty before and after practicing in virtual worlds.

Number of questionnaires at all HE levels 2013/2014	Average percentage of subject difficulty before the application of virtual worlds 2013/2014	Average percentage of subject difficulty after the application of virtual worlds 2013/2014
6	59.16%	34.00%

Table 6.3: The average percentage of subject difficulty before and after the application of virtual worlds (2013/2014).

With regards to the 'enhanced learning' of Computing complex abstract concepts, Table 6.4 below demonstrates a summary percentage of this aspect in all the questionnaires distributed across different levels in both academic years 2012/2013 and 2013/2014.

Number of questionnaires at all HE levels which investigated Enhanced Learning 2012/2013 & 2013/2014	Average percentage of enhanced learning after the application of virtual worlds
19	72.94%

Table 6.4: The summary of the enhanced learning aspect's results in all questionnaires

In the academic year 2013/2014 (with the structure of before and after the application of virtual world technologies in the questionnaires), Table 6.5 below shows the recorded average percentage of enhanced learning before and after practicing in virtual worlds.

Number of questionnaires at all HE levels 2013/2014	Average percentage of enhanced learning before the application of virtual worlds 2013/2014	Average percentage of enhanced learning after the application of virtual worlds 2013/2014
6	60.83%	85.50%

Table 6.5: The average percentage of enhanced learning before and after the application of virtual worlds (2013/2014).

2- <u>To what extent might the application of virtual world technologies in the above mentioned context increase students' engagement in their HE Computing sessions?</u>

The researcher's observations throughout both academic years demonstrated that the students felt more relaxed in repeating their work activities in virtual worlds when making mistakes or when not fully achieving their targets. This was due to the flexibility offered by the virtual world environment, and the fact that there were no physical consequences involved, e.g. being embarrassed in front of other students and/or the lecturer. This resulted in more engagement and involvement in the learning process, and consequently enhanced students' acquired skills and achievement.

As the students were represented in avatars within the virtual world platform, they had less hesitation in asking basic questions or requesting more information. The facility of carrying out private chatting (via text) with the lecturer inspired more interaction especially for the shy students. This increased students' self-confidence in actively participating in the learning process. In their experience in using virtual worlds for their learners, Fonseca *et al.* (2009) confirmed this argument by saying that students benefitted much from using a private channel to address their concerns. They added that students appreciated this mode of communication in virtual worlds because it made them feel that they had a private teacher and that they are able to discuss their issues and uncertainties without being embarrassed about lagging in relation to others.

The researcher's observations also demonstrated that the process of visualising Computing complex theory concepts was more effective in virtual worlds as it engaged students in this immersive environment much more than the situation in the physical world where the viewer watches passively. Fonseca *et al.* (2009) supported this by saying that it was very beneficial for students to construct and present their own visualisation, which increased their level of engagement as it inspired meaningful discussions about them.

Table 6.6 below demonstrates a summary of the engagement aspect in all the questionnaires distributed across different levels in both academic years 2012/2013 and 2013/2014.

Number of questionnaires at all HE levels which investigated level of engagement 2012/2013 & 2013/2014	Average percentage of engagement after the application of virtual worlds
15	70.33%

Table 6.6: The summary of the engagement aspect's results in all questionnaires

In the academic year 2013/2014 (with the structure of before and after the application of virtual world technologies in the questionnaires), Table 6.7 below shows the recorded average percentage of engagement before and after practicing in virtual worlds.

Number of questionnaires at all HE levels 2013/2014	Average percentage of engagement before the application of virtual worlds 2013/2014	Average percentage of engagement after the application of virtual worlds 2013/2014
6	55.66%	84.83%

Table 6.7: The average percentage of engagement before and after the application of virtual worlds (2013/2014).

3- **<u>To what extent might the application of virtual world technologies in the above mentioned context enhance affective quality (to include elements such as appeal, enjoyment, interest and appreciation)?</u>**

As explained above, the students enjoyed the aspect of observing each other's activities in virtual worlds, especially watching creative ideas implemented by smarter students, the matter which was not fully achievable within the physical classroom situation due to the way the rooms were structured and the seating arrangement. The comments by the other HE lecturer teaching part of the modules selected for this research confirmed this by saying that: "*…The virtual world scenarios added a new dimension to the illustration of the concepts, and the students appeared to enjoy the virtual interpretation of what was previously written/drawn on the whiteboard*". See Appendix-6 (page 406) for the full communication.

The observations by the researcher confirmed that the enhanced elements of affective quality increased students' motivation to actively contribute to their learning process, which consequently maximised their achievement. The Higher Education Academy (2009) supported this by saying that the more enjoyable the classes are, the more the students would like to attend them, and consequently, they will stand a better chance of success. The observations also reinforced what was previously indicated in Chapter One, as the enhanced affective quality elements converted what could have been viewed by certain students as 'dry' or 'boring' sessions to 'enjoyable', 'attractive' and 'creative'.

The researcher also saw an association between enhanced elements of affective quality and increased level of engagement in Computing sessions in virtual worlds. The observations demonstrated that learning the complex theory concepts of Computer Science subjects in the virtual world platform resulted in more engagement by students as they found the learning process within this immersive environment more interesting and enjoyable, because they were more able to appreciate the relevance of what they learned. Trowler (2010, p.5) confirmed the above by saying that: "*Students who engage emotionally would experience affective reactions such as interest, enjoyment, or a sense of belonging*".

Table 6.8 below demonstrates a summary of the affective quality aspect in all the questionnaires distributed across different levels in both academic years 2012/2013 and 2013/2014.

Number of questionnaires at all HE levels which investigated affective quality elements 2012/2013 & 2013/2014	Average percentage of affective quality after the application of virtual worlds
17	78.47%

Table 6.8: The summary of the affective quality aspect's results in all questionnaires

In the academic year 2013/2014 (with the structure of before and after the application of virtual world technologies in the questionnaires), Table 6.9 below shows the recorded average percentage of affective quality before and after practicing in virtual worlds.

Number of questionnaires at all HE levels 2013/2014	Average percentage of affective quality before the application of virtual worlds 2013/2014	Average percentage of affective quality after the application of virtual worlds 2013/2014
5	62.20%	94.00%

Table 6.9: The average percentage of affective quality before and after the application of virtual worlds (2013/2014).

4- **<u>To what extent might the application of virtual world technologies in the above mentioned context improve student's achievement (i.e. grades) in the targeted modules?</u>**

The students' grades of the modules covered by this research were analysed. Three academic years were considered for each module for comparison purposes, which included a previous academic year when virtual world technologies were not applied, then two academic years (2012/2013 and 2013/2014) when virtual world technologies were applied.

The research findings demonstrate an association between the two following aspects, 1) The percentage of enhanced learning of the complex theory concepts of the selected modules, and 2) The marks obtained for these modules. In other words, there was a correlation between the positive feedback obtained from students on their enhanced learning following the application of virtual world technologies in their studies, and their improved achievement, which was witnessed in the majority of the modules covered by this research in both academic years (2012/2013 & 2013/2014). However, it is vital to clearly indicate here that the researcher is not claiming causation in this situation.

Table 6.11 below provides a summary of improved achievement for each of the two academic years when virtual worlds were used. The module average grades, which were provided in Chapter Five above, were gathered and analysed as follows in order to judge whether students' achievement has improved following the application of virtual worlds in individual modules.

To clarify how the scores are calculated in Table 6.11, the grades of the programming and databases modules are copied (from Chapter Five) in Table 6.10 below as an example:

Academic Year / Subject Name	2011 / 2012 (15 students)	2012 / 2013 (7 students)	2013 / 2014 (17 students)
Database Normalisation, Year-1	**97.16**	**99.12**	**106.58**
Computer Programming, Year-1	**102.51**	**93.57**	**104.56**

Table 6.10: Copies of the programming and databases grades (from Chapter Five)

Following a comparison between the three grades of the databases module, it is clear that students' achievement improved in the two academic years, 2012/2013 and 2013/2014, when virtual worlds were applied, compared to 2011/2012 academic year, when virtual worlds were not applied. Therefore, this module scored '1' for students' improved achievement under both years in Table 6.11 below.

However, with the programming module, the academic year 2012/2013 did not witness an improved achievement, as the grade is lower than that for the academic year 2011/2012. Therefore, this module scored ‘0’ for students’ improved achievement under this year, and ‘1’ under the year 2013/2014 in Table 6.11.

The scores of all the modules covered by this research, which are displayed in Table 6.11 below, show that students’ achievement was enhanced in the majority of the modules following the application of virtual world technologies.

The modules handled by this research	Number of modules with improved achievement (i.e. higher average grades) 2012/2013	Number of modules with improved achievement (i.e. higher average grades) 2013/2014
Computer Programming – Year 1	0	1
Database Normalisation – Year 1	1	1
Helpdesk Support – Year 2	1	1
Multimedia Technologies – Year 2	1	1
Computer Programming – Year 2	1	1
Multithreading Techniques – BSc (Hons)	1	1
Research Methods – BSc (Hons)	N/A	0
Total	5 out of 6	6 out of 7

Table 6.11: Number of modules with improved achievement in both academic years.

It is also important to clarify here that the grades were used in this research as a general indicator of students' achievement per module. However, and as previously explained in a number of situations in Chapter Five, students' grades did not strongly reflect the positive feedback provided by the students. It is also worth mentioning here that the module assessments across the different HE levels were not specifically designed to measure students' enhanced learning of the complex theory concepts that were handled in this research, according to which, the grades obtained from these assessments cannot be considered a very accurate indicator in this aspect.

Nonetheless, the comments by the other HE lecturer teaching part of the modules selected for this research reinforced student's improved achievement by indicating that: "*…The virtual world scenarios have facilitated the students' learning and achievement*".

6.2 Other relevant observations and conclusions by the researcher

The personal observations by the researcher confirmed that the students, who previously practiced in virtual worlds during a previous academic year, had a better acceptance of virtual world technologies and more appreciation of the advantages of learning within this environment. This forms another evidence that the application of virtual world technologies in the HE Computing studies was successful, as if there were no leaning benefits obtained by students when they first practiced the technologies, more negative views would have been conveyed in the questionnaires in the following academic year.

The technical abilities of the researcher in building and scripting visualisation scenarios in virtual worlds were developing with time, and also as a result of completing four modules of the 'MA Education in Virtual Worlds Programme', at the University of the West of England. This development had noticeably improved the quality and facilities of the virtual visualisation scenarios designed for this research in the academic year 2013/2014 compared to 2012/2013. Consequently, this had its own impacts on the better learning and achievement (higher grades) of students in the former academic year compared to that in the latter. This experience by the researcher highlighted and stressed one of the recommendations indicated in Chapter Seven regarding the need to develop the required skills by HE lecturers in order to effectively and productively use virtual world technologies in HE, as this level involves more complex learning requirements and demands.

Based on students' behaviour and their indirect comments throughout the visualisation activities in virtual worlds across different levels, the researcher observed that the challenging behaviour and/or the limited acceptance of these technologies by certain students were down to the students believing that the application of virtual world technologies in their learning process was optional. Therefore, they did not take the whole process seriously and did not show enough commitment to spend the required effort to practice in the visualisation scenarios designed for them in this environment. The researcher, therefore, recommends that a clear message should be conveyed to students through, for example, having part of the summative assessment applied in virtual worlds so that they take the learning process in this platform seriously. In addition, such assessment activities would enable a more accurate connection between students' grades and the application of these technologies in the curriculum.

In the feedback obtained from students' questionnaires on different levels, and as previously explained in Chapter Five, a considerable number of students did not acknowledge facing difficulties in learning the complex theory concepts handled in this research. Although this was an understandable situation as some of them were either shy or embarrassed to admit this in front of their colleagues and lecturer, these students failed to provide correct answers to the quizzes/formative assessments that the module lecturer carried out to assess their understanding and learning. Appendix-7 (page 417) includes examples of this. Therefore, the percentages of students acknowledging a difficult subject in the questionnaires for all modules do not accurately reflect the actual situation. The poor answers received in the quizzes/formative assessments related to these complex theory concepts suggested that the percentages obtained from the questionnaires (related to subject difficulty) could well be much higher. Fonseca *et al.* (2009, p.15) explained a similar concern for a group of students learning computer programming using C-Language: "*One point to extol on was that these students did not recognise their own weaknesses. They said, 'I know the C language; I do not have* *difficulties in C.' However, they did not demonstrate that knowledge when they were developing the project*".

As a number of challenges that faced the application of virtual world technologies were due to administrative procedures and policies at the FE college, e.g. the students and the lecturer are required to attend the college (in the allocated time/hall) for individual timetabled sessions, where attendance registers should also be marked, the researcher concluded that creating a separate identity for HE within the FE framework is vital prior to investigating the application of emerging technologies in the learning process of the HE students. A clear example on this being the possibility of the HE students attending a session, with their lecturer, in virtual worlds from home and they are still considered to have physically attended their normal timetabled session in the college, with their attendance registers marked as 'Present'. A major aspect of this separate identity should be the differentiation between the policies and procedures, which are applicable on the FE adolescent learners and those for the HE adult ones.

6.3 Additional observations by the researcher on other modules

In order to further investigate students' improved acceptance of virtual world technologies, the researcher carried out additional observations on virtual activities for modules not selected for this research. Some of these activities were requested by the students based on the benefits they acknowledged to their learning and achievement following practicing their difficult Computing subjects in virtual worlds. These observations provided additional evidence to the success of applying these technologies in students' HE Computing curriculum.

The first activity in virtual worlds was Year 1 (Group-A) students interviewing customers in the workplace to discuss their requirements of hardware upgrade to their computer systems. This was part of the 'Computer Hardware' module, where the students were required to investigate a proper hardware solution to meet the users' needs.

The second activity was the unexpected request by the Year 2 (Group-B) students to deliver their project presentations of the 'Development Project' module in virtual worlds instead of the physical classroom. This activity formed the first of its kind in the college, which was also covered by a press article.

The third activity was for the 'Managing Information' module, BSc (Hons) (Group-C). In this virtual event, individual students were required to act the role of a company staff member, who is required to meet with other staff to discuss important information and convey a critical decision by the business management to them. The students were then asked to provide feedback to their lecturer (at the end of the activity) on their virtual experience and the advantages and limitations they faced in the process of achieving their target.

See Appendix-8 (page 438) for more information on the three activities and a summary of students' feedback.

6.4 Areas for future research

Two main areas for future research have emerged during the period of this research, the most important of which was the investigation on whether having more sessions in virtual worlds for individual modules would bring added enhancement to students' learning of Computing complex theory concepts. As indicated in Chapter Five, the number of sessions delivered using the virtual world platform was rather limited per module (excluding the time outside the timetabled sessions, which the students spent in using the virtual world scenarios in their own time).

The other area was based on the observations by the researcher on the application of virtual world technologies in all modules, which confirmed that certain students with less self-confidence or those of a weaker academic background felt more confident in exploring the virtual scenarios and using their facilities when their lecturer is around. Given the fact that additional support is required for the HE students within the FE framework, as explained in Chapter One, a clear area of potential research has arisen here. This involves the investigation whether allocating more sessions to be carried out in the virtual world environment, with the presence of the module lecturer to provide support and guidance and to answer curriculum related as well as platform related questions, would have a further positive impact on students' learning and achievement and also to motivate students to explore further and benefit from the different facilities provided by this environment.

Few steps forward were already taken by the researcher with regards to the second area, the first of which was the idea of adding a bot that is purposely created and scripted to replace the module lecturer outside the session times and be able to answer certain students' questions. This idea was developed following the researcher's completion of the 'Artificial intelligence, bots and non-player characters' module of the MA Education in Virtual Worlds Programme. After careful consideration of all the factors involved, it was not possible to take this idea forward for a number of reasons, the most important of which was not having a permanent, large and private virtual space to accommodate all the virtual scenarios for the required period of time (explained in Chapter Seven – sections 7.3 and 7.4). The other idea was the researcher allocating time after the college working hours to meet with the students in the virtual world environment and provide the additional support needed. Again, following careful consideration of the factors involved, it was also not possible to take this idea forward due to certain college policies/regulations, in addition to the fact that it was difficult to agree a certain time slot between the students, who travel back home to different areas and have different work shifts and commitments. In their discussion of their experience in teaching computing curriculum in virtual worlds, Fonseca *et al.* (2009) highlighted the need for additional support outside the session time for certain students by saying that their teacher spent many hours providing support for students in-world and outside the class, which the students appreciated and confirmed that this would be difficult to achieve in a normal class. The teacher, they added, also confirmed that although this needed extra effort but it was helpful for the students, as sometimes they struggle with even simple things and the lecturer's presence might provide a push forward so they overcome the difficulty.

Another potential area of future research is the investigation of the possibility to design virtual scenarios based on the preferred learning mode of students, and whether this will result in more enhancement to their learning. Although the outcomes of this research did not demonstrate a strong correlation between students' preferred learning modes and the amount of enhanced learning they managed to achieve in virtual worlds, the researcher's observations suggested that future research, which is focused on investigating the advantages of building more than one version of the same virtual scenario (a version per learning mode), will be able to better confirm or deny this correlation.

Chapter Seven: Challenges and recommendations

7.1 Technical challenges

The most important challenge that faced the research activities was the technical issues and difficulties accompanying the use of virtual worlds.

The feedback of certain students was, unfortunately, clearly affected by these issues, which are likely to occur in any other organisation that uses Second Life frequently. In a considerable number of cases, the success of the visualisation activity in this virtual world was not valued enough by the students following a number of technical faults and/or delays in achieving the lesson outcomes.

The following points summarise the main issues and concerns:

1- Second Life is a web-based software application that requires constant access to the internet. An unstable connection or disconnection will prevent the access to this virtual world completely. Such a situation would cancel the whole virtual session planned for the day, and consequently will affect the scheduled delivery of the module. Certain incidents, like the one happened in the college where the research activities took place, could terminate the access to the internet for several weeks.

2- Second Life has a viewer that requires to be downloaded and installed on the local computer in order to access its virtual world. Updates are issued regularly by the provider, which must be installed; otherwise, the software will not run. In any organisation or educational institution, this requires a network administrator's account on the machine, or to ask the IT Department of the organisation to perform the task. This sometimes causes delays in achieving a functional copy of the Second Life viewer due to aspects like the unavailability of IT staff.

3- Although Second Life is reliable on the broadband internet connection, it is not equally reliable on other types of connections, e.g. mobile broadband and dial-up, which certain students use to connect from home for their low cost.

4- Second Life has certain graphics features, which makes it non-functional on some computing devices due to the low specifications of their graphics adapters. Certain students were not able to access Second Life from outside the college due to such hardware limitations.

5- In order to interact appropriately with the activity in Second Life, students should use a headset (or a separate microphone and speakers) to be able to communicate with the others. In a considerable number of cases, this was an issue of concern when using Second Life, as not all the students were able to talk and hear although they used headsets of good/known brands. The researcher's experience in using Second Life during both academic years dictated that the sound system and protocols applied within this virtual world are not fairly stable. Similar challenges were also faced by the researcher when attending the MA modules in Second Life (indicated in Section 4.1 above).

6- Second Life employs the VOIP, which uses a number of internet ports. This requires the organisation that uses this virtual world to keep these ports open in their firewall system to facilitate the voice tool (Linden, 2012).

7- Certain students may exercise inappropriate behaviour in virtual worlds, where each student is represented by an avatar. Such students may find this open environment, where they can walk, run or fly freely, ideal for showing negative/challenging behaviour, especially that there is no 'physical' presence of the lecturer, who anyway has limited capabilities of minimising the consequences of such a behaviour in this environment. *"Second Life exposes students to many distractions, which might get in the way of their studies; this, however, is a commonly perceived threat with any web-based software. In addition, students sometimes find the unerring game-ness of the environment means that they cannot take academic activity in it seriously."* (Crellin *et al.*, 2009, p.331).

7.2 Challenges of HE in FE policies and regulations

1- When delivering HE within the FE framework, HE falls under the same umbrella of college policy and regulations, which are initially designed for students at the FE level. One of these regulations is the ‘Guided Learning Hours (GLH)’ aspect. Within the college, where the research activities took place, each HE lecturer should deliver a specific number of hours per academic year. These hours should be a ‘face-to-face delivery’ for the students. Meeting the students ‘in-world’ (i.e. in virtual worlds), where they attend from home for example, was a challenging aspect in this regard.

2- Asking students to use their own hardware equipment, when attending a session in virtual worlds from outside their classroom, had a clear drawback, as not all students have access to a computer or a laptop at home, and if they have, they need certain hardware specification to be able to run Second Life successfully (see the previous section).

3- The HE students are expected to attend their timetabled sessions in the college in pre-booked rooms, where daily college registers should be marked by the lecturer indicating the attendance per session. Again, students attending certain sessions in virtual worlds from home was another challenging aspect in this regard, as a ‘Present’ mark in the college registers can only be given when a student is ‘physically’ attending the college premises. This mark is used to calculate the attendance percentage of individual HE students per module, which affects a number of statistics for both the college and students.

4- The pre-written modules and their assessments (before considering the utilisation of virtual worlds) do not support an effective application of these technologies, as the HE lecturer must commit to the dictated methods of delivery and types of assessments.

7.3 Challenges of the availability of virtual world resources

Designing scenarios in virtual worlds requires having a ‘Land’ for the organisation/ institution within this environment to implement these scenarios. As the college, where the research activities took place, has just purchased a land in Second Life prior to the start of the research activities, the development of the buildings and facilities on the land were assigned to an outsourced company, with the plan that they start providing the virtual facilities for a couple of departments other than HE Computing at that stage. Accordingly, the researcher decided that a piece of land is outsourced elsewhere to carry out the activities of this research for both academic years (2012/2013 & 2013/2014).

Having such a situation caused a number of challenges, the major of which was the authentications and access rights. Certain needed areas within the outsourced land, e.g. the ‘Sandbox’ (a virtual space allocated for the building/development of objects), required certain configuration by the land administrator to allow the pre-defined students’ avatars to obtain the right to edit objects as part of the virtual scenarios. Arrangements needed to be made prior to individual activities in Second Life to cater for these requirements.

A number of activities needed to be re-scheduled due to the unavailability of the required areas on the outsourced land, due to either being used by other lecturers/ students or were changed to another type of virtual facilities, e.g. changing one of the Sandboxes to a number of buildings.

Educational activities in virtual worlds require the lecturer to have an authentication to edit virtual objects, e.g. a white board to view information or a presentation, to add notecards or create URLs to web resources. Such authentications are only set by the Land administrator according to the owner’s policy. Having an outsourced area within a land that belongs to another academic institution caused a considerable amount of additional admin work to be carried out on both sides for each session.

In addition, the outsourced land caused the situation that the visualisation scenarios added to areas like the Sandbox needed to be removed directly at the end of the session, because the area is needed by other courses/lecturers, and also to arrange for alternative dates when the area is free so that the scenario is added again for the students to have another access and benefit from the learning facilities.

On the other hand, and due to the fact that building and scripting scenarios in virtual worlds require a range of different skills, e.g. digital graphics, computer programming and 3D designs, lecturers in the HE sector with no such expertise will not feel confident in applying virtual world technologies in their curriculum delivery, as they will need to hire the skilled people to build and script the scenarios for them. This will obviously involve allocating a budget by the HE institution, which is not always easily achieved in light of the current economic and funding constraints.

7.4 Recommendations to tackle the challenges

The use of virtual world technologies within an organisation should be planned well ahead of the event to avoid potential restrictions and limitations in order to extend the success and the efficiency of the sessions delivered within this environment.

Below are some recommendations to face the challenges indicated in this Chapter.

Technical challenges:

- Lecturers applying the Second Life virtual world in their curriculum delivery should always have a 'Plan-B' Scheme of Work for their modules, in order to avoid disruptions to their module delivery due to a possible disconnection to the internet.

- The FE college needs to assign the Second Life software to a specific staff member within their IT department, in order to follow-up regularly and install the required updates whenever issued. This will guarantee that the software is available for students whenever needed.

- The FE college could invest in providing suitable laptops and headsets for HE students (on a loan basis) to facilitate their use of virtual world technologies in their studies; however, budget limitations could well face a successful implementation of this solution.

- The lecturer using virtual worlds needs to agree with the students, and sign, a ‘Code of Conduct’ agreement regarding the acceptable behaviour in the virtual world environment. Setting some penalties might also be considered depending on individual situations.

<u>HE in FE polices:</u>

- The application of virtual world technologies in HE within the FE framework requires modifications to be made to the college policies and procedures, in order to accommodate the requirements and the circumstances accompanying the implementation of these technologies. If the college is interested in applying such emerging technologies, it should work on building the appropriate infrastructure to facilitate achieving this effectively. Having the same regulations applied on both FE and HE students could well cause obstacles to face a successful application of technology-based tools and strategies in HE.

- The curriculum delivery in virtual worlds should be acknowledged by the college as proper ‘Guided Learning Hours’. This will confirm that the lecturers using these technologies are still meeting the requirements of their teaching contracts, and will motivate them to continue applying developing technologies in HE.

- Similarly, the FE college needs to acknowledge the HE students’ attendance of sessions in virtual worlds from outside its premises as a proper attendance, which will enable the lecturers to mark the college registers for these sessions as normal.

- Pre-written modules and assessments need to be reviewed to take advantage of potential educational methods and facilities within the virtual world environment. This will enable a more effective application of these technologies in the HE curriculum.

<u>Availability of resources:</u>

- The FE college needs to purchase a 'Land', i.e. a virtual space in virtual worlds, and assign an administrator for the development of facilities and learning scenarios prior to planning the application of these technologies in its HE.

- The learning needs of the involved college departments should be investigated and taken into account prior to starting the development work on the land, which should be tailored to meet their requirements.

- All the development work should be completed on the land before the start of the academic year in which virtual world technologies are planned to be applied in the HE curriculum.

- Allowing authentications to HE lecturers to edit objects within the land areas that are developed for their courses to facilitate displaying and updating curriculum material for their sessions within the virtual environment.

- Scheduling regular contacts, and facilitating the communication between the HE lecturers using virtual worlds and the land administrator in order to handle potential issues of access rights for students' avatars and any other problems facing their sessions.

- It would be of a substantial advantage if the HE lecturers have coding and design abilities in virtual worlds, as they could use these skills to develop their own learning scenarios for the students. This will cut the developing cost as well as the time and efforts required to communicate the requirements to the developer and the follow-up needed to achieve the final product. It is recommended that the FE college invests in providing adequate training for the HE lecturers to enable them to carry out the development of the learning scenarios themselves. However, possible obstacles could be the remission time required for the training and the cost involved.

Conclusions

Complex abstract concepts in Computer Science form a cause of concern to a large number of people studying this field. Research demonstrated that these concerns are the main reason behind the HE students' withdrawal from their computing courses, achieving poorly or failing the modules that include such concepts. This has inspired the idea for this research.

The government's agenda of 'Widening Participation' has reinforced the role of FE colleges in providing additional support to the 'non-traditional' HE learners studying within the FE framework, who would not have considered higher education otherwise. A number of governmental sources, educationists and researchers confirmed the need to such a support for this type of HE students to improve their learning experience and maximise their success opportunities.

Six Computer Science subjects were selected for this research, for which the researcher investigated the application of virtual world technologies to bring about the visualisation of complex theory concepts within this field in order to facilitate and enhance their understanding and learning by students at the HE level.

The research process demonstrated that there were strong indications of benefits of applying virtual worlds in the selected HE Computer Science programmes. This did not only cover enhancements to students' understanding of such complex abstract concepts, but also increasing their engagement in the sessions, enhancing affective quality and improving their achievement. In answer to the research questions, the research outcomes showed that subject difficulty was reduced by 25% and around three quarters of students acknowledged enhanced learning in the virtual environment. Seventy percent of students acknowledged becoming more engaged in their study sessions that were carried out in virtual worlds, and more than three quarters of students acknowledged enhanced affective quality. Finally, around 85% of the modules covered by the research witnessed improved students' achievement (i.e. higher grades).

Nevertheless, the application of these technologies was accompanied by a number of technical challenges, which had some negative impacts on student's appreciation of these advantages. In addition, there were issues with the availability and management of the resources required to successfully run the virtual activities, e.g. a private land in virtual worlds. Despite all that, the observations made by the researcher were strongly supporting the conclusion that the application of virtual world technologies to facilitate and enhance the understanding of difficult theory concepts of Computer Science subjects at the HE level (within the FE framework) was successful in improving students' learning and achievement.

As a result of this research experience, the researcher also concluded that there were a number of different factors involved in the process of applying these technologies in the above context. These factors had their own 'finger print' on the way this process was implemented, e.g. the policies and procedures of the FE college and certain academic rules and regulations, which regardless of being designed for the FE learners, they were also applied on the HE students studying within this framework. Moreover, the structure of the HE modules and their indicated methods of delivery and assessments were other examples of the factors involved in this process.

This research also highlighted the fact that the use of virtual world technologies is not a straight forward job, and that a lot of infrastructure work needs to be carried out in preparation for this prior to the planning of any virtual activities.

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Appendix-1: Sample communication with HE Computing lecturers in different FE colleges.

Eight questions were emailed to the HE lecturers of the ‘Multi-Tasking Systems Unit’ in the two other FE colleges teaching the same syllabus (and programme) for the same university to collect their views on the level of complexity in the theory concepts of this unit and the feedback of their students regarding that. Below are the replies received (the names of lecturers and their colleges were hidden for data protection):

Message No. 1

From: XXXX
Sent: 25 March 2013 10:50
To: Belsam Attallah
Subject: RE: Request to take part in a study

Belsam
I have put my thoughts down in the attached document.
Bit of a brain dump I am afraid. Hope it’s what you want.
XXXX.

1- Do you think that the concepts of multithreading techniques (concurrency and parallelism) of this unit are difficult for students to understand?

   Yes, these are more complex ideas than you might think if you have not taught them but their understanding varies from student to student. In my view, students need to see the concepts working in programs to gain the level of understanding of the subject. A few students have experience of concurrent programming language and such as Java and can run Java provided by me (see below). Also, most students struggle with low level programming nature of concurrency (i.e. any coding that is not graphical) and do not understand about computer architectures at the level required.

2- As a lecturer for this unit, did you face difficulties explaining the concurrency and parallelism concepts for the students using the traditional resources available in the classroom (whiteboard, smart board and a projector)?

These traditional tools are part of the teacher's kit. They are all useful to set the scene and explain why concurrency is required by computer architectures. For this unit, however, coding algorithms to solve concurrency problems is the core of this unit. Few of my students have used the programming languages required to do this type of programming before taking this unit.

Also, a good level of maths is needed to code the algorithms studied in this unit. Many of my students lack the level of expertise needed, including numbers used in Java primatives. To overcome this I provide examples for encryption techniques and worked answers. Students need to convert these into running programs, so the whiteboard and/or projector will not achieve this alone.

3- Did you feel that this unit requires some additional resource(s) beyond the traditional ones above, in order to assist in explaining these difficult concepts for the students to enhance their understanding and learning?

Yes. I have also used you tube videos about architecture. Students have found some of these themselves and shared the links. I have encouraged students to read books! The recommended books such as Silbershatz are required reading but unfortunately are not available electronically yet. The IDE I use for programming is Eclipse (IBM which has a free download) and Java because most of the examples for the unit are coded in Java.

3- As a lecturer for this unit, do you think that having a tool to visualise the theory concepts of concurrency and parallelism would be of value to the students to better understand how these concepts are actually applied by the operating system inside the computer processor and memory?

Yes, it is essential. Here is some code I use to assess student understanding by creating a thread object using the Java Thread function:

```
public class myThread extends Thread
{
	private String myName = "";
	private int timeout = 1000;

	public myThread(String test, int value)
	{
		myName = test;
		timeout = value;
	}

	public void run()
	{


		for( int x = 10; x > 0; x--)
		{
			System.out.println(myName + " -> " + x);
			try{
				sleep(timeout);
			}
			catch (Exception e)
			{
				// catch code here
			}
		}
	}
}
```

To run this students need a main program such as:

```
public class threadTest {
```

```
    /**
     * @param args
     */
    public static void main(String[] args) {
        // TODO Auto-generated method stub
        myThread P1 = new myThread("Process1", 500);
        myThread P2 = new myThread("Process2", 1000);
        myThread P3 = new myThread("Process3", 1500);
        myThread P4 = new myThread("Process4", 2000);
        P1.start();
        P2.start();
        P3.start();
        P4.start();
    }

}
```

Using this code in an IDE such as Eclipse, students can create as many thread processes they like and vary thread timeouts. All my students manage to run this code and explain what it is doing, **if not why it is being used**.

I also use a PC simulator called TOM. This allows students to run machine code in a processor. Most students, even at this BSc (Hons) level, assume machine code was dropped when high level languages were introduced! They don't understand that all processors still use machine code and that high level code is compiled or interpreted into machine code.

In my view, if students don't understand single threaded architectures, how will they understand concurrent architectures?

For programming I use on-line quizzes and worked examples.

4- What type of concerns did you hear from your students about the difficulties they face in understanding the concepts of this unit?

Lecturer did not explain ….

Don't understand the programming language used…

5- If you have taught this unit in the previous years, did you face the same issues and concerns by the students?

Yes, to varying degrees. My view is that to understand this unit students need to read about it themselves so my explanations are introductory. Exercises are provided to develop understanding and expertise. Did all students complete these exercises? Not all students.

Introductions to Java were provided prior to the start of the unit. Very few students download these materials in preparation for the start of the unit.

6- How many students did you have in this academic year and how many of them have passed the unit?

This year I had 11 students. 9 have passed the unit. Two failed to complete this and other units. There was quite a wide range of passes from just passed to a first class pass.

8- Any other comments on the grade profile of the students, their concerns, and/or your own concerns when teaching this unit.

Student concerns are consistent throughout the years I have taught this unit. This is a difficult unit with too much work to do, can't understand the programming, can't understand the algorithms. However, one part time student who converted from an HND course and got a first, said "this unit was easier than some of his HND units!"

My concerns are:

Lack of practical programming skills, lack of maths skills (A level would be good!), lack of willingness to read about the topics in the syllabus, lack of completion of practical exercises.

Yes, this is a complex unit but to build expertise you need to work at it. I did a very similar unit in my BSc Computing course and the basics, such as deadlock, encryption, scheduling, memory management, multi- threading remain the same however the architectures are more complex now.

I have thought of using Linux architectures to illustrate this unit, and have the advantage of using open and well documented architectures. I do already use some of these to illustrate the kernel architecture subjects, however, this would take a lot of work.

Message No. 2

From: XXXXXX
Sent: 24 April 2013 19:35
To: Belsam Attallah
Subject: RE: The MTS unit

1- Do you think that the concepts of multithreading techniques (concurrency and parallelism) of this unit are difficult for students to understand?

Yes, most students struggle with them -- but what I call the "natural programmers" do not. This is normally 10-20% of the students.

2- As a lecturer for this unit, did you face difficulties explaining the concurrency and parallelism concepts for the students using the traditional resources available in the classroom (whiteboard, smart board and a projector)?

Yes, but presenting it in a variety of "real-life" scenarios seems to help

3- Did you feel that this unit requires some additional resource(s) beyond the traditional ones above, in order to assist in explaining these difficult concepts for the students to enhance their understanding and learning?

Possibly, but I am not currently aware of any suitable resources

4- As a lecturer for this unit, do you think that having a tool to visualise the theory concepts of concurrency and parallelism would be of value to the students to better understand how these concepts are actually applied by the operating system inside the computer processor and memory?

It would be of some value, but I feel that detailed knowledge of a computer's internal workings is not the central issue in this unit

5- What type of concerns did you hear from your students about the difficulties they face in understanding the concepts of this unit?

Their concerns seem to centre not on how concurrency and parallelism are applied inside a computer, but on OO generally and on how to write safe, efficient OOP software using threads and sockets

6- If you have taught this unit in the previous years, did you face the same issues and concerns by the students?

Yes, it seems to be similar each year

7- How many students did you have in this academic year and how many of them have passed the unit?

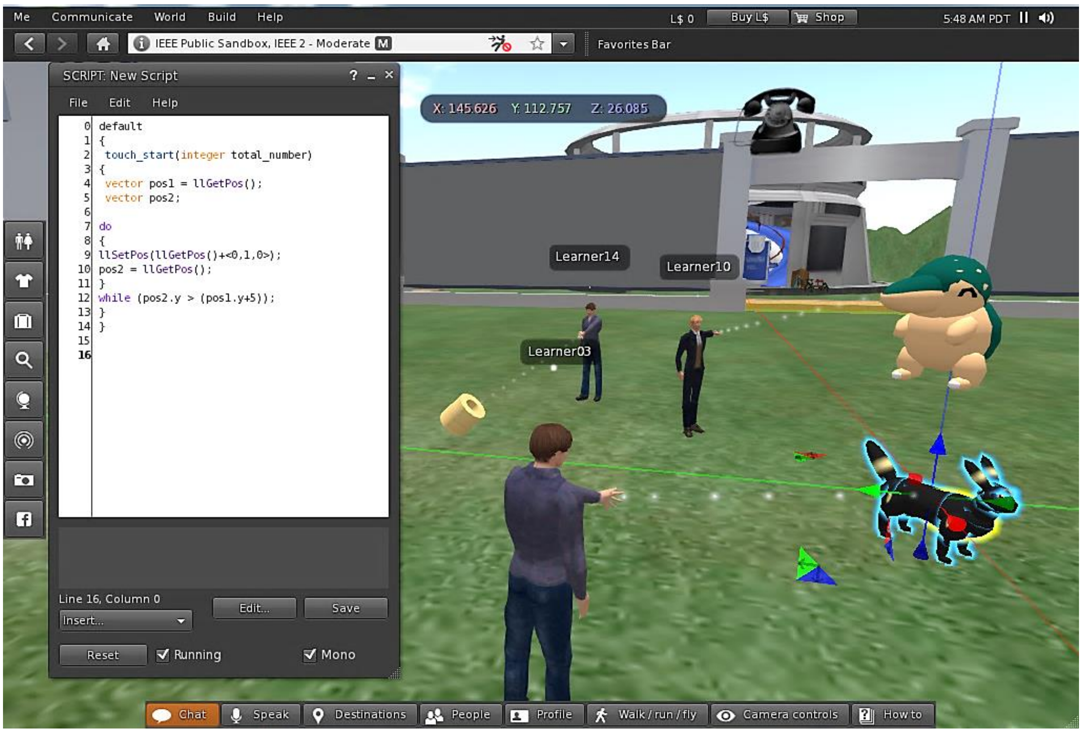
15/15

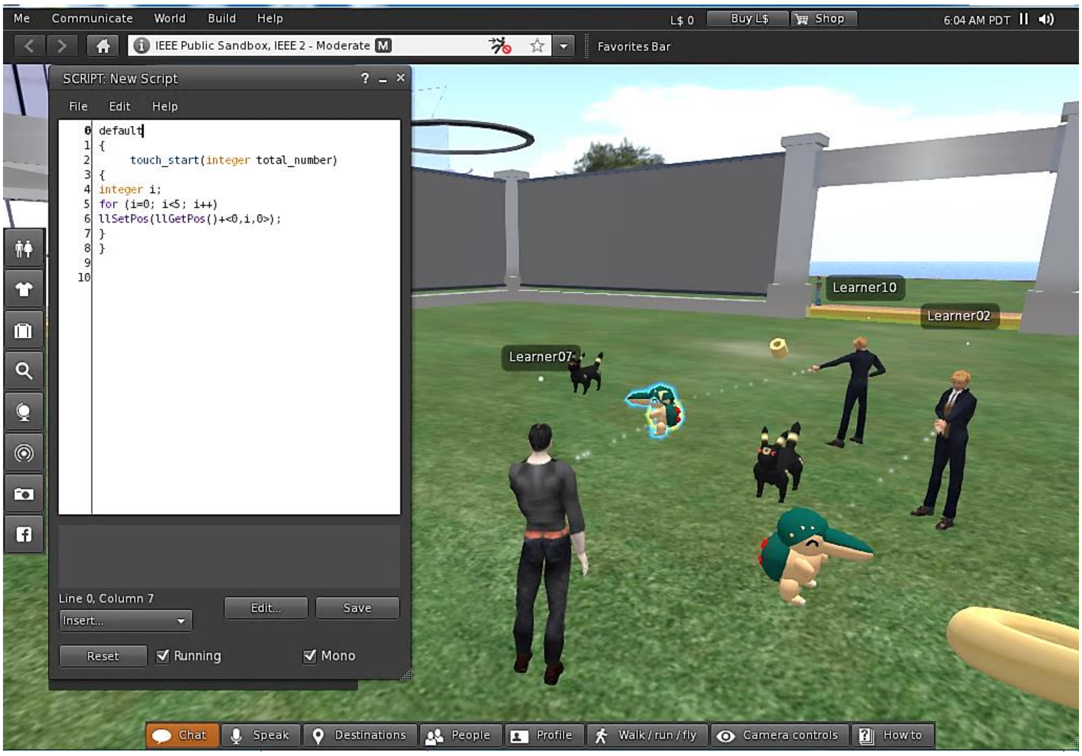
8- Any other comments on the grade profile of the students, their concerns, and/or your own concerns when teaching this unit.

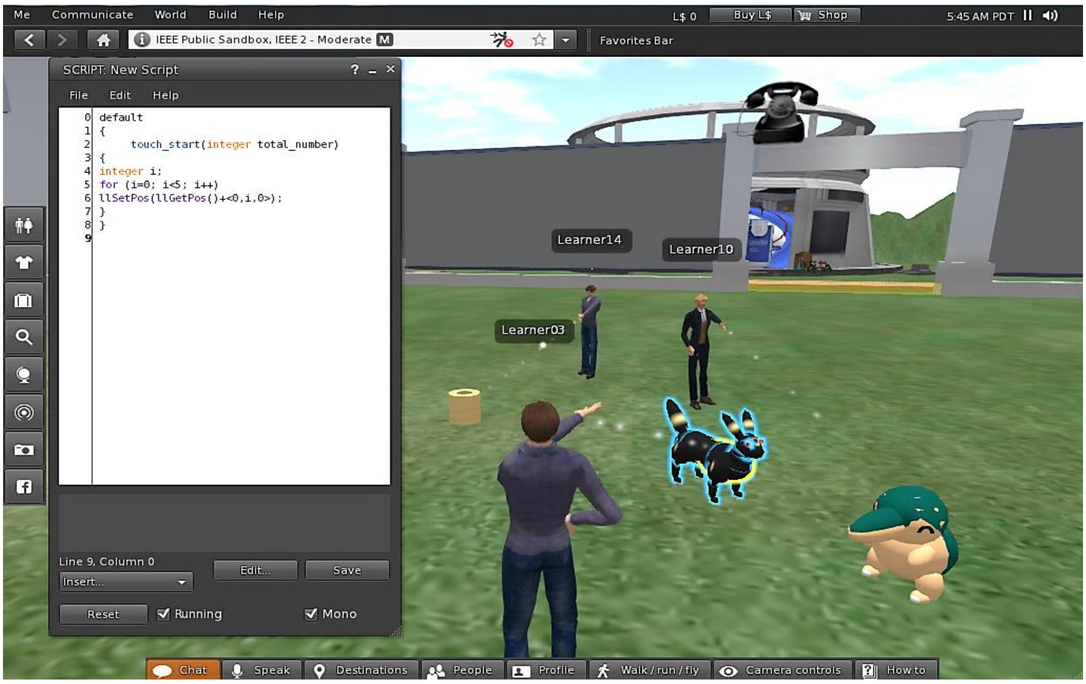
I hope not to teach a class of 15 again in the future!

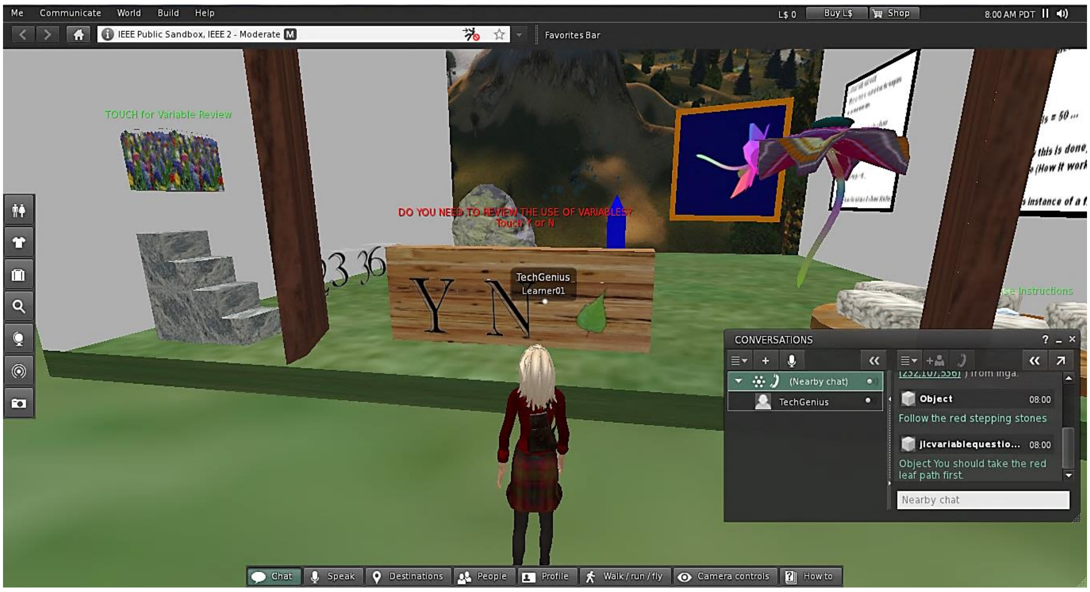
Appendix-2: Screenshots showing areas of the scenarios designed in the virtual world of 'Second Life'.

A2.1 Computer Programming virtual scenario:

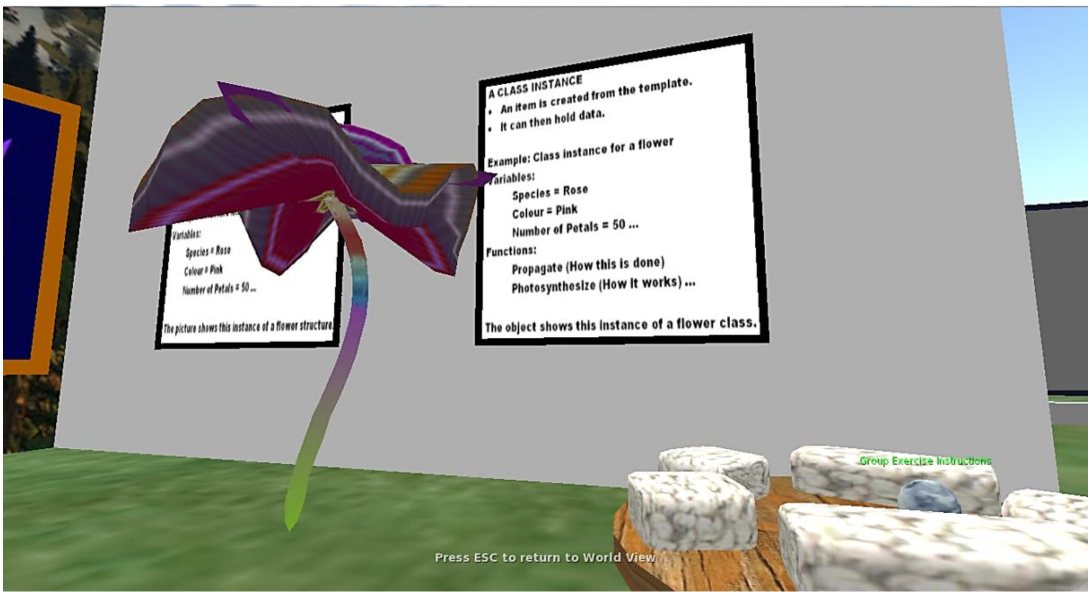


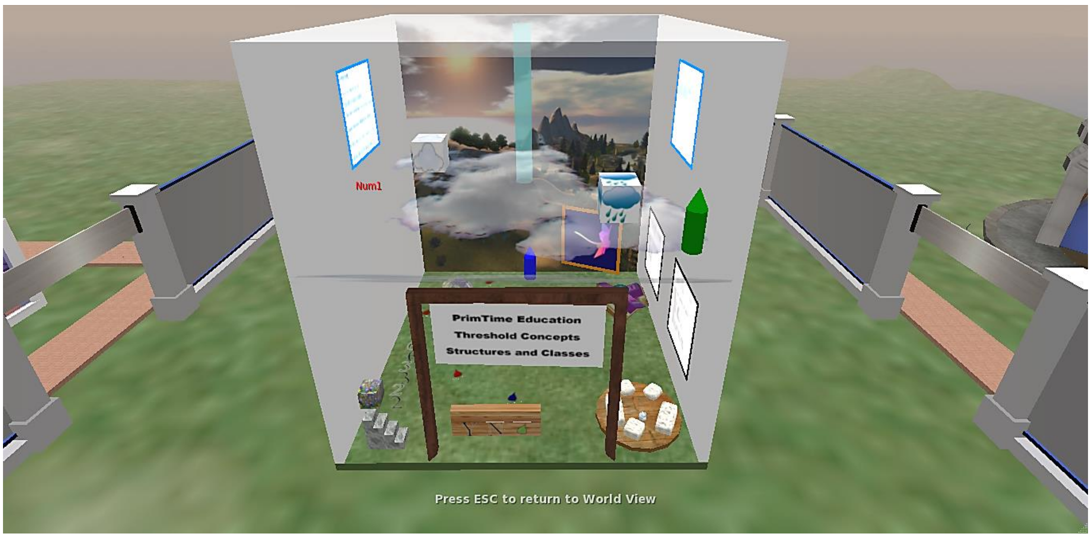



Me Communicate World Build Help
L$ 0 Buy L$ Shop
5:45 AM PDT
IEEE Public Sandbox, IEEE 2 - Moderate
Favorites Bar
SCRIPT: New Script
File Edit Help
default
{
touch_start(integer total_number)
{
integer i;
for (i=0; i<5; i++)
llSetPos(llGetPos()+<0,i,0>);
}
}
Line 9, Column 0
Edit... Save
Insert...
Reset Running Mono
Learner14
Learner10
Learner03
Chat Speak Destinations People Profile Walk / run / fly Camera controls How to


Me Communicate World Build Help
L$ 0 Buy L$ Shop
8:00 AM PDT
IEEE Public Sandbox, IEEE 2 - Moderate
Favorites Bar
TOUCH for Variable Review
DO YOU NEED TO REVIEW THE USE OF VARIABLES?
Touch Y or N
Y N
TechGenius
Learner01
CONVERSATIONS
(Nearby chat)
TechGenius
Object 08:00
Follow the red stepping stones
jlcvariablequestio... 08:00
Object You should take the red leaf path first.
Nearby chat
Chat Speak Destinations People Profile Walk / run / fly Camera controls How to

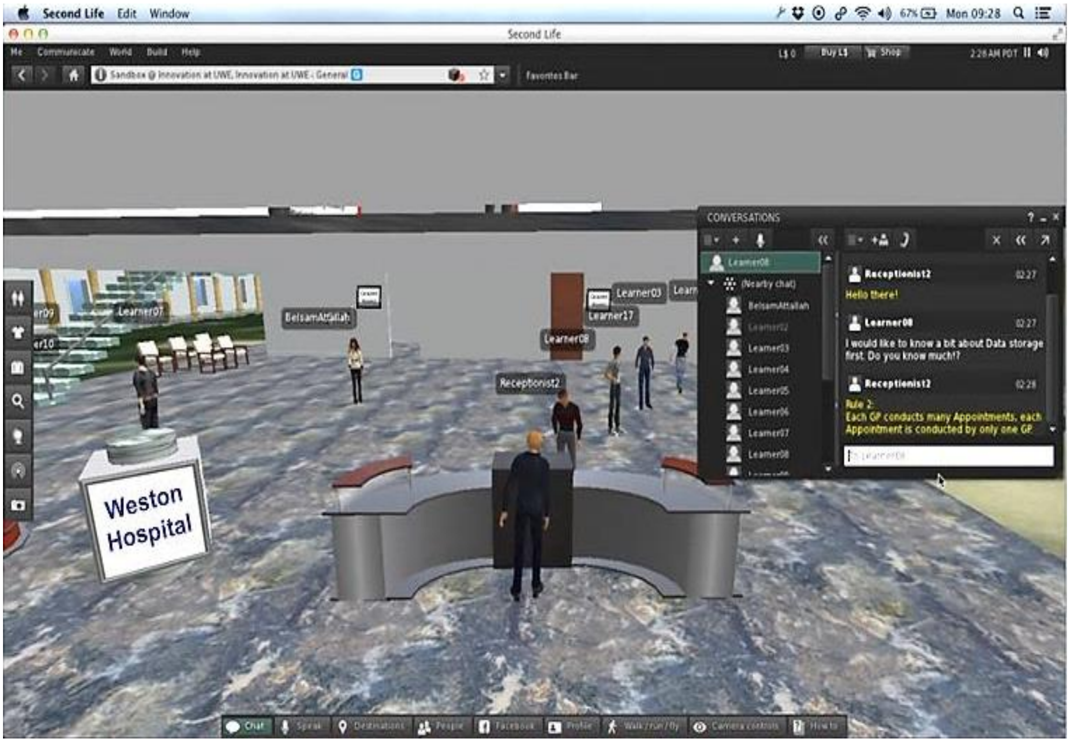

A STRUCTURE INSTANCE
When an item is created from the template.
It can then hold data.
Example: Structure instance for a flower
Variables:
Species = Rose
Colour = Pink
Number of Petals = 50 ...
The picture shows this instance of a flower structure.
Press ESC to return to World View

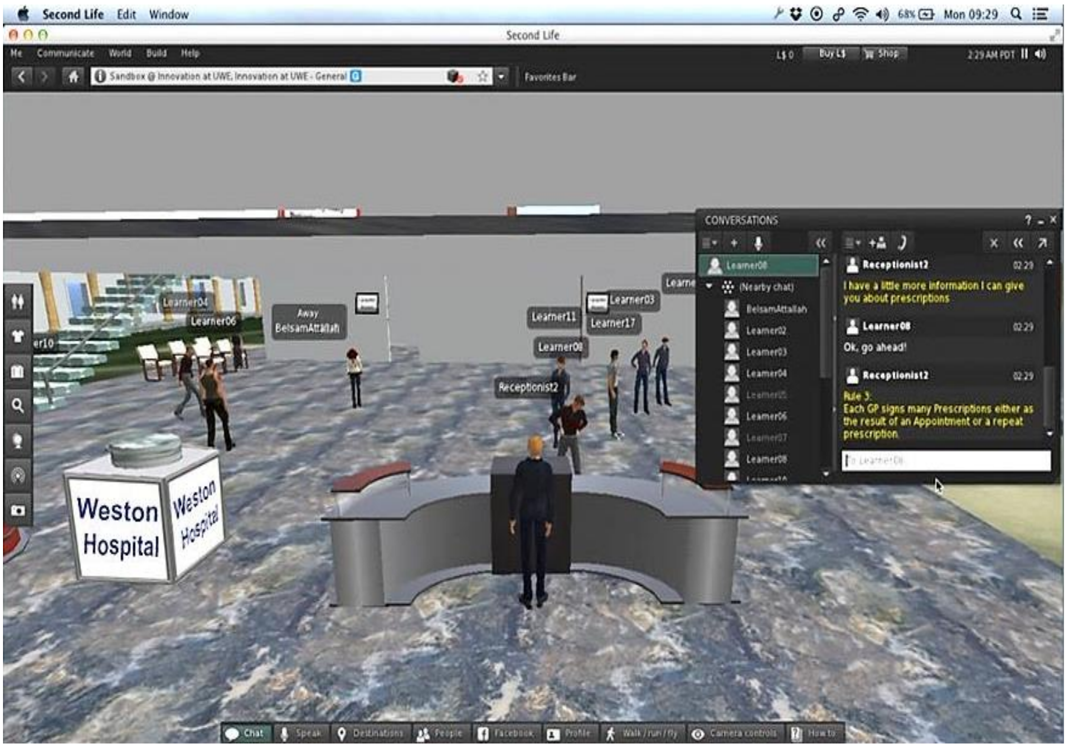

A CLASS INSTANCE
An item is created from the template.
It can then hold data.
Example: Class instance for a flower
Variables:
Species = Rose
Colour = Pink
Number of Petals = 50 ...
Functions:
Propagate (How this is done)
Photosynthesize (How it works) ...
The object shows this instance of a flower class.
Group Exercise Instructions
Press ESC to return to World View

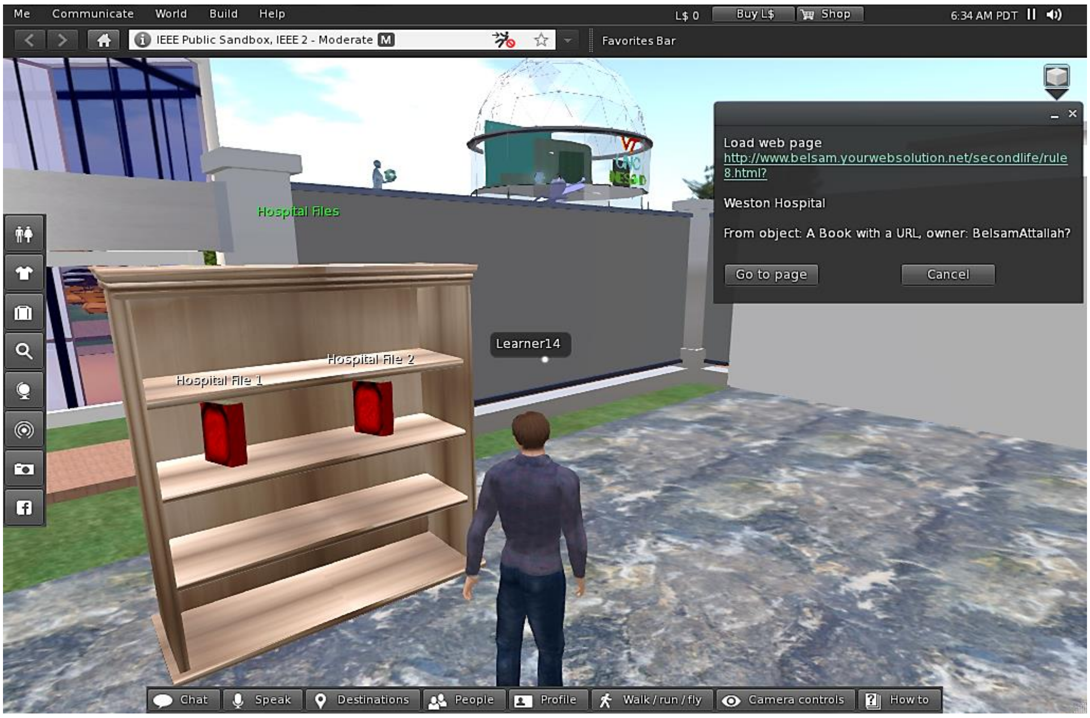

Num1
PrimTime Education
Threshold Concepts
Structures and Classes
Press ESC to return to World View

A2.2 Database Normalisation virtual scenario:


Me
Communicate
World
Build
Help
L$ 390
Buy L$
Shop
2:57 AM PST
Sandbox @ Innovation at UWE, Innovation at UWE - Gen
Favorites Bar
BUILD TOOLS
16
Learner05
Learner07
Learner06
BelsamAttallah
Chat
Speak
Destinations
People
Facebook
Profile
Walk / run / fly
Camera controls
How to


Second Life
Edit
Window
Mon 09:28
Second Life
BelsamAttallah
Receptionist2
Learner03
Learner17
Learner08
Weston Hospital
CONVERSATIONS
Learner08
(Nearby chat)
BelsamAttallah
Learner03
Learner04
Learner05
Learner06
Learner07
Learner08
Receptionist2
02:27
Hello there!
Learner08
02:27
I would like to know a bit about Data storage first. Do you know much!?
Receptionist2
02:28
Rule 2:
Each GP conducts many Appointments, each Appointment is conducted by only one GP


Second Life Edit Window
Second Life
Me Communicate World Build Help
Sandbox @ Innovation at UWE, Innovation at UWE - General
Favorites Bar
CONVERSATIONS
Receptionist2
I have a little more information I can give you about prescriptions
Learner08
Ok, go ahead!
Receptionist2
Rule 3:
Each GP signs many Prescriptions either as the result of an Appointment or a repeat prescription.
Weston Hospital
Weston Hospital
Receptionist2
Learner08
Learner11
Learner17
Learner03
Learner04
Learner06

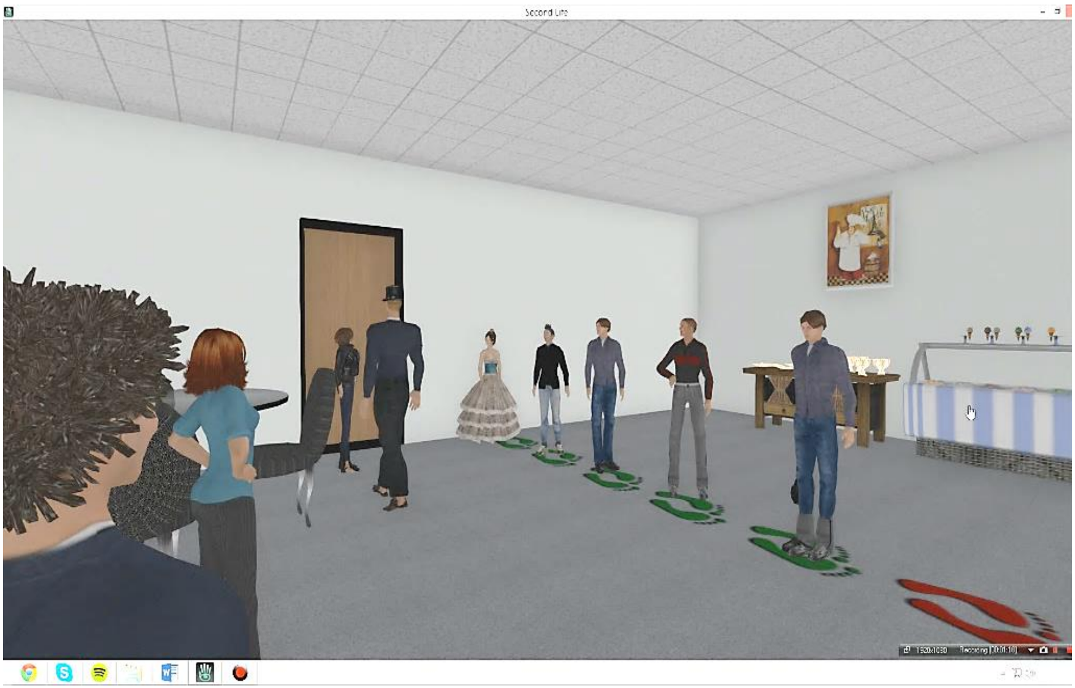

Me Communicate World Build Help
L$ 0 Buy L$ Shop
6:34 AM PDT
IEEE Public Sandbox, IEEE 2 - Moderate M
Favorites Bar
Load web page
http://www.belsam.yourwebsolution.net/secondlife/rule8.html?
Weston Hospital
From object: A Book with a URL, owner: BelsamAttallah?
Go to page
Cancel
Hospital Files
Hospital File 1
Hospital File 2
Learner14
Chat Speak Destinations People Profile Walk / run / fly Camera controls How to


Me Communicate World Build Help
L$ 0
Buy L$
Shop
5:13 AM PDT
IEEE Public Sandbox, IEEE 2 - Moderate
Favorites Bar
Touch for light
Learner08
Learner15
Cardiology Ward
Chat Speak Destinations People Profile Walk / run / fly Camera controls How to

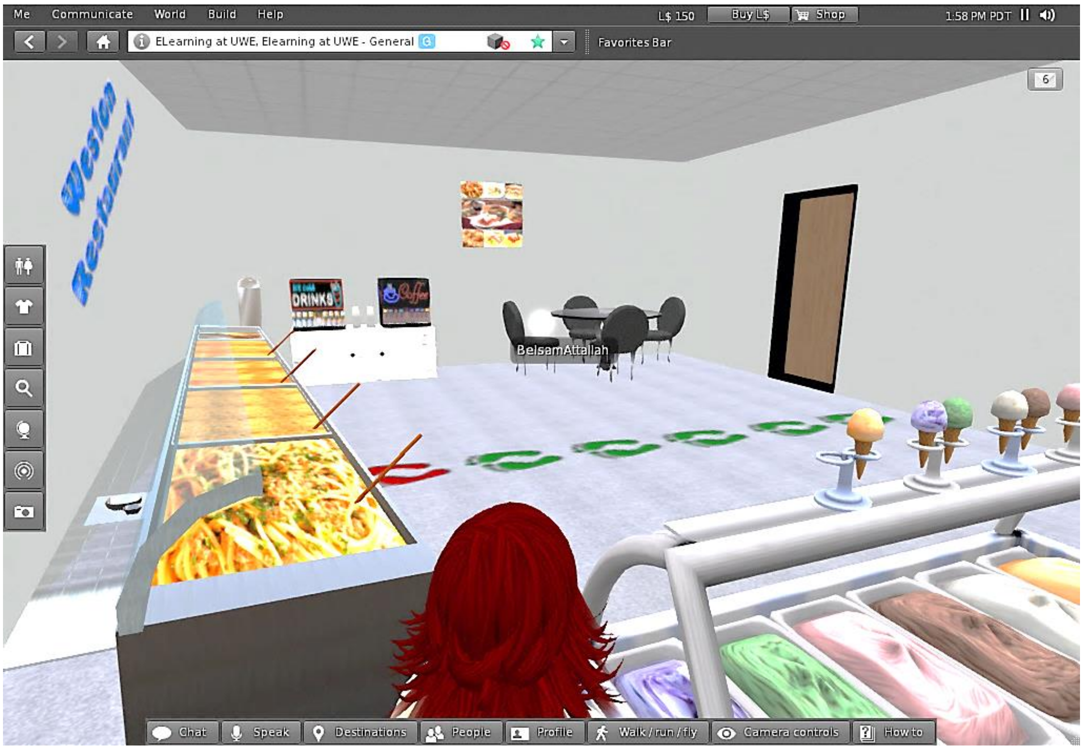

Me Communicate World Build Help
L$ 0
Buy L$
Shop
5:14 AM PDT
IEEE Public Sandbox, IEEE 2 - Moderate
Favorites Bar
Learner02
Call for Information
Learner08
Name: Tanya James
Age: 28
Gender: Female
Chat Speak Destinations People Profile Walk / run / fly Camera controls How to

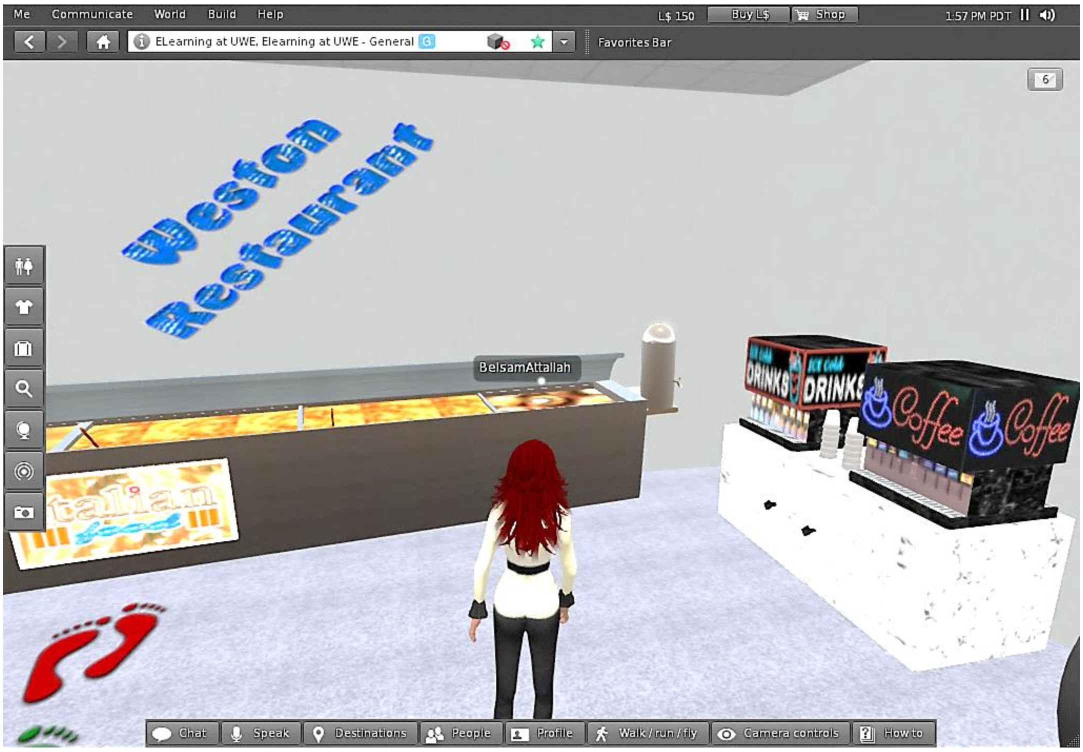
A2.3 Multithreading Techniques virtual scenario:


Weston Restaurant
Lerner05
Learner04
Learner02
BelsamAttallah
Learner06
Learner07
Learner10
Learner09
Learner01

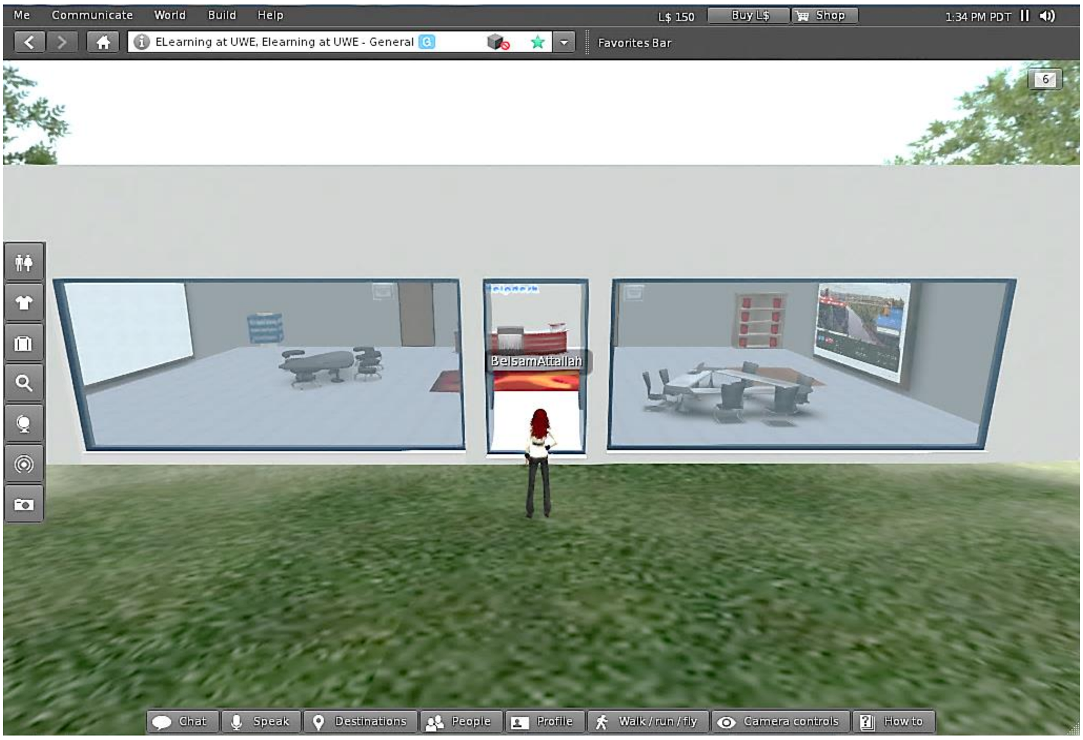

Second Life

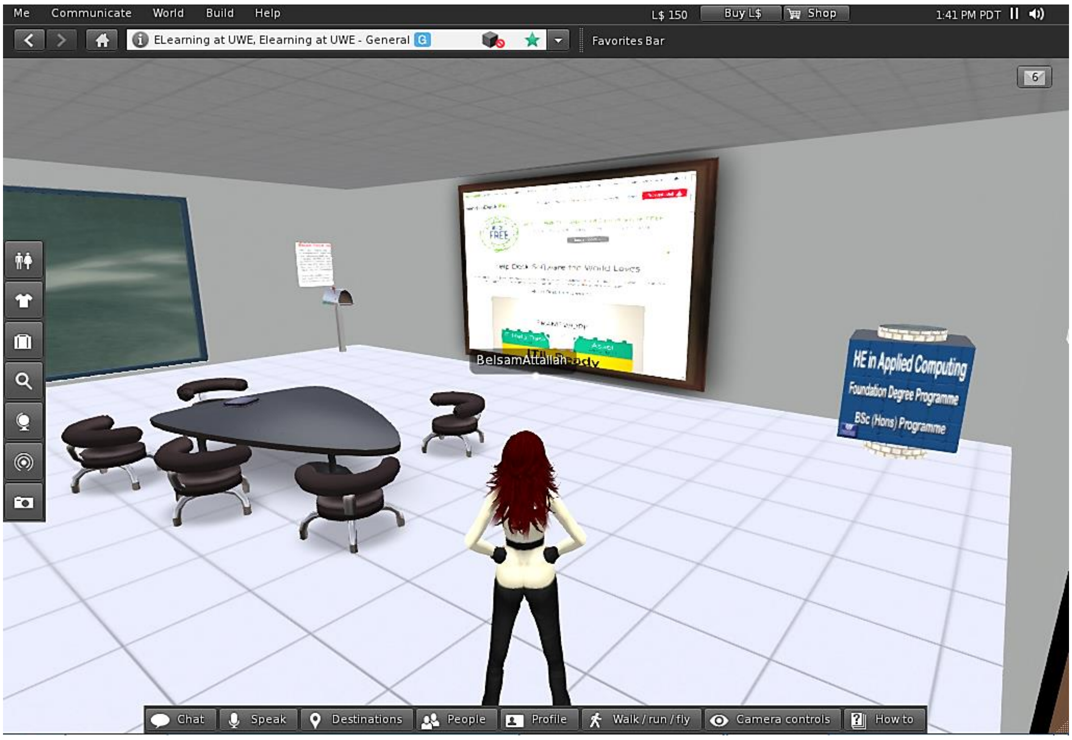

Me
Communicate
World
Build
Help
L$ 150
Buy L$
Shop
1:53 PM PDT
ELearning at UWE, Elearning at UWE - General
Favorites Bar
Weston
Restaurant
BelsamAttallah
Chat
Speak
Destinations
People
Profile
Walk / run / fly
Camera controls
How to

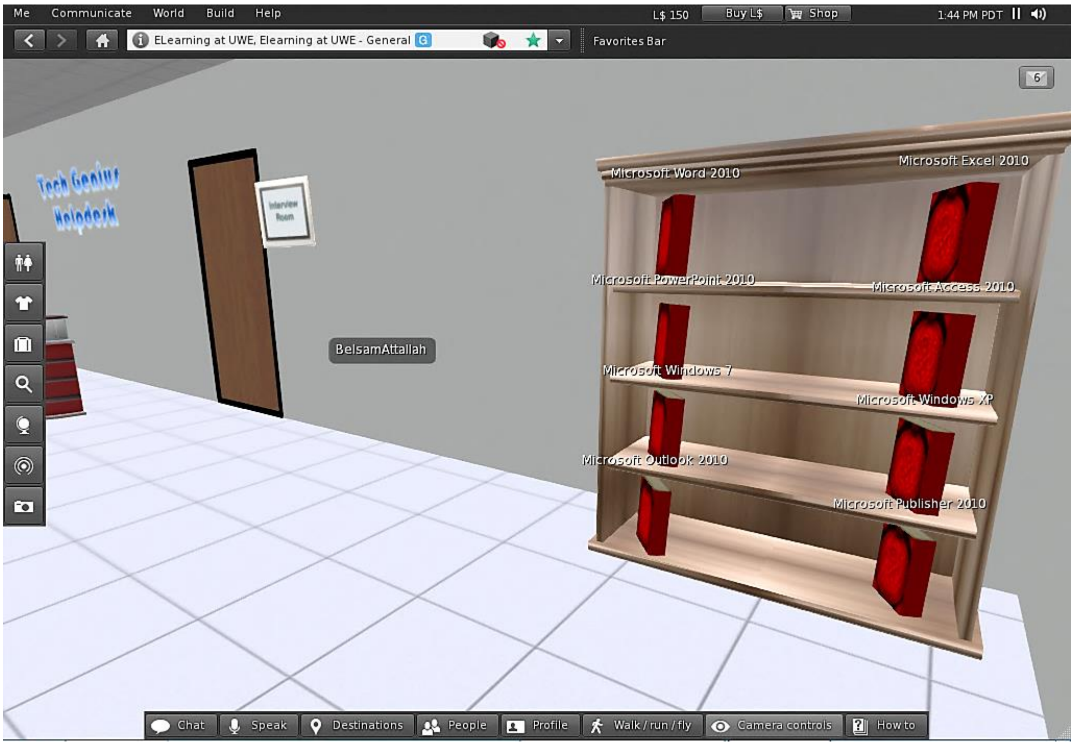

Me
Communicate
World
Build
Help
L$ 150
Buy L$
Shop
1:58 PM PDT
ELearning at UWE, Elearning at UWE - General
Favorites Bar
Weston
Restaurant
DRINKS
BelsamAttallah
Chat
Speak
Destinations
People
Profile
Walk / run / fly
Camera controls
How to

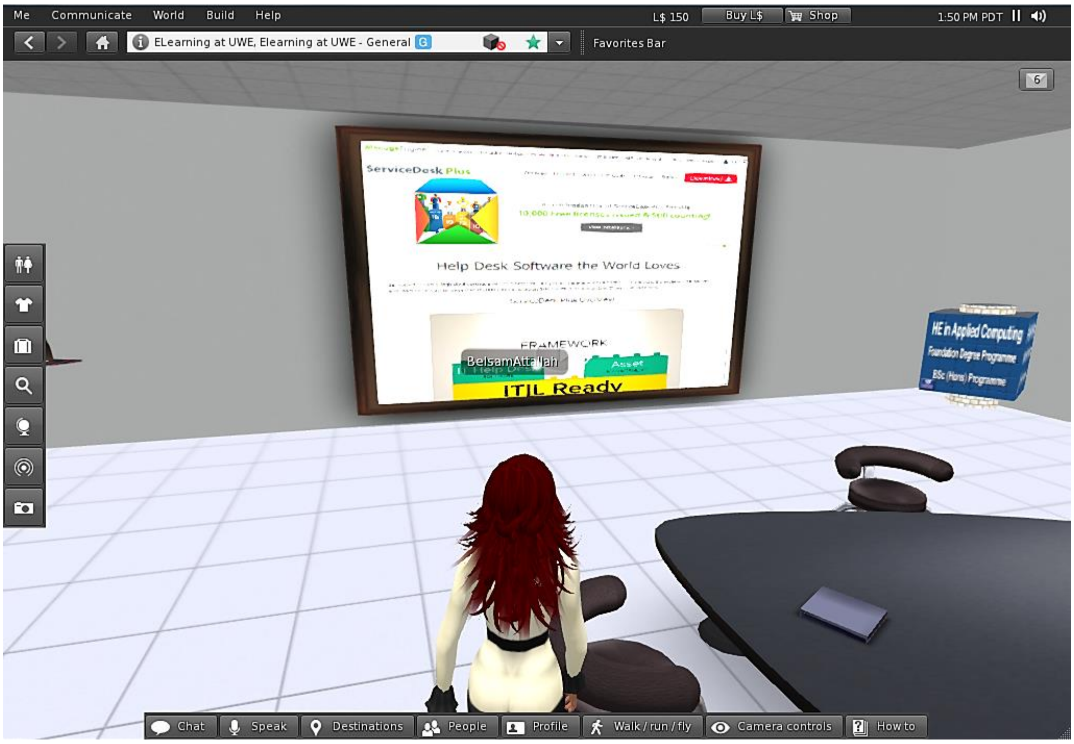


A2.4 Helpdesk Support virtual scenario:




Me
Communicate
World
Build
Help
L$ 150
Buy L$
Shop
1:41 PM PDT
ELearning at UWE, Elearning at UWE - General
Favorites Bar
BelsamAttallah
HE in Applied Computing
Foundation Degree Programme
BSc (Hons) Programme
Chat
Speak
Destinations
People
Profile
Walk / run / fly
Camera controls
How to


Me
Communicate
World
Build
Help
L$ 150
Buy L$
Shop
1:44 PM PDT
ELearning at UWE, Elearning at UWE - General
Favorites Bar
Tech Genius
Helpdesk
BelsamAttallah
Microsoft Word 2010
Microsoft Excel 2010
Microsoft PowerPoint 2010
Microsoft Access 2010
Microsoft Windows 7
Microsoft Windows XP
Microsoft Outlook 2010
Microsoft Publisher 2010
Chat
Speak
Destinations
People
Profile
Walk / run / fly
Camera controls
How to



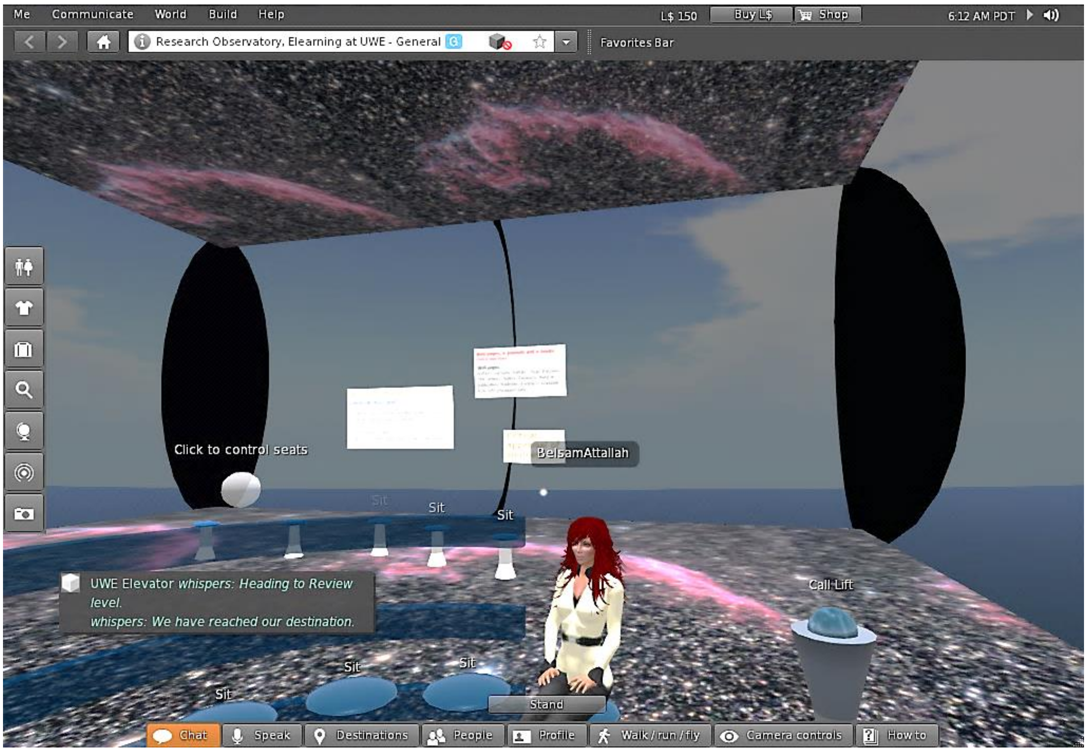
Me
Communicate
World
Build
Help
L$ 150
Buy L$
Shop
1:50 PM PDT
ELearning at UWE, Elearning at UWE - General
Favorites Bar
ServiceDesk Plus
Help Desk Software the World Loves
FRAMEWORK
BelsamAttallah
ITIL Ready
HE in Applied Computing
Foundation Degree Programme
BSc (Hons) Programme
Chat
Speak
Destinations
People
Profile
Walk / run / fly
Camera controls
How to

Me
Communicate
World
Build
Help
L$ 150
Buy L$
Shop
1:45 PM PDT
ELearning at UWE, Elearning at UWE - General
Favorites Bar
BelsamAttallah
Chat
Speak
Destinations
People
Profile
Walk / run / fly
Camera controls
How to

A2.5 Research Methods virtual scenario:


Me Communicate World Build Help
L$ 150 Buy L$ Shop
6:13 AM PDT
Research Observatory, Elearning at UWE - General
Favorites Bar
BelsamAttallah
Call Lift
Sit
Stand
Chat Speak Destinations People Profile Walk / run / fly Camera controls How to


Me Communicate World Build Help
L$ 150 Buy L$ Shop
6:11 AM PDT
Research Observatory, Elearning at UWE - General
Favorites Bar
CAN THE TOPIC BE REFINED?
Click to control seats
BelsamAttallah
UWE Elevator whispers: Heading to Focus level.
whispers: We have reached our destination.
Sit
Stand
Chat Speak Destinations People Profile Walk / run / fly Camera controls How to



A2.6 Multimedia Technologies virtual scenario:


Me Communicate World Build Help
Visitor 01
Visitor 03
Visitor 02
Learner06
ShvanNoori
Joseph1950
Learnero3
Learner01
Chat
Speak
Destinations
People
Profile
Walk / run / fly
Camera controls
How to


Me Communicate World Build Help
ELearning at UWE, Elearning at UWE - General
Favorites Bar
AliQassem
Learner 05
Learner 04
Learner 07
Learner 03
Learner 01
Stand
Chat
Speak
Destinations
People
Profile
Walk / run / fly
Camera controls
How to

Appendix-3: Questionnaires and data analysis.

A3.1 General Questionnaires on Second Life - Start of the academic year 2012/2013

HE in Computing – Year 1:

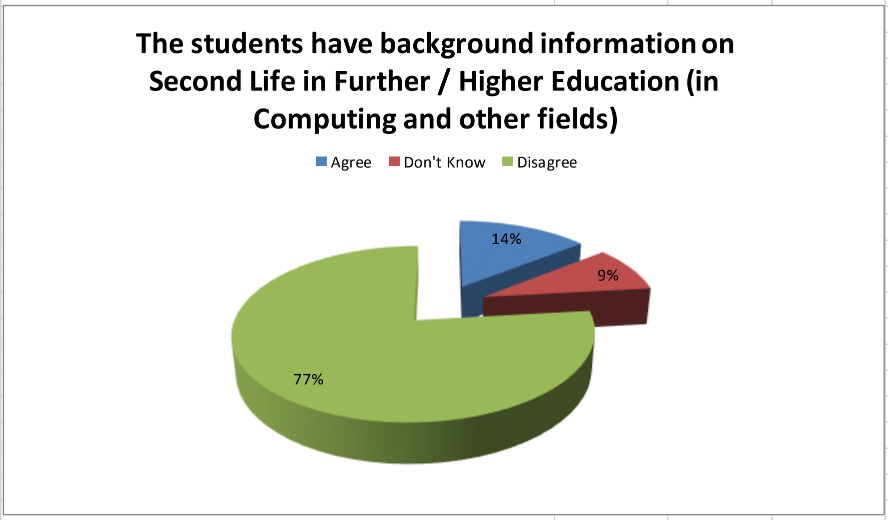
	Technology Enhanced Learning in Higher Education					
				Date	24-Sep-12	
				Participants	8	
	Foundation Degree in Applied Computing – Year 1					
	Beginning of the Year Questionnaire					
Seq.	**Question**	Fully Agree	Agree	I don't Know	Disagree	Fully disagree
1	You have heard of the Second Life software before.	**1**	**2**		**2**	**3**
2	You have good general background information about Second Life.			**1**	**4**	**3**
3	You have good background knowledge about the application of Second Life in Further Education.		**1**	**2**	**3**	**2**
4	You have good background knowledge about the application of Second Life in Higher Education.		**1**	**1**	**4**	**2**
5	You have good background knowledge about the application of Second Life in Further Education Computing.		**1**	**1**	**4**	**2**
6	You have good background knowledge about the application of Second Life in Higher Education Computing.		**1**		**4**	**3**
7	You have good background knowledge about the application of Second Life in electronic libraries of universities.		**1**		**3**	**4**
8	You have heard and understood the term 'Social Computing'.	**1**	**6**	**1**		
9	You have heard and understood the term 'Simulation'.	**3**	**5**			
10	Applying education (in general) in a virtual world will enhance the students' learning experience.	**1**	**4**	**2**		**1**
11	Applying Computing education in a virtual world will enhance the students' learning experience.	**1**	**4**	**2**		**1**
12	As a Computing student, you are open to different Computing technologies.	**6**	**2**			
13	As a Computing student, you would like to investigate and exercise the developing technologies in the Computing field.	**4**	**4**			

Group A						
The students have background information on Second Life in Further / Higher Education (in Computing and other fields)						

Date	24-Sep-12
Participants	8

Seq.	Question	Fully Agree	Agree	I don't Know	Disagree	Fully disagree
1	You have heard of the Second Life software before.	1	2		2	3
2	You have good general background information about Second Life.			1	4	3
3	You have good background knowledge about the application of Second Life in Further Education.		1	2	3	2
4	You have good background knowledge about the application of Second Life in Higher Education.		1	1	4	2
5	You have good background knowledge about the application of Second Life in Further Education Computing.		1	1	4	2
6	You have good background knowledge about the application of Second Life in Higher Education Computing.		1		4	3
7	You have good background knowledge about the application of Second Life in electronic libraries of universities.		1		3	4
	Total	1	7	5	24	19
		1.14		0.71	6.14	

Second Life in Further / Higher Education (in Computing and other fields)	Agree	Don't Know	Disagree
8 students	14.29	8.93	76.79



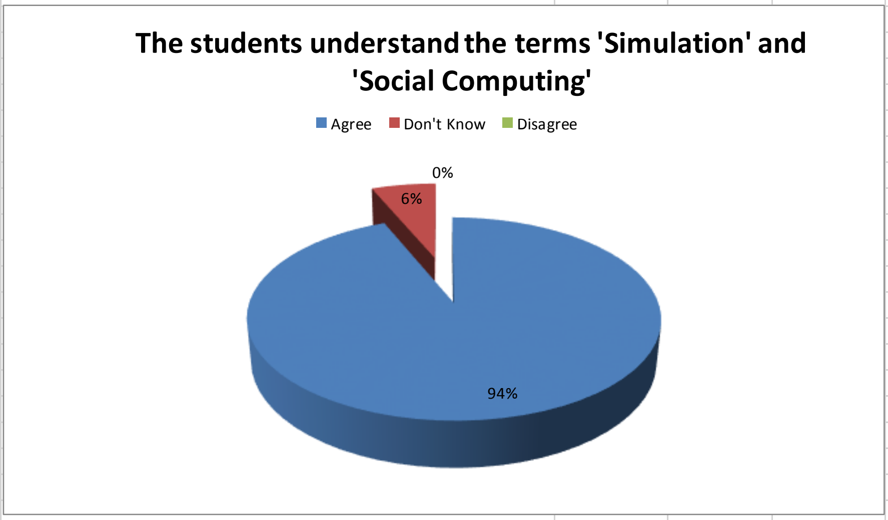
Group B

The students understand the terms 'Simulation' and 'Social Computing'

Date	24-Sep-12
Participants	8

Seq.	Question	Fully Agree	Agree	I don't Know	Disagree	Fully disagree
8	You have heard and understood the term 'Social Computing'.	1	6	1		
9	You have heard and understood the term 'Simulation'.	3	5			
	Total	**4**	**11**	**1**	**0**	**0**
		7.50		**0.50**	**0.00**	

The students understand the terms 'Simulation' and 'Social Computing'	Agree	Don't Know	Disagree
8 students	**93.75**	**6.25**	**0.00**

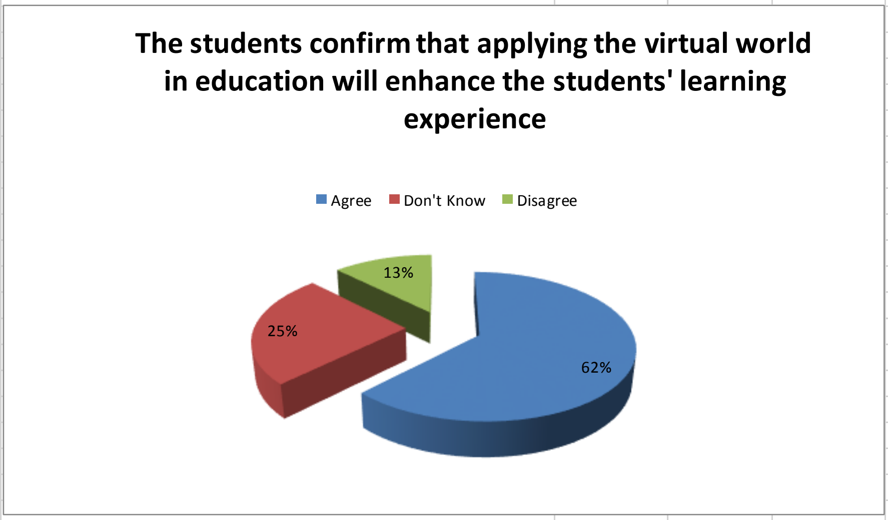


Group C
The students confirm that applying the virtual world in education will enhance the students' learning experience

Date	**24-Sep-12**
Participants	**8**

Seq.	Question	Fully Agree	Agree	I don't Know	Disagree	Fully disagree
10	Applying education (in general) in a virtual world will enhance the students' learning experience.	1	4	2		1
11	Applying Computing education in a virtual world will enhance the students' learning experience.	1	4	2		1
	Total	2	8	4	0	2
		5.00		2.00	1.00	

The students confirm that applying the virtual world in education will enhance the students' learning experience	Agree	Don't Know	Disagree
8 students	62.50	25.00	12.50

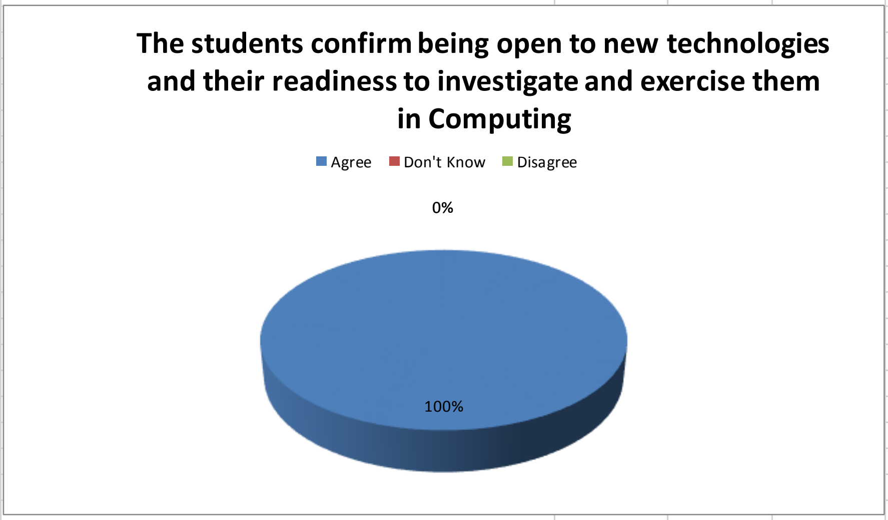


Group D						
The students confirm being open to new technologies and their readiness to investigate and exercise them in Computing						

Date	24-Sep-12
Participants	8

Seq.	Question	Fully Agree	Agree	I don't Know	Disagree	Fully disagree
12	As a Computing student, you are open to different Computing technolo	6	2			
13	As a Computing student, you would like to investigate and exercise the developing technologies in the Computing field.	4	4			
	Total	10	6	0	0	0
		8.00		0.00	0.00	

The students confirm being open to new technologies and their readiness to investigate and exercise them in Computing	Agree	Don't Know	Disagree
8 students	100.00	0.00	0.00



HE in Computing – Year 2:

Technology Enhanced Learning in Higher Education

Date	**27-Sep-12**
Participants	**14**

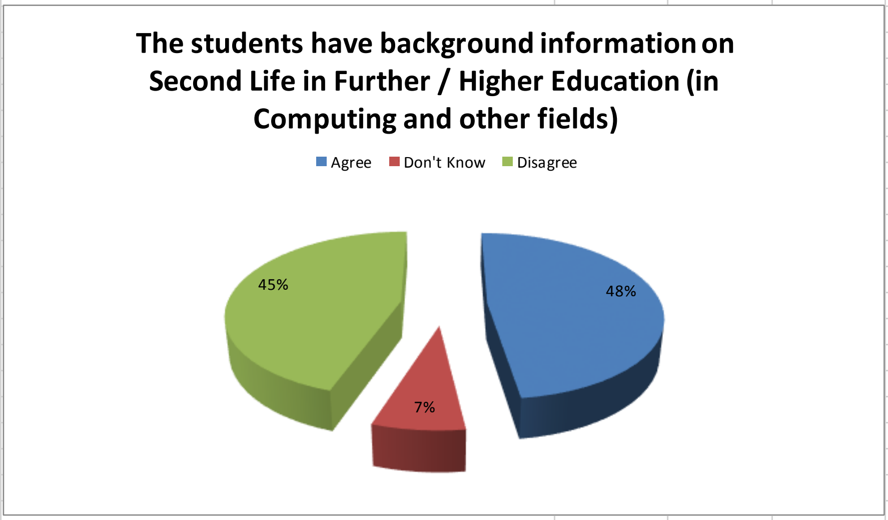
Foundation Degree in Applied Computing – Year 2

Begining of the Year Questionnaire

Question	Fully Agree	Agree	I don't Know	Disagree	Fully disagree
You have heard of the Second Life software before.	9	4			1
You have good general background information about Second Life.		7	2	3	2
You have good background knowledge about the application of Second Life in Further Education.	1	5		4	4
You have good background knowledge about the application of Second Life in Higher Education.	1	4	1	5	3
You have good background knowledge about the application of Second Life in Further Education Computing.	1	4	2	4	3
You have good background knowledge about the application of Second Life in Higher Education Computing.	1	5	1	3	4
You have good background knowledge about the application of Second Life in electronic libraries of universities.	1	4	1	4	4
You have heard and understood the term 'Social Computing'.	2	9	1	1	1
You have heard and understood the term 'Simulation'.	10	3		1	
Applying education (in general) in a virtual world will enhance the students' learning experience.		5	6	1	2
Applying Computing education in a virtual world will enhance the students' learning experience.	2	4	6		2
As a Computing student, you are open to different Computing technologies.	12	2			
As a Computing student, you would like to investigate and exercise the developing technologies in the Computing field.	7	7			

Group A						
The students have background information on Second Life in Further / Higher Education (in Computing and other fields)						
				Date	27-Sep-12	
				Participants	14	
Seq.	**Question**	Fully Agree	Agree	I don't Know	Disagree	Fully disagree
1	You have heard of the Second Life software before.	**9**	**4**			**1**
2	You have good general background information about Second Life.		**7**	**2**	**3**	**2**
3	You have good background knowledge about the application of Second Life in Further Education.	**1**	**5**		**4**	**4**
4	You have good background knowledge about the application of Second Life in Higher Education.	**1**	**4**	**1**	**5**	**3**
5	You have good background knowledge about the application of Second Life in Further Education Computing.	**1**	**4**	**2**	**4**	**3**
6	You have good background knowledge about the application of Second Life in Higher Education Computing.	**1**	**5**	**1**	**3**	**4**
7	You have good background knowledge about the application of Second Life in electronic libraries of universities.	**1**	**4**	**1**	**4**	**4**
	Total	**14**	**33**	**7**	**23**	**21**
		6.71		**1.00**	**6.29**	

Second Life in Further / Higher Education (in Computing and other fields)	Agree	Don't Know	Disagree
14 students	**47.96**	**7.14**	**44.90**

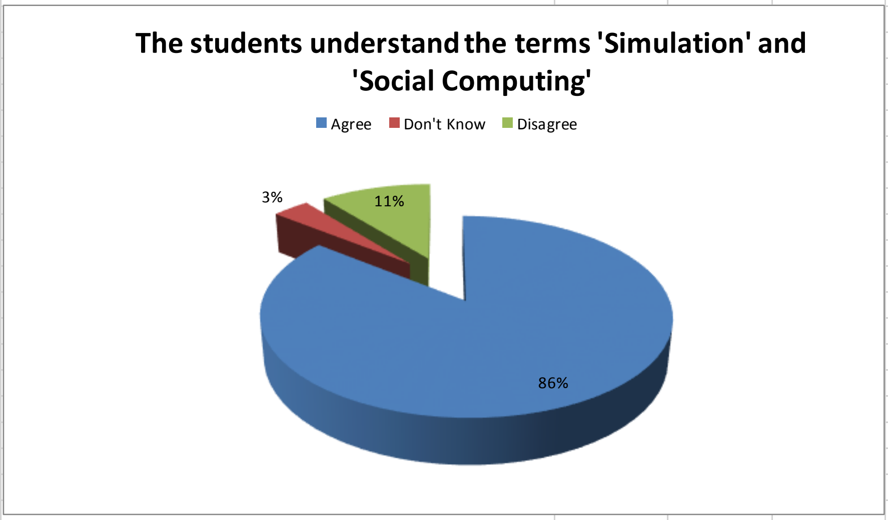


Group B
The students understand the terms 'Simulation' and 'Social Computing'

Date	27-Sep-12
Participants	14

Seq.	Question	Fully Agree	Agree	I don't Know	Disagree	Fully disagree
8	You have heard and understood the term 'Social Computing'.	2	9	1	1	1
9	You have heard and understood the term 'Simulation'.	10	3		1	
	Total	12	12	1	2	1
		12.00		0.50	1.50	

The students understand the terms 'Simulation' and 'Social Computing'	Agree	Don't Know	Disagree
14 students	85.71	3.57	10.71

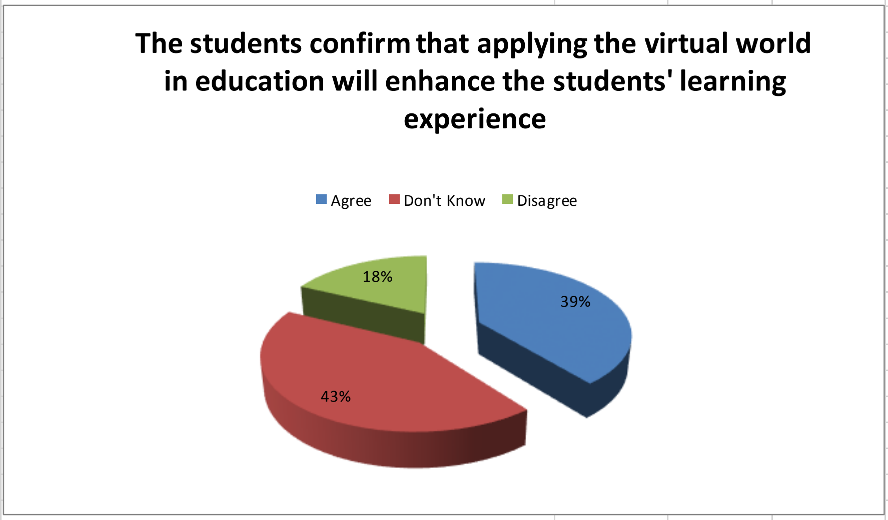


Group C
The students confirm that applying the virtual world in education will enhance the students' learning experience

Date	27-Sep-12
Participants	14

Seq.	Question	Fully Agree	Agree	I don't Know	Disagree	Fully disagree
10	Applying education (in general) in a virtual world will enhance the students' learning experience.		5	6	1	2
11	Applying Computing education in a virtual world will enhance the students' learning experience.	2	4	6		2
	Total	**2**	**9**	**12**	**1**	**4**
		5.50		**6.00**	**2.50**	

The students confirm that applying the virtual world in education will enhance the students' learning experience	Agree	Don't Know	Disagree
14 students	39.29	42.86	17.86

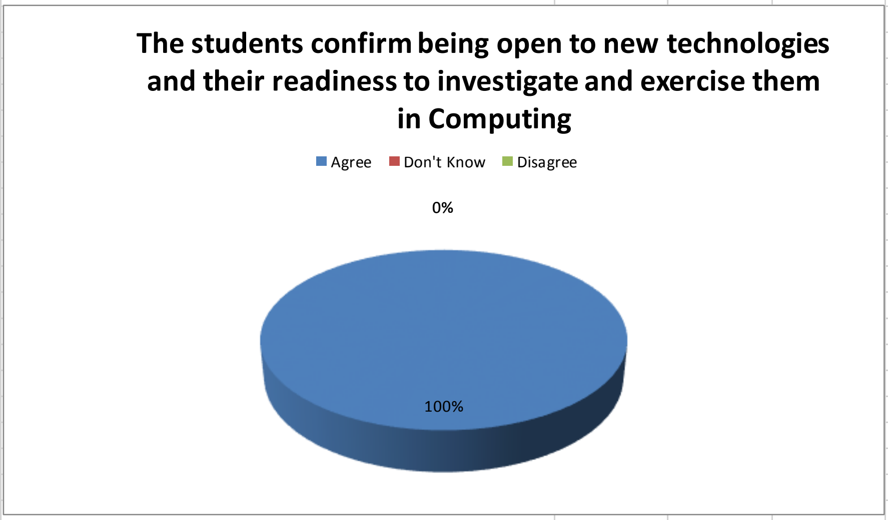


Group D
The students confirm being open to new technologies and their readiness to investigate and exercise them in Computing

Date	27-Sep-12
Participants	14

Seq.	Question	Fully Agree	Agree	I don't Know	Disagree	Fully disagree
12	As a Computing student, you are open to different Computing technolo	12	2			
13	As a Computing student, you would like to investigate and exercise the developing technologies in the Computing field.	7	7			
	Total	19	9	0	0	0
		14.00		0.00	0.00	

The students confirm being open to new technologies and their readiness to investigate and exercise them in Computing	Agree	Don't Know	Disagree
14 students	100.00	0.00	0.00



HE in Computing – BSc (Year 3):

Technology Enhanced Learning in Higher Education

Date	**24-Sep-12**
Participants	**7**

BSc(Hons) in Applied Computing

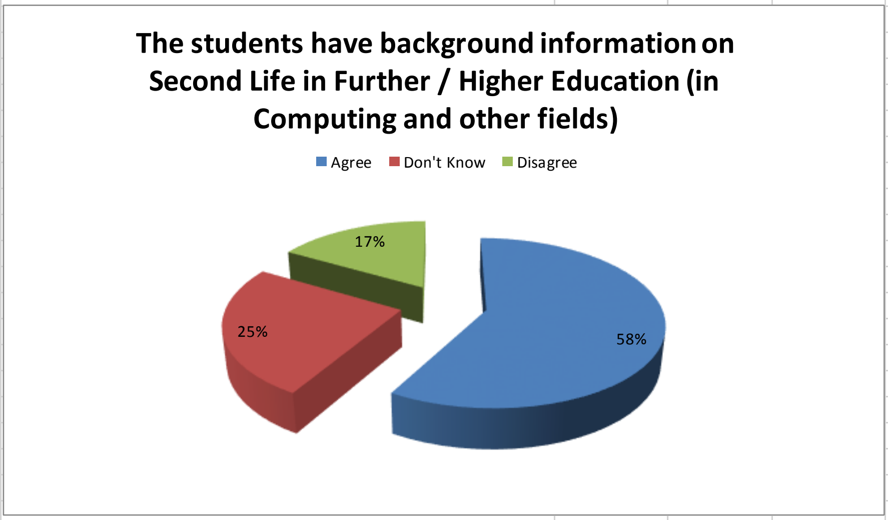
Beginning of the Year Questionnaire

Question	Fully Agree	Agree	I don't Know	Disagree	Fully disagree
You have heard of the Second Life software before.	5	1			1
You have good general background information about Second Life.	2	1	1	2	
You have good background knowledge about the application of Second Life in Further Education.		4	2	1	
You have good background knowledge about the application of Second Life in Higher Education.		4	2	1	
You have good background knowledge about the application of Second Life in Further Education Computing.		4	2	1	
You have good background knowledge about the application of Second Life in Higher Education Computing.		5	1	1	
You have good background knowledge about the application of Second Life in electronic libraries of universities.		2	4	1	
You have heard and understood the term 'Social Computing'.	2	2	3		
You have heard and understood the term 'Simulation'.	6	1			
Applying education (in general) in a virtual world will enhance the students' learning experience.		3	2	1	1
Applying Computing education in a virtual world will enhance the students' learning experience.	1	3	1	2	
As a Computing student, you are open to different Computing technologies.	3	4			
As a Computing student, you would like to investigate and exercise the developing technologies in the Computing field.	2	5			

Group A						
The students have background information on Second Life in Further / Higher Education (in Computing and other fields)						
				Date	24-Sep-12	
				Participants	7	

Seq.	Question	Fully Agree	Agree	I don't Know	Disagree	Fully disagree
1	You have heard of the Second Life software before.	5	1			1
2	You have good general background information about Second Life.	2	1	1	2	
3	You have good background knowledge about the application of Second Life in Further Education.		4	2	1	
4	You have good background knowledge about the application of Second Life in Higher Education.		4	2	1	
5	You have good background knowledge about the application of Second Life in Further Education Computing.		4	2	1	
6	You have good background knowledge about the application of Second Life in Higher Education Computing.		5	1	1	
7	You have good background knowledge about the application of Second Life in electronic libraries of universities.		2	4	1	
	Total	7	21	12	7	1
		4.00		1.71	1.14	

Second Life in Further / Higher Education (in Computing and other fields)	Agree	Don't Know	Disagree
7 students	57.14	24.49	16.33

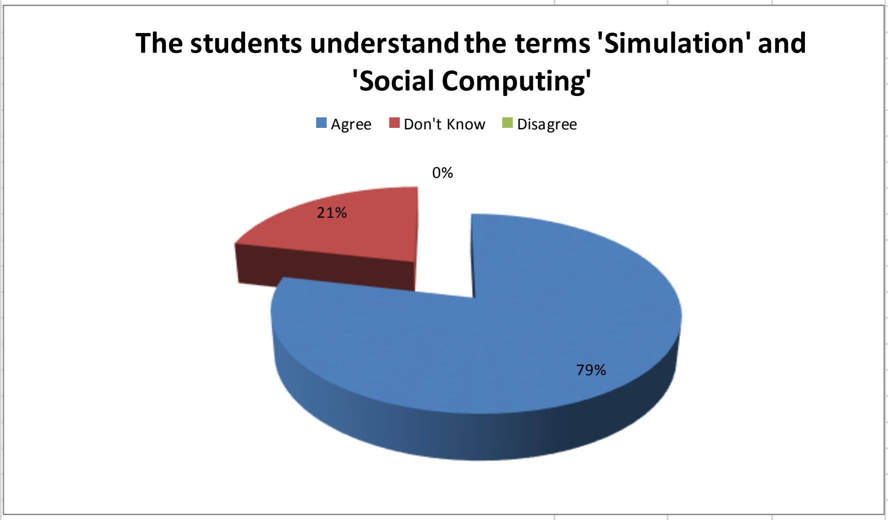


Group B						
The students understand the terms 'Simulation' and 'Social Computing'						

Date	24-Sep-12
Participants	7

Seq.	Question	Fully Agree	Agree	I don't Know	Disagree	Fully disagree
8	You have heard and understood the term 'Social Computing'.	2	2	3		
9	You have heard and understood the term 'Simulation'.	6	1			
	Total	8	3	3	0	0
		5.50		1.50	0.00	

The students understand the terms 'Simulation' and 'Social Computing'	Agree	Don't Know	Disagree
7 students	78.57	21.43	0.00

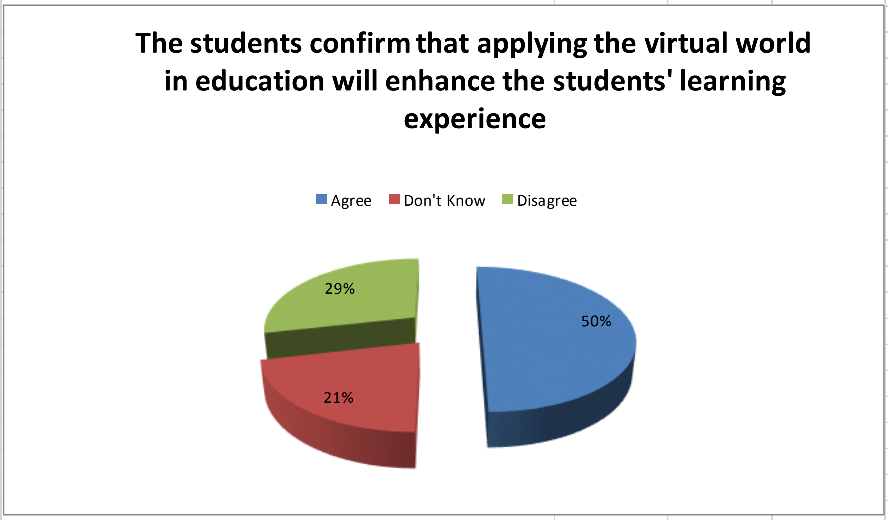


Group C
The students confirm that applying the virtual world in education will enhance the students' learning experience

Date	24-Sep-12
Participants	7

Seq.	Question	Fully Agree	Agree	I don't Know	Disagree	Fully disagree
10	Applying education (in general) in a virtual world will enhance the students' learning experience.		3	2	1	1
11	Applying Computing education in a virtual world will enhance the students' learning experience.	1	3	1	2	
	Total	1	6	3	3	1
		3.50		1.50	2.00	

The students confirm that applying the virtual world in education will enhance the students' learning experience	Agree	Don't Know	Disagree
7 students	50.00	21.43	28.57

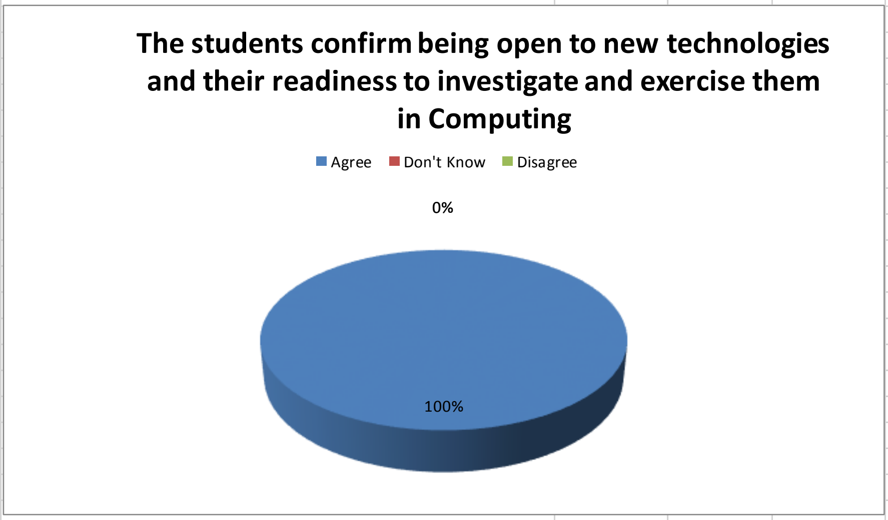


Group D
The students confirm being open to new technologies and their readiness to investigate and exercise them in Computing

Date	24-Sep-12
Participants	7

Seq.	Question	Fully Agree	Agree	I don't Know	Disagree	Fully disagree
12	As a Computing student, you are open to different Computing technolo	3	4			
13	As a Computing student, you would like to investigate and exercise the developing technologies in the Computing field.	2	5			
	Total	5	9	0	0	0
		7.00		0.00	0.00	

The students confirm being open to new technologies and their readiness to investigate and exercise them in Computing	Agree	Don't Know	Disagree
7 students	100.00	0.00	0.00



A3.2 General Questionnaires on Second Life - End of the academic year 2012/2013

HE in Computing – Year 1:

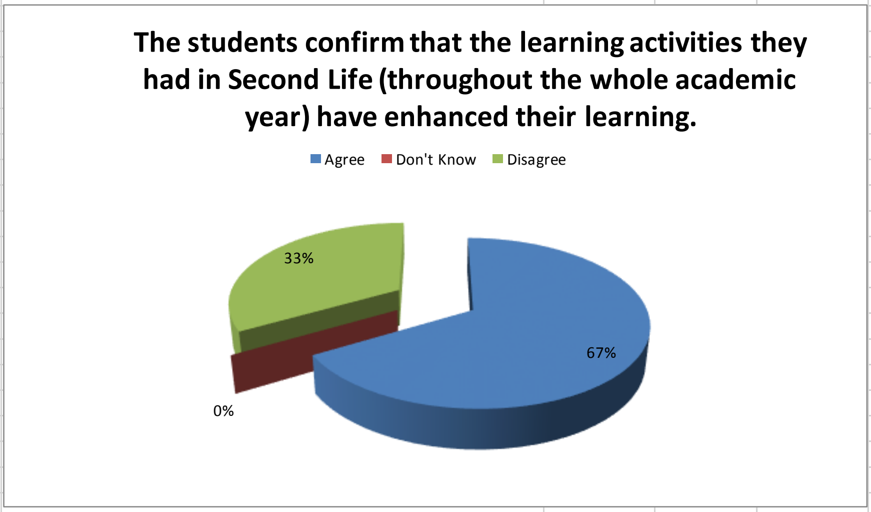
	Technology Enhanced Learning in Higher Education					
				Date	**22-Apr-13**	
				Participants	**6**	
	Foundation Degree in Applied Computing – Year 1					
	End of Year Questionnaire					
Seq.	**Question**	Fully Agree	Agree	I don't Know	Disagree	Fully disagree
1	The different educational activities that you had in the virtual world of Second Life provided you with a different experience to the traditional learning in the physical classroom environment.	**1**	**5**			
2	You believe that these activities were generally beneficial and facilitated your learning.	**1**	**3**		**2**	
3	If you believe that learning in the physical classroom is better and more beneficial to you, you also believe that having some educational activities in Second Life was not a waste of time, as it introduced you to a new technology in your specialist area – Computing.		**2**		**4**	
4	You believe that being introduced to the virtual world and its applications in Computing and some other fields is an opportunity for you to enrich your CV with an element that is not commonly found in the CVs of many other students. This might enhance your employment opportunity in the future.	**1**	**2**	**1**	**2**	
5	Generally, you enjoyed the different activities (or the majority of them) that you attended in Second Life, as they broke the routine activities in the physical classroom throughout the whole of the academic year.	**1**	**3**		**2**	
6	Attending all the activities in Second Life throughout the academic year managed to change your initial idea/opinion about the use of virtual world in a positive manner.	**1**	**3**		**2**	
7	If you are continuing your studies next year, you would like to have some more educational activities in Second Life to enhance and facilitate your learning.(If N/A tick here ☐)	**1**	**3**			**2**
8	You think that you will be explaining the opportunities in Second Life to your future employer so that they extend their services and/or market for their customers.		**2**	**2**	**1**	**1**
9	You believe that sometimes people are not open to new technologies and/or they have prejudgments based on one-side news or another person's experience.	**1**	**3**	**1**	**1**	
10	(Based on Question No. 9) – You believe that the statement in Question no. 9 applies to your initial judgment on Second Life. (If N/A tick here ☐)		**3**	**1**	**2**	
11	(Based on Question No. 9) – You believe that the experience obtained from attending the different activities in Second Life managed to change the negative opinion that you initially had on the use of virtual world in your higher education.(If N/A tick here ☐)	**1**	**3**		**2**	
12	(Based on Question No. 9) – You believe that you are open to new technologies and consider that it is very useful to have technology-enhanced tools in your higher education, one of which is the use of virtual worlds. (If N/A tick here ☐)	**2**	**3**	**1**		

Group A						
The students confirm that the learning activities they had in Second Life (throughout the whole academic year) have enhanced their learning.						

Date	**22-Apr-13**
Participants	**6**

Seq.	Question	Fully Agree	Agree	I don't Know	Disagree	Fully disagree
1	The different educational activities that you had in the virtual world of Second Life provided you with a different experience to the traditional learning in the physical classroom environment.	**1**	**5**			
2	You believe that these activities were generally beneficial and facilitated your learning.	**1**	**3**		**2**	
3	If you believe that learning in the physical classroom is better and more beneficial to you, you also believe that having some educational activities in Second Life was not a waste of time, as it introduced you to a new technology in your specialist area – Computing.		**2**		**4**	
7	If you are continuing your studies next year, you would like to have some more educational activities in Second Life to enhance and facilitate your learning.(If N/A tick here ☐)	**1**	**3**			**2**
	Total	**3**	**13**	**0**	**6**	**2**
		4.00		**0.00**	**2.00**	

The students confirm that the learning activities they had in Second Life (throughout the whole academic year) have enhanced their learning.	Agree	Don't Know	Disagree
6 students	66.67	0.00	33.33



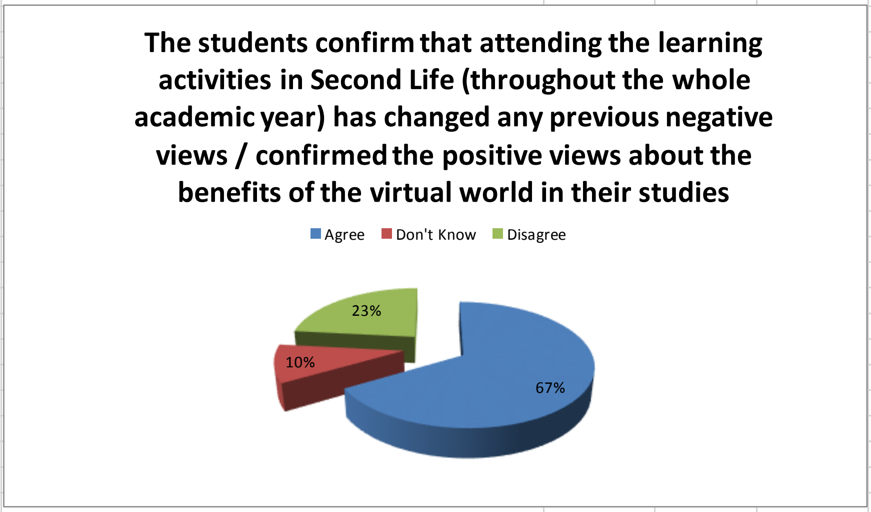
Group B

The students confirm that attending the learning activities in Second Life (throughout the whole academic year) has changed any previous negative views / confirmed the positive views about the benefits of the virtual world in their studies

Date	**22-Apr-13**
Participants	**6**

Seq.	Question	Fully Agree	Agree	I don't Know	Disagree	Fully disagree
6	Attending all the activities in Second Life throughout the academic year managed to change your initial idea/opinion about the use of virtual world in a positive manner.	1	3		2	
9	You believe that sometimes people are not open to new technologies and/or they have prejudgments based on one-side news or another person's experience.	1	3	1	1	
10	(Based on Question No. 9) – You believe that the statement in Question no. 9 applies to your initial judgment on Second Life. (If N/A tick here ☐)		3	1	2	
11	(Based on Question No. 9) – You believe that the experience obtained from attending the different activities in Second Life managed to change the negative opinion that you initially had on the use of virtual world in your higher education.(If N/A tick here ☐)	1	3		2	
12	(Based on Question No. 9) – You believe that you are open to new technologies and consider that it is very useful to have technology-enhanced tools in your higher education, one of which is the use of virtual worlds. (If N/A tick here ☐)	2	3	1		
	Total	**5**	**15**	**3**	**7**	**0**
		4.00		**0.60**	**1.40**	

The students confirm that attending the learning activities in Second Life (throughout the whole academic year) has changed any previous negative views / confirmed the positive views about the benefits of the virtual world in their studies	Agree	Don't Know	Disagree
6 students	**66.67**	**10.00**	**23.33**

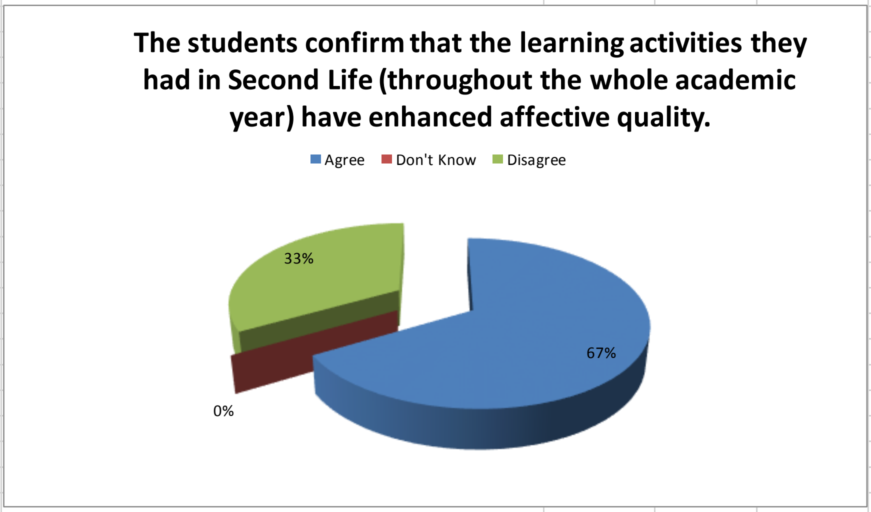


Group C
The students confirm that the learning activities they had in Second Life (throughout the whole academic year) have enhanced affective quality.

Date	22-Apr-13
Participants	6

Seq.	Question	Fully Agree	Agree	I don't Know	Disagree	Fully disagree
5	Generally, you enjoyed the different activities (or the majority of them) that you attended in Second Life, as they broke the routine activities in the physical classroom throughout the whole of the academic year.	1	3		2	
	Total	1	3	0	2	0
		4.00		0.00	2.00	

The students confirm that the learning activities they had in Second Life (throughout the whole academic year) have enhanced affective quality.	Agree	Don't Know	Disagree
6 students	66.67	0.00	33.33

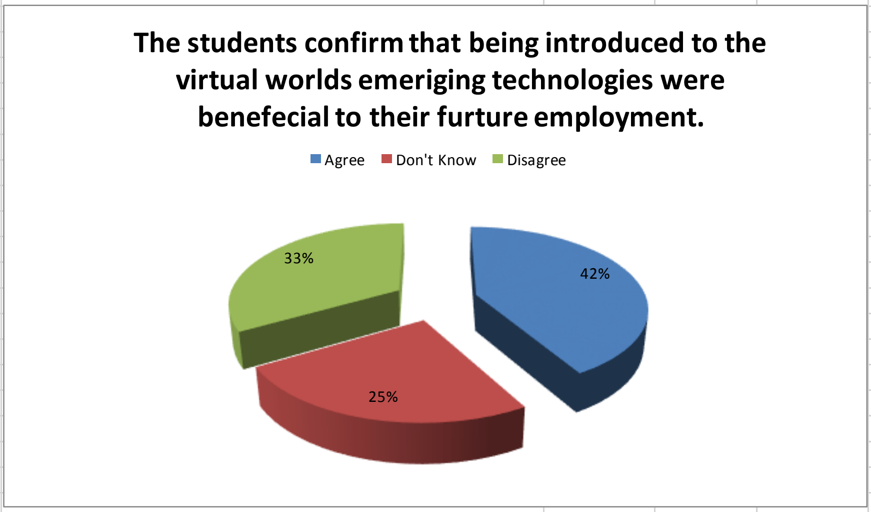


Group D
The students confirm that being introduced to the virtual worlds emeriging technologies were benefecial to their furture employment.

Date	**22-Apr-13**
Participants	**6**

Seq.	**Question**	Fully Agree	Agree	I don't Know	Disagree	Fully disagree
4	You believe that being introduced to the virtual world and its applications in Computing and some other fields is an opportunity for you to enrich your CV with an element that is not commonly found in the CVs of many other students. This might enhance your employment opportunity in the future.	**1**	**2**	**1**	**2**	
8	You think that you will be explaining the opportunities in Second Life to your future employer so that they extend their services and/or market for their customers.		**2**	**2**	**1**	**1**
	Total	**1**	**4**	**3**	**3**	**1**
		2.50		**1.50**	**2.00**	

The students confirm that being introduced to the virtual worlds emeriging technologies were benefecial to their furture employment.	**Agree**	**Don't Know**	**Disagree**
6 students	**41.67**	**25.00**	**33.33**



HE in Computing – Year 2:

Technology Enhanced Learning in Higher Education

Date	**18-Apr-13**
Participants	**11**

Foundation Degree in Applied Computing – Year 2

End of the Year Questionnaire

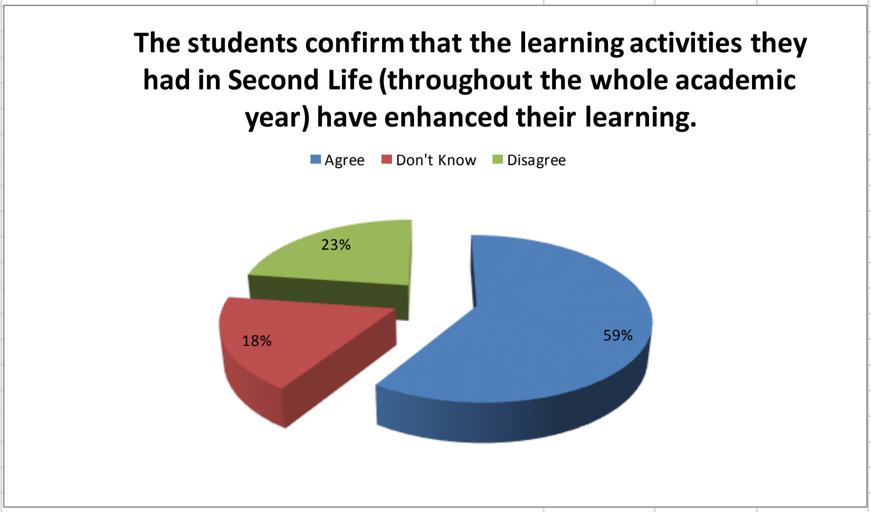
Seq.	Question	Fully Agree	Agree	I don't Know	Disagree	Fully disagree	N/A
1	The different educational activities that you had in the virtual world of Second Life provided you with a different experience to the traditional learning in the physical classroom environment.	3	7		1		
2	You believe that these activities were generally beneficial and facilitated your learning.	2	6	1	1	1	
3	If you believe that learning in the physical classroom is better and more beneficial to you, you also believe that having some educational activities in Second Life was not a waste of time, as it introduced you to a new technology in your specialist area – Computing.	3	2	3	3		
4	You believe that being introduced to the virtual world and its applications in Computing and some other fields is an opportunity for you to enrich your CV with an element that is not commonly found in the CVs of many other students. This might enhance your employment opportunity in the future.	3	3	4	1		
5	Generally, you enjoyed the different activities (or the majority of them) that you attended in Second Life, as they broke the routine activities in the physical classroom throughout the whole of the academic year.	2	6		3		
6	Attending all the activities in Second Life throughout the academic year managed to change your initial idea/opinion about the use of virtual world in a positive manner.	2	4		4	1	
7	If you are continuing your studies next year, you would like to have some more educational activities in Second Life to enhance and facilitate your learning.(If N/A tick here ☐)	1	2	1	3	1	3
8	You think that you will be explaining the opportunities in Second Life to your future employer so that they extend their services and/or market for their customers.	2	2	1	4	2	
9	You believe that sometimes people are not open to new technologies and/or they have prejudgments based on one-side news or another person's experience.	3	8				
10	(Based on Question No. 9) – You believe that the statement in Question no. 9 applies to your initial judgment on Second Life. (If N/A tick here ☐)	2	3		4	2	
11	(Based on Question No. 9) – You believe that the experience obtained from attending the different activities in Second Life managed to change the negative opinion that you initially had on the use of virtual world in your higher education.(If N/A tick here ☐)	1	2	1	4	1	2
12	(Based on Question No. 9) – You believe that you are open to new technologies and consider that it is very useful to have technology-enhanced tools in your higher education, one of which is the use of virtual worlds. (If N/A tick here ☐)	4	6				1

Group A
The students confirm that the learning activities they had in Second Life (throughout the whole academic year) have enhanced their learning.

Date	18-Apr-13
Participants	11

Seq.	Question	Fully Agree	Agree	I don't Know	Disagree	Fully disagree
1	The different educational activities that you had in the virtual world of Second Life provided you with a different experience to the traditional learning in the physical classroom environment.	3	7		1	
2	You believe that these activities were generally beneficial and facilitated your learning.	2	6	1	1	1
3	If you believe that learning in the physical classroom is better and more beneficial to you, you also believe that having some educational activities in Second Life was not a waste of time, as it introduced you to a new technology in your specialist area – Computing.	3	2	3	3	
7	If you are continuing your studies next year, you would like to have some more educational activities in Second Life to enhance and facilitate your learning.(If N/A tick here ☐)	1	2	4	3	1
	Total	9	17	8	8	2
		6.50		2.00	2.50	

The students confirm that the learning activities they had in Second Life (throughout the whole academic year) have enhanced their learning.	Agree	Don't Know	Disagree
11 students	59.09	18.18	22.73



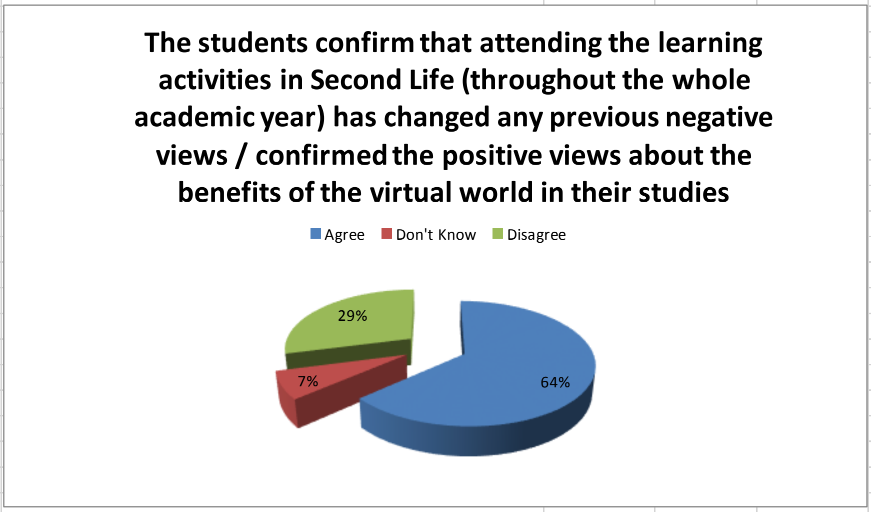
Group B

The students confirm that attending the learning activities in Second Life (throughout the whole academic year) has changed any previous negative views / confirmed the positive views about the benefits of the virtual world in their studies

Date	**18-Apr-13**
Participants	**11**

Seq.	Question	Fully Agree	Agree	I don't Know	Disagree	Fully disagree
6	Attending all the activities in Second Life throughout the academic year managed to change your initial idea/opinion about the use of virtual world in a positive manner.	2	4		4	1
9	You believe that sometimes people are not open to new technologies and/or they have prejudgments based on one-side news or another person's experience.	3	8			
10	(Based on Question No. 9) – You believe that the statement in Question no. 9 applies to your initial judgment on Second Life. (If N/A tick here ☐)	2	3		4	2
11	(Based on Question No. 9) – You believe that the experience obtained from attending the different activities in Second Life managed to change the negative opinion that you initially had on the use of virtual world in your higher education.(If N/A tick here ☐)	1	2	3	4	1
12	(Based on Question No. 9) – You believe that you are open to new technologies and consider that it is very useful to have technology-enhanced tools in your higher education, one of which is the use of virtual worlds. (If N/A tick here ☐)	4	6	1		
	Total	12	23	4	12	4
		7.00		0.80	3.20	

The students confirm that attending the learning activities in Second Life (throughout the whole academic year) has changed any previous negative views / confirmed the positive views about the benefits of the virtual world in their studies	Agree	Don't Know	Disagree
11 students	63.64	7.27	29.09

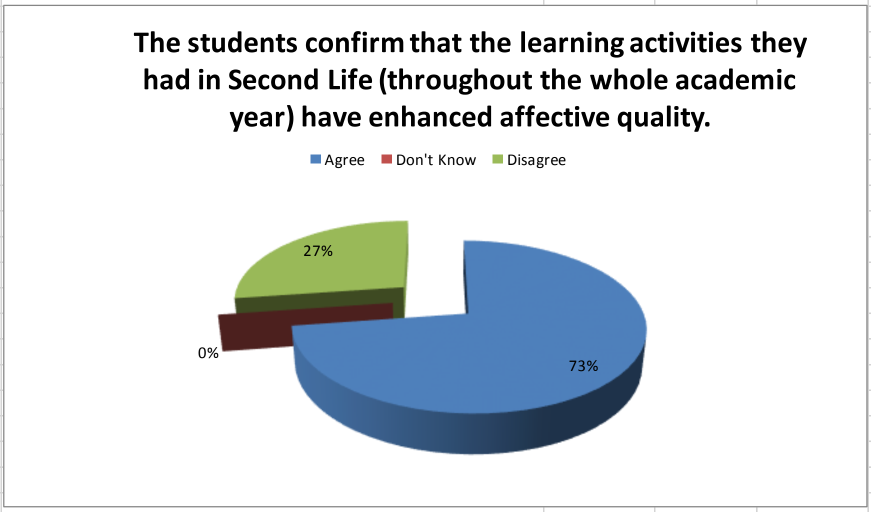


Group C
The students confirm that the learning activities they had in Second Life (throughout the whole academic year) have enhanced affective quality.

Date	18-Apr-13
Participants	11

Seq.	Question	Fully Agree	Agree	I don't Know	Disagree	Fully disagree
5	Generally, you enjoyed the different activities (or the majority of them) that you attended in Second Life, as they broke the routine activities in the physical classroom throughout the whole of the academic year.	2	6		3	
	Total	2	6	0	3	0
		8.00		0.00	3.00	

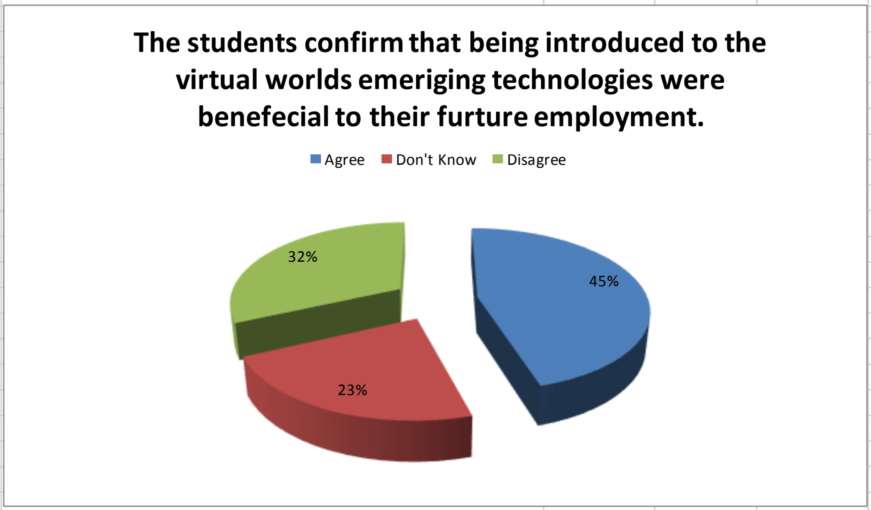
The students confirm that the learning activities they had in Second Life (throughout the whole academic year) have enhanced affective quality.	Agree	Don't Know	Disagree
11 students	72.73	0.00	27.27



Group D						
The students confirm that being introduced to the virtual worlds emeriging technologies were benefecial to their furture employment.						
				Date	18-Apr-13	
				Participants	11	

Seq.	Question	Fully Agree	Agree	I don't Know	Disagree	Fully disagree
4	You believe that being introduced to the virtual world and its applications in Computing and some other fields is an opportunity for you to enrich your CV with an element that is not commonly found in the CVs of many other students. This might enhance your employment opportunity in the future.	3	3	4	1	
8	You think that you will be explaining the opportunities in Second Life to your future employer so that they extend their services and/or market for their customers.	2	2	1	4	2
	Total	**5**	**5**	**5**	**5**	**2**
		5.00		**2.50**	**3.50**	

The students confirm that being introduced to the virtual worlds emeriging technologies were benefecial to their furture employment.	Agree	Don't Know	Disagree
11 students	45.45	22.73	31.82



HE in Computing – BSc (Year 3):

Technology Enhanced Learning in Higher Education

Date	17-Apr-13
Participants	7

Foundation Degree in Applied Computing – Year3

End of the Year Questionnaire

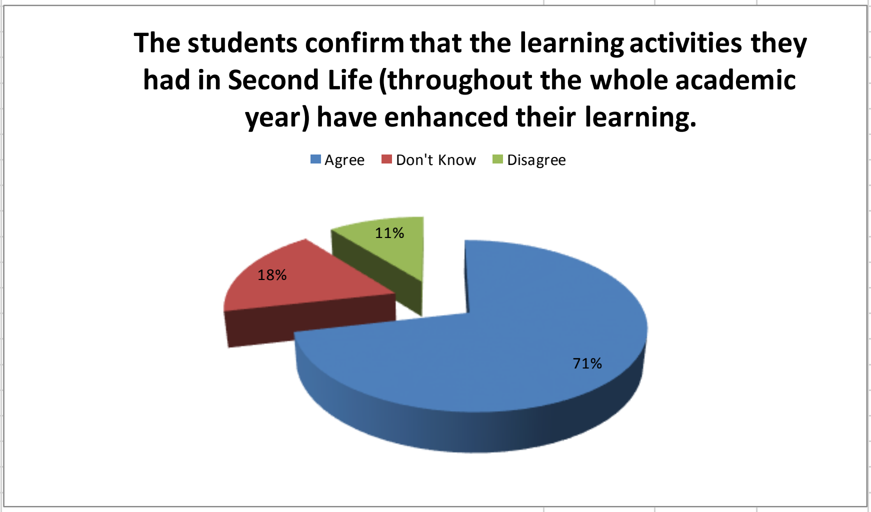
Seq.	Question	Fully Agree	Agree	I don't Know	Disagree	Fully disagree	N/A
1	The different educational activities that you had in the virtual world of Second Life provided you with a different experience to the traditional learning in the	4	3				
2	You believe that these activities were generally beneficial and facilitated your learning.	1	5			1	
3	If you believe that learning in the physical classroom is better and more beneficial to you, you also believe that having some educational activities in Second Life was not a waste of time, as it introduced you to a new technology in your specialist area – Computing.	2	4			1	
4	You believe that being introduced to the virtual world and its applications in Computing and some other fields is an opportunity for you to enrich your CV with an element that is not commonly found in the CVs of many other students. This might enhance your employment opportunity in the future.	1	4	1	1		
5	Generally, you enjoyed the different activities (or the majority of them) that you attended in Second Life, as they broke the routine activities in the physical classroom throughout the whole of the academic year.	2	3	1		1	
6	Attending all the activities in Second Life throughout the academic year managed to change your initial idea/opinion about the use of virtual world in a positive manner.	2	4			1	
7	If you are continuing your studies next year, you would like to have some more educational activities in Second Life to enhance and facilitate your learning.(If N/A tick here ☐)	1				1	5
8	You think that you will be explaining the opportunities in Second Life to your future employer so that they extend their services and/or market for their customers.		2	3	1	1	
9	You believe that sometimes people are not open to new technologies and/or they have prejudgments based on one-side news or another person's experience.	4	3				
10	(Based on Question No. 9) – You believe that the statement in Question no. 9 applies to your initial judgment on Second Life. (If N/A tick here ☐)		5			2	
11	(Based on Question No. 9) – You believe that the experience obtained from attending the different activities in Second Life managed to change the negative opinion that you initially had on the use of virtual world in your higher education.(If N/A tick here ☐)		4	1		1	1
12	(Based on Question No. 9) – You believe that you are open to new technologies and consider that it is very useful to have technology-enhanced tools in your higher education, one of which is the use of virtual worlds. (If N/A tick here ☐)	4	2	1			

Group A						
The students confirm that the learning activities they had in Second Life (throughout the whole academic year) have enhanced their learning.						

Date	17-Apr-13
Participants	7

Seq.	Question	Fully Agree	Agree	I don't Know	Disagree	Fully disagree
1	The different educational activities that you had in the virtual world of Second Life provided you with a different experience to the traditional	4	3			
2	You believe that these activities were generally beneficial and facilitated your learning.	1	5			1
3	If you believe that learning in the physical classroom is better and more beneficial to you, you also believe that having some educational activities in Second Life was not a waste of time, as it introduced you to a new technology in your specialist area – Computing.	2	4			1
7	If you are continuing your studies next year, you would like to have some more educational activities in Second Life to enhance and	1		5		1
	Total	8	12	5	0	3
		5.00		1.25	0.75	

The students confirm that the learning activities they had in Second Life (throughout the whole academic year) have enhanced their learning.	Agree	Don't Know	Disagree
7 students	71.43	17.86	10.71

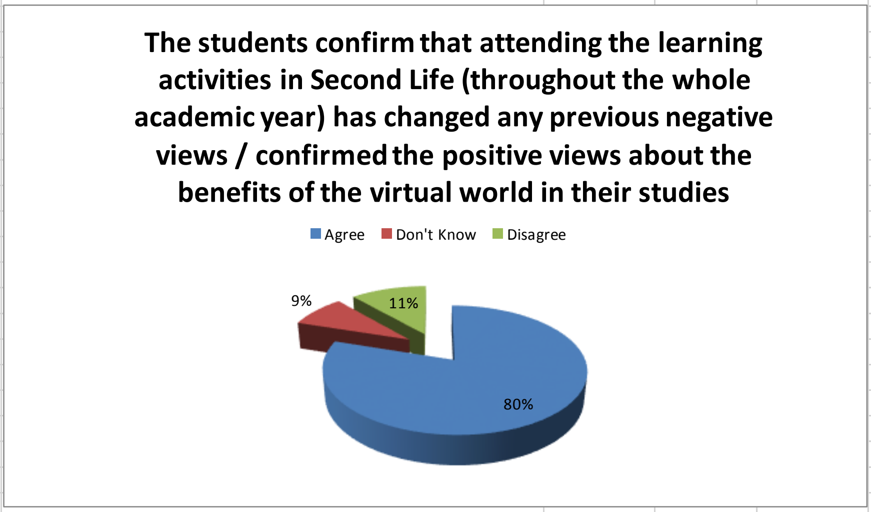


Group B						
The students confirm that attending the learning activities in Second Life (throughout the whole academic year) has changed any previous negative views / confirmed the positive views about the benefits of the virtual world in their studies						

Date	17-Apr-13
Participants	7

Seq.	Question	Fully Agree	Agree	I don't Know	Disagree	Fully disagree
6	Attending all the activities in Second Life throughout the academic year managed to change your initial idea/opinion about the use of virtual world in a positive manner.	2	4			1
9	You believe that sometimes people are not open to new technologies and/or they have prejudgments based on one-side news or another person's experience.	4	3			
10	(Based on Question No. 9) – You believe that the statement in Question no. 9 applies to your initial judgment on Second Life. (If N/A tick here ☐)		5			2
11	(Based on Question No. 9) – You believe that the experience obtained from attending the different activities in Second Life managed to change the negative opinion that you initially had on the use of virtual world in your higher education.(If N/A tick here ☐)		4	2		1
12	(Based on Question No. 9) – You believe that you are open to new technologies and consider that it is very useful to have technology-enhanced tools in your higher education, one of which is the use of virtual worlds. (If N/A tick here ☐)	4	2	1		
	Total	10	18	3	0	4
		5.60		0.60	0.80	

The students confirm that attending the learning activities in Second Life (throughout the whole academic year) has changed any previous negative views / confirmed the positive views about the benefits of the virtual world in their studies	Agree	Don't Know	Disagree
7 students	80.00	8.57	11.43

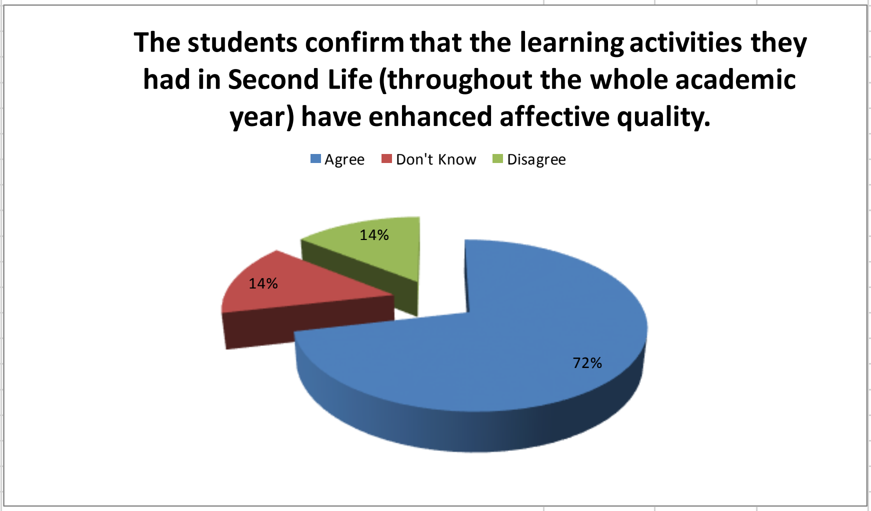


Group C
The students confirm that the learning activities they had in Second Life (throughout the whole academic year) have enhanced affective quality.

Date	17-Apr-13
Participants	7

Seq.	Question	Fully Agree	Agree	I don't Know	Disagree	Fully disagree
5	Generally, you enjoyed the different activities (or the majority of them) that you attended in Second Life, as they broke the routine activities	2	3	1		1
	Total	2	3	1	0	1
		5.00		1.00	1.00	

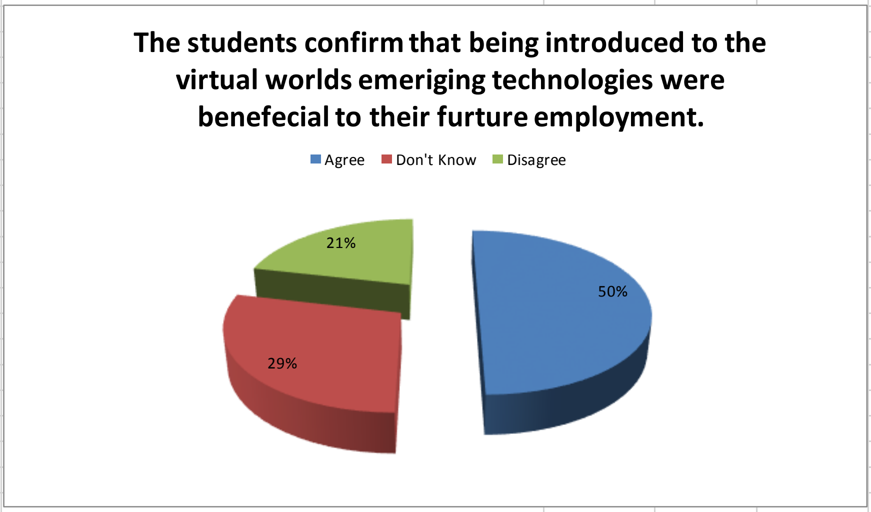
The students confirm that the learning activities they had in Second Life (throughout the whole academic year) have enhanced affective quality.	Agree	Don't Know	Disagree
7 students	71.43	14.29	14.29



Group D						
The students confirm that being introduced to the virtual worlds emeriging technologies were benefecial to their furture employment.						
				Date	17-Apr-13	
				Participants	7	

Seq.	Question	Fully Agree	Agree	I don't Know	Disagree	Fully disagree
4	You believe that being introduced to the virtual world and its applications in Computing and some other fields is an opportunity for you to enrich your CV with an element that is not commonly found in the CVs of many other students. This might enhance your employment opportunity in the future.	1	4	1	1	
8	You think that you will be explaining the opportunities in Second Life to your future employer so that they extend their services and/or market for their customers.		2	3	1	1
	Total	1	6	4	2	1
		3.50		2.00	1.50	

The students confirm that being introduced to the virtual worlds emeriging technologies were benefecial to their furture employment.	Agree	Don't Know	Disagree
7 students	50.00	28.57	21.43



A3.3 Data Analysis of HE Modules - Academic year 2012/2013

Computer Hardware – Year 1:

Technology Enhanced Learning in Higher Education

The use of Second Life to visualize difficult concepts in Computing – Computer Hardware

Foundation Degree in Applied Computing – Year 1

Date	12-Nov-12
Participants	8

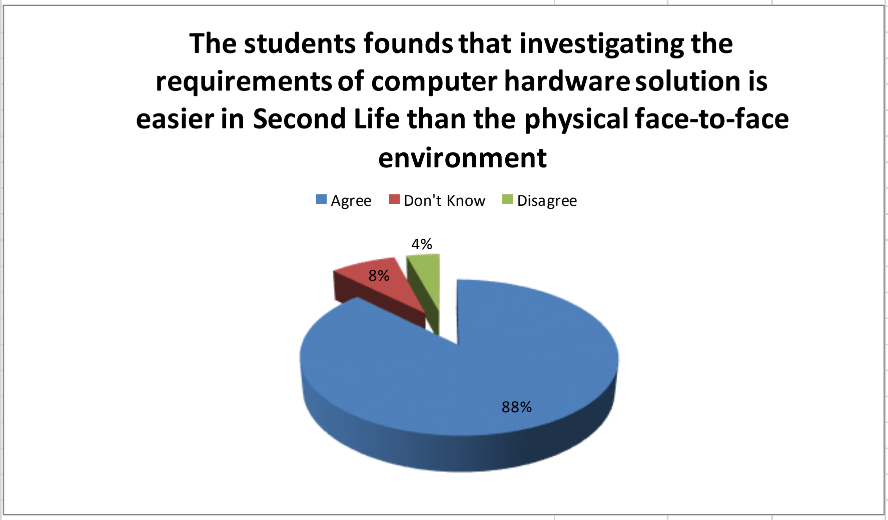
Seq.	Question	Fully Agree	Agree	I don't Know	Disagree	Fully disagree
1	You have found out that investigating the requirements of computer hardware solutions in Second Life is easier than that in a face-to-face appointment with employers.	1	6		1	
2	You felt that you had more self-confidence in running interviews and managing very technical discussions in computing with employers in the virtual world compared to the physical world.	1	5	2		
3	You believe that talking to an avatar in a virtual world removes the possible barriers to conversation with high-rank people in the physical world.	2	6			
4	After carrying out 3 interviews with employers in Second Life to investigate the proper hardware solutions for their businesses, you believe that if you are given the choice in a similar situation, you will chose the virtual world again.		5	2	1	
5	You believe that the virtual world of Second Life is a useful tool to enhance the learning and achievement of Computing students.		6	2		
6	You will think of using the virtual world of Second Life in the future after you complete the unit.		3	4	1	

Group A						
The students founds that investigating the requirements of computer hardware solution is easier in Second Life than the physical face-to-face environment						

Date	12-Nov-12
Participants	8

Seq.	Question	Fully Agree	Agree	I don't Know	Disagree	Fully disagree
1	You have found out that investigating the requirements of computer hardware solutions in Second Life is easier than that in a face-to-face appointment with employers.	1	6		1	
2	You felt that you had more self-confidence in running interviews and managing very technical discussions in computing with employers in the virtual world compared to the physical world.	1	5	2		
3	You believe that talking to an avatar in a virtual world removes the possible barriers to conversation with high-rank people in the physical world.	2	6			
	Total	4	17	2	1	0
		7.00		0.67	0.33	

The students founds that investigating the requirements of computer hardware solution is easier in Second Life than the physical face-to-face environment	Agree	Don't Know	Disagree
8 students	87.50	8.33	4.17

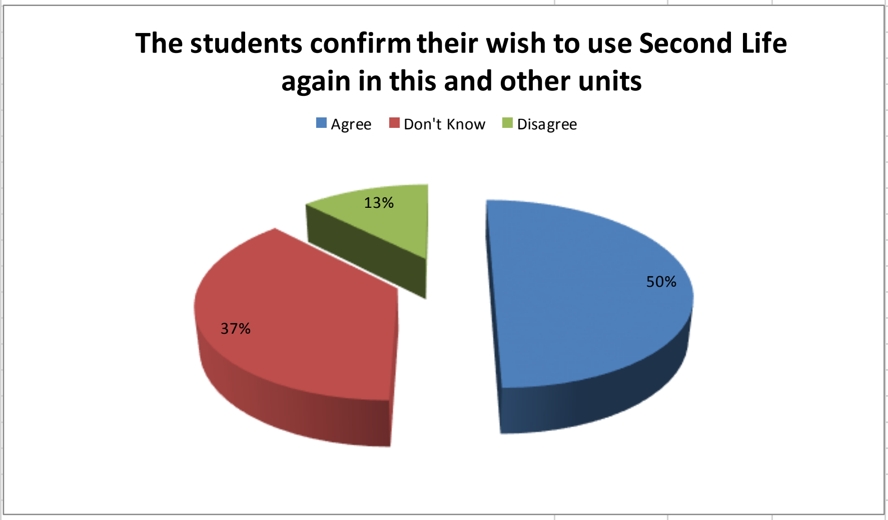


Group B						
The students confirm their wish to use Second Life again in this and other units						

Date	12-Nov-12
Participants	8

Seq.	Question	Fully Agree	Agree	I don't Know	Disagree	Fully disagree
4	After carrying out 3 interviews with employers in Second Life to investigate the proper hardware solutions for their businesses, you believe that if you are given the choice in a similar situation, you will chose the virtual world again.		5	2	1	
6	You will think of using the virtual world of Second Life in the future after you complete the unit.		3	4	1	
	Total	0	8	6	2	0
		4.00		3.00	1.00	

The students confirm their wish to use Second Life again in this and other units	Agree	Don't Know	Disagree
8 students	50.00	37.50	12.50

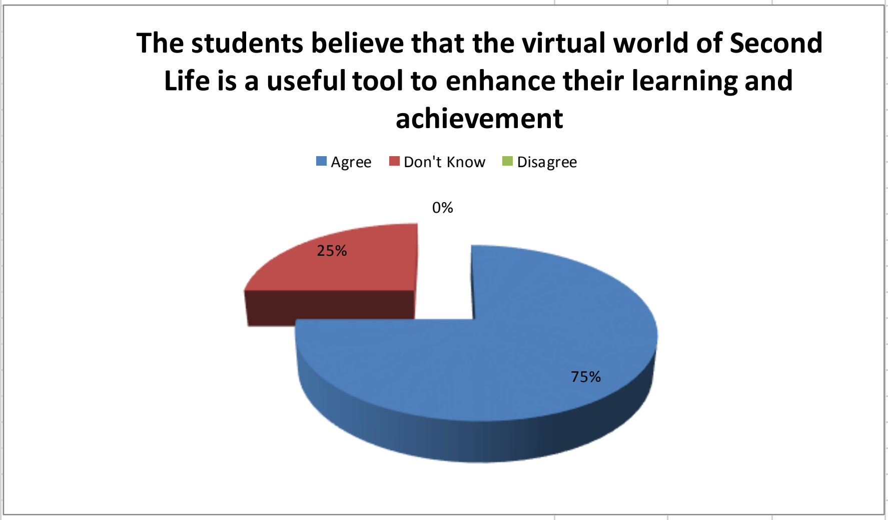


Group C						
The students believe that the virtual world of Second Life is a useful tool to enhance their learning and achievement						

Date	12-Nov-12
Participants	8

Seq.	Question	Fully Agree	Agree	I don't Know	Disagree	Fully disagree
5	You believe that the virtual world of Second Life is a useful tool to enhance the learning and achievement of Computing students.		6	2		
	Total	0	6	2	0	0
		6.00		2.00	0.00	

The students believe that the virtual world of Second Life is a useful tool to enhance their learning and achievement	Agree	Don't Know	Disagree
8 students	75.00	25.00	0.00



Database Normalisation – Year 1:

Technology Enhanced Learning in Higher Education

The use of Second Life to visualize difficult concepts in Computing – Database Normalization

Foundation Degree in Applied Computing – Year 1

Date	**27-Feb-13**
Participants	**7**

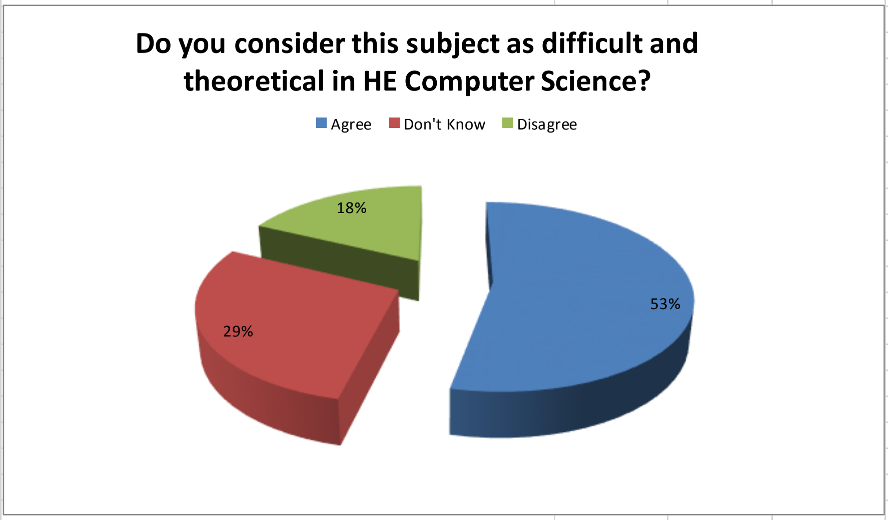
Seq.	Question	Fully Agree	Agree	I don't Know	Disagree	Fully disagree
1	You consider that the database normalization is a difficult subject in HE Computing.	**1**	**5**		**1**	
2	You believe that the delivery of this subject should incorporate a more visual and interactive method, in which you participate further in the process of collecting and analysing the data.		**5**	**1**		**1**
3	According to your unit lecturer, you were unable to remember the explanations delivered to you on the database normalization subject (in the physical classroom) a week later.		**2**	**4**	**1**	
4	You have enjoyed the scenario designed for you in the virtual world of Second Life to learn database normalization.	**1**	**3**	**2**		**1**
5	You believe that the scenario in Second Life was useful and appropriate to facilitate your understanding and learning of this difficult concept.		**4**	**2**	**1**	
6	You liked the idea of role-playing and gathering the information yourself for the database in the virtual world.		**5**	**1**		**1**
7	Being able to observe your peers' investigation of the information/data in the virtual world, and being able to interact with them in this process has facilitated and enhanced your learning of this subject.		**3**	**2**	**1**	**1**
8	As you have now received tuition on this subject in both the physical and the virtual worlds, you believe that the database normalization is better learned in the virtual world.		**2**	**3**	**1**	**1**
9	You felt more encouraged to take a more active role in the virtual world for your own learning of this subject.		**3**	**1**	**2**	**1**
10	You felt more enthusiastic to explore the learning space designed for you in the virtual world and to investigate the scenario provided for this subject.		**6**			**1**
11	You had a less engagement in the activities of the database normalization lesson in the physical classroom.	**1**	**2**	**3**		**1**
12	When you had the lesson for the database normalization subject in the physical classroom, you realised that this subject requires a method beyond the white/smart board and the presentation/handout approach.		**2**	**3**		**2**
13	Having immersed and role played in the virtual scenario to learn database normalization, you believe that you will be able to better recall the information you learned in the virtual world compared to the physical one.		**3**	**3**		**1**
14	You prefer using the 3D multimedia environment of Second Life to visualize other difficult concepts in your Computing degree to facilitate your learning and achievement.		**4**	**1**	**1**	**1**

Group A
Do you consider this subject as difficult and theoretical in HE Computer Science?

Date	27-Feb-13
Participants	7

Seq.	Question	Fully Agree	Agree	I don't Know	Disagree	Fully disagree
1	You consider that the database normalization is a difficult subject in HE Computing.	1	5		1	
2	You believe that the delivery of this subject should incorporate a more visual and interactive method, in which you participate further in the process of collecting and analysing the data.		5	1		1
3	According to your unit lecturer, you were unable to remember the explanations delivered to you on the database normalization subject (in the physical classroom) a week later.		2	4	1	
12	When you had the lesson for the database normalization subject in the physical classroom, you realised that this subject requires a method beyond the white/smart board and the presentation/handout approach.		2	3		2
	Total	1	14	8	2	3
		3.75		2.00	1.25	

Do you consider this subject as difficult and theoretical in HE Computer Science?	Agree	Don't Know	Disagree
7 students	53.57	28.57	17.86

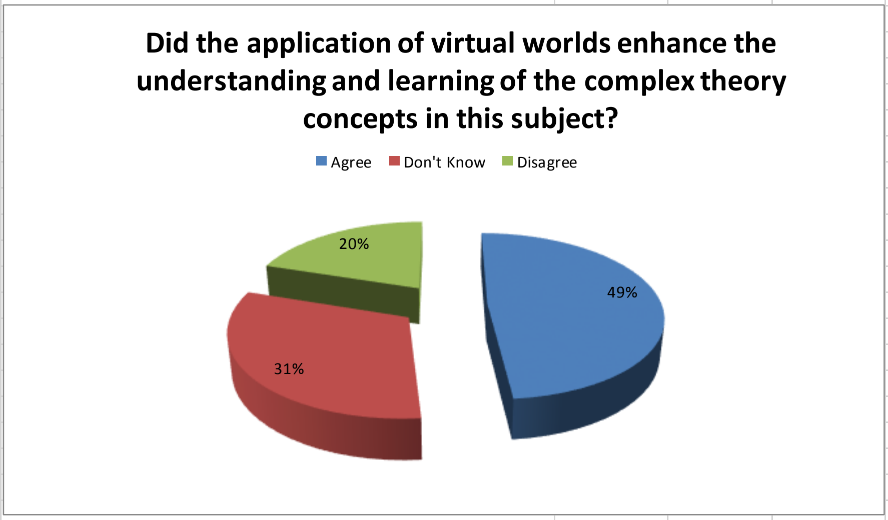


Group B						
Did the application of virtual worlds enhance the understanding and learning of the complex theory concepts in this subject?						

Date	27-Feb-13
Participants	7

Seq.	Question	Fully Agree	Agree	I don't Know	Disagree	Fully disagree
5	You believe that the scenario in Second Life was useful and appropriate to facilitate your understanding and learning of this difficult concept.		4	2	1	
6	You liked the idea of role-playing and gathering the information yourself for the database in the virtual world.		5	1		1
7	Being able to observe your peers' investigation of the information/data in the virtual world, and being able to interact with them in this process has facilitated and enhanced your learning of this subject.		3	2	1	1
8	As you have now received tuition on this subject in both the physical and the virtual worlds, you believe that the database normalization is better learned in the virtual world.		2	3	1	1
13	Having immersed and role played in the virtual scenario to learn database normalization, you believe that you will be able to better recall the information you learned in the virtual world compared to the physical one.		3	3		1
	Total	0	17	11	3	4
		3.40		2.20	1.40	

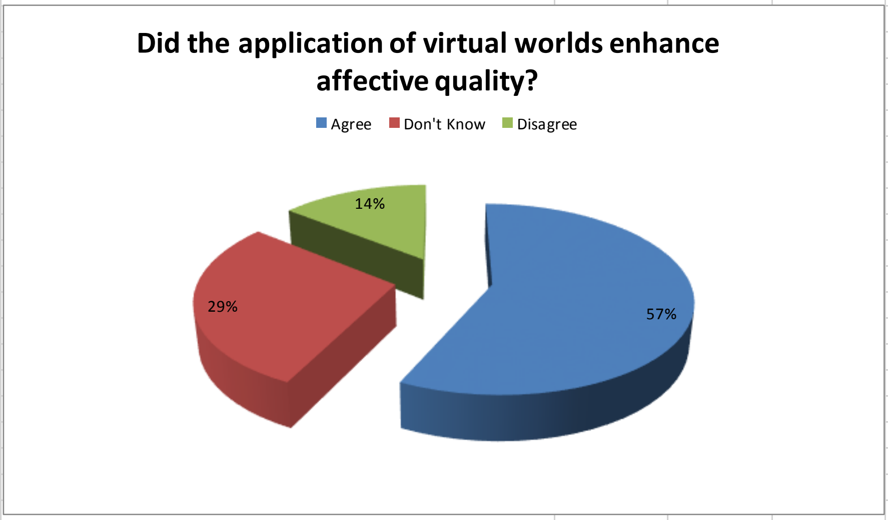
Did the application of virtual worlds enhance the understanding and learning of the complex theory concepts in this subject?	Agree	Don't Know	Disagree
7 students	48.57	31.43	20.00



Group C						
Did the application of virtual worlds enhance affective quality?						
				Date	27-Feb-13	
				Participants	7	

Seq.	Question	Fully Agree	Agree	I don't Know	Disagree	Fully disagree
4	You have enjoyed the scenario designed for you in the virtual world of Second Life to learn database normalization.	1	3	2		1
	Total	1	3	2	0	1
		4.00		2.00	1.00	

Did the application of virtual worlds enhance affective quality?	Agree	Don't Know	Disagree
7 students	57.14	28.57	14.29



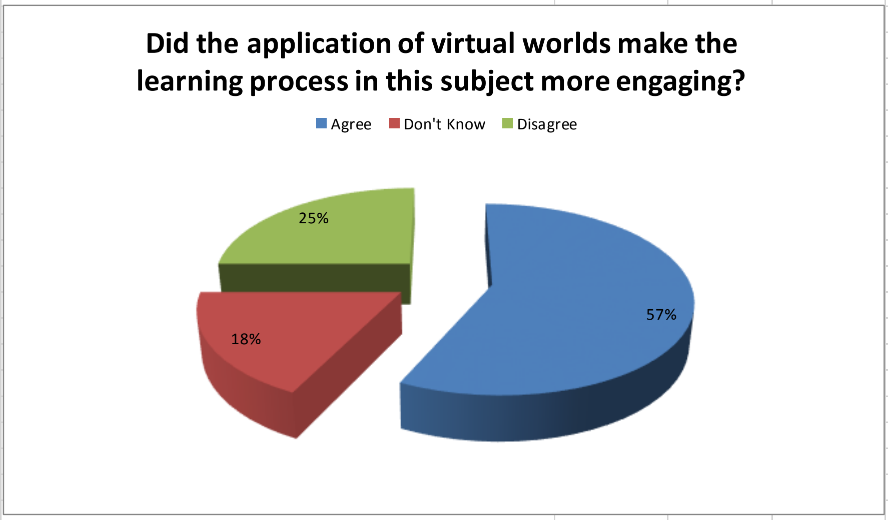
Group D

Did the application of virtual worlds make the learning process in this subject more engaging?

Date	27-Feb-13
Participants	7

Seq.	Question	Fully Agree	Agree	I don't Know	Disagree	Fully disagree
9	You felt more encouraged to take a more active role in the virtual world for your own learning of this subject.		3	1	2	1
10	You felt more enthusiastic to explore the learning space designed for you in the virtual world and to investigate the scenario provided for this subject.		6			1
11	You had a less engagement in the activities of the database normalization lesson in the physical classroom.	1	2	3		1
14	You prefer using the 3D multimedia environment of Second Life to visualize other difficult concepts in your Computing degree to facilitate your learning and achievement.		4	1	1	1
	Total	1	15	5	3	4
		4.00		1.25	1.75	

Did the application of virtual worlds make the learning process in this subject more engaging?	Agree	Don't Know	Disagree
7 students	57.14	17.86	25.00



Computer Programming – Year 1 (2 Questionnaires):

Technology Enhanced Learning in Higher Education

The use of SecondLife to visualize difficult concepts in Computing – Programming

Foundation Degree in Applied Computing – Year 1

Date	27-Feb-13
Participants	6

Seq.	Question	Fully Agree	Agree	I don't Know	Disagree	Fully disagree
1	You consider that the learning programming is a difficult subject in HE Computing.	3			3	
2	You believe that the delivery of this subject should incorporate a more visual and interactive method, in which you interact further with the program that you produce and its results.	1	4		1	
3	According to your unit lecturer and previous observations to your programming sessions, you face difficulties in learning essential programming concepts like the different types of loops and the type of execution expected as a result of applying them in a program.		4			2
4	You believe that seeing the visual result of individual instructions that you apply in the program (in the virtual world) has facilitated a better understanding of what these individual programming instructions do.		5	1		
5	You have enjoyed the scenario designed for you in the virtual world of SecondLife to learn programming in a visual manner.	4	2			
6	You believe that programming 3D objects in the multimedia environment of SecondLife has facilitated a better imagination of what a computer program do.	1	4			1
7	You believe that the scenario in SecondLife was useful and appropriate to facilitate your understanding and learning of this difficult subject.	1	5			
8	You liked the idea of interacting with your peers in the virtual world to program a mutual object in a competition to achieve a final target.	1	4		1	
9	Being able to observe your peers' achievement with their 3D objects in the virtual world, and being able to interact with them in the programming process has facilitated and enhanced your learning of this subject.		5		1	
10	As you have now received tuition on this subject in both the physical and the virtual worlds, you believe that programming is better learned in the virtual world.		3	1		2
11	You felt more encouraged to take a more active role in the virtual world for your own learning of computer programming.		3	1	1	1
12	You felt more enthusiastic to apply the programming instructions to a 3D object in the virtual world compared to the ordinary variables in the physical world.	1	3	1		1
13	You felt having less engagement in the programming activities carried out in the physical classroom compared to the virtual world.		3	2	1	
14	When you had the programming lessons in the physical classroom, you realised that this subject requires a method beyond the white/smart board and the presentation/handout approach.	1	3			2
15	Having immersed in the 3D virtual world and its objects, you believe that you will be able to better recall the programming instructions that you learned in the virtual world compared to the physical one.	1	4			1
16	You prefer using the 3D multimedia environment of SecondLife to visualize other difficult concepts in your Computing degree to facilitate your learning and achievement.	1	3	1		1

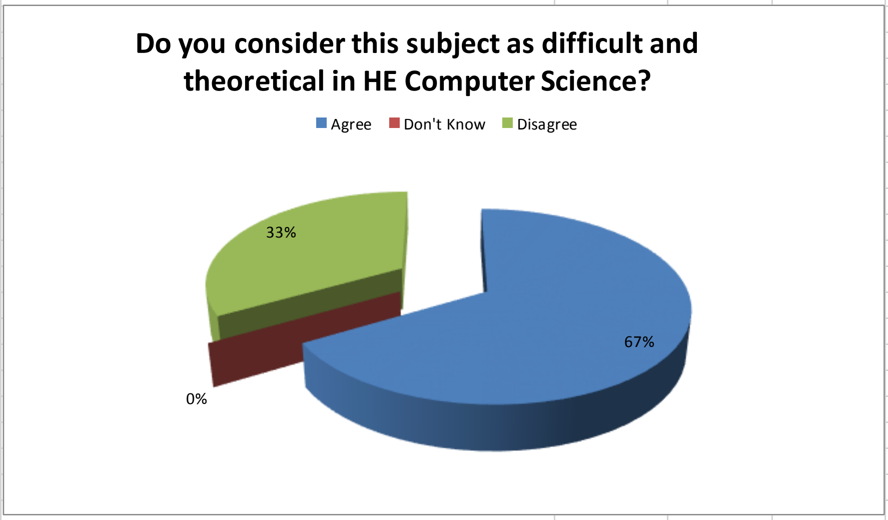
Group A

Do you consider this subject as difficult and theoretical in HE Computer Science?

Date	27-Feb-13
Participants	6

Seq.	Question	Fully Agree	Agree	I don't Know	Disagree	Fully disagree
1	You consider that the learning programming is a difficult subject in HE Computing.	3			3	
2	You believe that the delivery of this subject should incorporate a more visual and interactive method, in which you interact further with the program that you produce and its results.	1	4		1	
3	According to your unit lecturer and previous observations to your programming sessions, you face difficulties in learning essential programming concepts like the different types of loops and the type of execution expected as a result of applying them in a program.		4			2
14	When you had the programming lessons in the physical classroom, you realised that this subject requires a method beyond the white/smart board and the presentation/handout approach.	1	3			2
	Total	5	11	0	4	4
		4.00		0.00	2.00	

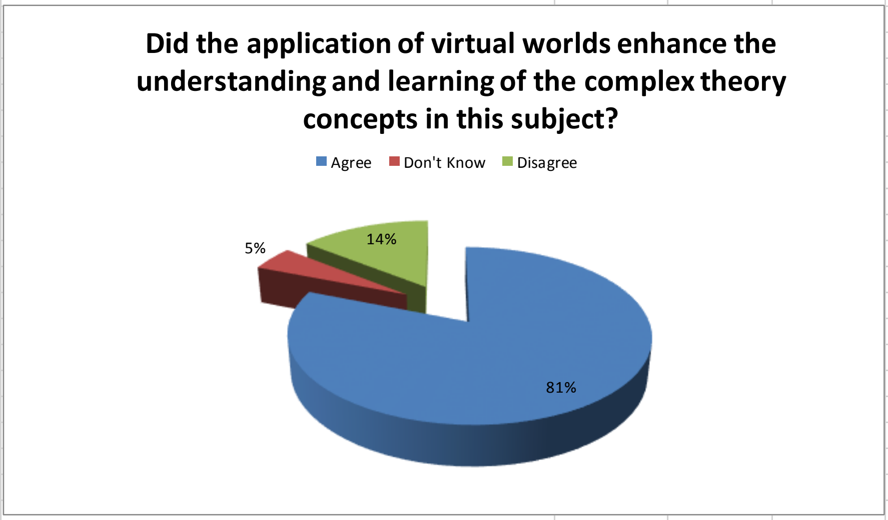
Do you consider this subject as difficult and theoretical in HE Computer Science?	Agree	Don't Know	Disagree
6 students	66.67	0.00	33.33



Group B						
Did the application of virtual worlds enhance the understanding and learning of the complex theory concepts in this subject?						
				Date	27-Feb-13	
				Participants	6	

Seq.	Question	Fully Agree	Agree	I don't Know	Disagree	Fully disagree
4	You believe that seeing the visual result of individual instructions that you apply in the program (in the virtual world) has facilitated a better understanding of what these individual programming instructions do.		5	1		
6	You believe that programming 3D objects in the multimedia environment of SecondLife has facilitated a better imagination of what a computer program do.	1	4			1
7	You believe that the scenario in SecondLife was useful and appropriate to facilitate your understanding and learning of this difficult subject.	1	5			
8	You liked the idea of interacting with your peers in the virtual world to program a mutual object in a competition to achieve a final target.	1	4		1	
9	Being able to observe your peers' achievement with their 3D objects in the virtual world, and being able to interact with them in the programming process has facilitated and enhanced your learning of this subject.		5		1	
10	As you have now received tuition on this subject in both the physical and the virtual worlds, you believe that programming is better learned in the virtual world.		3	1		2
15	Having immersed in the 3D virtual world and its objects, you believe that you will be able to better recall the programming instructions that you learned in the virtual world compared to the physical one.	1	4			1
	Total	4	30	2	2	4
		4.86		0.29	0.86	

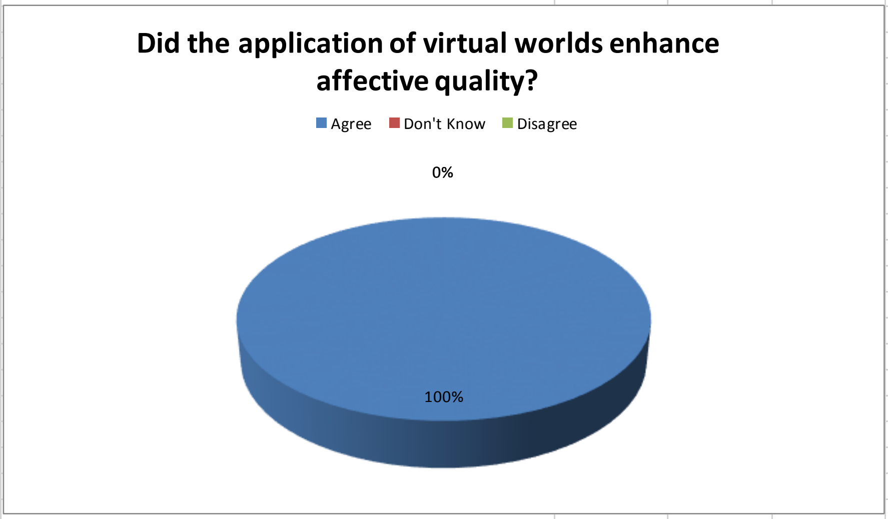
Did the application of virtual worlds enhance the understanding and learning of the complex theory concepts in this subject?	Agree	Don't Know	Disagree
6 students	80.95	4.76	14.29



Group C						
Did the application of virtual worlds enhance affective quality?						
					Date	27-Feb-13
					Participants	6

Seq.	Question	Fully Agree	Agree	I don't Know	Disagree	Fully disagree
5	You have enjoyed the scenario designed for you in the virtual world of SecondLife to learn programming in a visual manner.	4	2			
	Total	**4**	**2**	**0**	**0**	**0**
		6.00		**0.00**	**0.00**	

Did the application of virtual worlds enhance affective quality?	Agree	Don't Know	Disagree
6 students	100.00	0.00	0.00

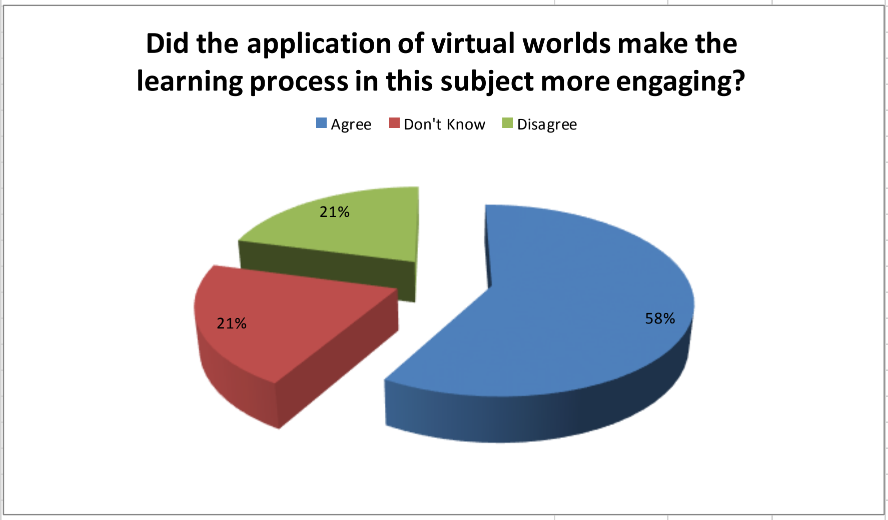


Group D						
Did the application of virtual worlds make the learning process in this subject more engaging?						

Date	27-Feb-13
Participants	6

Seq.	Question	Fully Agree	Agree	I don't Know	Disagree	Fully disagree
11	You felt more encouraged to take a more active role in the virtual world for your own learning of computer programming.		3	1	1	1
12	You felt more enthusiastic to apply the programming instructions to a 3D object in the virtual world compared to the ordinary variables in the physical world.	1	3	1		1
13	You felt having less engagement in the programming activities carried out in the physical classroom compared to the virtual world.		3	2	1	
16	You prefer using the 3D multimedia environment of SecondLife to visualize other difficult concepts in your Computing degree to facilitate your learning and achievement.	1	3	1		1
	Total	2	12	5	2	3
		3.50		1.25	1.25	

Did the application of virtual worlds make the learning process in this subject more engaging?	Agree	Don't Know	Disagree
6 students	58.33	20.83	20.83



Introduction to Object Oriented Programming

Date	15-Apr-13
Participants	6

Object Oriented Programming

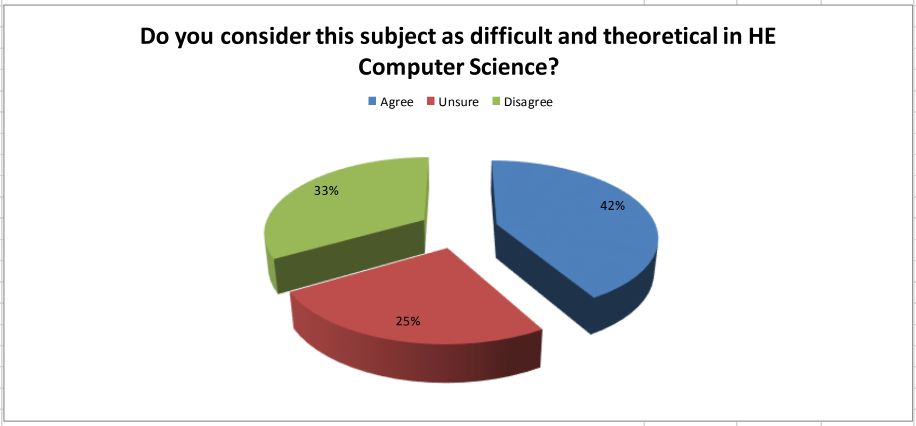
Seq.	Question	Agree	Somewhat Agree	Unsure	Somewhat Disagree	Disagree
1	The scenario increased my understanding of the concepts.	3	1	1		1
2	I was able to explain the concepts following the scenario.	2	4			
3	The virtual world helped me to visualize the ideas better than I could have in the real world.	3	1		1	1
4	The scenario was appealing.	3	2		1	
5	I would like to have similar scenarios to help me understand difficult concepts.	4			2	
6	The scenario helped me to imagine how user defined data types are created.	4		1		1
7	The scenario was a good representation of design and creation of structures and classes.	3	3			
8	The links between variables, structures and classes helped me build on my knowledge.	2	3		1	
9	The situation of a virtual world provided less distractions than the real world allowing me to concentrate more fully on the issue in hand.	3	1			2
10	The ability to move around an environment helped me to learn.	3		3		
11	The scenario formed a good basis on which to progress.	2	3		1	
12	The scenario could have been used in a standalone situation.	2	2	2		
13	The scenario added interest to the Introduction to Programming unit.	3		2	1	
14	The scenario made the concepts memorable.	3		2	1	
15	I quickly understood the concept of a class; how to create one and how to create an object.	1	4	1		
16	You consider that Object Oriented Programming is a difficult concept.	1	1	2	1	1
17	As previous physical lectures have been delivered to you to introduce concepts of Object Oriented Programming, you realised that the delivery of this subject requires resources beyond the traditional white/smart board, projector…etc.	2	1	1	1	1
18	As you were allowed the opportunity to have this subject delivered to you in both the physical classroom situation and in a virtual world scenario, the latter has better facilitated your learning and understanding of this subject.	2	1	1	1	1
19	Following carrying out this transition activity in the virtual world and the previous activity to learn programming in the virtual world, you believe that you prefer to learn Object Oriented Programming in the virtual world.	3		1	1	1
20	You believe that being within the 3D visual environment of the virtual world of Second Life enables a more relaxing atmosphere when coding and a less panicking situation when dealing with the code syntax and errors.	3		1	2	
21	Generally, you believe that the 3D visualization of difficult Computing concepts in the virtual world facilitates their understanding and learning.	2	3		1	

Group A						
Do you consider this subject as difficult and theoretical in HE Computer Science?						

					Date	**15-Apr-13**
					Participants	**6**

Seq.	Question	Agree	Somewhat Agree	Unsure	Somewhat Disagree	Disagree
16	You consider that Object Oriented Programming is a difficult concept.	**1**	**1**	**2**	**1**	**1**
17	As previous physical lectures have been delivered to you to introduce concepts of Object Oriented Programming, you realised that the delivery of this subject requires resources beyond the traditional white/smart board, projector…etc.	**2**	**1**	**1**	**1**	**1**
	Total	**3**	**2**	**3**	**2**	**2**
		2.50		**1.50**	**2.00**	

Do you consider this subject as difficult and theoretical in HE Computer Science?	Agree	Unsure	Disagree
6 students	41.67	25.00	33.33

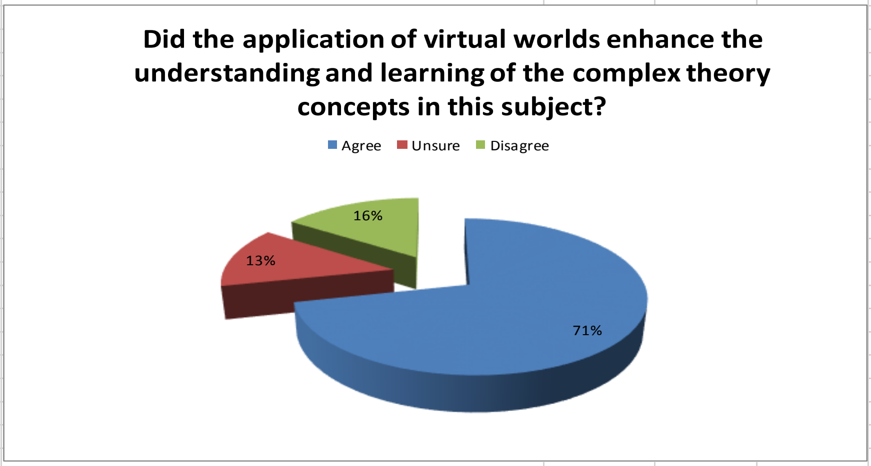


Group B
Did the application of virtual worlds enhance the understanding and learning of the complex theory concepts in this subject?

Date	15-Apr-13
Participants	6

Seq.	Question	Agree	Somewhat Agree	Unsure	Somewhat Disagree	Disagree
1	The scenario increased my understanding of the concepts.	3	1	1		1
2	I was able to explain the concepts following the scenario.	2	4			
3	The virtual world helped me to visualize the ideas better than I could have in the real world.	3	1		1	1
6	The scenario helped me to imagine how user defined data types are created.	4		1		1
7	The scenario was a good representation of design and creation of structures and classes.	3	3			
8	The links between variables, structures and classes helped me build on my knowledge.	2	3		1	
11	The scenario formed a good basis on which to progress.	2	3		1	
12	The scenario could have been used in a standalone situation.	2	2	2		
13	The scenario added interest to the Introduction to Programming unit.	3		2	1	
14	The scenario made the concepts memorable.	3		2	1	
15	I quickly understood the concept of a class; how to create one and how to create an object.	1	4	1		
18	As you were allowed the opportunity to have this subject delivered to you in both the physical classroom situation and in a virtual world scenario, the latter has better facilitated your learning and understanding of this subject.	2	1	1	1	1
19	Following carrying out this transition activity in the virtual world and the previous activity to learn programming in the virtual world, you believe that you prefer to learn Object Oriented Programming in the virtual world.	3		1	1	1
21	Generally, you believe that the 3D visualization of difficult Computing concepts in the virtual world facilitates their understanding and learning.	2	3		1	
	Total	35	25	11	8	5
		4.29		0.79	0.93	

Did the application of virtual worlds enhance the understanding and learning of the complex theory concepts in this subject?	Agree	Unsure	Disagree
6 students	71.43	13.10	15.48

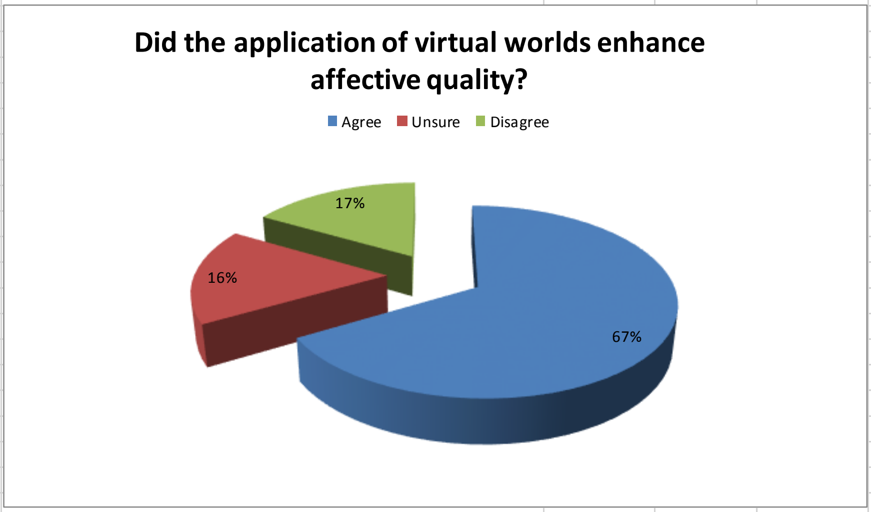


Group C						
Did the application of virtual worlds enhance affective quality?						

Date	15-Apr-13
Participants	6

Seq.	Question	Agree	Somewhat Agree	Unsure	Somewhat Disagree	Disagree
4	The scenario was appealing.	3	2		1	
13	The scenario added interest to the Introduction to Programming unit.	3		2	1	
	Total	6	2	2	2	0
		4.00		1.00	1.00	

Did the application of virtual worlds enhance affective quality?	Agree	Unsure	Disagree
6 students	66.67	16.67	16.67

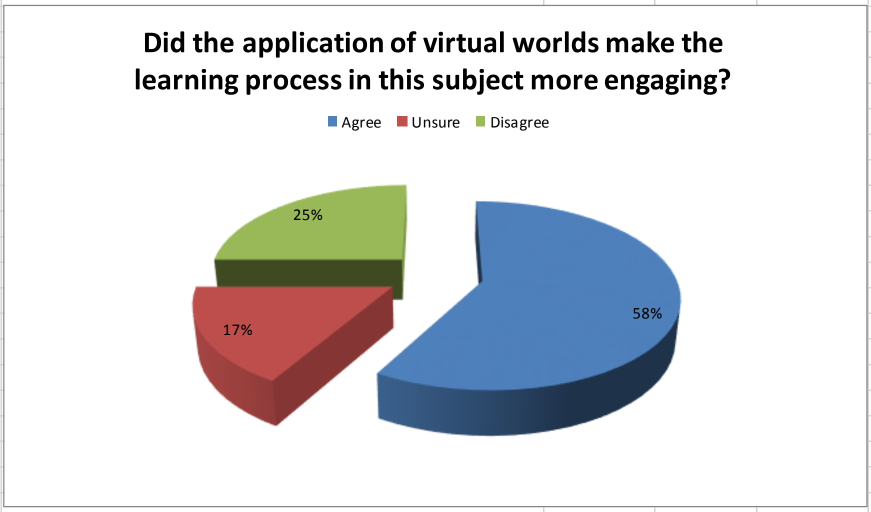


Group D						
Did the application of virtual worlds make the learning process in this subject more engaging?						

Date	15-Apr-13
Participants	6

Seq.	Question	Agree	Somewhat Agree	Unsure	Somewhat Disagree	Disagree
5	I would like to have similar scenarios to help me understand difficult concepts.	4			2	
9	The situation of a virtual world provided less distractions than the real world allowing me to concentrate more fully on the issue in hand.	3	1			2
10	The ability to move around an environment helped me to learn.	3		3		
20	You believe that being within the 3D visual environment of the virtual world of Second Life enables a more relaxing atmosphere when coding and a less panicking situation when dealing with the code syntax and errors.	3		1	2	
	Total	13	1	4	4	2
		3.50		1.00	1.50	

Did the application of virtual worlds make the learning process in this subject more engaging?	Agree	Unsure	Disagree
6 students	58.33	16.67	25.00



Helpdesk Support – Year 2 (2 Questionnaires):

ICTSS - Virtual Help Desk Support

Date	Mid October 2012
Participants	11

Seq.	Question	Fully Agree	Agree	I don't Know	Disagree	Fully disagree	N/A
1	The virtual environment added flexibility to support.	2	5	1	2	1	
2	The virtual environment resulted in easier support.		2	1	7	1	
3	Customer personality traits were easier to identify.		3	3	5		
4	Dealing with different personality traits was easier.		4	1	5	1	
5	The environment meant that personality traits made less impact upon the success of the outcome.		5	1	4	1	
6	The facilities offered by the setting e.g. refreshments, enabled me to handle a difficult situation better.		2	2	4	3	
7	The environment (a dedicated building) offered more credibility to the Help Desk support.	2	7		2		
8	The environment (a dedicated building) provided me with more confidence as a help desk technician.	2	4	3	1	1	
9	The situation of a virtual world provided less distraction than the real world allowing me to concentrate more fully on the issue in hand.	1	3		6	1	
10	Support facilities e.g. on-line were easier to access in the virtual environment.	2	4	2	3		
11	I found non-verbal communication easier in a virtual environment.	1	3	1	4	2	
12	I found verbal communication easier in a virtual environment.	1	2	2	5		
13	You believe that performing the duties of a staff member at a physical helpdesk system without an actual training on the different skills and techniques required for a successful delivery of such a service is difficult to achieve.	1	2	6	2		
14	You believe that acting as a staff member of the Tech Genius Helpdesk in Second Life, in which you were required to serve a number of customers at the same time, has enabled you to practice on a replication of an actual helpdesk system with real customers.		4	1	5	1	
15	You believe that changing your role from a staff member at Tech Genius to an anonymous customer (to be served with other customers by another staff member) has allowed you the opportunity to experience the differentiation between different customers and how they could be satisfied by the helpdesk staff.	2	5	2	2		
16	You believe that having the opportunity to monitor and evaluate the performance of your peers when serving anonymous customers in the virtual Tech Genius was beneficial to you in comparing different customer's behaviour, and how effective the service activities of individual staff members were.	1	5	2	2	1	
17	You believe that the Tech Genius Helpdesk building in Second Life is well-designed and equipped to perform the helpdesk activities to a high standard.		5	2	3	1	
18	You believe that the idea of acting the different roles within Tech Genius Helpdesk in the virtual world has facilitated your learning and understanding of the 'IT Service Support' Unit.	1	4	3	2	1	
19	You believe that the limited time given to you to serve a number of customers in the virtual Tech Genius has facilitated replicating a physical helpdesk situation.		4	3	3	1	
20	You believe that acting the different roles within Tech Genius in the virtual world has allowed you a better opportunity to focus on the quality of the service delivered.		8	1	1	1	
21	When you acted as Tech Genius staff in the virtual world, you believed that having anonymous customers to serve was a very good idea that enabled and emphasized the replication of an actual helpdesk situation.		5	1	4	1	
22	You believe that having the same activity of the helpdesk carried out face-to-face in the physical classroom with your peers would have distracted you and would not have enabled the same achievement as being done in the virtual world.	1	4	2	3	1	
23	You believe that having the same activity of the helpdesk carried out face-to-face in the physical classroom with your peers would not have emphasized the same feeling of being in an actual helpdesk situation compared to the purposely designed and equipped Tech Genius building in the virtual world.		2	4	2	3	
24	(Based on Questions 22&23):If you agreed (or strongly agreed) to both questions, you believe that the use of virtual world for carrying out this activity was appropriate and has enhanced your learning and achievement in the helpdesk field. (If N/A tick here ☐)		2		1		7

	Q.3: Not processed (irrelevant)
	Q.24: Processed separately (qualitative)

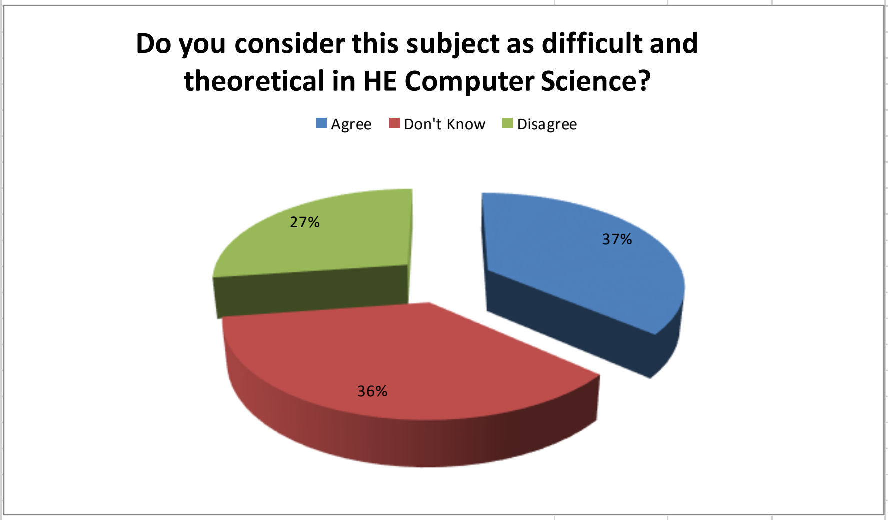
Group A

Do you consider this subject as difficult and theoretical in HE Computer Science?

Date	Mid October 2012
Participants	11

Seq.	Question	Fully Agree	Agree	I don't Know	Disagree	Fully disagree
13	You believe that performing the duties of a staff member at a physical helpdesk system without an actual training on the different skills and techniques required for a successful delivery of such a service is difficult to achieve.	1	2	6	2	
22	You believe that having the same activity of the helpdesk carried out face-to-face in the physical classroom with your peers would have distracted you and would not have enabled the same achievement as being done in the virtual world.	1	4	2	3	1
	Total	2	6	8	5	1
		4.00		4.00	3.00	

Do you consider this subject as difficult and theoretical in HE Computer Science?	Agree	Don't Know	Disagree
11 students	36.36	36.36	27.27



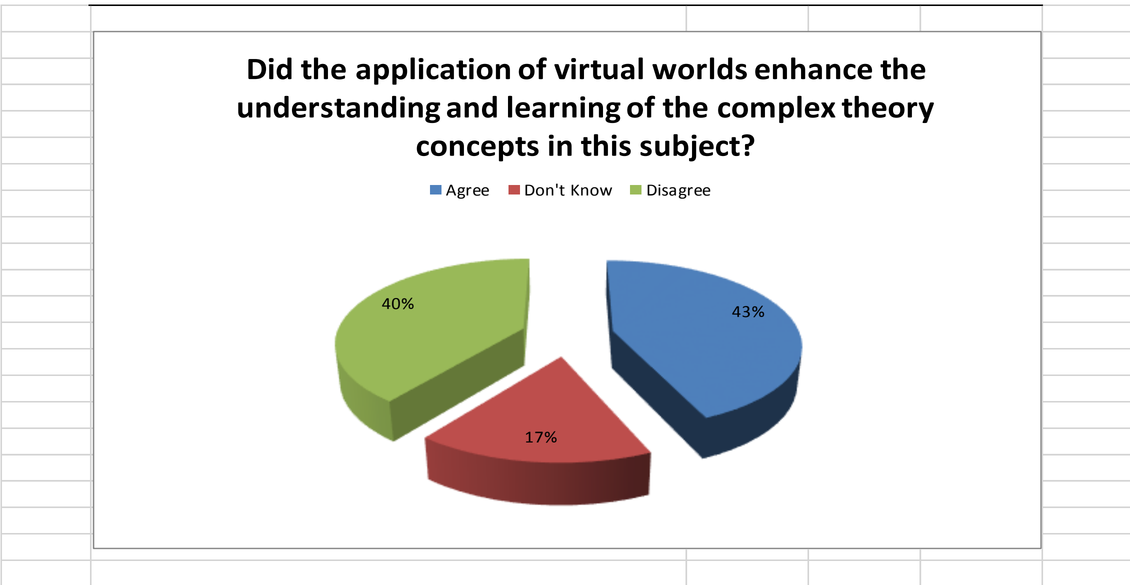
Group B

Did the application of virtual worlds enhance the understanding and learning of the complex theory concepts in this subject?

Date	**Mid October 2012**
Participants	**11**

Seq.	Question	Fully Agree	Agree	I don't Know	Disagree	Fully disagree
1	The virtual environment added flexibility to support.	2	5	1	2	1
2	The virtual environment resulted in easier support.		2	1	7	1
4	Dealing with different personality traits was easier.		4	1	5	1
5	The environment meant that personality traits made less impact upon the success of the outcome.		5	1	4	1
6	The facilities offered by the setting e.g. refreshments, enabled me to handle a difficult situation better.		2	2	4	3
8	The environment (a dedicated building) provided me with more confidence as a help desk technician.	2	4	3	1	1
14	You believe that acting as a staff member of the Tech Genius Helpdesk in Second Life, in which you were required to serve a number of customers at the same time, has enabled you to practice on a replication of an actual helpdesk system with real customers.		4	1	5	1
15	You believe that changing your role from a staff member at Tech Genius to an anonymous customer (to be served with other customers by another staff member) has allowed you the opportunity to experience the differentiation between different customers and how they could be satisfied by the helpdesk staff.	2	5	2	2	
16	You believe that having the opportunity to monitor and evaluate the performance of your peers when serving anonymous customers in the virtual Tech Genius was beneficial to you in comparing different customer's behaviour, and how effective the service activities of individual staff members were.	1	5	2	2	1
18	You believe that the idea of acting the different roles within Tech Genius Helpdesk in the virtual world has facilitated your learning and understanding of the 'IT Service Support' Unit.	1	4	3	2	1
19	You believe that the limited time given to you to serve a number of customers in the virtual Tech Genius has facilitated replicating a physical helpdesk situation.		4	3	3	1
20	You believe that acting the different roles within Tech Genius in the virtual world has allowed you a better opportunity to focus on the quality of the service delivered.		8	1	1	1
21	When you acted as Tech Genius staff in the virtual world, you believed that having anonymous customers to serve was a very good idea that enabled and emphasized the replication of an actual helpdesk situation.		5	1	4	1
23	You believe that having the same activity of the helpdesk carried out face-to-face in the physical classroom with your peers would not have emphasized the same feeling of being in an actual helpdesk situation compared to the purposely designed and equipped Tech Genius building in the virtual world.		2	4	2	3
	Total	**8**	**59**	**26**	**44**	**17**
		4.79		**1.86**	**4.36**	

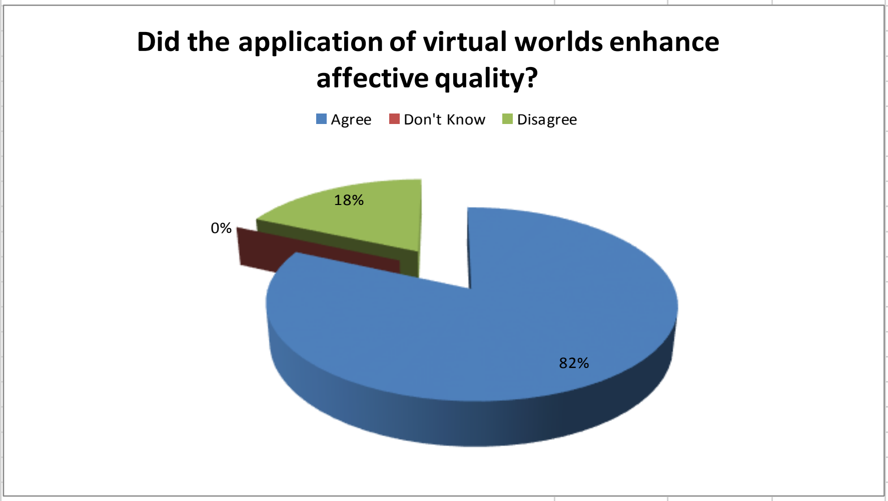
Did the application of virtual worlds enhance the understanding and learning of the complex theory concepts in this subject?	Agree	Don't Know	Disagree
11 students	**43.51**	**16.88**	**39.61**


Did the application of virtual worlds enhance the understanding and learning of the complex theory concepts in this subject?
Agree
Don't Know
Disagree
40%
43%
17%

Group C						
Did the application of virtual worlds enhance affective quality?						
				Date	Mid October 2012	
				Participants	11	

Seq.	Question	Fully Agree	Agree	I don't Know	Disagree	Fully disagree
7	The environment (a dedicated building) offered more credibility to the Help Desk support.	2	7		2	
	Total	2	7	0	2	0
		9.00		0.00	2.00	

Did the application of virtual worlds enhance affective quality?	Agree	Don't Know	Disagree
11 students	81.82	0.00	18.18



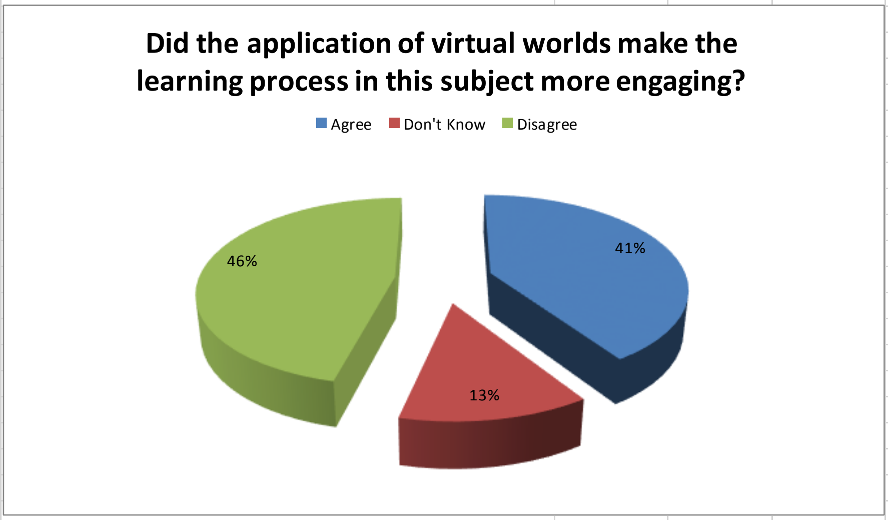
Group D

Did the application of virtual worlds make the learning process in this subject more engaging?

Date	**Mid October 2012**
Participants	**11**

Seq.	Question	Fully Agree	Agree	I don't Know	Disagree	Fully disagree
9	The situation of a virtual world provided less distraction than the real world allowing me to concentrate more fully on the issue in hand.	1	3		6	1
10	Support facilities e.g. on-line were easier to access in the virtual environment.	2	4	2	3	
11	I found non-verbal communication easier in a virtual environment.	1	3	1	4	2
12	I found verbal communication easier in a virtual environment.	1	2	2	5	
17	You believe that the Tech Genius Helpdesk building in Second Life is well-designed and equipped to perform the helpdesk activities to a high standard.		5	2	3	1
	Total	5	17	7	21	4
		4.40		1.40	5.00	

Did the application of virtual worlds make the learning process in this subject more engaging?	Agree	Don't Know	Disagree
11 students	40.00	12.73	45.45



Technology Enhanced Learning in Higher Education

The IT Service Support Unit -a- Virtual Helpdesk

Foundation Degree in Applied Computing – Year 2

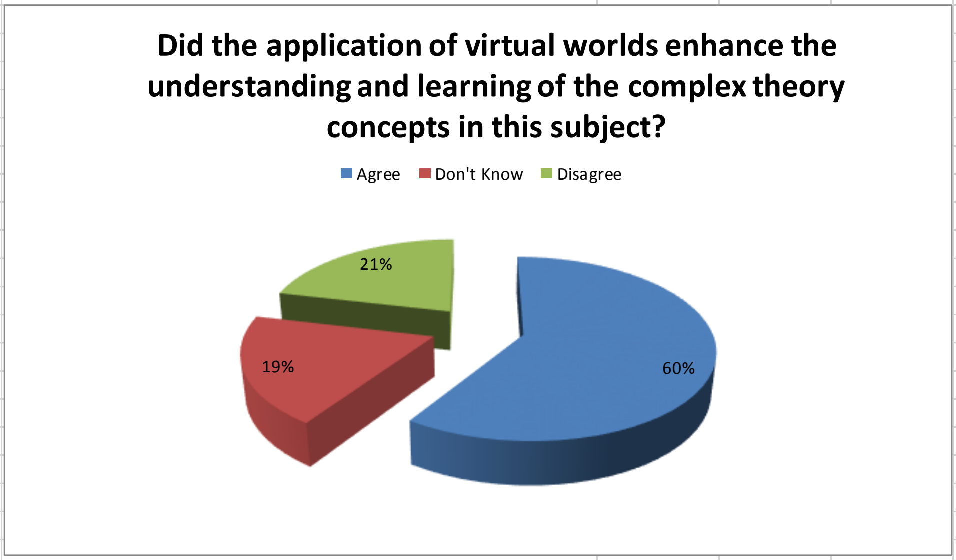
Date	06-Dec-12
Participants	10

Seq.	Question	Fully Agree	Agree	I don't Know	Disagree	Fully disagree
1	In my first experience using Second Life as a platform for learning, I found the 3D environment of the software user friendly and easy to navigate.		5	1	3	1
2	Before using Second Life, I was not sure about the context in which this software could be used to assist my learning in this unit.	3	5		2	
3	Following the first session in Second Life, I realised the advantages of 'Role-Playing' in a virtual environment to replicate a physical 'Call Centre'.	1	6	1	2	
4	I believe that students' attitude in general was better in the virtual environment, which facilitated a successful lesson and maximized learning.		5	1	4	
5	Attending the first virtual session as part of a small group isolated from other groups, has helped me to focus better on the scenarios and role-playing, which has inspired my learning.	2	3	2	2	1
6	I believe that the individual attendance of the following session(s) in Second Life (from home for example) will help me to think more and provide positive contribution to my own learning if I am separated from other influences.	3	3	2	1	1
7	I believe that the 6 different helpdesk scenarios that have been role-played in Second Life between the students would not have been achieved (to the same professional level) in a physical classroom situation.	2	4		3	1
8	As it is very difficult for all students to find a placement in a real/physical Helpdesk Project to get the experience of being a technical staff facing real customers, I found the opportunity to replicate a physical helpdesk system in the virtual world very beneficial for me to build and develop the skills required to pass this unit with good grades.	2	5	1	1	1
9	I believe that Second Life is a useful platform to enhance learning in Higher Education.		4	4	1	1
10	I believe that the 'Computing Building' in Second Life was well designed to suit the needs of Higher Education Computing students.	2	4	2	1	1
11	Acting as a customer/technical support staff gave me more of an appreciation of another person's perspective.		8	1	1	
12	Helping customers in a virtual world helped me to concentrate and focus more on the problem.	2	4	1	2	1
13	In the virtual environment, having no feedback with respect to body language was less stressful for me.	1	5		3	1
14	In the virtual world, I could readily detect the type of person I was dealing with.		4	1	4	1
15	I was more easily able to deal with the individual's personality traits in a virtual world.		5	3	1	1
16	I felt more comfortable dealing with a stressful situation as I did not have to concentrate, in the virtual environment, on my body language.	1	3	3	2	1
17	I learnt some new coping mechanisms when dealing with people in the virtual world.		6	1	2	1
18	The virtual world helped me to prevent a difficult situation from escalating.		3	5	1	1
19	I dealt with the given situation better in a virtual world than I would have in the real world.		4	2	1	3
20	It was useful to be able to try out techniques in a simulated environment before being put into a real life situation.	2	6	2		
21	Interviewing individuals/eliciting information about the problem was much easier in the virtual world.	1	2	6		1
22	The virtual world helped me to practice my interpersonal skills.		5	2	2	1
23	The virtual world allowed me to deal better with people I do not already know.		8	1	1	
24	I preferred using the virtual world to 'the Apprentice Style real-world activity' session.	2	2	3	2	1
25	I feel less self-conscious in the virtual world.		6	2	1	1
26	I felt less likely to give up trying to deal with the problem in the virtual world.	1	2	2	3	2
27	It took me a longer time to find out what the problem was in the virtual world than it would have taken me in the real world.	3	5	2		

28	I would be happier spending time doing virtual rather than physical support.		2	4	1	3
29	I think it would be sensible to incorporate some virtual support as part of the Tech Genius Helpdesk Project.		8	1		1
30	I have to concentrate more on what I was saying in the virtual world.		4	5	1	
31	I am looking forward to a second session in Second Life to play a different role in the virtual helpdesk to develop your skills.	1	4	3	1	1
32	The experience of simulated scenarios has increased my confidence in dealing with the unexpected.	2	3	4	1	
	Irrelevant questions not being processed					

Group B						
Did the application of virtual worlds enhance the understanding and learning of the complex theory concepts in this subject?						
				Date	06-Dec-12	
				Participants	10	
Seq.	**Question**	Fully Agree	Agree	I don't Know	Disagree	Fully disagree
3	Following the first session in Second Life, I realised the advantages of 'Role-Playing' in a virtual environment to replicate a physical 'Call Centre'.	**1**	**6**	**1**	**2**	
5	Attending the first virtual session as part of a small group isolated from other groups, has helped me to focus better on the scenarios and role-playing, which has inspired my learning.	**2**	**3**	**2**	**2**	**1**
7	I believe that the 6 different helpdesk scenarios that have been role-played in Second Life between the students would not have been achieved (to the same professional level) in a physical classroom situation.	**2**	**4**		**3**	**1**
8	As it is very difficult for all students to find a placement in a real/physical Helpdesk Project to get the experience of being a technical staff facing real customers, I found the opportunity to replicate a physical helpdesk system in the virtual world very beneficial for me to build and develop the skills required to pass this unit with good grades.	**2**	**5**	**1**	**1**	**1**
11	Acting as a customer/technical support staff gave me more of an appreciation of another person's perspective.		**8**	**1**	**1**	
12	Helping customers in a virtual world helped me to concentrate and focus more on the problem.	**2**	**4**	**1**	**2**	**1**
15	I was more easily able to deal with the individual's personality traits in a virtual world.		**5**	**3**	**1**	**1**
17	I learnt some new coping mechanisms when dealing with people in the virtual world.		6	1	2	1
18	The virtual world helped me to prevent a difficult situation from escalating.		3	5	1	1
19	I dealt with the given situation better in a virtual world than I would have in the real world.		4	2	1	3
20	It was useful to be able to try out techniques in a simulated environment before being put into a real life situation.	2	6	2		
21	Interviewing individuals/eliciting information about the problem was much easier in the virtual world.	1	2	6		1
22	The virtual world helped me to practice my interpersonal skills.		5	2	2	1
23	The virtual world allowed me to deal better with people I do not already know.		8	1	1	
29	I think it would be sensible to incorporate some virtual support as part of the Tech Genius Helpdesk Project.		8	1		1
	Total	**12**	**77**	**29**	**19**	**13**
		5.93		**1.93**	**2.13**	

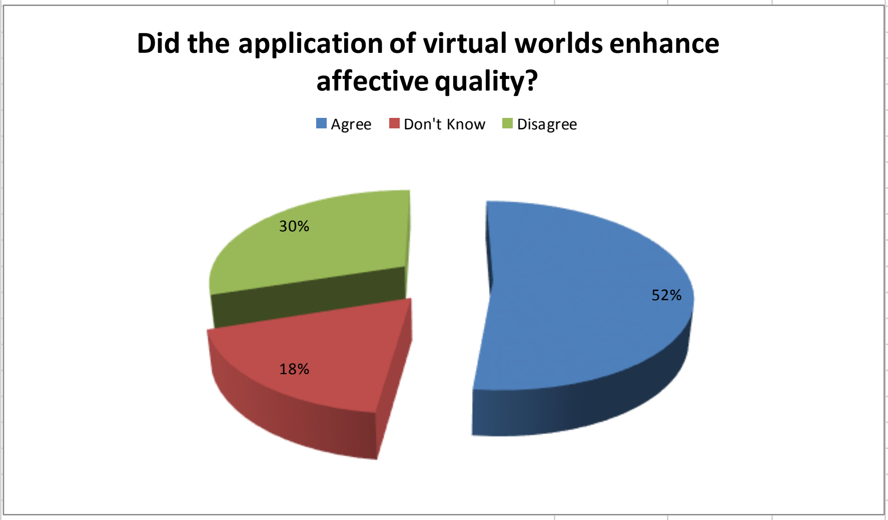
Did the application of virtual worlds enhance the understanding and learning of the complex theory concepts in this subject?	**Agree**	**Don't Know**	**Disagree**
10 students	**59.33**	**19.33**	**21.33**


Did the application of virtual worlds enhance the understanding and learning of the complex theory concepts in this subject?
Agree
Don't Know
Disagree
21%
19%
60%

Group C						
Did the application of virtual worlds enhance affective quality?						
				Date	06-Dec-12	
				Participants	10	

Seq.	Question	Fully Agree	Agree	I don't Know	Disagree	Fully disagree
1	In my first experience using Second Life as a platform for learning, I found the 3D environment of the software user friendly and easy to navigate.		5	1	3	1
13	In the virtual environment, having no feedback with respect to body language was less stressful for me.	1	5		3	1
28	I would be happier spending time doing virtual rather than physical support.		2	4	1	3
29	I think it would be sensible to incorporate some virtual support as part of the Tech Genius Helpdesk Project.		8	1		1
31	I am looking forward to a second session in Second Life to play a different role in the virtual helpdesk to develop your skills.	1	4	3	1	1
	Total	**2**	**24**	**9**	**8**	**7**
		5.20		**1.80**	**3.00**	

Did the application of virtual worlds enhance affective quality?	Agree	Don't Know	Disagree
10 students	52.00	18.00	30.00



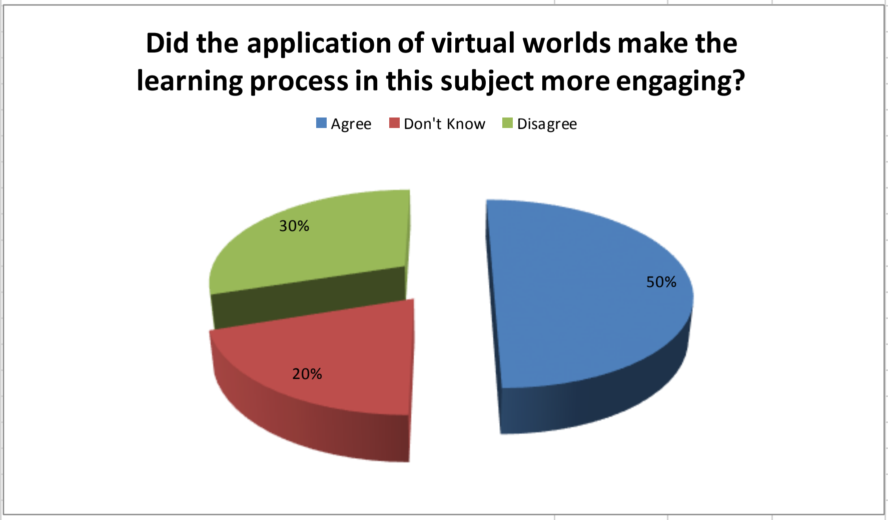
Group D

Did the application of virtual worlds make the learning process in this subject more engaging?

Date	**06-Dec-12**
Participants	**10**

Seq.	Question	Fully Agree	Agree	I don't Know	Disagree	Fully disagree
4	I believe that students' attitude in general was better in the virtual environment, which facilitated a successful lesson and maximized learning.		**5**	**1**	**4**	
6	I believe that the individual attendance of the following session(s) in Second Life (from home for example) will help me to think more and provide positive contribution to my own learning if I am separated from other influences.	**3**	**3**	**2**	**1**	**1**
10	I believe that the 'Computing Building' in Second Life was well designed to suit the needs of Higher Education Computing students.	**2**	**4**	**2**	**1**	**1**
13	In the virtual environment, having no feedback with respect to body language was less stressful for me.	**1**	**5**		**3**	**1**
16	I felt more comfortable dealing with a stressful situation as I did not have to concentrate, in the virtual environment, on my body language.	**1**	**3**	**3**	**2**	**1**
26	I felt less likely to give up trying to deal with the problem in the virtual world.	1	2	2	3	2
32	The experience of simulated scenarios has increased my confidence in dealing with the unexpected.	2	3	4	1	
	Total	**10**	**25**	**14**	**15**	**6**
		5.00		**2.00**	**3.00**	

Did the application of virtual worlds make the learning process in this subject more engaging?	Agree	Don't Know	Disagree
10 students	**50.00**	**20.00**	**30.00**



Multimedia Technologies – Year 2:

Students attended/practiced in the virtual scenario:

Technology Enhanced Learning in Higher Education

The use of Second Life to visualize difficult concepts in Multimedia-Technologies

Foundation Degree in Applied Computing – Year 2

Date	**28-Jan-13**
Participants	**7**

If you attended the activity

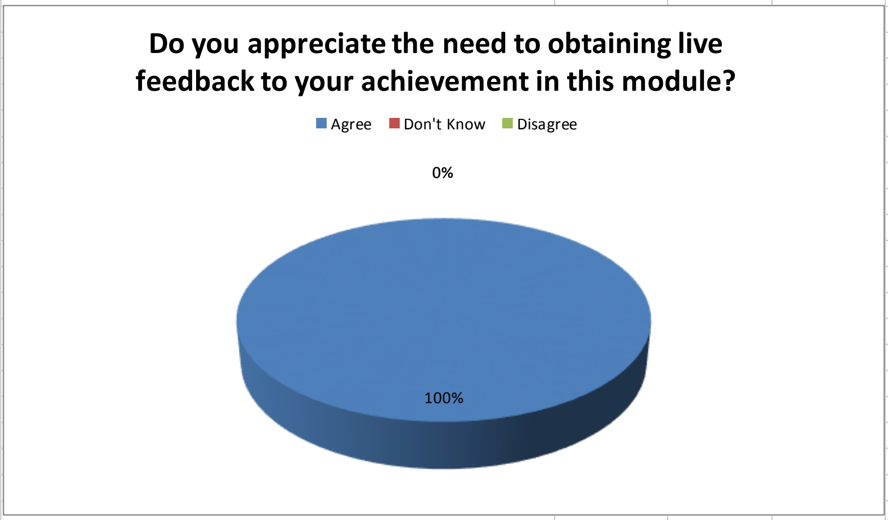
Seq.	Question	Fully Agree	Agree	I don't Know	Disagree	Fully disagree
1	The activity of obtaining live feedback from a broad audience in Second Life was successful.	2	4		1	
2	You under estimated the various advantages of this activity when it was first explained to you be your unit lecturer.	2	3	2		
3	You found the activity engaging and the atmosphere was user-friendly.	1	3		3	
4	You obtained a valuable and constructive feedback from the audience on your marketing digital story.	2	4		1	
5	You realised the differences between offline feedback received from people on the internet compared to the live feedback you obtained in Second Life, which you were able to discuss with the audience.	2	5			
6	You believe that the live feedback was useful to you in improving the quality of your final product before final submission of the product.	4	3			
7	The additional resources that the audience provided via email following the session as extra support was an added value to the virtual experience and emphasised the advantage of obtaining live feedback in the virtual world.	2	3	1	1	
8	You appreciate being able to demonstrate your product to such a broad audience that you would not normally be able to source in the physical world within your college environment.	1	6			
9	You believe that the immediate feedback that you obtained in Second Life has cut down the amount of time required to evaluate the product compared to other methods like uploading the video to services like YouTube and wait for offline comments.	3	3		1	
10	The honesty of the feedback has been increased by the anonymity of the audience.	3	3	1		
11	You would think of using the virtual world of Second Life again in a similar task in your future workplace to enhance your professional image in front of the employer by providing a high quality product.	1	5	1		

Group A						
Do you appreciate the need to obtaining live feedback to your achievement in this module?						

Date	28-Jan-13
Participants	7

Seq.	Question	Fully Agree	Agree	I don't Know	Disagree	Fully disagree
5	You realised the differences between offline feedback received from people on the internet compared to the live feedback you obtained in Second Life, which you were able to discuss with the audience.	2	5			
	Total	2	5	0	0	0
		7.00		0.00	0.00	

Do you appreciate the need to obtaining live feedback to your achievement in this module?	Agree	Don't Know	Disagree
7 students	100.00	0.00	0.00

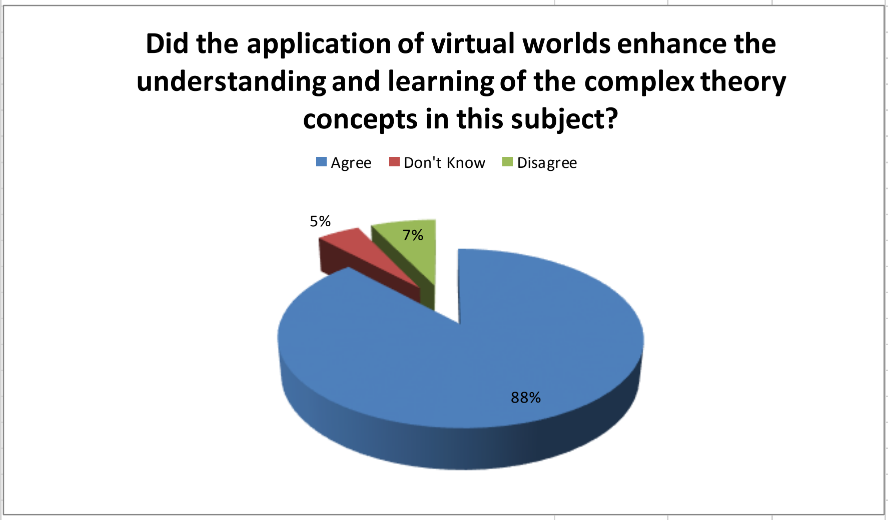


Group B						
Did the application of virtual worlds enhance the understanding and learning of the complex theory concepts in this subject?						

Date	28-Jan-13
Participants	7

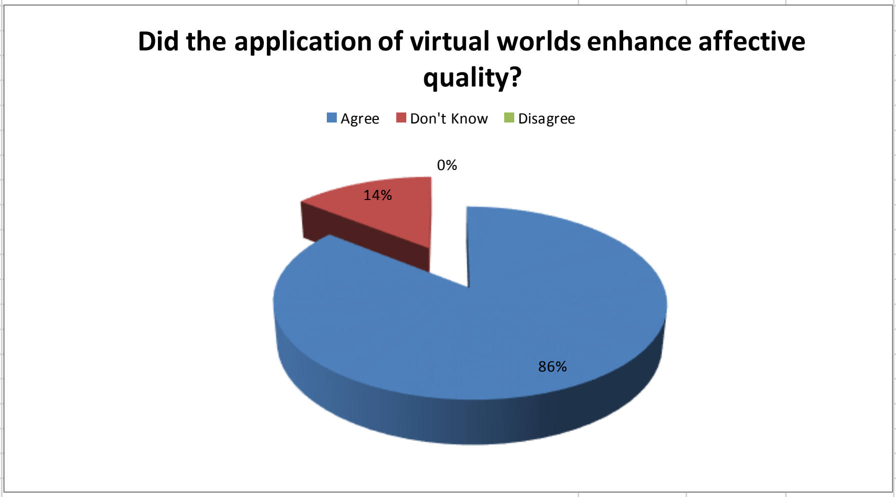
Seq.	Question	Fully Agree	Agree	I don't Know	Disagree	Fully disagree
4	You obtained a valuable and constructive feedback from the audience on your marketing digital story.	2	4		1	
6	You believe that the live feedback was useful to you in improving the quality of your final product before final submission of the product.	4	3			
7	The additional resources that the audience provided via email following the session as extra support was an added value to the virtual experience and emphasised the advantage of obtaining live feedback in the virtual world.	2	3	1	1	
8	You appreciate being able to demonstrate your product to such a broad audience that you would not normally be able to source in the physical world within your college environment.	1	6			
9	You believe that the immediate feedback that you obtained in Second Life has cut down the amount of time required to evaluate the product compared to other methods like uploading the video to services like YouTube and wait for offline comments.	3	3		1	
10	The honesty of the feedback has been increased by the anonymity of the audience.	3	3	1		
	Total	15	22	2	3	0
		6.17		0.33	0.50	

Did the application of virtual worlds enhance the understanding and learning of the complex theory concepts in this subject?	Agree	Don't Know	Disagree
7 students	88.10	4.76	7.14



Group C						
Did the application of virtual worlds enhance affective quality?						
				Date	28-Jan-13	
				Participants	7	
Seq.	**Question**	Fully Agree	Agree	I don't Know	Disagree	Fully disagree
11	You would think of using the virtual world of Second Life again in a similar task in your future workplace to enhance your professional image in front of the employer by providing a high quality product.	**1**	**5**	**1**		
	Total	**1**	**5**	**1**	**0**	**0**
		3.00		**0.50**	**0.00**	

Did the application of virtual worlds enhance affective quality?	Agree	Don't Know	Disagree
7 students	42.86	7.14	0.00

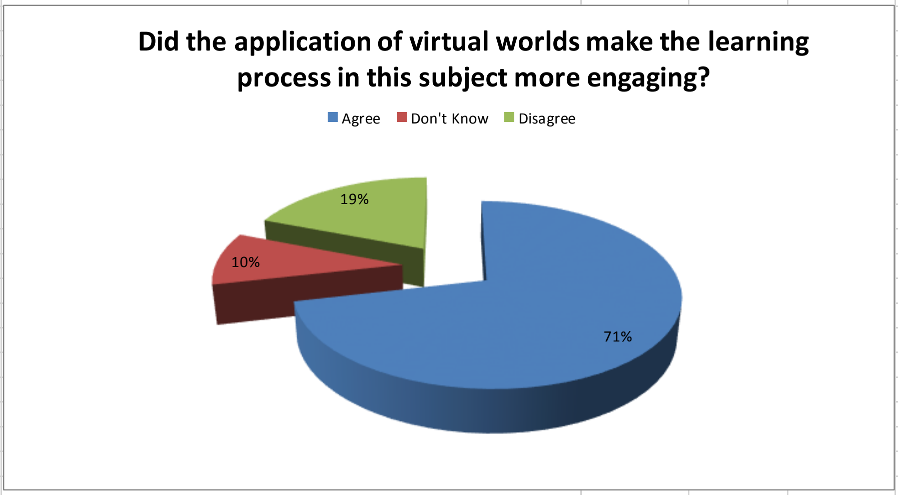


Group D						
Did the application of virtual worlds make the learning process in this subject more engaging?						

Date	**28-Jan-13**
Participants	**7**

Seq.	Question	Fully Agree	Agree	I don't Know	Disagree	Fully disagree
1	The activity of obtaining live feedback from a broad audience in Second Life was successful.	2	4		1	
2	You under estimated the various advantages of this activity when it was first explained to you be your unit lecturer.	2	3	2		
3	You found the activity engaging and the atmosphere was user-friendly.	1	3		3	
	Total	5	10	2	4	0
		3.75		0.50	1.00	

Did the application of virtual worlds make the learning process in this subject more engaging?	Agree	Don't Know	Disagree
7 students	53.57	7.14	14.29



Students who did not attend/practice in the virtual scenario:

Technology Enhanced Learning in Higher Education

The use of SecondLife to visualize difficult concepts in Computing – Multimedia Technologies

Foundation Degree in Applied Computing – Year 2

Date	28-Jan-13
Participants	4

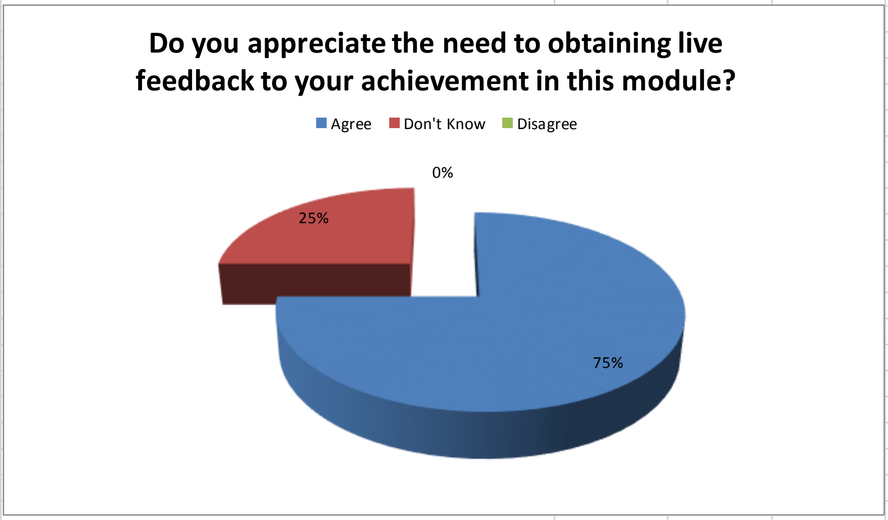
If you have not attended the activity and only attended the briefing

Seq.	Question	Fully Agree	Agree	I don't Know	Disagree	Fully disagree
1	You found that the briefing by the groups that attended the activity interesting.	2	1	1		
2	You felt that obtaining live feedback is useful for the development process of your product.	2	1	1		
3	You realised that the virtual world of SecondLife was an appropriate environment to carry out the activity of obtaining live feedback from a broad audience.	2	1		1	
4	You realised that this activity has added greater credibility to the outcome of the final product.	2	1	1		
5	You believe that you should have participated in this activity to allow you to make a more objective evaluation of your product.	3		1		
6	You think that this activity adds more versatility to the feedback, especially that you will be able to discuss the feedback directly with the audience.	3			1	
7	You now understand the benefits of demonstrating your product to such a broad audience that you would not normally be able to source in the physical world within your college environment.	3	1			
8	You believe that the immediate feedback that was obtained by the other groups in SecondLife has cut down the amount of time required to evaluate the product compared to other methods like uploading the video to services like Youtube and wait for offline comments.	3			1	
9	The honesty of the feedback in the virtual world is increased by the anonymity of the audience.	3		1		
10	You would value the opportunity of using the virtual world of SecondLife in a similar task in your future workplace to enhance your professional image in front of the employer by providing a high quality product.	3				1

Group A						
Do you appreciate the need to obtaining live feedback to your achievement in this module?						
				Date	28-Jan-13	
				Participants	4	

Seq.	Question	Fully Agree	Agree	I don't Know	Disagree	Fully disagree
2	You felt that obtaining live feedback is useful for the development process of your product.	2	1	1		
	Total	2	1	1	0	0
		3.00		1.00	0.00	

Do you appreciate the need to obtaining live feedback to your achievement in this module?	Agree	Don't Know	Disagree
4 students	75.00	25.00	0.00

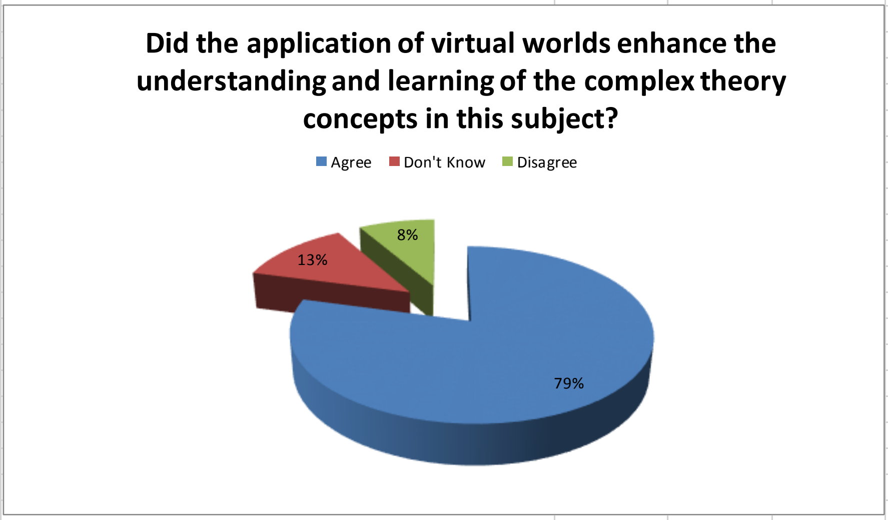


Group B						
Did the application of virtual worlds enhance the understanding and learning of the complex theory concepts in this subject?						

Date	28-Jan-13
Participants	4

Seq.	Question	Fully Agree	Agree	I don't Know	Disagree	Fully disagree
4	You realised that this activity has added greater credibility to the outcome of the final product.	2	1	1		
5	You believe that you should have participated in this activity to allow you to make a more objective evaluation of your product.	3		1		
6	You think that this activity adds more versatility to the feedback, especially that you will be able to discuss the feedback directly with the audience.	3			1	
7	You now understand the benefits of demonstrating your product to such a broad audience that you would not normally be able to source in the physical world within your college environment.	3	1			
8	You believe that the immediate feedback that was obtained by the other groups in SecondLife has cut down the amount of time required to evaluate the product compared to other methods like uploading the video to services like Youtube and wait for offline comments.	3			1	
9	The honesty of the feedback in the virtual world is increased by the anonymity of the audience.	3		1		
	Total	17	2	3	2	0
		3.17		0.50	0.33	

Did the application of virtual worlds enhance the understanding and learning of the complex theory concepts in this subject?	Agree	Don't Know	Disagree
4 students	79.17	12.50	8.33



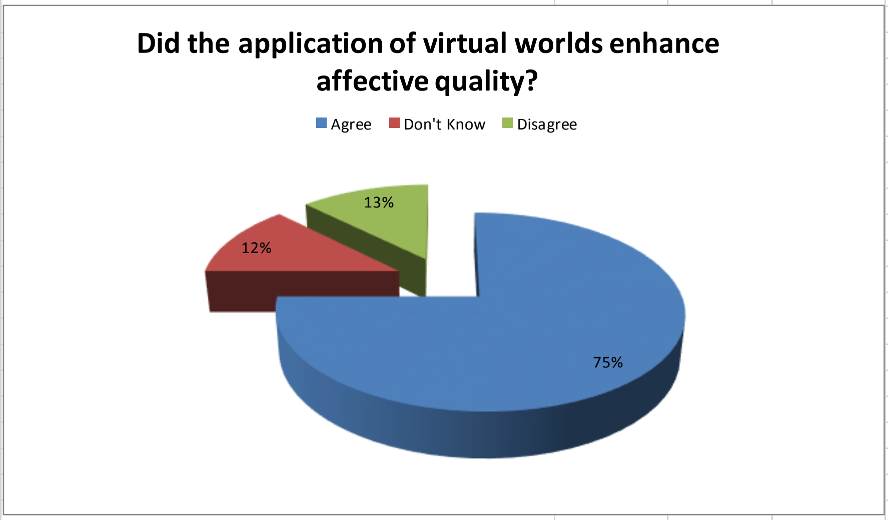
Group C

Did the application of virtual worlds enhance affective quality?

Date	28-Jan-13
Participants	4

Seq.	Question	Fully Agree	Agree	I don't Know	Disagree	Fully disagree
1	You found that the briefing by the groups that attended the activity interesting.	2	1	1		
10	You would value the opportunity of using the virtual world of SecondLife in a similar task in your future workplace to enhance your professional image in front of the employer by providing a high quality product.	3				1
	Total	5	1	1	0	1
		3.00		0.50	0.50	

Did the application of virtual worlds enhance affective quality?	Agree	Don't Know	Disagree
4 students	75.00	12.50	12.50

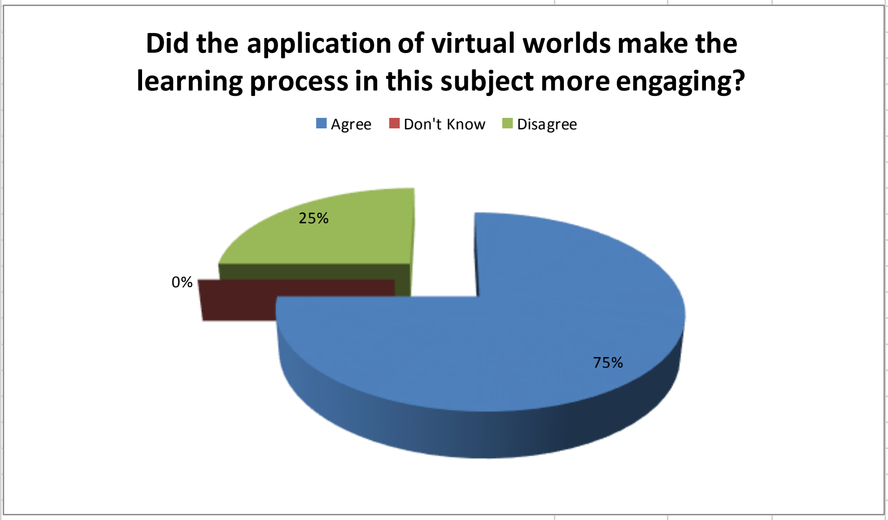


Group D						
Did the application of virtual worlds make the learning process in this subject more engaging?						

Date	28-Jan-13
Participants	4

Seq.	Question	Fully Agree	Agree	I don't Know	Disagree	Fully disagree
3	You realised that the virtual world of SecondLife was an appropriate environment to carry out the activity of obtaining live feedback from a broad audience.	2	1		1	
	Total	2	1	0	1	0
		3.00		0.00	1.00	

Did the application of virtual worlds make the learning process in this subject more engaging?	Agree	Don't Know	Disagree
4 students	75.00	0.00	25.00



Object Oriented Programming – Year 2:

	Technology Enhanced Learning in Higher Education					
	The use of SecondLife to visualize difficult concepts in Computing – Object Oriented Programming			**Date**	**04-Mar-13**	
	Foundation Degree in Applied Computing – Year 2			**Participants**	**10**	

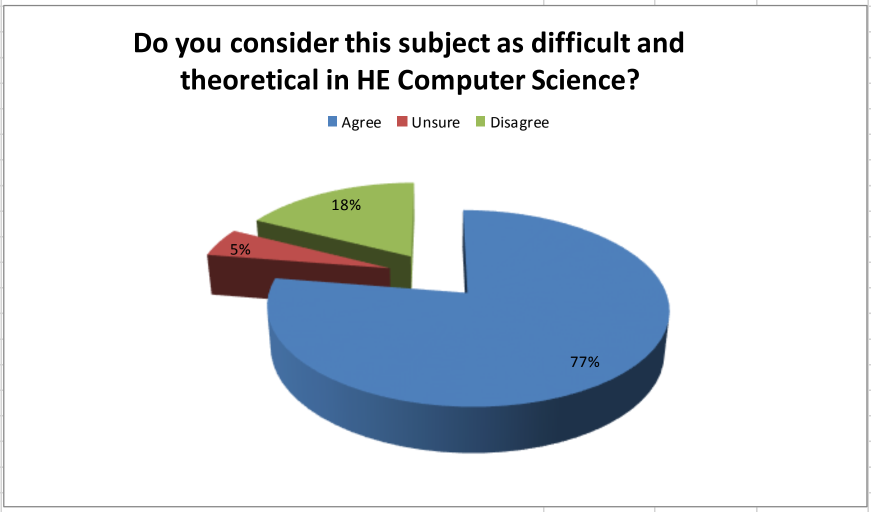
Seq.	**Question**	Fully Agree	Agree	I don't Know	Disagree	Fully disagree
1	You consider that the learning programming is a difficult subject in HE Computing.	**6**	**2**		**1**	**1**
2	You believe that the delivery of this subject should incorporate a more visual and interactive method, in which you interact further with the program that you produce and its results.	**5**	**4**			**1**
3	According to your unit lecturer and previous observations to your programming sessions, you face difficulties in learning essential programming concepts and the type of execution expected as a result of applying them in a program.	**2**	**6**			**2**
4	You believe that seeing the visual result of individual instructions that you apply in the program (in the virtual world) has facilitate a better understanding of what these individual programming instructions do.	**3**	**6**		**1**	
5	You have enjoyed the scenario designed for you in the virtual world of SecondLife to learn programming in a visual manner.	**4**	**5**		**1**	
6	You believe that programming 3D objects in the multimedia environment of SecondLife has facilitated a better imagination of what a computer program do.	**5**	**2**	**2**		**1**
7	You believe that the scenario in SecondLife was useful and appropriate to facilitate your understanding and learning of this difficult subject.	**4**	**5**		**1**	
8	You liked the idea of interacting with your peers in the virtual world to program a mutual object in a competition to achieve a final target.	**5**	**4**			**1**
9	Being able to observe your peers' achievement with their 3D objects in the virtual world, and being able to interact with them in the programming process has facilitated and enhanced your learning of this subject.	**4**	**5**		**1**	
10	As you have now received tuition on this subject in both the physical and the virtual worlds, you believe that programming is better learned in the virtual environment.	**5**	**1**	**3**		**1**
11	You felt more encouraged to take a more active role in the virtual world for your own learning of computer programming.	**4**	**2**	**3**		**1**
12	You felt more enthusiastic to apply the programming instructions to a 3D object in the virtual world compared to the ordinary variables in the physical world.	**4**	**3**	**1**		**1**
13	You felt having less engagement in the programming activities carried out in the physical classroom compared to the virtual world.	**4**	**2**	**1**	**2**	**1**
14	When you had the programming lessons in the physical classroom, you realised that this subject requires a method beyond the white/smart board and the presentation/handout approach.	**4**	**2**	**2**		**2**
15	Having immersed in the 3D virtual world and its objects, you believe that you will be able to better recall the programming instructions that you learned in the virtual world compared to the physical one.	**5**	**1**	**2**		**2**
16	You prefer using the 3D multimedia environment of SecondLife to visualize other difficult concepts in your Computing degree to facilitate your learning and achievement.	**5**	**1**	**3**	**1**	

Group A						
Do you consider this subject as difficult and theoretical in HE Computer Science?						

Date	04-Mar-13
Participants	10

Seq.	Question	Agree	Somewhat Agree	Unsure	Somewhat Disagree	Disagree
1	You consider that the learning programming is a difficult subject in HE Computing.	6	2		1	1
2	You believe that the delivery of this subject should incorporate a more visual and interactive method, in which you interact further with the program that you produce and its results.	5	4			1
3	According to your unit lecturer and previous observations to your programming sessions, you face difficulties in learning essential programming concepts and the type of execution expected as a result of applying them in a program.	2	6			2
14	When you had the programming lessons in the physical classroom, you realised that this subject requires a method beyond the white/smart board and the presentation/handout approach.	4	2	2		2
	Total	17	14	2	1	6
		7.75		0.50	1.75	

Do you consider this subject as difficult and theoretical in HE Computer Science?	Agree	Unsure	Disagree
10 students	77.50	5.00	17.50

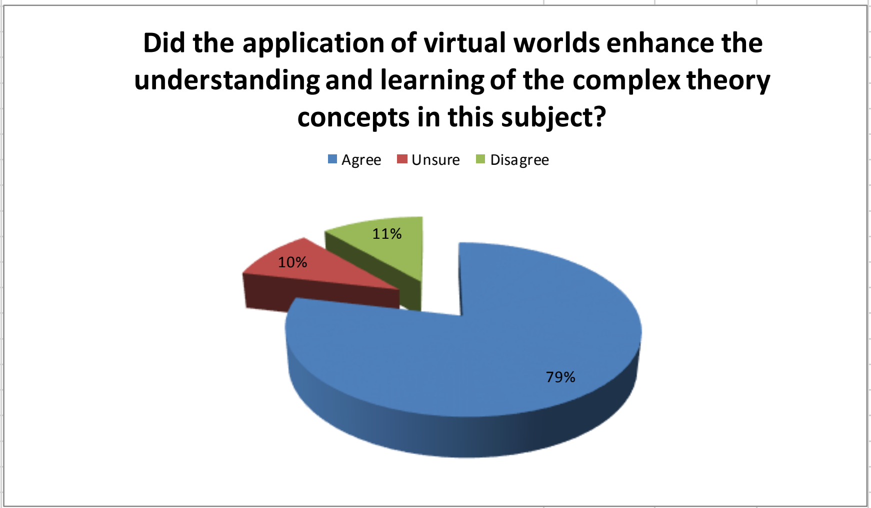


Group B
Did the application of virtual worlds enhance the understanding and learning of the complex theory concepts in this subject?

Date	04-Mar-13
Participants	10

Seq.	Question	Agree	Somewhat Agree	Unsure	Somewhat Disagree	Disagree
4	You believe that seeing the visual result of individual instructions that you apply in the program (in the virtual world) has facilitate a better understanding of what these individual programming instructions do.	3	6		1	
6	You believe that programming 3D objects in the multimedia environment of SecondLife has facilitated a better imagination of what a computer program do.	5	2	2		1
7	You believe that the scenario in SecondLife was useful and appropriate to facilitate your understanding and learning of this difficult subject.	4	5		1	
8	You liked the idea of interacting with your peers in the virtual world to program a mutual object in a competition to achieve a final target.	5	4			1
9	Being able to observe your peers' achievement with their 3D objects in the virtual world, and being able to interact with them in the programming process has facilitated and enhanced your learning of this subject.	4	5		1	
10	As you have now received tuition on this subject in both the physical and the virtual worlds, you believe that programming is better learned in the virtual environment.	5	1	3		1
15	Having immersed in the 3D virtual world and its objects, you believe that you will be able to better recall the programming instructions that you learned in the virtual world compared to the physical one.	5	1	2		2
	Total	**31**	**24**	**7**	**3**	**5**
		7.86		**1.00**	**1.14**	

Did the application of virtual worlds enhance the understanding and learning of the complex theory concepts in this subject?	Agree	Unsure	Disagree
10 students	78.57	10.00	11.43

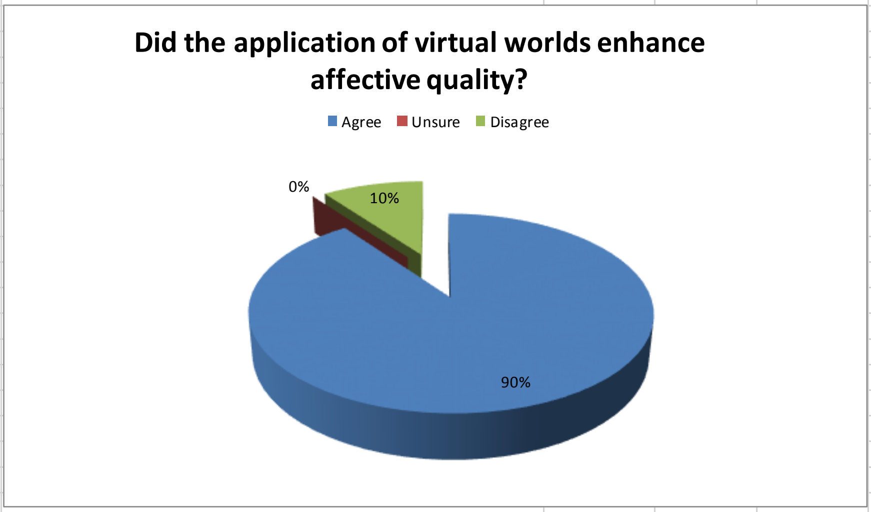


Group C						
Did the application of virtual worlds enhance affective quality?						

Date	04-Mar-13
Participants	10

Seq.	Question	Agree	Somewhat Agree	Unsure	Somewhat Disagree	Disagree
5	You have enjoyed the scenario designed for you in the virtual world of SecondLife to learn programming in a visual manner.	4	5		1	
	Total	4	5	0	1	0
		9.00		0.00	1.00	

Did the application of virtual worlds enhance affective quality?	Agree	Unsure	Disagree
10 students	90.00	0.00	10.00

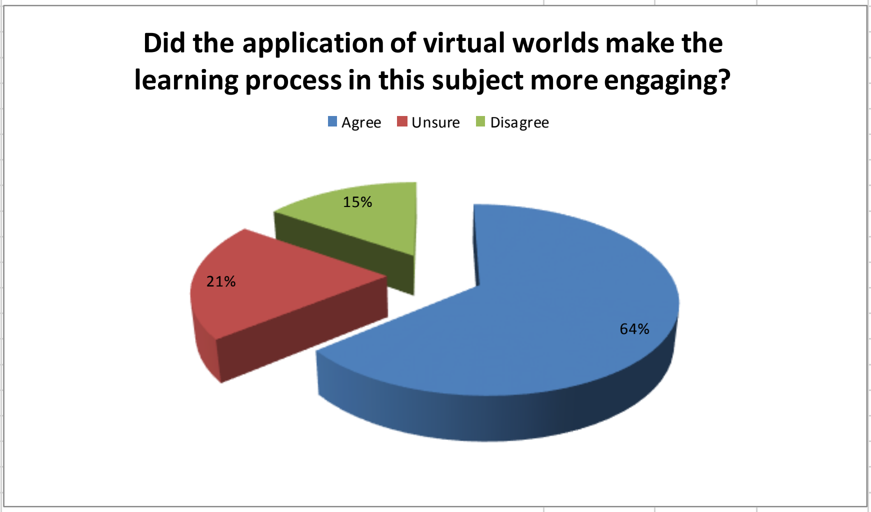


Group D
Did the application of virtual worlds make the learning process in this subject more engaging?

Date	04-Mar-13
Participants	10

Seq.	Question	Agree	Somewhat Agree	Unsure	Somewhat Disagree	Disagree
11	You felt more encouraged to take a more active role in the virtual world for your own learning of computer programming.	4	2	3		1
12	You felt more enthusiastic to apply the programming instructions to a 3D object in the virtual world compared to the ordinary variables in the physical world.	4	3	1		1
13	You felt having less engagement in the programming activities carried out in the physical classroom compared to the virtual world.	4	2	1	2	1
16	You prefer using the 3D multimedia environment of SecondLife to visualize other difficult concepts in your Computing degree to facilitate your learning and achievement.	5	1	3	1	
	Total	17	8	8	3	3
		6.25		2.00	1.50	

Did the application of virtual worlds make the learning process in this subject more engaging?	Agree	Unsure	Disagree
10 students	62.50	20.00	15.00



Multithreading Techniques (Concurrency and Parallelism) – BSc (2 Questionnaires):

Technology Enhanced Learning in Higher Education

The use of SecondLife to visualize difficult concepts in Computing – Concurrency and Parallelism

BSc (Hons) in Applied Computing

Date	**18-Oct-12**
Participants	**7**

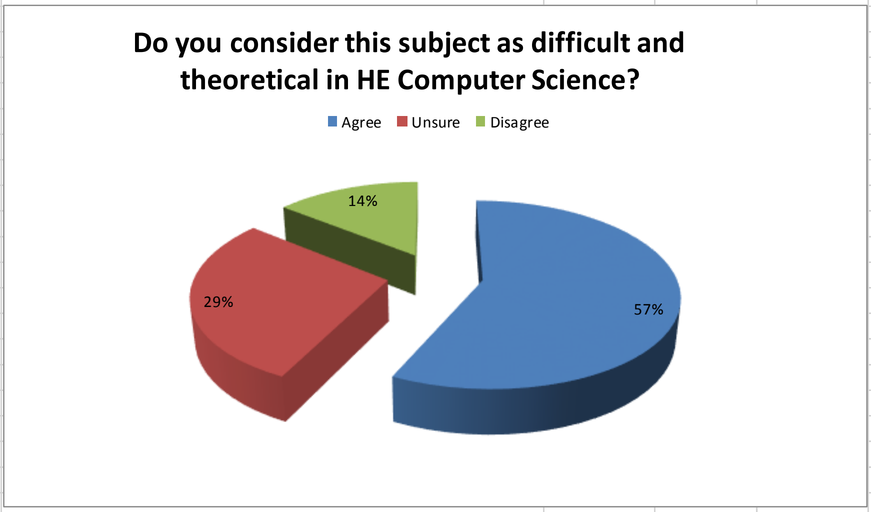
Seq.	Question	Fully Agree	Agree	I don't Know	Disagree	Fully disagree
1	You have found SecondLife user friendly and easy to use.	1	4	1	1	
2	The (hour and a half) initial visualization session in SecondLife helped you more in understanding the difficult concepts of concurrency and multithreading techniques in the computer RAM, processor, virtual memory and the role of Operating System.	3	2	1		1
3	Before the actual visualization in SecondLife starts, you were surprised to see the whole of your group expressing a wrong understanding of the queuing technique for concurrency and multithreading in the computer RAM (in answer to a question by the lecturer).	1	3	2	1	
4	The visualization of concurrency and multithreading techniques in SecondLife enhanced your learning compared to the theory sessions delivered in-class earlier	1	1	3	1	1
5	Playing the role of computer tasks in RAM and the virtual memory in different case scenarios facilitated the visualization of this difficult concept.	5	1			1
6	Attending this session in SecondLife from home (in separation from other students) has enabled more concentration on the demonstration and visualization activities and encouraged you to think more, interact and answer questions in isolation of the effects, interruption and distraction by other student(s).	1	4	1	1	
7	Despite the fact that some students, who attended this first session in SecondLife, had difficulties in their headsets and were able to chat (in writing) only – due to which the session was made shorter by the lecturer, you found the session interesting in terms of enhancing you learning and encouraged you to attend further sessions in SecondLife.	1	4	1	1	
8	Following your first session in SecondLife, and taking into account that computing technical faults can happen anytime/anywhere, you believe that you may use SecondLife in the future for 'Social Computing' activities.	1		3	1	2

Group A
Do you consider this subject as difficult and theoretical in HE Computer Science?

Date	18-Oct-12
Participants	7

Seq.	Question	Agree	Somewhat Agree	Unsure	Somewhat Disagree	Disagree
3	Before the actual visualization in Second Life starts, you were surprised to see the whole of your group expressing a wrong understanding of the queuing technique for concurrency and multithreading in the computer RAM (in answer to a question by the lecturer).	1	3	2	1	
	Total	**1**	**3**	**2**	**1**	**0**
		4.00		**2.00**	**1.00**	

Do you consider this subject as difficult and theoretical in HE Computer Science?	Agree	Unsure	Disagree
7 students	57.14	28.57	14.29



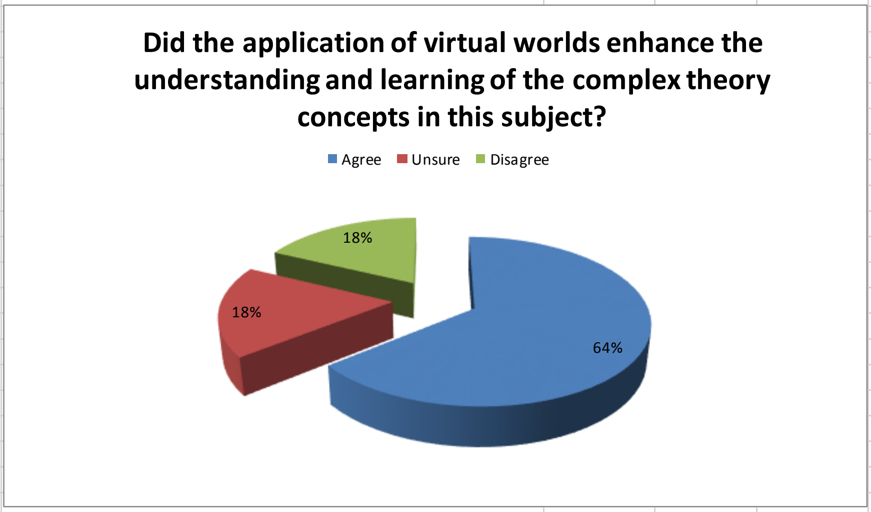
Group B

Did the application of virtual worlds enhance the understanding and learning of the complex theory concepts in this subject?

Date	**18-Oct-12**
Participants	**7**

Seq.	Question	Agree	Somewhat Agree	Unsure	Somewhat Disagree	Disagree
2	The (hour and a half) initial visualization session in SecondLife helped you more in understanding the difficult concepts of concurrency and multithreading techniques in the computer RAM, processor, virtual memory and the role of Operating System.	**3**	**2**	**1**		**1**
4	The visualization of concurrency and multithreading techniques in SecondLife enhanced your learning compared to the theory sessions delivered in-class earlier	**1**	**1**	**3**	**1**	**1**
5	Playing the role of computer tasks in RAM and the virtual memory in different case scenarios facilitated the visualization of this difficult concept.	**5**	**1**			**1**
7	Despite the fact that some students, who attended this first session in SecondLife, had difficulties in their headsets and were able to chat (in writing) only – due to which the session was made shorter by the lecturer, you found the session interesting in terms of enhancing you learning and encouraged you to attend further sessions in SecondLife.	**1**	**4**	**1**	**1**	
	Total	**10**	**8**	**5**	**2**	**3**
		4.50		**1.25**	**1.25**	

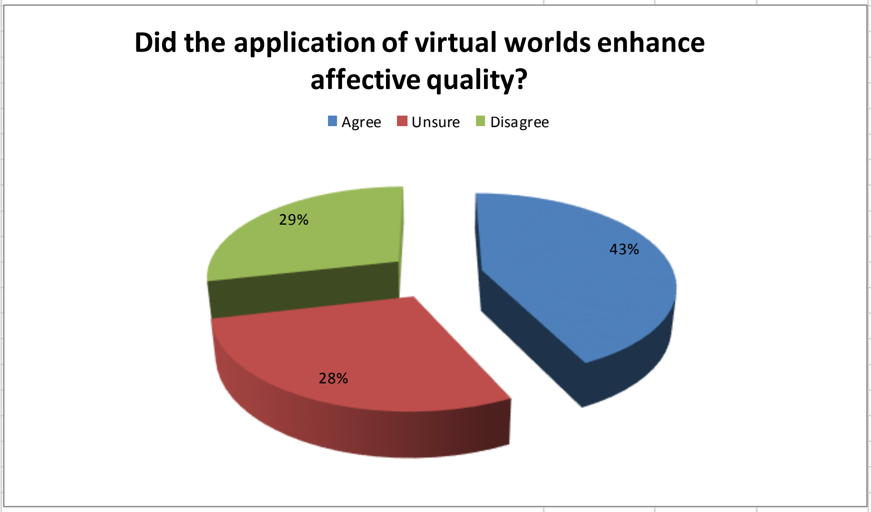
Did the application of virtual worlds enhance the understanding and learning of the complex theory concepts in this subject?	Agree	Unsure	Disagree
7 students	**64.29**	**17.86**	**17.86**



Group C						
Did the application of virtual worlds enhance affective quality?						
				Date	18-Oct-12	
				Participants	7	

Seq.	Question	Agree	Somewhat Agree	Unsure	Somewhat Disagree	Disagree
1	You have found SecondLife user friendly and easy to use.	1	4	1	1	
8	Following your first session in Second Life, and taking into account that computing technical faults can happen anytime/anywhere, you believe that you may use Second Life in the future for 'Social Computing' activities.	1		3	1	2
	Total	2	4	4	2	2
		3.00		2.00	2.00	

Did the application of virtual worlds enhance affective quality?	Agree	Unsure	Disagree
7 students	42.86	28.57	28.57



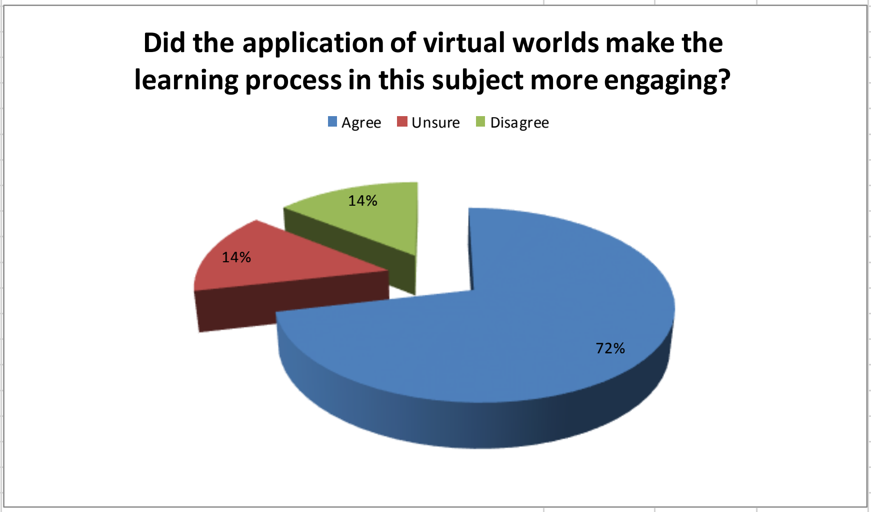
Group D

Did the application of virtual worlds make the learning process in this subject more engaging?

Date	18-Oct-12
Participants	7

Seq.	Question	Agree	Somewhat Agree	Unsure	Somewhat Disagree	Disagree
6	Attending this session in SecondLife from home (in separation from other students) has enabled more concentration on the demonstration and visualization activities and encouraged you to think more, interact and answer questions in isolation of the effects, interruption and distraction by other student(s).	1	4	1	1	
	Total	1	4	1	1	0
		5.00		1.00	1.00	

Did the application of virtual worlds make the learning process in this subject more engaging?	Agree	Unsure	Disagree
7 students	71.43	14.29	14.29



Technology Enhanced Learning in Higher Education

The use of SecondLife to visualize difficult concepts in Concurrency and Parallelism

BSc(Hons) in Applied Computing

Date	13-Nov-12
Participants	7

Seq.	Question	Fully Agree	Agree	I don't Know	Disagree	Fully disagree
1	The session in SecondLife has facilitated your learning and understating of the difficult concept of parallelism in a dual core/multi-processor computer system.	1	5			1
2	Acting the role of the Computer Operating System in SecondLife in judging the different parallelism scenarios that have been made available to you has corrected one or more wrong concepts that you had following the theory sessions.	1	2	1	2	1
3	As you will undertake a written exam for the Multi-Tasking Systems Unit at the end of this Semester, you believe that you will be able to remember the simulation of different scenarios in SecondLife more than the information delivered in the theory sessions.	2	2	1	1	1
4	Following having 3 sessions in SecondLife for the Multi-Tasking Systems Unit, you believe that this is a useful tool to enhance the learning and achievement of students in this unit.	1	2	1	2	1
5	You will think of using the virtual world of SecondLife in the future after you complete the unit.	1		1	1	4

Q.5: Processed Separately

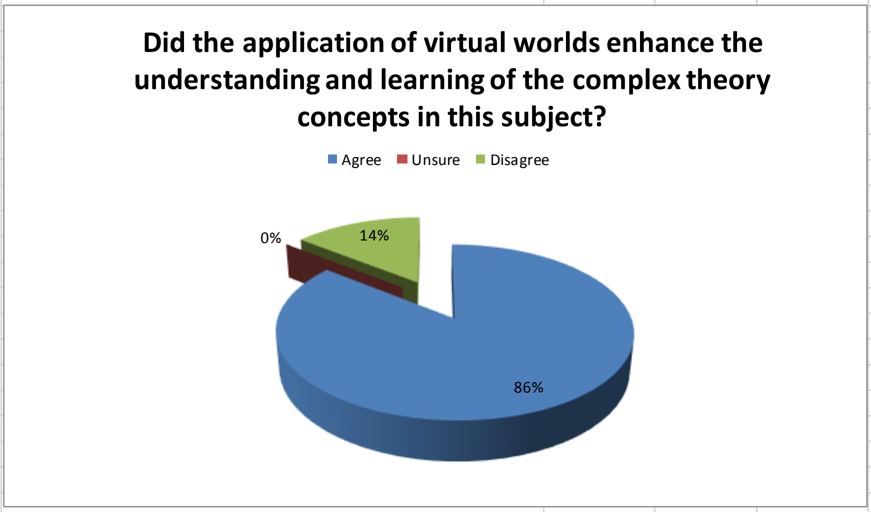
Group B1

Did the application of virtual worlds enhance the understanding and learning of the complex theory concepts in this subject?

Date	13-Nov-12
Participants	7

Seq.	Question	Agree	Somewhat Agree	Unsure	Somewhat Disagree	Disagree
1	The session in SecondLife has facilitated your learning and understating of the difficult concept of parallelism in a dual core/multi-processor computer system.	1	5			1
	Total	1	5	0	0	1
		6.00		0.00	1.00	

Did the application of virtual worlds enhance the understanding and learning of the complex theory concepts in this subject?	Agree	Unsure	Disagree
7 students	85.71	0.00	14.29

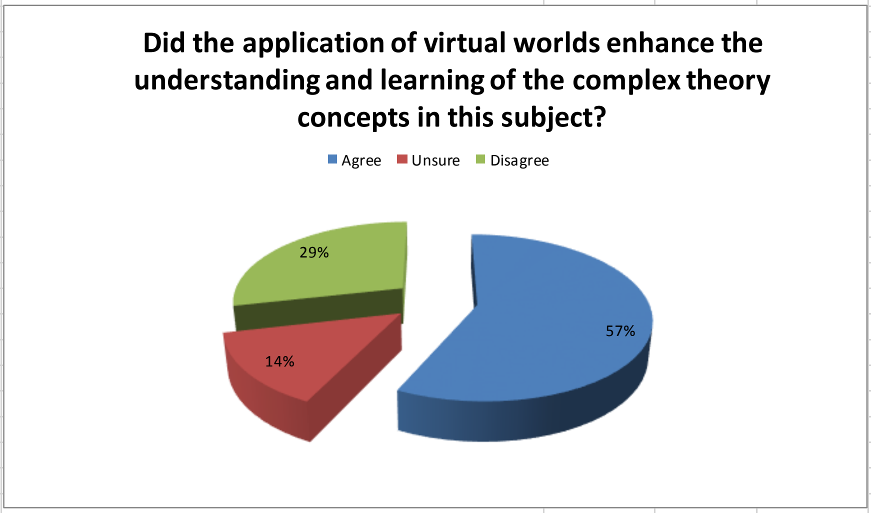


Group B2
Did the application of virtual worlds enhance the understanding and learning of the complex theory concepts in this subject?

Date	**13-Nov-12**
Participants	**7**

Seq.	Question	Agree	Somewhat Agree	Unsure	Somewhat Disagree	Disagree
3	As you will undertake a written exam for the Multi-Tasking Systems Unit at the end of this Semester, you believe that you will be able to remember the simulation of different scenarios in SecondLife more than the information delivered in the theory sessions.	2	2	1	1	1
	Total	2	2	1	1	1
		4.00		1.00	2.00	

Did the application of virtual worlds enhance the understanding and learning of the complex theory concepts in this subject?	Agree	Unsure	Disagree
7 students	57.14	14.29	28.57



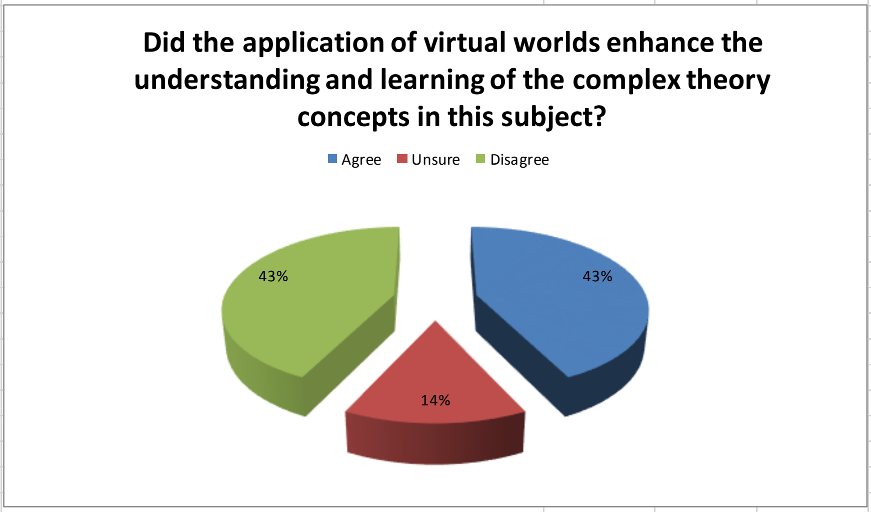
Group B3

Did the application of virtual worlds enhance the understanding and learning of the complex theory concepts in this subject?

Date	**13-Nov-12**
Participants	**7**

Seq.	Question	Agree	Somewhat Agree	Unsure	Somewhat Disagree	Disagree
2	Acting the role of the Computer Operating System in SecondLife in judging the different parallelism scenarios that have been made available to you has corrected one or more wrong concepts that you had following the theory sessions.	1	2	1	2	1
4	Following having 3 sessions in SecondLife for the Multi-Tasking Systems Unit, you believe that this is a useful tool to enhance the learning and achievement of students in this unit.	1	2	1	2	1
	Total	2	4	2	4	2
		3.00		1.00	3.00	

Did the application of virtual worlds enhance the understanding and learning of the complex theory concepts in this subject?	Agree	Unsure	Disagree
7 students	42.86	14.29	42.86



A3.4 Data Analysis of HE Modules - Academic year 2013/2014

Computer Programming – Year 1 (3 Questionnaires):

Technology Enhanced Learning in Higher Education

What do you think of programming so far….

Date	**07-Oct-13**
Participants	**17**

Seq.	Statement	Fully Agree	Agree	Disagree	Fully disagree
1	Before the start of the course, you thought that you would enjoy programming.	**3**	**7**	**5**	**2**
2	Computer programming is a difficult subject.	**3**	**9**	**5**	
3	Programming being a conceptual subject makes the learning more difficult.	**2**	**8**	**6**	**1**
4	Being able to visualize the programming process would make learning it easier.	**5**	**10**	**2**	
5	You believe that at this stage you will not be able to master the programming subject.	**1**	**4**	**11**	**1**
6	Programming subjects make Computing degrees difficult to achieve.	**1**	**4**	**7**	**5**
7	You think that the traditional method of teaching programming makes it difficult to imagine the ideas and how the programming instructions actually work.	**1**	**6**	**9**	**1**
8	A visualized scenario and the use of metaphors will improve your understanding of programming.	**7**	**8**	**2**	

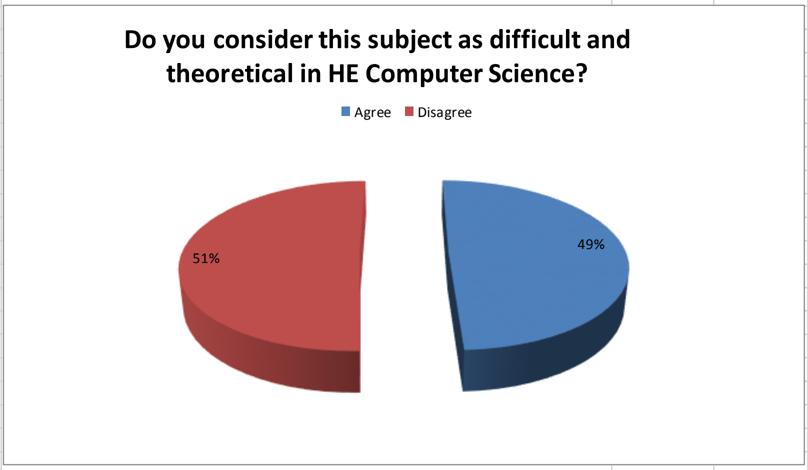
Group A

Do you consider this subject as difficult and theoretical in HE Computer Science?

Date	**07-Oct-13**
Participants	**17**

Seq.	Question	Fully Agree	Agree	Disagree	Fully disagree
1	Before the start of the course, you thought that you would enjoy programming.	3	7	5	2
2	Computer programming is a difficult subject.	3	9	5	
3	Programming being a conceptual subject makes the learning more difficult.	2	8	6	1
5	You believe that at this stage you will not be able to master the programming subject.	1	4	11	1
6	Programming subjects make Computing degrees difficult to achieve.	1	4	7	5
	Total	**10**	**32**	**34**	**9**
		8.40		**8.60**	

Do you consider this subject as difficult and theoretical in HE Computer Science?	Agree	Disagree
17 students	**49.41**	**50.59**

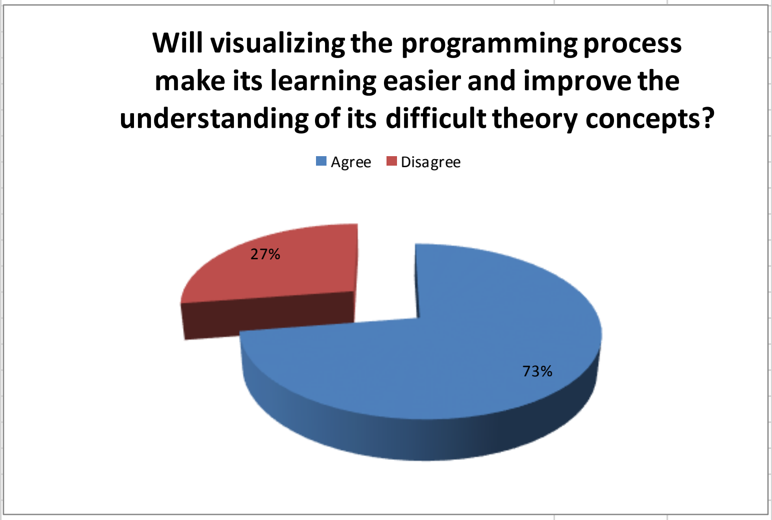


Group B					
Will visualizing the programming process make its learning easier and improve the understanding of its difficult theory concepts?					

Date	07-Oct-13
Participants	17

Seq.	Question	Fully Agree	Agree	Disagree	Fully disagree
4	Being able to visualize the programming process would make learning it easier.	5	10	2	
7	You think that the traditional method of teaching programming makes it difficult to imagine the ideas and how the programming instructions actually work.	1	6	9	1
8	A visualized scenario and the use of metaphors will improve your understanding of programming.	7	8	2	
	Total	13	24	13	1
		12.33		4.67	

Will visualizing the programming process make its learning easier and improve the understanding of its difficult theory concepts?	Agree	Disagree
17 students	72.55	27.45



Technology Enhanced Learning in Higher Education	
Software Design and Development Unit	
Computer Programming	

Date	12-Nov-13
Participants	16

Seq.	Question	Before Using the Virtual World				After Using the Virtual World			
		Slightly Agree	Fully Agree	Slightly Disagree	Fully Disagree	Slightly Agree	Fully Agree	Slightly Disagree	Fully Disagree
1	'Computer Programming' is a difficult subject.	7	8	1		6		8	2
2	The visualized mode of explaining the concepts and application of programming helped my understanding and learning of this subject.(i.e. on the white/smart board compared to the virtual world scenario)	9	2	4	1	4	9	2	1
3	I am confident with the main concepts of the programming subject (e.g. sequence, selection, iteration).	4	3	6	3	6	8	1	1
4	Being able to see the immediate effects of programming instructions (visualized) aided the retention of that information.(i.e. the traditional exercises in the classroom and the visualized exercises in the virtual world)	10	2	3	1	3	12		1
5	Using metaphors (symbols) in the learning environment improved my understanding and learning of this fundamental area of computing.(i.e. the imagined situation in the physical classroom compared to the objects appearing in the virtual world)	8	3	4	1	4	11		1
6	The traditional method of teaching the programming subject in the physical classroom (alone) is suitable for facilitating the understanding and learning of its concepts.	2	6	4	4	5	5	4	2
7	I find it difficult to imagine the process of executing the individual programming instructions and their results.	5	5	5	1	6		5	5
8	The use of technology-enhanced tools has furthered my understanding and learning of the programming subject. (e.g. the use of the smart-board technology compared to the virtual world technology).	9	2	2	3	6	8	1	1
9	The learning tools used to explain the difficult concepts of the programming subject were successful in making the understanding and learning memorable.(e.g. the PowerPoint presentations, notes, fragmented program questions compared to the visualized exercises and metaphors in the immersive environment of the virtual world).	8	2	3	2	7	5	2	1
10	The learning tools used to explain the difficult concepts of the programming subject were successful in making my learning environment enjoyable.	6	3	6	1	7	8		1
11	I understood the programming concepts quickly because of the learning tools used to explain them.	6	2	6	2	6	8	1	1
12	One method of teaching the programming concepts would be sufficient State your preferred method (e.g. the real world, the virtual world, or both):	7	2	3	4	7	2	4	3

Processed separately - Qualitative

Group A

Do you consider this subject as difficult and theoretical in HE Computer Science?

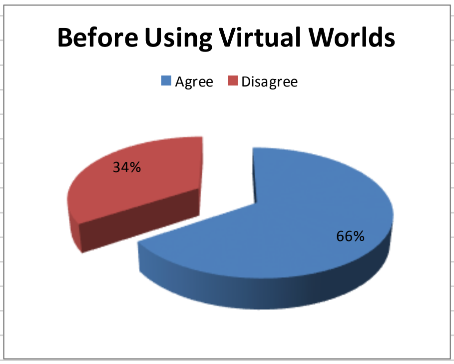
Date	**12-Nov-13**
Participants	**16**

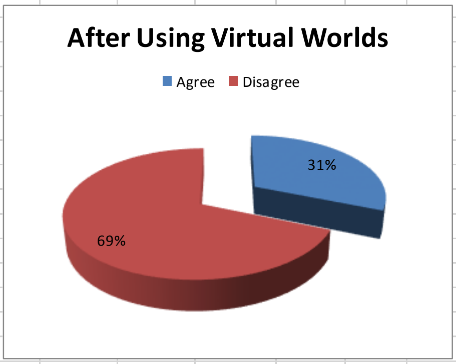
Seq.	Question	Before Using the Virtual World				After Using the Virtual World			
		Slightly Agree	Fully Agree	Slightly Disagree	Fully Disagree	Slightly Agree	Fully Agree	Slightly Disagree	Fully Disagree
1	'Computer Programming' is a difficult subject.	7	8	1		6		8	2
3	*I am NOT confident with the main concepts of the programming subject (e.g. sequence, selection, iteration).*	6	3	4	3	1	1	6	8
6	*The traditional method of teaching the programming subject in the physical classroom (alone) is NOT suitable for facilitating the understanding and learning of its concepts.*	4	4	2	6	4	2	5	5
7	I find it difficult to imagine the process of executing the individual programming instructions and their results.	5	5	5	1	6		5	5
	Total	**22**	**20**	**12**	**10**	**17**	**3**	**24**	**20**
		10.50		**5.50**		**5.00**		**11.00**	

Questions No. 3 & 6 - Reversed

Before Using the Virtual World		After Using the Virtual World	
Agree	**Disagree**	**Agree**	**Disagree**
65.63	**34.38**	**31.25**	**68.75**

Before using virtual worlds	After using virtual worlds





Group B

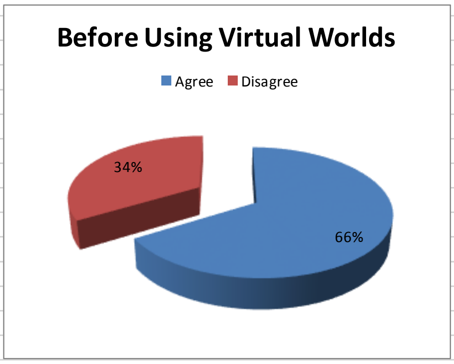
Is learning more enhanced before and/or after the application of virtual worlds?

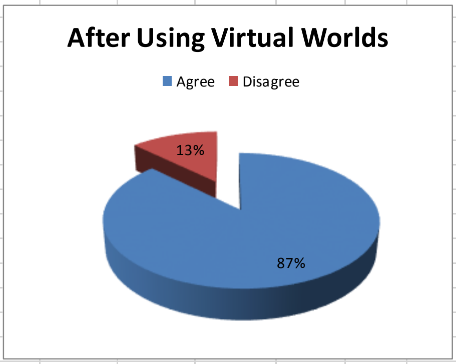
Date	12-Nov-13
Participants	16

Seq.	Question	Before Using the Virtual World				After Using the Virtual World			
		Slightly Agree	Fully Agree	Slightly Disagree	Fully Disagree	Slightly Agree	Fully Agree	Slightly Disagree	Fully Disagree
2	The visualized mode of explaining the concepts and application of programming helped my understanding and learning of this subject.(i.e. on the white/smart board compared to the virtual world scenario)	9	2	4	1	4	9	2	1
4	Being able to see the immediate effects of programming instructions (visualized) aided the retention of that information.(i.e. the traditional exercises in the classroom and the visualized exercises in the virtual world)	10	2	3	1	3	12		1
5	Using metaphors (symbols) in the learning environment improved my understanding and learning of this fundamental area of computing.(i.e. the imagined situation in the physical classroom compared to the objects appearing in the virtual world)	8	3	4	1	4	11		1
8	The use of technology-enhanced tools has furthered my understanding and learning of the programming subject. (e.g. the use of the smart-board technology compared to the virtual world technology).	9	2	2	3	6	8	1	1
9	The learning tools used to explain the difficult concepts of the programming subject were successful in making the understanding and learning memorable.(e.g. the PowerPoint presentations, notes, fragmented program questions compared to the visualized exercises and metaphors in the immersive environment of the virtual world).	8	2	3	2	7	5	2	1
11	I understood the programming concepts quickly because of the learning tools used to explain them.	6	2	6	2	6	8	1	1
	Total	**50**	**13**	**22**	**10**	**30**	**53**	**6**	**6**
		10.50		**5.33**		**13.83**		**2.00**	

Before Using the Virtual World		After Using the Virtual World	
Agree	Disagree	Agree	Disagree
65.63	33.33	86.46	12.50

Before using virtual worlds	After using virtual worlds





Group C

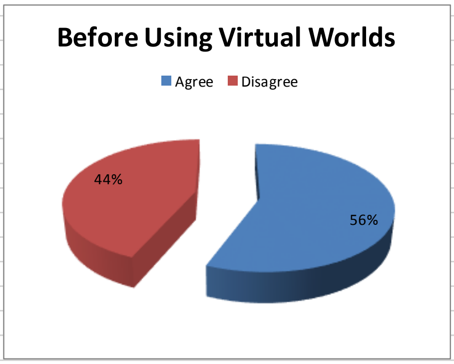
Is affective quality more enhanced before and/or after the application of virtual worlds?

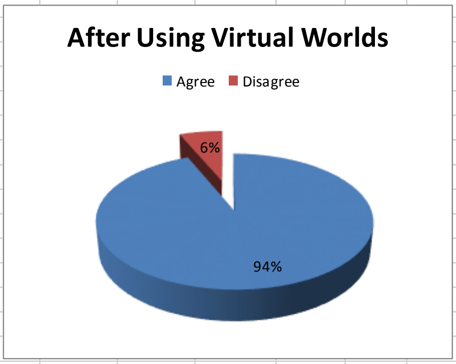
Date	12-Nov-13
Participants	16

Seq.	Question	Before Using the Virtual World				After Using the Virtual World			
		Slightly Agree	Fully Agree	Slightly Disagree	Fully Disagree	Slightly Agree	Fully Agree	Slightly Disagree	Fully Disagree
10	The learning tools used to explain the difficult concepts of the programming subject were successful in making my learning environment enjoyable.	6	3	6	1	7	8		1
	Total	**6**	**3**	**6**	**1**	**7**	**8**	**0**	**1**
		9.00		**7.00**		**15.00**		**1.00**	

Before Using the Virtual World		After Using the Virtual World	
Agree	Disagree	Agree	Disagree
56.25	43.75	93.75	6.25

Before using virtual worlds	After using virtual worlds





Group D

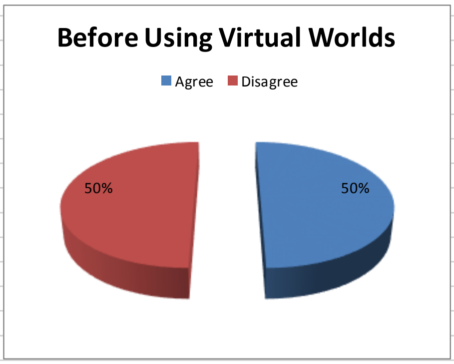
Is the learning process more engaging before and/or after the application of virtual worlds?

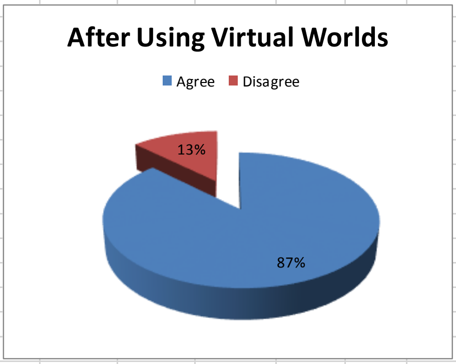
Date	18-Nov-13
Participants	16

Seq.	Question	Before Using the Virtual World				After Using the Virtual World			
		Slightly Agree	Fully Agree	Slightly Disagree	Fully Disagree	Slightly Agree	Fully Agree	Slightly Disagree	Fully Disagree
11	I understood the programming concepts quickly because of the learning tools used to explain them.	6	2	6	2	6	8	1	1
	Total	**6**	**2**	**6**	**2**	**6**	**8**	**1**	**1**
		8.00		**8.00**		**14.00**		**2.00**	

	Before Using the Virtual World		After Using the Virtual World	
	Agree	Disagree	Agree	Disagree
Questions No. 3 & 6 - Reversed	50.00	50.00	87.50	12.50

Before using virtual worlds	After using virtual worlds





Technology-Enhanced Learning for Higher Education	
Software Design and Development	
Structures and Classes	
	Date	**10-Dec-13**
	Participants	**15**

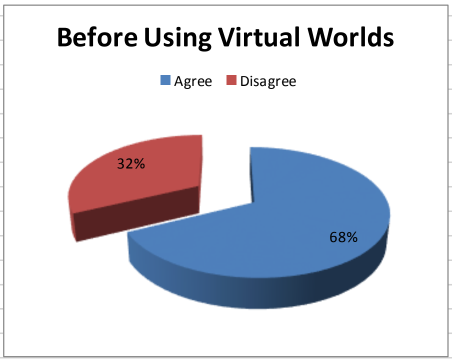
Seq.	Quuestion	Before Using the Virtual World				Before Using the Virtual World			
		Slightly Agree	Fully Agree	Slightly Disagree	Fully Disagree	Slightly Agree	Fully Agree	Slightly Disagree	Fully Disagree
1	The link between variables structures and classes is clear.	4		8	3	7	5	2	1
2	Structure and Classes subject is difficult to understand.	7	4	2	1	8	2	3	1
3	The abstract concept of a Class and a Structure is readily understood.	5	2	5	3	8	5		2
4	The physical implementation of a Class and a Structure is easily visible.	4	1	6	4	3	8	2	2
5	The environment used to convey this specific subject facilitated the learning of it.	4	2	6	3	6	5	3	1
6	The subject was made more memorable by the method used to explain it.	6	1	5	3	8	5	1	1
7	The theory concepts of the Structure and Classes subject require visualization to facilitate understanding.(i.e. on the white/smart board compared to the virtual world scenario)	5	4	3	3	3	8	3	1
8	Examples and the use of metaphors (symbols) make this subject more imaginable.	7	2	4	2	5	8		2
9	It is clear how to use these facilities successfully in programming.	8		2	4	2	9	2	1
10	The method used to deliver this subject was enjoyable.	6		6	3	9	5		1
11	This subject was understood quickly.	3	1	7	4	10	4		1
12	Learning in multiple environments addressed my learning needs/preferences.	6	4	2	3	2	10	2	1

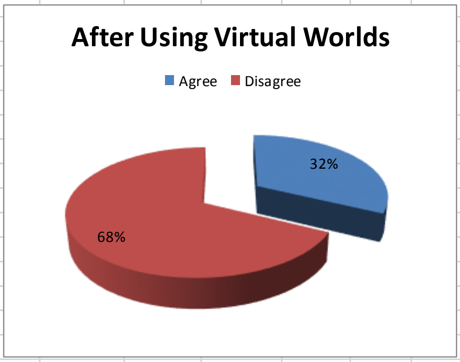
Group A									
Do you consider this subject as difficult and theoretical in HE Computer Science?									
								Date	**10-Dec-13**
								Participants	**15**
Seq.	**Question**	**Before Using the Virtual World**				**After Using the Virtual World**			
		Slightly Agree	Fully Agree	Slightly Disagree	Fully Disagree	Slightly Agree	Fully Agree	Slightly Disagree	Fully Disagree
1	*The link between variables structures and classes is NOT clear.*	8	3	4		2	1	7	5
2	Structure and Classes subject is difficult to understand.	7	4	2	1	8	2	3	1
3	*The abstract concept of a Class and a Structure is NOT readily understood.*	5	3	5	2		2	8	5
4	*The physical implementation of a Class and a Structure is NOT easily visible.*	6	4	4	1	2	2	3	8
	Total	**26**	**14**	**15**	**4**	**12**	**7**	**21**	**19**
		10.00		**4.75**		**4.75**		**10.00**	

Questions No. 1, 3 & 4 - Reversed

Before Using the Virtual World		**After Using the Virtual World**	
Agree	**Disagree**	**Agree**	**Disagree**
66.67	**31.67**	**31.67**	**66.67**

Before using virtual worlds	**After using virtual worlds**





Group B

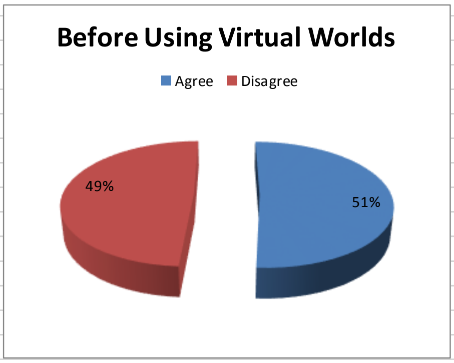
Is learning more enhanced before and/or after the application of virtual worlds?

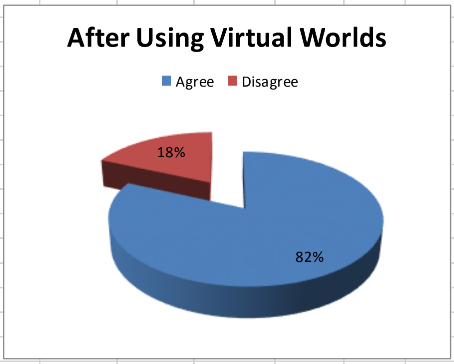
Date	**10-Dec-13**
Participants	**15**

Seq.	Question	Before Using the Virtual World				After Using the Virtual World			
		Slightly Agree	Fully Agree	Slightly Disagree	Fully Disagree	Slightly Agree	Fully Agree	Slightly Disagree	Fully Disagree
5	The environment used to convey this specific subject facilitated the learning of it.	4	2	6	3	6	5	3	1
6	The subject was made more memorable by the method used to explain it.	6	1	5	3	8	5	1	1
7	The theory concepts of the Structure and Classes subject require visualization to facilitate understanding.(i.e. on the white/smart board compared to the virtual world scenario)	5	4	3	3	3	8	3	1
8	Examples and the use of metaphors (symbols) make this subject more imaginable.	7	2	4	2	5	8		2
9	It is clear how to use these facilities successfully in programming.	8		2	4	2	9	2	1
11	This subject was understood quickly.	3	1	7	4	10	4		1
12	Learning in multiple environments addressed my learning needs/preferences.	6	4	2	3	2	10	2	1
	Total	**39**	**14**	**29**	**22**	**36**	**49**	**11**	**8**
		7.57		**7.29**		**12.14**		**2.71**	

Before Using the Virtual World		After Using the Virtual World	
Agree	**Disagree**	**Agree**	**Disagree**
50.48	**48.57**	**80.95**	**18.10**

Before using virtual worlds	After using virtual worlds





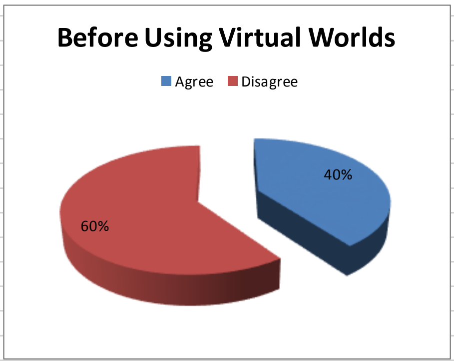
Group C
Is affective quality more enhanced before and/or after the application of virtual worlds?

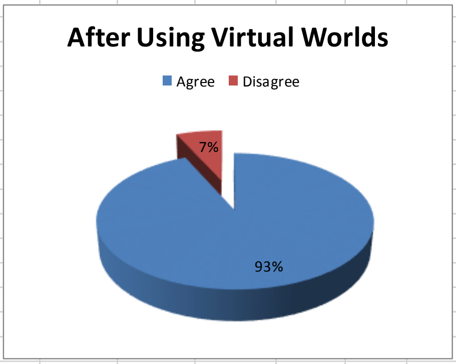
Date	10-Dec-13
Participants	15

Seq.	Question	Before Using the Virtual World				After Using the Virtual World			
		Slightly Agree	Fully Agree	Slightly Disagree	Fully Disagree	Slightly Agree	Fully Agree	Slightly Disagree	Fully Disagree
10	The method used to deliver this subject was enjoyable.	6		6	3	9	5		1
	Total	**6**	**0**	**6**	**3**	**9**	**5**	**0**	**1**
		6.00		**9.00**		**14.00**		**1.00**	

Before Using the Virtual World		After Using the Virtual World	
Agree	Disagree	Agree	Disagree
40.00	60.00	93.33	6.67

Before using virtual worlds	After using virtual worlds





Group D

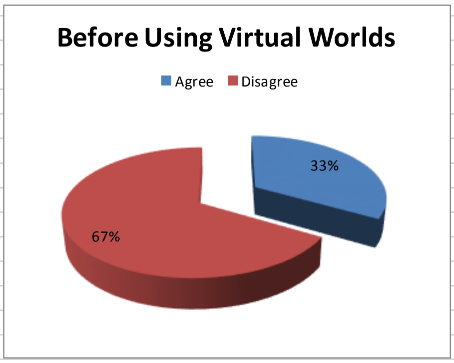
Is the learning process more engaging before and/or after the application of virtual worlds?

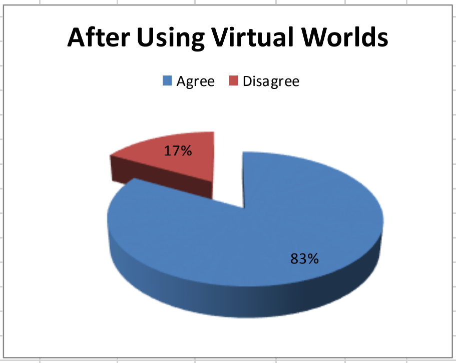
Date	18-Nov-13
Participants	15

Seq.	Question	Before Using the Virtual World				After Using the Virtual World			
		Slightly Agree	Fully Agree	Slightly Disagree	Fully Disagree	Slightly Agree	Fully Agree	Slightly Disagree	Fully Disagree
5	The environment used to convey this specific subject facilitated the learning of it.	4	2	6	3	6	5	3	1
11	This subject was understood quickly.	3	1	7	4	10	4		1
	Total	**7**	**3**	**13**	**7**	**16**	**9**	**3**	**2**
		5.00		**10.00**		**12.50**		**2.50**	

	Before Using the Virtual World		After Using the Virtual World	
	Agree	Disagree	Agree	Disagree
Questions No. 3 & 6 - Reversed	33.33	66.67	83.33	16.67

Before using virtual worlds	After using virtual worlds





Database Normalisation – Year 1:

Technology Enhanced Learning in Higher Education			
Systems Analysis and Databases Unit			
Database Normalization		Date	18-Nov-13
		Participants	18

Seq.	Question	Before Using the Virtual World				After Using the Virtual World			
		Slightly Agree	Fully Agree	Slightly Disagree	Fully Disagree	Slightly Agree	Fully Agree	Slightly Disagree	Fully Disagree
1	‘Database Normalisation’ is a difficult subject.	7	7	4		4	3	7	4
2	The visualized mode of explaining the concepts and application of database normalisation helped my understanding and learning of this subject.(i.e. on the white/smart board compared to the virtual world scenario)	9	5	2	2	4	9	3	2
3	I am confident with the main concepts of the database normalisation subject (e.g. UNF, 1NF, 2NF, 3NF).	6	2	7	2	5	10		3
4	Being able to see the real-time effects of database normalisation process (visualized) aided the retention of that information.(i.e. the traditional exercises in the classroom and the visualized exercises in the virtual world)	7	4	6	1	7	8	2	1
5	Using metaphors (symbols) in the learning environment improved my understanding and learning of this fundamental area.(i.e. the imagined situation in the physical classroom compared to the objects appearing in the virtual world)	5	2	10	1	6	8	3	1
6	The traditional method of teaching the database normalisation subject in the physical classroom (alone) is suitable for facilitating the understanding and learning of its concepts.	9	3	4	2	5	11	2	
7	I find it difficult to imagine the process of carrying out the different normalisation rules and their resulting outcome.	5	4	7	2	6	1	6	5
8	The use of technology-enhanced tools has furthered my understanding and learning of the database normalisation subject.(e.g. the use of the smart-board technology compared to the virtual world technology).	8	1	8	1	5	9	2	2
9	The learning tools used to explain the difficult concepts of the database normalisation subject were successful in making the understanding and learning memorable.(e.g. the PowerPoint presentations, notes, examples compared to the visualized scenario and 3D objects in the immersive environment of the virtual world).	9	1	7	1	6	9	3	
10	The learning tools used to explain the difficult concepts of the database normalisation subject were successful in making my learning environment enjoyable.	11	1	3	3	6	9	2	1
11	I understood the database normalisation concepts quickly because of the learning tools used to explain them.	6	2	9	1	5	7	4	2
12	One method of teaching the database normalisation concepts would be sufficient State your preferred method (e.g. the real world, the virtual world, or both):	4	2	7	3	5	5	4	2
	Unprocessed question - Qualitative								

Group A

Do you consider this subject as difficult and theoretical in HE Computer Science?

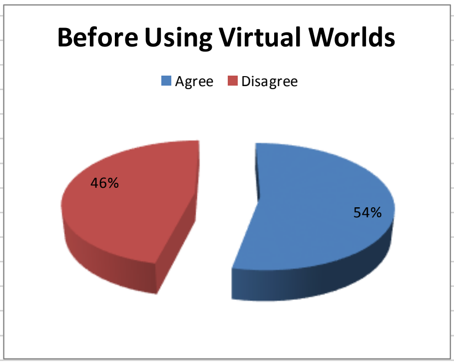
Date	18-Nov-13
Participants	18

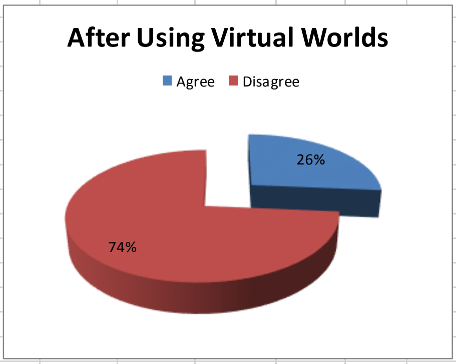
Seq.	Question	Before Using the Virtual World				After Using the Virtual World			
		Slightly Agree	Fully Agree	Slightly Disagree	Fully Disagree	Slightly Agree	Fully Agree	Slightly Disagree	Fully Disagree
1	'Database Normalisation' is a difficult subject.	7	7	4		4	3	7	4
3	*I am NOT confident with the main concepts of the database normalisation subject (e.g. UNF, 1NF, 2NF, 3NF).*	7	2	6	2		3	5	10
6	*The traditional method of teaching the database normalisation subject in the physical classroom (alone) is NOT suitable for facilitating the understanding and learning of its concepts.*	4	2	9	3	2		5	11
7	I find it difficult to imagine the process of carrying out the different normalisation rules and their resulting outcome.	5	4	7	2	6	1	6	5
	Total	**23**	**15**	**26**	**7**	**12**	**7**	**23**	**30**
		9.50		**8.25**		**4.75**		**13.25**	

Questions No. 3 & 6 - Reversed

Before Using the Virtual World		After Using the Virtual World	
Agree	Disagree	Agree	Disagree
52.78	45.83	26.39	73.61

Before using virtual worlds	After using virtual worlds





Group B

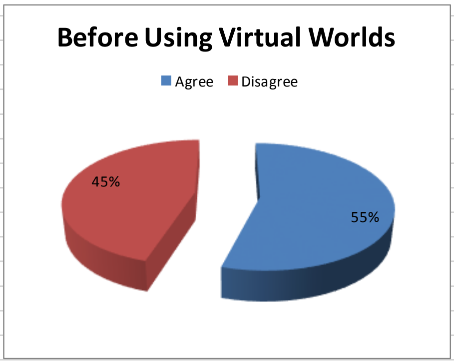
Is learning more enhanced before and/or after the application of virtual worlds?

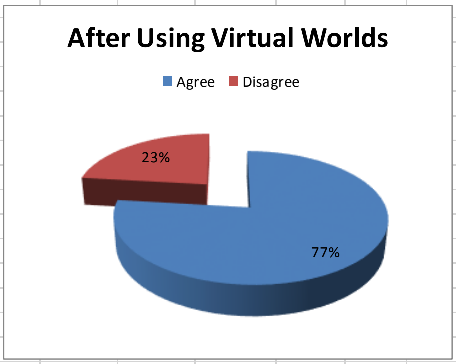
Date	**18-Nov-13**
Participants	**18**

Seq.	Question	Before Using the Virtual World				After Using the Virtual World			
		Slightly Agree	Fully Agree	Slightly Disagree	Fully Disagree	Slightly Agree	Fully Agree	Slightly Disagree	Fully Disagree
2	The visualized mode of explaining the concepts and application of database normalisation helped my understanding and learning of this subject.(i.e. on the white/smart board compared to the virtual world scenario)	9	5	2	2	4	9	3	2
4	Being able to see the real-time effects of database normalisation process (visualized) aided the retention of that information.(i.e. the traditional exercises in the classroom and the visualized exercises in the virtual world)	7	4	6	1	7	8	2	1
5	Using metaphors (symbols) in the learning environment improved my understanding and learning of this fundamental area.(i.e. the imagined situation in the physical classroom compared to the objects appearing in the virtual world)	5	2	10	1	6	8	3	1
8	The use of technology-enhanced tools has furthered my understanding and learning of the database normalisation subject.(e.g. the use of the smart-board technology compared to the virtual world technology).	8	1	8	1	5	9	2	2
9	The learning tools used to explain the difficult concepts of the database normalisation subject were successful in making the understanding and learning memorable.(e.g. the PowerPoint presentations, notes, examples compared to the visualized scenario and 3D objects in the immersive environment of the virtual world).	9	1	7	1	6	9	3	
11	I understood the database normalisation concepts quickly because of the learning tools used to explain them.	6	2	9	1	5	7	4	2
		44	**15**	**42**	**7**	**33**	**50**	**17**	**8**
		9.83		**8.17**		**13.83**		**4.17**	

Before Using the Virtual World		After Using the Virtual World	
Agree	**Disagree**	**Agree**	**Disagree**
54.63	**45.37**	**76.85**	**23.15**

Before using virtual worlds	After using virtual worlds





Group C

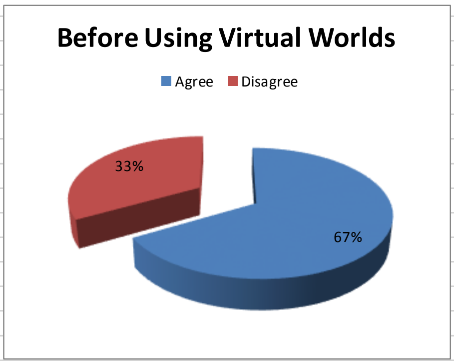
Is affective quality more enhanced before and/or after the application of virtual worlds?

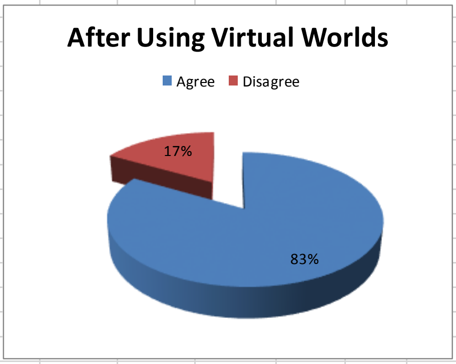
Date	18-Nov-13
Participants	18

Seq.	Question	Before Using the Virtual World				After Using the Virtual World			
		Slightly Agree	Fully Agree	Slightly Disagree	Fully Disagree	Slightly Agree	Fully Agree	Slightly Disagree	Fully Disagree
10	The learning tools used to explain the difficult concepts of the database normalisation subject were successful in making my learning environment enjoyable.	11	1	3	3	6	9	2	1
	Total	**11**	**1**	**3**	**3**	**6**	**9**	**2**	**1**
		12.00		**6.00**		**15.00**		**3.00**	

	Before Using the Virtual World		After Using the Virtual World	
	Agree	Disagree	Agree	Disagree
Questions No. 3 & 6 - Reversed	66.67	33.33	83.33	16.67

Before using virtual worlds	After using virtual worlds





Group D

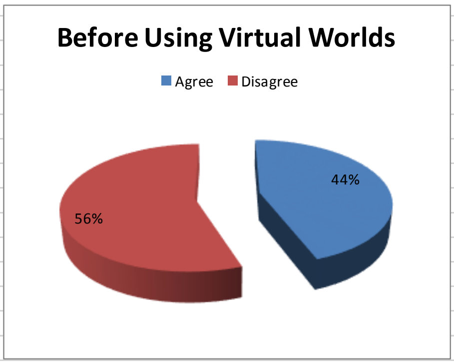
Is the learning process more engaging before and/or after the application of virtual worlds?

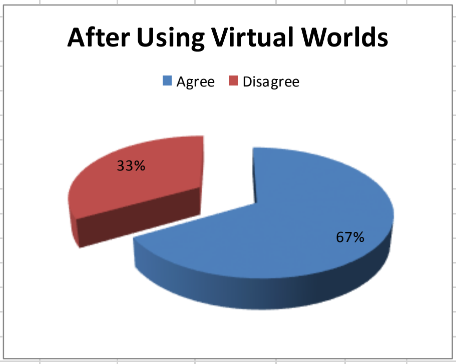
Date	18-Nov-13
Participants	18

Seq.	Question	Before Using the Virtual World				After Using the Virtual World			
		Slightly Agree	Fully Agree	Slightly Disagree	Fully Disagree	Slightly Agree	Fully Agree	Slightly Disagree	Fully Disagree
11	I understood the database normalisation concepts quickly because of the learning tools used to explain them.	6	2	9	1	5	7	4	2
	Total	**6**	**2**	**9**	**1**	**5**	**7**	**4**	**2**
		8.00		**10.00**		**12.00**		**6.00**	

	Before Using the Virtual World		After Using the Virtual World	
	Agree	Disagree	Agree	Disagree
Questions No. 3 & 6 - Reversed	44.44	55.56	66.67	33.33

Before using virtual worlds	After using virtual worlds





Helpdesk Support – Year 2:

	Technology-Enhanced Learning for Higher Education								
	ICT Service Support Unit					Date		18-Oct-13	
						Participants		7	

Seq.	Question	Before Using the Virtual World				After Using the Virtual World			
		Slightly Agree	FullyA gree	Slightly Disagree	Fully Disagree	Slightly Agree	Fully Agree	Slightly Disagree	Fully Disagree
1	Unexpected situations make me unsettled.	3	1	3		2		4	1
2	I find it difficult to imagine what types of problems I could encounter at the helpdesk.	2	2	2	1	2	1	2	2
3	I find it difficult dealing with a variety of different people with certain personality traits.	4		2	1	3		2	2
4	Communication can sometimes be a challenge to me.	1	1	3	2	2		3	2
5	I find the unit requirement easy to achieve.	6		1		5	1	1	
6	I am not comfortable to go on a real helpdesk without experience.	1	2	4		2		3	2
7	I find it very difficult to interpret people's non-verbal communication (e.g. body language).	3		3	1	1		5	1
8	I find the training on the helpdesk duties helpful.	3	2	2		2	4	1	
9	Being able to simulate situations improve my self-confidence and helped me to better prepare for a real-life situation.	4	1	2		2	3	2	
10	Being able to rehearse/experience potentially difficult situation has added to my planning to defuse/deal with them in the real world.	3	1	3		5	1	1	
11	I can recommend ways of extending the range of ICT service support beyond the traditional approach.	4	1	2		4	1	2	
12	I appreciate the advantages of providing ICT service support in a non-traditional environment.	5	1	1		6	1		
	Not processed - irrelevant								

Group A

Do you consider this subject as difficult and theoretical in HE Computer Science?

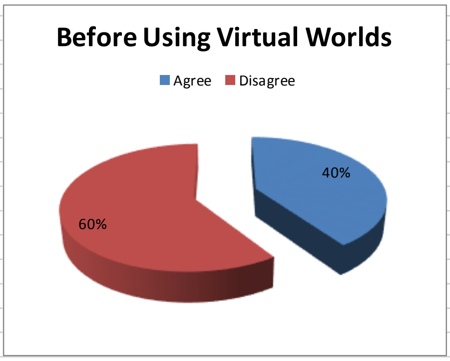
Date	**18-Oct-13**
Participants	**7**

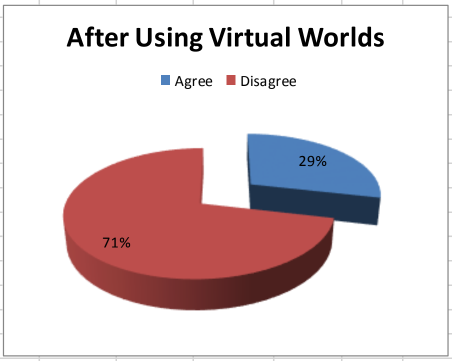
Seq.	Question	Before Using the Virtual World				After Using the Virtual World			
		Slightly Agree	Fully Agree	Slightly Disagree	Fully Disagree	Slightly Agree	Fully Agree	Slightly Disagree	Fully Disagree
2	I find it difficult to imagine what types of problems I could encounter at the helpdesk.	2	2	2	1	2	1	2	2
3	I find it difficult dealing with a variety of different people with certain personality traits.	4		2	1	3		2	2
4	Communication can sometimes be a challenge to me.	1	1	3	2	2		3	2
5	*I find the unit requirement NOT easy to achieve.*	1		6		1		5	1
6	I am not comfortable to go on a real helpdesk without experience.	1	2	4		2		3	2
7	I find it very difficult to interpret people's non-verbal communication (e.g. body language).	3		3	1	1		5	1
	Total	**12**	**5**	**20**	**5**	**11**	**1**	**20**	**10**
		2.83		**4.17**		**2.00**		**5.00**	

Question No. 5 - Reversed

Before Using the Virtual World		After Using the Virtual World	
Agree	Disagree	Agree	Disagree
40.48	59.52	28.57	71.43

Before using virtual worlds	After using virtual worlds





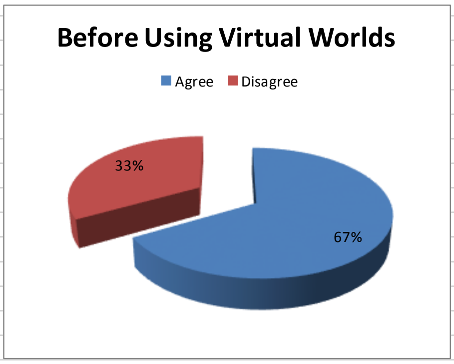
Group B
Is learning more enhanced before and/or after the application of virtual worlds?

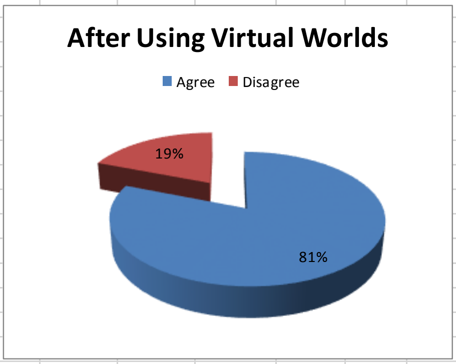
Date	18-Oct-13
Participants	7

Seq.	Question	Before Using the Virtual World				After Using the Virtual World			
		Slightly Agree	Fully Agree	Slightly Disagree	Fully Disagree	Slightly Agree	Fully Agree	Slightly Disagree	Fully Disagree
8	I find the training on the helpdesk duties helpful.	3	2	2		2	4	1	
9	Being able to simulate situations improve my self-confidence and helped me to better prepare for a real-life situation.	4	1	2		2	3	2	
10	Being able to rehearse/experience potentially difficult situation has added to my planning to defuse/deal with them in the real world.	3	1	3		5	1	1	
	Total	**10**	**4**	**7**	**0**	**9**	**8**	**4**	**0**
		4.67		**2.33**		**5.67**		**1.33**	

Before Using the Virtual World		After Using the Virtual World	
Agree	Disagree	Agree	Disagree
66.67	33.33	80.95	19.05

Before using virtual worlds	After using virtual worlds





Group C

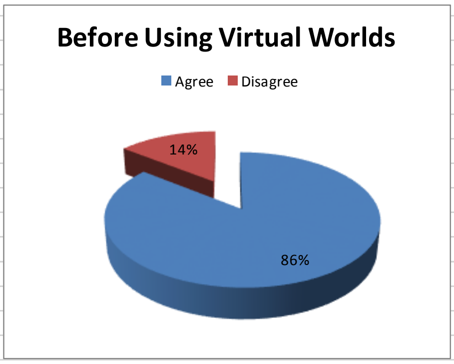
Is affective quality more enhanced before and/or after the application of virtual worlds?

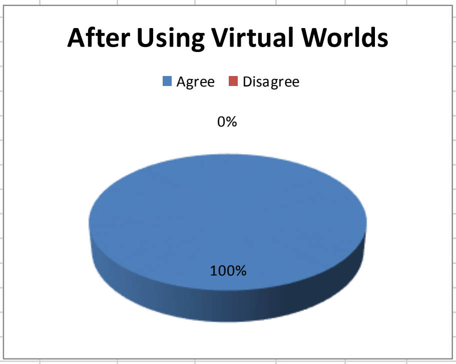
Date	18-Oct-13
Participants	7

Seq.	Question	Before Using the Virtual World				After Using the Virtual World			
		Slightly Agree	Fully Agree	Slightly Disagree	Fully Disagree	Slightly Agree	Fully Agree	Slightly Disagree	Fully Disagree
12	I appreciate the advantages of providing ICT service support in a non-traditional environment.	5	1	1		6	1		
	Total	**5**	**1**	**1**	**0**	**6**	**1**	**0**	**0**
		6.00		**1.00**		**7.00**		**0.00**	

Before Using the Virtual World		After Using the Virtual World	
Agree	Disagree	Agree	Disagree
85.71	14.29	100.00	0.00

Before using virtual worlds	After using virtual worlds





Group D

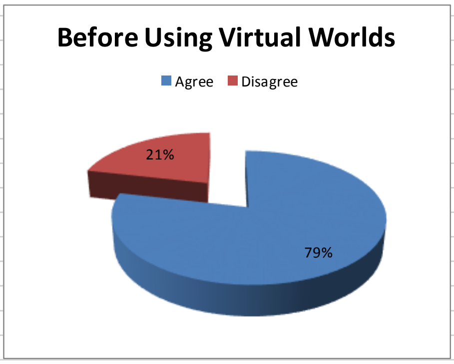
Is the learning process more engaging before and/or after the application of virtual worlds?

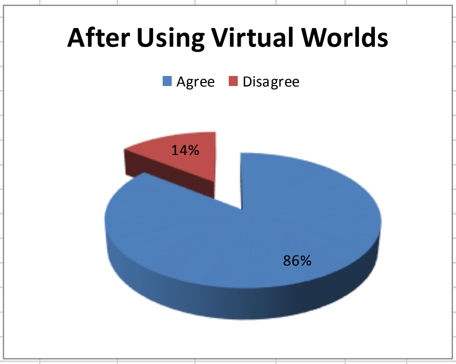
Date	18-Oct-13
Participants	7

Seq.	Question	Before Using the Virtual World				After Using the Virtual World			
		Slightly Agree	Fully Agree	Slightly Disagree	Fully Disagree	Slightly Agree	Fully Agree	Slightly Disagree	Fully Disagree
11	I can recommend ways of extending the range of ICT service support beyond the traditional approach.	4	1	2		4	1	2	
12	I appreciate the advantages of providing ICT service support in a non-traditional environment.	5	1	1		6	1		
	Total	**9**	**2**	**3**	**0**	**10**	**2**	**2**	**0**
		5.50		**1.50**		**6.00**		**1.00**	

Before Using the Virtual World		After Using the Virtual World	
Agree	Disagree	Agree	Disagree
78.57	21.43	85.71	14.29

Before using virtual worlds	After using virtual worlds





Multithreading Techniques (Concurrency and Parallelism) – BSc (Year 3):

Technology Enhanced Learning in Higher Education			
Multi-Tasking System Unit			
Coneurrency and Parallelism		**Date**	**06-Nov-13**
		Participants	**7**

Seq.	Question	Before Using the Virtual World				After Using the Virtual World			
		Slightly Agree	Fully Agree	Slightly Disagree	Fully Disagree	Slightly Agree	Fully Agree	Slightly Disagree	Fully Disagree
1	'Concurrency and Parallelism' is a difficult subject.	2	4		1	1	2	2	2
2	The visualized mode of explaining the concepts and application of concurrency and parallelism helped my understanding and learning.	3	1	3		2	5		
3	I am confident with the technical subject of 'Concurrency and Parallelism'.	2	2	2	1	2	5		
4	Playing the different roles of the CPU, RAM and the Operating System facilitated my understanding and learning of this technical subject.	3	1	2	1	1	6		
5	An analogy adds interest to the subject, making it more enjoyable and as a result more memorable.	2	2	2		2	5		
6	The traditional method of teaching the 'Concurrency and Parallelism' subject (alone) is suitable for facilitating the understanding and learning of its concepts.	3	1	3		2	3	1	
7	I find it difficult to imagine the process of concurrency and parallelism and the queuing technique handled by the Operating System (with the different factors and priorities).	2	3	1	1	2		1	4
8	The inclusion of technology-enhanced tools has furthered my understanding and learning of the 'Concurrency and Parallelism' subject.	3		4		2	5		
9	Because of the subject difficulty, verbal communication of the concepts was not adequate to convey the ideas fully.	2	2	3		2	2	2	1
10	Using visual metaphors (symbols) in an immersive environment improved my understanding and learning of this fundamental area of Multi-Tasking Systems.	2	1	3	1	1	5	1	
11	Being able to place myself in the role of a specific computer component helped me to appreciate its job in service provided.	3	1	2	1	2	5		

Group A

Do you consider this subject as difficult and theoretical in HE Computer Science?

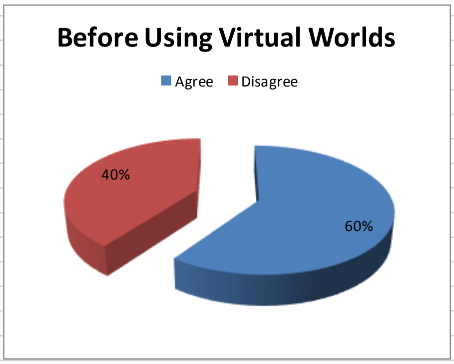
Date	**06-Nov-13**
Participants	**7**

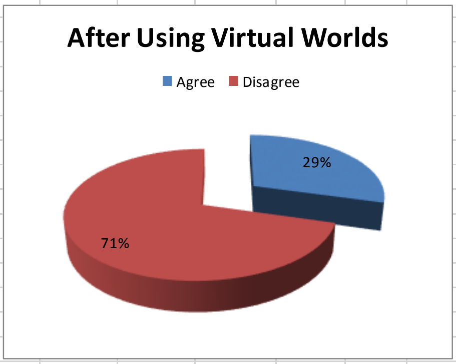
Seq.	Question	Before Using the Virtual World				After Using the Virtual World			
		Slightly Agree	Fully Agree	Slightly Disagree	Fully Disagree	Slightly Agree	Fully Agree	Slightly Disagree	Fully Disagree
1	'Concurrency and Parallelism' is a difficult subject.	2	4		1	1	2	2	2
3	*I am NOT confident with the technical subject of 'Concurrency and Parallelism'.*	2	1	2	2			2	5
6	*The traditional method of teaching the 'Concurrency and Parallelism' subject (alone) is NOT suitable for facilitating the understanding and learning of its concepts.*	3		3	1	1		2	3
7	I find it difficult to imagine the process of concurrency and parallelism and the queuing technique handled by the Operating System (with the different factors and priorities).	2	3	1	1	2		1	4
9	Because of the subject difficulty, verbal communication of the concepts was not adequate to convey the ideas fully.	2	2	3		2	2	2	1
	Total	**11**	**10**	**9**	**5**	**6**	**4**	**9**	**15**
		4.20		**2.80**		**2.00**		**4.80**	

QuestionS No. 3 & 6 - Reversed

Before Using the Virtual World		After Using the Virtual World	
Agree	**Disagree**	**Agree**	**Disagree**
60.00	**40.00**	**28.57**	**68.57**

Before using virtual worlds	**After using virtual worlds**





Group B

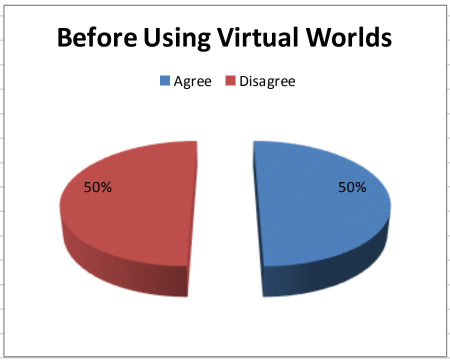
Is learning more enhanced before and/or after the application of virtual worlds?

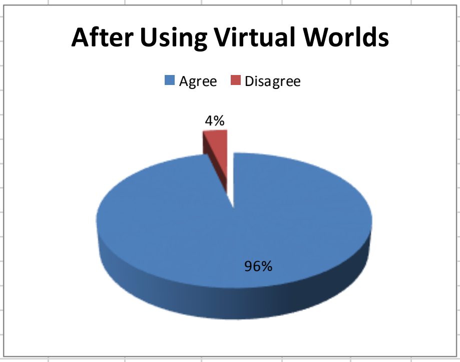
Date	06-Nov-13
Participants	7

Seq.	Question	Before Using the Virtual World				After Using the Virtual World			
		Slightly Agree	Fully Agree	Slightly Disagree	Fully Disagree	Slightly Agree	Fully Agree	Slightly Disagree	Fully Disagree
2	The visualized mode of explaining the concepts and application of concurrency and parallelism helped my understanding and learning.	3	1	3		2	5		
4	Playing the different roles of the CPU, RAM and the Operating System facilitated my understanding and learning of this technical subject.	3	1	2	1	1	6		
8	The inclusion of technology-enhanced tools has furthered my understanding and learning of the 'Concurrency and Parallelism' subject.	3		4		2	5		
10	Using visual metaphors (symbols) in an immersive environment improved my understanding and learning of this fundamental area of Multi-Tasking Systems.	2	1	3	1	1	5	1	
	Total	11	3	12	2	6	21	1	0
		3.50		3.50		6.75		0.25	

Before Using the Virtual World		After Using the Virtual World	
Agree	Disagree	Agree	Disagree
50.00	50.00	96.43	3.57

Before using virtual worlds	After using virtual worlds





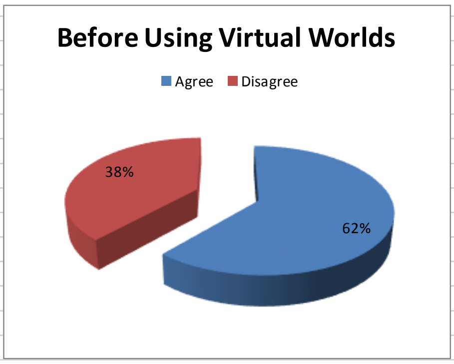
Group C
Is affective quality more enhanced before and/or after the application of virtual worlds?

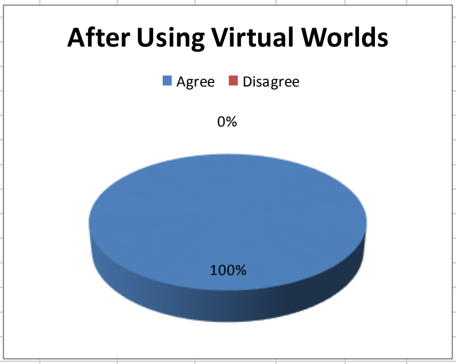
Date	06-Nov-13
Participants	7

Seq.	Question	Before Using the Virtual World				After Using the Virtual World			
		Slightly Agree	Fully Agree	Slightly Disagree	Fully Disagree	Slightly Agree	Fully Agree	Slightly Disagree	Fully Disagree
5	An analogy adds interest to the subject, making it more enjoyable and as a result more memorable.	2	2	2		2	5		
11	Being able to place myself in the role of a specific computer component helped me to appreciate its job in service provided.	3	1	2	1	2	5		
	Total	**5**	**3**	**4**	**1**	**4**	**10**	**0**	**0**
		4.00		**2.50**		**7.00**		**0.00**	

Before Using the Virtual World		After Using the Virtual World	
Agree	Disagree	Agree	Disagree
57.14	35.71	100.00	0.00

Before using virtual worlds	After using virtual worlds





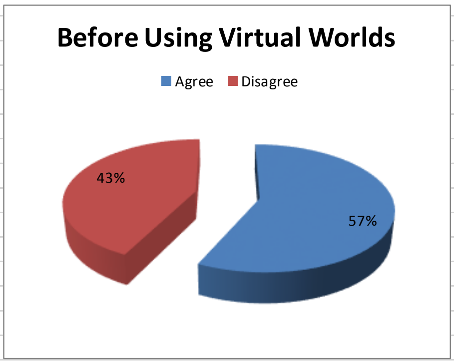
Group D									
Is the learning process more engaging before and/or after the application of virtual worlds?									

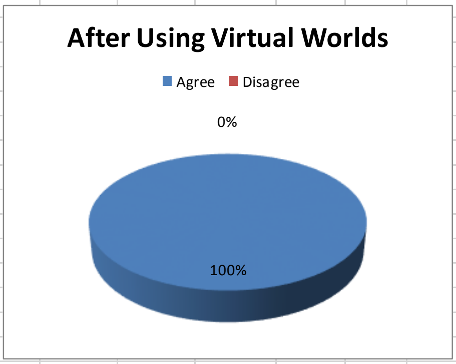
Date	06-Nov-13
Participants	7

Seq.	Question	Before Using the Virtual World				After Using the Virtual World			
		Slightly Agree	Fully Agree	Slightly Disagree	Fully Disagree	Slightly Agree	Fully Agree	Slightly Disagree	Fully Disagree
11	Being able to place myself in the role of a specific computer component helped me to appreciate its job in service provided.	3	1	2	1	2	5		
	Total	**3**	**1**	**2**	**1**	**2**	**5**	**0**	**0**
		4.00		**3.00**		**7.00**		**0.00**	

Before Using the Virtual World		After Using the Virtual World	
Agree	Disagree	Agree	Disagree
57.14	42.86	100.00	0.00

Before using virtual worlds	After using virtual worlds





Research Methods (Concurrency and Parallelism) – BSc (Year 3):

Technology-Enhanced Learning for Higher Education	
Research Methods	
Date	**04-Dec-13**
Participants	**7**

Seq.	Question	Before Using the Virtual World				After Using the Virtual World			
		Slightly Agree	Fully Agree	Slightly Disagree	Fully Disagree	Slightly Agree	Fully Agree	Slightly Disagree	Fully Disagree
1	Research Methods is a challenging topic.	4	1	2		4		3	
2	Methods of investigating the information on computing projects are limited.		3	1	3	1	1	2	3
3	The theory concepts of this subject require visualization in order to be better understood.	1	5	1		2	5		
4	You feel that different approached to studying this subject are needed.	3	3	1		3	3	1	
5	The ability to extend methods of research increases the potential of success to a computing project.		5	2		4	3		
6	The experience of being able to research within multiple environments has increased my vision of how my computing project should develop.	5		2		4	3		
7	The opportunity to develop my understanding of the research methods concepts according to my own learning needs and at my own pace has helped me to achieve a better investigation of my computing project.	4	2	1		2	4	1	
8	The use of an observatory metaphor (symbol) for research methods aids the understanding of this subject.	3		3	1	1	4	2	
9	I am able to concentrate and focus clearly on this subject.	4	2			1	4	1	
10	I can visualize a clear structure for research methods which has furthered my understanding and as a result has enabled me to feel more engaged in this unit.	4	1	2		4	2	1	
11	Teaching the research methods concepts within one environment only e.g. either the real or the virtual world, would be sufficient to achieve a successful computing research project.	4	2	1		3	3	1	
12	State your preferred method of teaching the Research Methods (for computing projects) subject:	**The Real world**			**The Virtual World**			**Both**	
		2						5	

Question processed separately - Qualitative

Group A

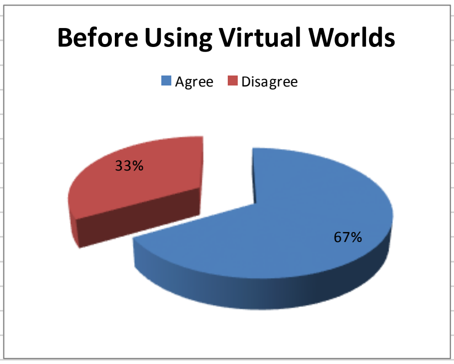
Do you consider this subject as difficult and theoretical in HE Computer Science?

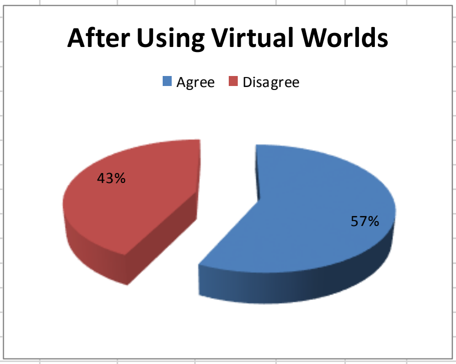
Date	**04-Dec-13**
Participants	**7**

Seq.	Question	Before Using the Virtual World				After Using the Virtual World			
		Slightly Agree	Fully Agree	Slightly Disagree	Fully Disagree	Slightly Agree	Fully Agree	Slightly Disagree	Fully Disagree
1	Research Methods is a challenging topic.	4	1	2		4		3	
2	Methods of investigating the information on computing projects are limited.		3	1	3	1	1	2	3
4	You feel that different approached to studying this subject are needed.	3	3	1		3	3	1	
	Total	**7**	**7**	**4**	**3**	**8**	**4**	**6**	**3**
		4.67		**2.33**		**4.00**		**3.00**	

Before Using the Virtual World		After Using the Virtual World	
Agree	**Disagree**	**Agree**	**Disagree**
66.67	**33.33**	**57.14**	**42.86**

Before using virtual worlds | **After using virtual worlds**





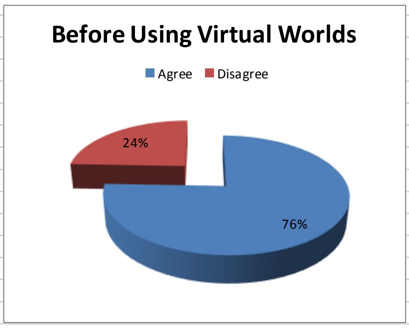
Group B									
Is learning more enhanced before and/or after the application of virtual worlds?									

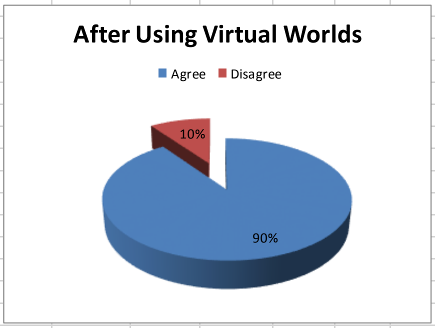
Date	**04-Dec-13**
Participants	**7**

Seq.	**Question**	**Before Using the Virtual World**				**After Using the Virtual World**			
		Slightly Agree	Fully Agree	Slightly Disagree	Fully Disagree	Slightly Agree	Fully Agree	Slightly Disagree	Fully Disagree
3	The theory concepts of this subject require visualization in order to be better understood.	1	5	1		2	5		
5	The ability to extend methods of research increases the potential of success to a computing project.		5	2		4	3		
6	The experience of being able to research within multiple environments has increased my vision of how my computing project should develop.	5		2		4	3		
7	The opportunity to develop my understanding of the research methods concepts according to my own learning needs and at my own pace has helped me to achieve a better investigation of my computing project.	4	2	1		2	4	1	
8	The use of an observatory metaphor (symbol) for research methods aids the understanding of this subject.	3		3	1	1	4	2	
9	I am able to concentrate and focus clearly on this subject.	4	2			1	4	1	
	Total	**17**	**14**	**9**	**1**	**14**	**23**	**4**	**0**
		5.17		**1.67**		**6.17**		**0.67**	

Before Using the		**After Using the**	
Agree	**Disagree**	**Agree**	**Disagree**
73.81	**23.81**	**88.10**	**9.52**

Before using virtual worlds	**After using virtual worlds**





Group D

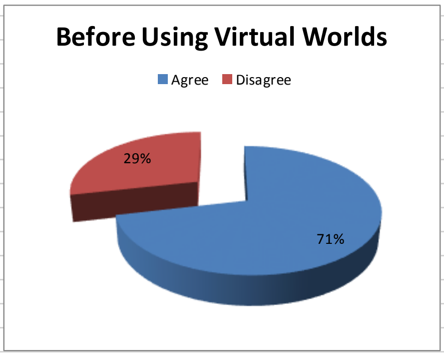
Is the learning process more engaging before and/or after the application of virtual worlds?

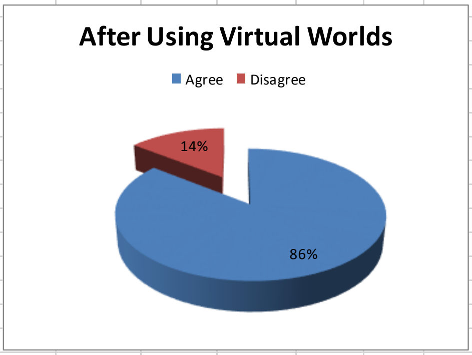
Date	04-Dec-13
Participants	7

Seq.	Question	Before Using the Virtual World				After Using the Virtual World			
		Slightly Agree	Fully Agree	Slightly Disagree	Fully Disagree	Slightly Agree	Fully Agree	Slightly Disagree	Fully Disagree
10	I can visualize a clear structure for research methods which has furthered my understanding and as a result has enabled me to feel more engaged in this unit.	4	1	2		4	2	1	
	Total	**4**	**1**	**2**	**0**	**4**	**2**	**1**	**0**
		5.00		**2.00**		**6.00**		**1.00**	

Before Using the		After Using the	
Agree	Disagree	Agree	Disagree
71.43	28.57	85.71	14.29

Before using virtual worlds	After using virtual worlds





A3.5 Further Data Analysis - Data Correlation

Computer Programming – Year 1 (2012/2013):

Technology Enhanced Learning in Higher Education

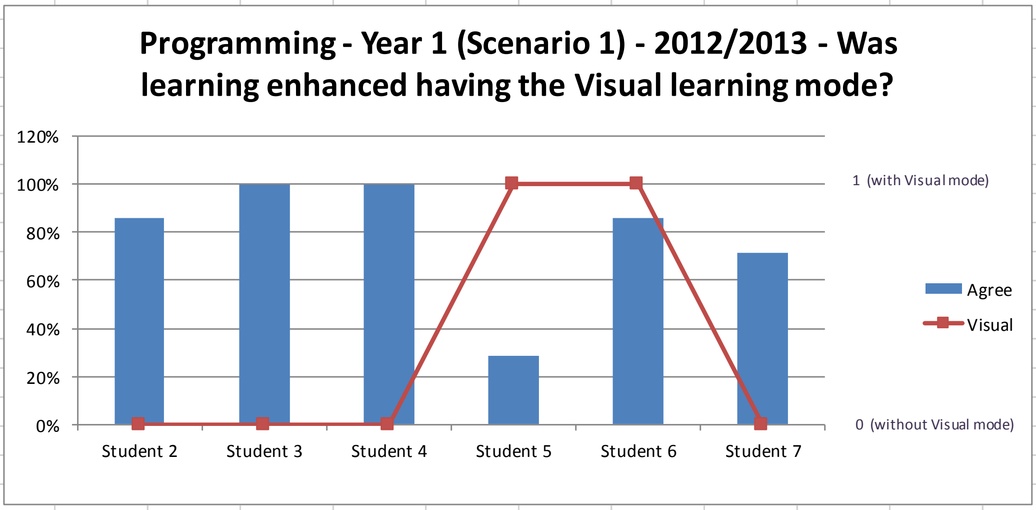
Subject	Programming	Date	27 Feb. 2013
Description	Introduction to Programming	Number of Students	6
Year	1	Number of Questions	16

Student Name and No.	Learning Modes		Questions with 'Agree'/'Fully agree' answer																Correlation				Correlation %			
	Visual	Kinesthetic																	Difficult Subject	Enhanced Learning	Enhanced Affective Quality	Enhanced Engagement	Difficult Subject	Enhanced Learning	Enhanced Affective Quality	Enhanced Engagement
Student 1	1	1																								
Student 2	0	1	1	2	3	4	5	6	7	8	9	12	14	15	16				Y	Y	Y	Y	100%	86%	100%	50%
Student 3	0	1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Y	Y	Y	Y	100%	100%	100%	100%
Student 4	0	1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Y	Y	Y	Y	100%	100%	100%	100%
Student 5	1	1	4	5	7														N	N	Y	N	0%	29%	100%	0%
Student 6	1	1	2	3	5	6	7	8	9	10	11	12	13	14	15	16			Y	Y	Y	Y	75%	86%	100%	100%
Student 7	0	1	2	5	6	7	8	9	15										N	Y	Y	N	25%	71%	100%	0%

1. What is the number of students who found the subject difficult but their learning was enhanced after the application of virtual worlds?	100%
2. What is the number of students who found the subject difficult but their affective quality was enhanced after the application of virtual worlds?	100%
3. What is the number of students who found the subject difficult but their engagement was enhanced after the application of virtual worlds?	100%
4. What is the number of students who found the subject difficult but their learning was not enhanced after the application of virtual worlds?	0%
5. What is the number of students who did not find the subject difficult but their learning was enhanced after the application of virtual worlds?	50%

Programming - Year 1 (Scenario 1) - 2012/2013 - Was learning enhanced having the Visual learning mode?

Student	Student 2	Student 3	Student 4	Student 5	Student 6	Student 7
Agree	86%	100%	100%	29%	86%	71%
Visual	0	0	0	1	1	0



Technology Enhanced Learning in Higher Education

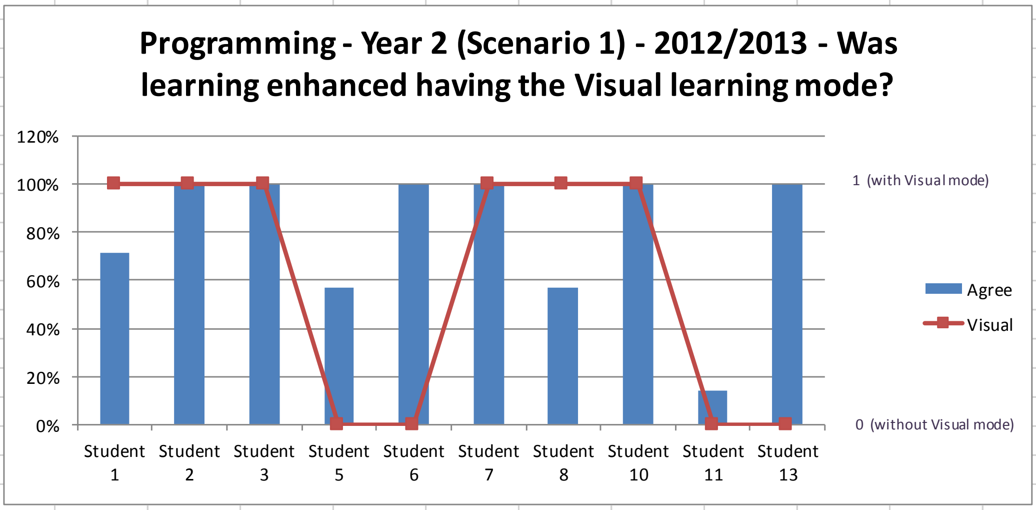
Subject	Object Oriented Programming		Date	04 Mar. 2013
Description			Number of Students	10
Year	2		Number of Questions	16

Student Name and No.	Learning Modes		Questions with 'Agree'/'Fully agree' answer																Correlation				Correlation %			
	Visual	Kinesthetic																	Difficult Subject	Enhanced Learning	Enhanced Affective Quality	Enhanced Engagement	Difficult Subject	Enhanced Learning	Enhanced Affective Quality	Enhanced Engagement
Student 1	1	1	2	4	5	6	7	8	9	12									N	Y	Y	N	25%	71%	100%	25%
Student 2	1	1	1	2	3	4	5	6	7	8	9	10	11	12	14	15	16		Y	Y	Y	Y	100%	100%	100%	75%
Student 3	1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Y	Y	Y	Y	100%	100%	100%	100%
Student 4	1	1																								
Student 5	0	1	1	2	3	4	5	7	8	9	12	13							Y	Y	Y	Y	75%	57%	100%	50%
Student 6	0	1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Y	Y	Y	Y	100%	100%	100%	100%
Student 7	1	1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Y	Y	Y	Y	100%	100%	100%	100%
Student 8	1	1	1	2	3	4	5	7	8	9									Y	Y	Y	N	75%	57%	100%	0%
Student 9	0	0																								
Student 10	1	1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Y	Y	Y	Y	100%	100%	100%	100%
Student 11	0	0	8																N	N	N	N	0%	14%	0%	0%
Student 12	1	0																								
Student 13			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Y	Y	Y	Y	100%	100%	100%	100%

1. What is the number of students who found the subject difficult but their learning was enhanced after the application of virtual worlds?	100%
2. What is the number of students who found the subject difficult but their affective quality was enhanced after the application of virtual worlds?	100%
3. What is the number of students who found the subject difficult but their engagement was enhanced after the application of virtual worlds?	88%
4. What is the number of students who found the subject difficult but their learning was not enhanced after the application of virtual worlds?	0%
5. What is the number of students who did not find the subject difficult but their learning was enhanced after the application of virtual worlds?	50%

Programming - Year 2 (Scenario 1) - 2012/2013 - Was learning enhanced having the Visual learning mode?

Student	Student 1	Student 2	Student 3	Student 5	Student 6	Student 7	Student 8	Student 10	Student 11	Student 13
Agree	71%	100%	100%	57%	100%	100%	57%	100%	14%	100%
Visual	1	1	1	0	0	1	1	1	0	



Technology Enhanced Learning in Higher Education

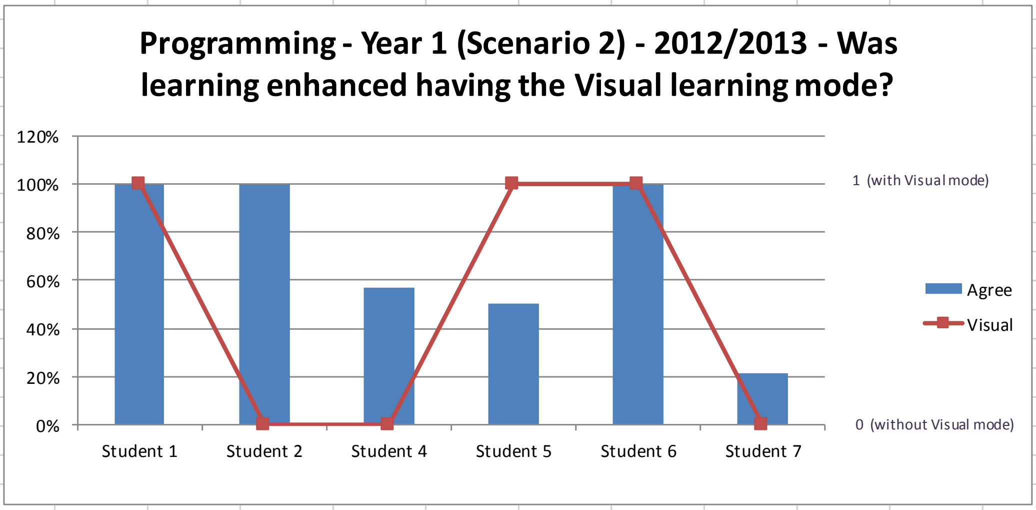
Subject	Programming		Date	15 Apr. 13
Description	Object Oriented Programming		Number of Students	6
Year	1		Number of Questions	21

Student Name/No.	Learning Modes		Questions with 'Agree'/'Fully agree' answer																					Correlation				Correlation %			
	Visual	Kinesthetic																						Difficult Subject	Enhanced Learning	Enhanced Affective Quality	Enhanced Engagement	Difficult Subject	Enhanced Learning	Enhanced Affective Quality	Enhanced Engagement
Student 1	1	1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	Y	Y	Y	Y	100%	100%	100%	100%
Student 2	0	1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	Y	Y	Y	Y	100%	100%	100%	100%
Student 3	0	1																													
Student 4	0	1	1	2	3	4	5	6	7	8	9	11	21											N	Y	Y	Y	0%	57%	50%	50%
Student 5	1	1	2	7	8	11	12	15	21															N	Y	N	N	0%	50%	0%	0%
Student 6	1	1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	17	18	19	20	21		Y	Y	Y	Y	50%	100%	100%	100%
Student 7	0	1	2	4	7	15																		N	N	Y	N	0%	21%	50%	0%

1. What is the number of students who found the subject difficult but their learning was enhanced after the application of virtual worlds?	100%
2. What is the number of students who found the subject difficult but their affective quality was enhanced after the application of virtual worlds?	100%
3. What is the number of students who found the subject difficult but their engagement was enhanced after the application of virtual worlds?	100%
4. What is the number of students who found the subject difficult but their learning was not enhanced after the application of virtual worlds?	0%
5. What is the number of students who did not find the subject difficult but their learning was enhanced after the application of virtual worlds?	67%

Programming - Year 1 (Scenario 2) - 2012/2013 - Was learning enhanced having the Visual learning mode?

Student	Student 1	Student 2	Student 4	Student 5	Student 6	Student 7
Agree	100%	100%	57%	50%	100%	21%
Visual	1	0	0	1	1	0



Computer Programming – Year 1 (2013/2014):

Technology Enhanced Learning in Higher Education

Subject	Programming		Date	12 Nov. 2013
Description	Introduction to Programming		Number of Students	15
Year	1		Number of Questions	12

Student Name and No.	Learning Modes: Visual	Learning Modes: Kinesthetic	Questions with 'Agree'/'Fully agree' answer – Before the application of virtual worlds											
Student 1	1	0	1	2	3	4	5	8	9	10				
Student 2	0	1	1	3	6	7								
Student 3	1	1												
Student 4	1	1	1	2	4	5	6	7	8					
Student 5	0	1	4	5	7	8	9	10	11	12				
Student 6	0	0	1	2	4	5	7	8	9	10	11			
Student 7	0	1	1	2	3	4	5	6	8	10	11	12		
Student 8	0	1	1	2	4	5	7	8	9	10	11	12		
Student 9	1	1	1	2	3	4	6	7	8	9	12			
Student 10	0	1	1	3	4	5	6	8	9	10	11	12		
Student 11	1	1	1	3	6									
Student 12	0	1	1	3	6	7								
Student 13	1	1	1	2	3	4	5	6	9	12				
Student 14	1	1	1	2	4	5	8	9	11	12				
Student 15	1	1	1	2	4	8	9	10	11	12				
Student 16	0	1	1	2	4	5	7	8	10	11				
Student 17	0	1												

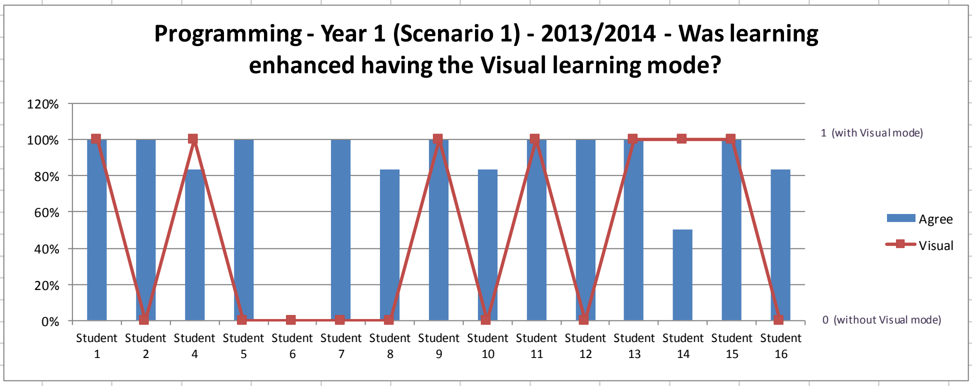
Student Name and No.	Questions with 'Agree'/'Fully agree' answer – After the application of virtual worlds											
Student 1	2	4	5	7	8	9	10	11				
Student 2	2	3	4	5	6	7	8	9	10	11		
Student 3												
Student 4	4	5	6	8	9	10	11					
Student 5	2	4	5	7	8	9	10	11	12			
Student 6	3	6	12									
Student 7	1	2	4	5	6	8	9	10	11	12		
Student 8	1	2	4	5	6	8	9	10				
Student 9	2	4	5	8	9	10	11	12				
Student 10	1	2	4	5	6	7	8	10	11	12		
Student 11	1	2	4	5	7	8	9	10	11	12		
Student 12	2	4	5	8	9	10	11	12				
Student 13	2	4	5	7	8	9	10	11	12			
Student 14	4	5	6	10	11	12						
Student 15	2	4	5	8	9	10	11	12				
Student 16	1	2	4	5	8	10	11					
Student 17												

Student Name and No.	Correlation: Difficult Subject Before VW	Correlation: Enhanced Learning After VW	Correlation: Enhanced Affective Quality After VW	Correlation: Enhanced Engagement After VW	Correlation %: Difficult Subject Before VW	Correlation %: Enhanced Learning After VW	Correlation %: Enhanced Affective Quality After VW	Correlation %: Enhanced Engagement After VW
Student 1	Y	Y	Y	Y	50%	100%	100%	100%
Student 2	Y	Y	Y	Y	100%	100%	100%	100%
Student 3								
Student 4	Y	Y	Y	Y	75%	83%	100%	100%
Student 5	N	Y	Y	Y	25%	100%	100%	100%
Student 6	Y	N	N	N	50%	0%	0%	0%
Student 7	Y	Y	Y	Y	75%	100%	100%	100%
Student 8	Y	Y	Y	N	50%	83%	100%	0%
Student 9	Y	Y	Y	Y	100%	100%	100%	100%
Student 10	Y	Y	Y	Y	75%	83%	100%	100%
Student 11	Y	Y	Y	Y	75%	100%	100%	100%
Student 12	Y	Y	Y	Y	100%	100%	100%	100%
Student 13	Y	Y	Y	Y	75%	100%	100%	100%
Student 14	N	Y	Y	Y	25%	50%	100%	100%
Student 15	N	Y	Y	Y	25%	100%	100%	100%
Student 16	Y	Y	Y	Y	50%	83%	100%	100%
Student 17								

1. What is the number of students who found the subject difficult (before the application of virtual worlds), but their learning was enhanced (after the application of virtual worlds)?	92%
2. What is the number of students who found the subject difficult (before the application of virtual worlds), but their affective quality was enhanced (after the application of virtual worlds)?	92%
3. What is the number of students who found the subject difficult (before the application of virtual worlds), but their engagement was enhanced (after the application of virtual worlds)?	83%
4. What is the number of students who found the subject difficult (before the application of virtual worlds), but their learning was not enhanced (after the application of virtual worlds)?	8%
5. What is the number of students who did not find the subject difficult (before the application of virtual worlds), but their learning was enhanced (after the application of virtual worlds)?	100%

Programming - Year 1 (Scenario 1) - 2013/2014 - Was learning enhanced having the Visual learning mode?

Student	Student 1	Student 2	Student 4	Student 5	Student 6	Student 7	Student 8	Student 9	Student 10	Student 11	Student 12	Student 13	Student 14	Student 15	Student 16
Agree	100%	100%	83%	100%	0%	100%	83%	100%	83%	100%	100%	100%	50%	100%	83%
Visual	1	0	1	0	0	0	0	1	0	1	0	1	1	1	0



Technology Enhanced Learning in Higher Education

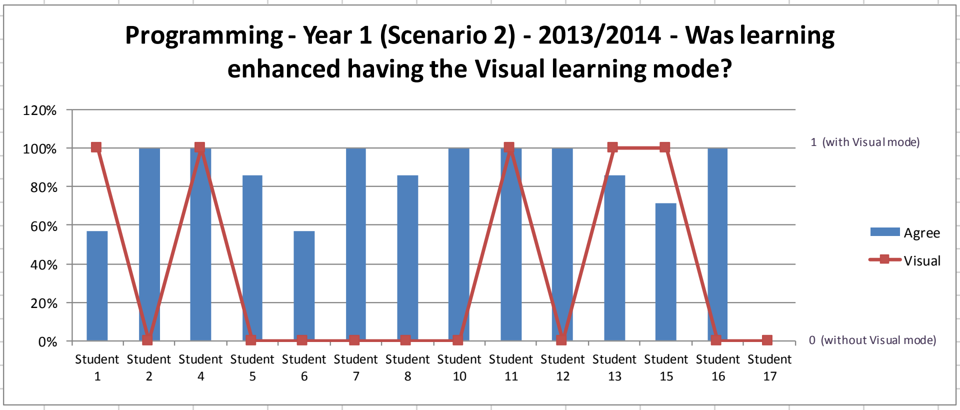
Subject	Programming	Date	10 Dec. 2013
Description	Object Oriented Programming	Number of Students	14
Year	1	Number of Questions	12

Student Name and No.	Learning Modes		Questions with 'Agree'/'Fully agree' answer Before the application of virtual worlds													Questions with 'Agree'/'Fully agree' answer After the application of virtual worlds												Correlation				Correlation %			
	Visual	Kinesthetic																										Difficult Subject Before VW	Enhanced Learning After VW	Enhanced Affective Quality After VW	Enhanced Engagement After VW	Difficult Subject Before VW	Enhanced Learning After VW	Enhanced Affective Quality After VW	Enhanced Engagement After VW
Student 1	1	0	1	2	3	6	7	8	9							1	2	7	8	9	10	11						Y	Y	Y	Y	75%	57%	100%	50%
Student 2	0	1	1	2	4	7	11									5	6	7	8	9	10	11	12					Y	Y	Y	Y	75%	100%	100%	100%
Student 3	1	1																																	
Student 4	1	1	1	2	3	4	5	6	7	8	9	10	12			2	5	6	7	8	9	10	11	12				Y	Y	Y	Y	100%	100%	100%	100%
Student 5	0	1	1	3	4	6	8	9	10	12						5	6	8	9	10	11	12						Y	Y	Y	Y	75%	86%	100%	100%
Student 6	0	0	1	5	6	7	12									4	6	9	10	11	12							N	Y	Y	Y	25%	57%	100%	50%
Student 7	0	1	4	6	7	8	9	11	12							2	5	6	7	8	9	10	11	12				N	Y	Y	Y	25%	100%	100%	100%
Student 8	0	1	1	2	3	4	5	6	7	8	9	12				5	6	7	8	10	11	12						Y	Y	Y	Y	100%	86%	100%	100%
Student 9	1	1																																	
Student 10	0	1	1	2	4	5	6	7	8	10	12					2	4	5	6	7	8	9	10	11	12			Y	Y	Y	Y	75%	100%	100%	100%
Student 11	1	1	1	3												2	5	6	7	8	9	10	11	12				Y	Y	Y	Y	50%	100%	100%	100%
Student 12	0	1	1	2	3	4										5	6	7	8	9	10	11	12					Y	Y	Y	Y	100%	100%	100%	100%
Student 13	1	1	2	4	6	7	9	12								6	7	8	9	10	11	12						Y	Y	Y	Y	50%	86%	100%	50%
Student 14	1	1																																	
Student 15	1	1	1	2	3	4	6	8	9	10	11	12				1	2	3	4	5	6	8	10	11	12			Y	Y	Y	Y	100%	71%	100%	100%
Student 16	0	1	2	7	8	9	10	11	12							2	5	6	7	8	9	10	11	12				N	Y	Y	Y	25%	100%	100%	100%
Student 17	0	1	1	2	3	4										1	2	3	4									Y	N	N	N	100%	0%	0%	0%

1. What is the number of students who found the subject difficult (before the application of virtual worlds), but their learning was enhanced (after the application of virtual worlds)?	91%
2. What is the number of students who found the subject difficult (before the application of virtual worlds), but their affective quality was enhanced (after the application of virtual worlds)?	91%
3. What is the number of students who found the subject difficult (before the application of virtual worlds), but their engagement was enhanced (after the application of virtual worlds)?	91%
4. What is the number of students who found the subject difficult (before the application of virtual worlds), but their learning was not enhanced (after the application of virtual worlds)?	9%
5. What is the number of students who did not find the subject difficult (before the application of virtual worlds), but their learning was enhanced (after the application of virtual worlds)?	100%

Programming - Year 1 (Scenario 2) - 2013/2014 - Was learning enhanced having the Visual learning mode?

Student	Student 1	Student 2	Student 4	Student 5	Student 6	Student 7	Student 8	Student 10	Student 11	Student 12	Student 13	Student 15	Student 16	Student 17
Agree	57%	100%	100%	86%	57%	100%	86%	100%	100%	100%	86%	71%	100%	0%
Visual	1	0	1	0	0	0	0	0	1	0	1	1	0	0



Database Normalisation – Year 1 (2012/2013):

Technology Enhanced Learning in Higher Education

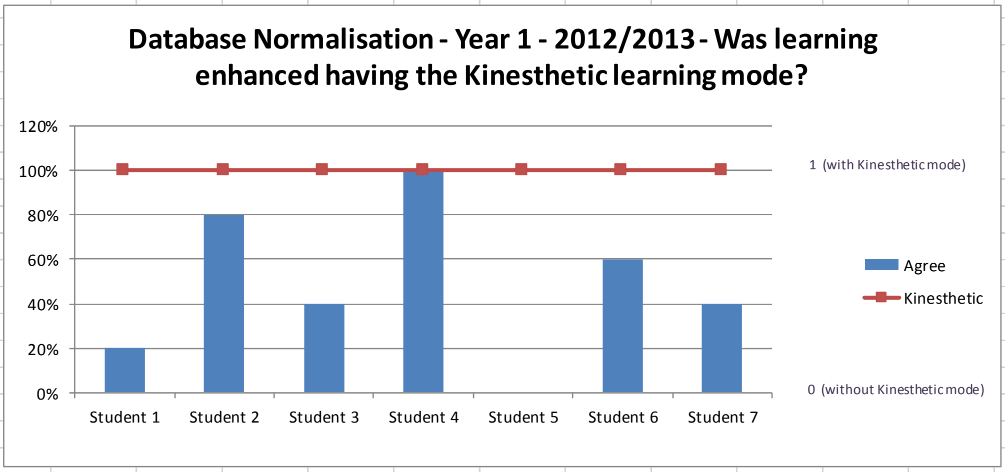
Subject	Database Normalisation	Date	27 Feb. 2013
Description		Number of Students	7
Year	1	Number of Questions	14

Student Name and No.	Learning Modes		Questions with 'Agree'/'Fully agree' answer											Correlation				Correlation %			
	Visual	Kinesthetic												Difficult Subject	Enhanced Learning	Enhanced Affective Quality	Enhanced Engagement	Difficult Subject	Enhanced Learning	Enhanced Affective Quality	Enhanced Engagement
Student 1	1	1	1	2	6	9	10	11	14					Y	N	N	Y	50%	20%	0%	100%
Student 2	0	1	1	2	3	4	5	6	7	9	10	12	13	Y	Y	Y	Y	100%	80%	100%	50%
Student 3	0	1	1	2	4	5	6							Y	N	Y	N	50%	40%	100%	0%
Student 4	0	1	1	5	6	7	8	9	10	11	12	13	14	Y	Y	N	Y	50%	100%	0%	100%
Student 5	1	1												N	N	N	N	0%	0%	0%	0%
Student 6	1	1	1	2	4	7	8	11	13	14				Y	Y	Y	Y	50%	60%	100%	50%
Student 7	0	1	1	2	3	4	5	6	10	14				Y	N	Y	Y	75%	40%	100%	50%

1. What is the number of students who found the subject difficult but their learning was enhanced after the application of virtual worlds?	50%
2. What is the number of students who found the subject difficult but their affective quality was enhanced after the application of virtual worlds?	67%
3. What is the number of students who found the subject difficult but their engagement was enhanced after the application of virtual worlds?	83%
4. What is the number of students who found the subject difficult but their learning was not enhanced after the application of virtual worlds?	50%
5. What is the number of students who did not find the subject difficult but their learning was enhanced after the application of virtual worlds?	0%

Database Normalisation - Year 1 - 2012/2013 - Was learning enhanced having the Kinesthetic learning mode?

Student	Student 1	Student 2	Student 3	Student 4	Student 5	Student 6	Student 7
Agree	20%	80%	40%	100%	0%	60%	40%
Kinesthetic	1	1	1	1	1	1	1



Database Normalisation – Year 1 (2013/2014):

Technology Enhanced Learning in Higher Education

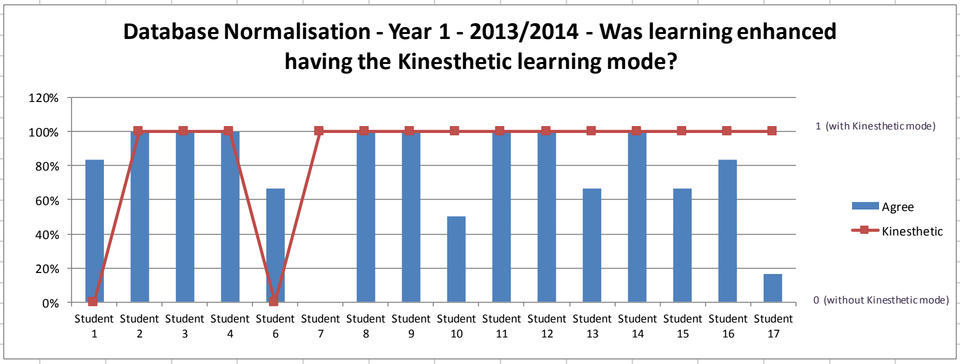
Subject	Database Normalisation		Date	18 Nov. 2013
Description			Number of Students	16
Year	1		Number of Questions	12

Student Name and No.	Learning Modes: Visual	Learning Modes: Kinesthetic	Questions with 'Agree'/'Fully agree' answer – Before the application of virtual worlds	Questions with 'Agree'/'Fully agree' answer – After the application of virtual worlds	Correlation: Difficult Subject Before VW	Correlation: Enhanced Learning After VW	Correlation: Enhanced Affective Quality After VW	Correlation: Enhanced Engagement After VW	Correlation %: Difficult Subject Before VW	Correlation %: Enhanced Learning After VW	Correlation %: Enhanced Affective Quality After VW	Correlation %: Enhanced Engagement After VW
Student 1	1	0	2 4 7 9 10 12	2 4 5 9 10 11 12	N	Y	Y	Y	25%	83%	100%	100%
Student 2	0	1	1 3 7 10	1 2 4 5 8 9 10 11	Y	Y	Y	Y	75%	100%	100%	100%
Student 3	1	1	2 4 5 8 9 11 12	2 4 5 8 9 10 11 12	N	Y	Y	Y	0%	100%	100%	100%
Student 4	1	1	1 2 4 8 9 10 11	2 4 5 8 9 10 11	N	Y	Y	Y	25%	100%	100%	100%
Student 5	0	1										
Student 6	0	0	1 2 3 4 5 6 7 11	5 7 8 9 10 11 12	Y	Y	Y	Y	100%	67%	100%	100%
Student 7	0	1	1 2 4 5 8 9 10 11	1 3	N	N	N	N	25%	0%	0%	0%
Student 8	0	1	1 2 3 4 5 8 10 11 12	2 4 5 6 8 9 10 11 12	Y	Y	Y	Y	50%	100%	100%	100%
Student 9	1	1	1 2 3 6 7 8 9 10	2 3 4 5 7 8 9 10 11	Y	Y	Y	Y	100%	100%	100%	100%
Student 10	0	1	1 2 4 8 11	1 4 7 8 11 12	N	Y	N	Y	25%	50%	0%	100%
Student 11	1	1	1 2 3 6	2 4 5 7 8 9 10 11	Y	Y	Y	Y	75%	100%	100%	100%
Student 12	0	1	1 3 6 7	2 4 5 8 9 10 11 12	Y	Y	Y	Y	100%	100%	100%	100%
Student 13	1	1	1 2 5 7 9	1 2 4 5 9 10	Y	Y	Y	N	50%	67%	100%	0%
Student 14	1	1	1 2 3 5 6 10	2 4 5 7 8 9 10 11 12	Y	Y	Y	Y	75%	100%	100%	100%
Student 15	1	1	1 2 3 4 5 7 8 9 10 11	1 3 4 5 7 8 9 10	Y	Y	Y	N	75%	67%	100%	0%
Student 16	0	1	1 2 3 4 7 8 10	1 2 4 5 7 8 9 10	Y	Y	Y	N	75%	83%	100%	0%
Student 17	0	1	3 9 10 12	3 9 10 12	N	N	Y	N	25%	17%	100%	0%

1. What is the number of students who found the subject difficult (before the application of virtual worlds), but their learning was enhanced (after the application of virtual worlds)?	100%
2. What is the number of students who found the subject difficult (before the application of virtual worlds), but their affective quality was enhanced (after the application of virtual worlds)?	100%
3. What is the number of students who found the subject difficult (before the application of virtual worlds), but their engagement was enhanced (after the application of virtual worlds)?	70%
4. What is the number of students who found the subject difficult (before the application of virtual worlds), but their learning was not enhanced (after the application of virtual worlds)?	0%
5. What is the number of students who did not find the subject difficult (before the application of virtual worlds), but their learning was enhanced (after the application of virtual worlds)?	67%

Database Normalisation - Year 1 - 2013/2014 - Was learning enhanced having the Kinesthetic learning mode?

Student	Student 1	Student 2	Student 3	Student 4	Student 6	Student 7	Student 8	Student 9	Student 10	Student 11	Student 12	Student 13	Student 14	Student 15	Student 16	Student 17
Agree	83%	100%	100%	100%	67%	0%	100%	100%	50%	100%	100%	67%	100%	67%	83%	17%
Kinesthetic	0	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1



Helpdesk Support – Year 2 (2012/2013):

Technology Enhanced Learning in Higher Education

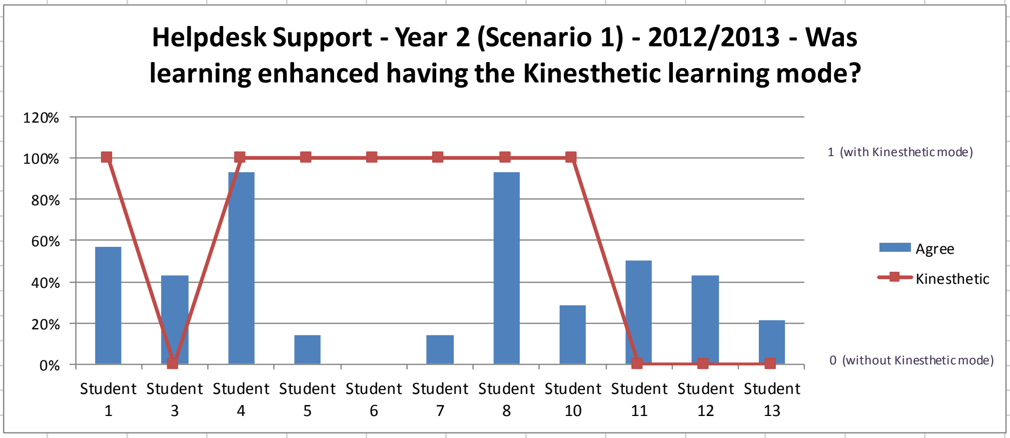
Subject	Helpdesk Support		Date	Mid Oct. 2012
Description			Number of Students	11
Year	2		Number of Questions	24

Student Name and No.	Learning Modes		Questions with 'Agree'/'Fully agree' answer																						Correlation				Correlation %			
	Visual	Kinesthetic																							Difficult Subject	Enhanced Learning	Enhanced Affective Quality	Enhanced Engagement	Difficult Subject	Enhanced Learning	Enhanced Affective Quality	Enhanced Engagement
Student 1	1	1	1	5	7	8	9	10	15	16	18	19	20	21	22										Y	Y	Y	N	50%	57%	100%	40%
Student 2	1	1																														
Student 3	1	0	1	4	7	8	15	20	21																N	N	Y	N	0%	43%	100%	0%
Student 4	1	1	1	2	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Y	Y	Y	Y	100%	93%	100%	100%
Student 5	0	1	13	15	16																				Y	N	N	N	50%	14%	0%	0%
Student 6	0	1	3	12	22																				Y	N	N	N	50%	0%	0%	20%
Student 7	1	1	7	15	20																				N	N	Y	N	0%	14%	100%	0%
Student 8	1	1	1	2	3	4	5	6	7	8	9	10	11	13	14	15	16	17	18	20	21	23			Y	Y	Y	Y	50%	93%	100%	80%
Student 9	0	0																														
Student 10	1	1	1	4	7	10	15	17	20																N	N	Y	N	0%	29%	100%	40%
Student 11	0	0	1	3	5	7	8	9	10	11	16	17	18	20	21	22									Y	Y	Y	Y	50%	50%	100%	80%
Student 12	1	0	4	7	8	10	12	14	16	17	19	20	22	24											Y	N	Y	Y	50%	43%	100%	60%
Student 13			1	7	11	18	19																		N	N	Y	N	0%	21%	100%	20%

1. What is the number of students who found the subject difficult but their learning was enhanced after the application of virtual worlds?	57%
2. What is the number of students who found the subject difficult but their affective quality was enhanced after the application of virtual worlds?	71%
3. What is the number of students who found the subject difficult but their engagement was enhanced after the application of virtual worlds?	57%
4. What is the number of students who found the subject difficult but their learning was not enhanced after the application of virtual worlds?	43%
5. What is the number of students who did not find the subject difficult but their learning was enhanced after the application of virtual worlds?	0%

Helpdesk Support - Year 2 (Scenario 1) - 2012/2013 - Was learning enhanced having the Kinesthetic learning mode?

Student	Student 1	Student 3	Student 4	Student 5	Student 6	Student 7	Student 8	Student 10	Student 11	Student 12	Student 13
Agree	57%	43%	93%	14%	0%	14%	93%	29%	50%	43%	21%
Kinesthetic	1	0	1	1	1	1	1	1	0	0	



Helpdesk Support – Year 2 (2013/2014):

Technology Enhanced Learning in Higher Education

Subject	Helpdesk Support
Description	
Year	2

Date	18 Oct. 2013
Number of Students	6
Number of Questions	12

Student Name and No.	Learning Modes: Visual	Learning Modes: Kinesthetic	Questions with 'Agree'/'Fully agree' answer – Before the application of virtual worlds											
Student 1	1	1	1	2	8	12								
Student 2	0	1	5	7	9	10	11	12						
Student 3	0	1	1	3	4	8	9	10	11	12				
Student 4	1	1	1	2	3	6	10	12						
Student 5	1	1	1	2	3	4	6	7	8	9	11	12		
Student 6	0	1	8	9	10	11	12							

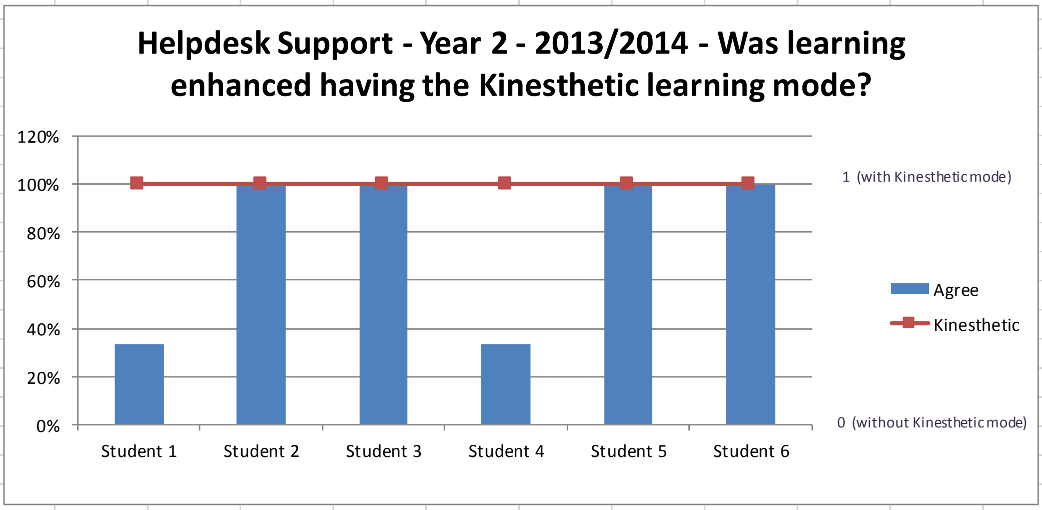
Student Name and No.	Questions with 'Agree'/'Fully agree' answer – After the application of virtual worlds											
Student 1	1	2	8	12								
Student 2	5	8	9	10	11	12						
Student 3	3	8	9	10	11	12						
Student 4	1	2	3	6	10	12						
Student 5	4	8	9	10	11	12						
Student 6	8	9	10	11	12							

Student Name and No.	Correlation: Difficult Subject Before VW	Correlation: Enhanced Learning After VW	Correlation: Enhanced Affective Quality After VW	Correlation: Enhanced Engagement After VW	Correlation %: Difficult Subject Before VW	Correlation %: Enhanced Learning After VW	Correlation %: Enhanced Affective Quality After VW	Correlation %: Enhanced Engagement After VW
Student 1	N	N	Y	Y	17%	33%	100%	50%
Student 2	N	Y	Y	Y	33%	100%	100%	100%
Student 3	N	Y	Y	Y	33%	100%	100%	100%
Student 4	Y	N	Y	Y	50%	33%	100%	50%
Student 5	Y	Y	Y	Y	83%	100%	100%	100%
Student 6	N	Y	Y	Y	0%	100%	100%	100%

1. What is the number of students who found the subject difficult (before the application of virtual worlds), but their learning was enhanced (after the application of virtual worlds)?	50%
2. What is the number of students who found the subject difficult (before the application of virtual worlds), but their affective quality was enhanced (after the application of virtual worlds)?	100%
3. What is the number of students who found the subject difficult (before the application of virtual worlds), but their engagement was enhanced (after the application of virtual worlds)?	100%
4. What is the number of students who found the subject difficult (before the application of virtual worlds), but their learning was not enhanced (after the application of virtual worlds)?	50%
5. What is the number of students who did not find the subject difficult (before the application of virtual worlds), but their learning was enhanced (after the application of virtual worlds)?	75%

Helpdesk Support - Year 2 - 2013/2014 - Was learning enhanced having the Kinesthetic learning mode?

Student	Student 1	Student 2	Student 3	Student 4	Student 5	Student 6
Agree	33%	100%	100%	33%	100%	100%
Kinesthetic	1	1	1	1	1	1



Multimedia Technologies – Year 2 (2012/2013) – Students attending the VW scenario:

Technology Enhanced Learning in Higher Education

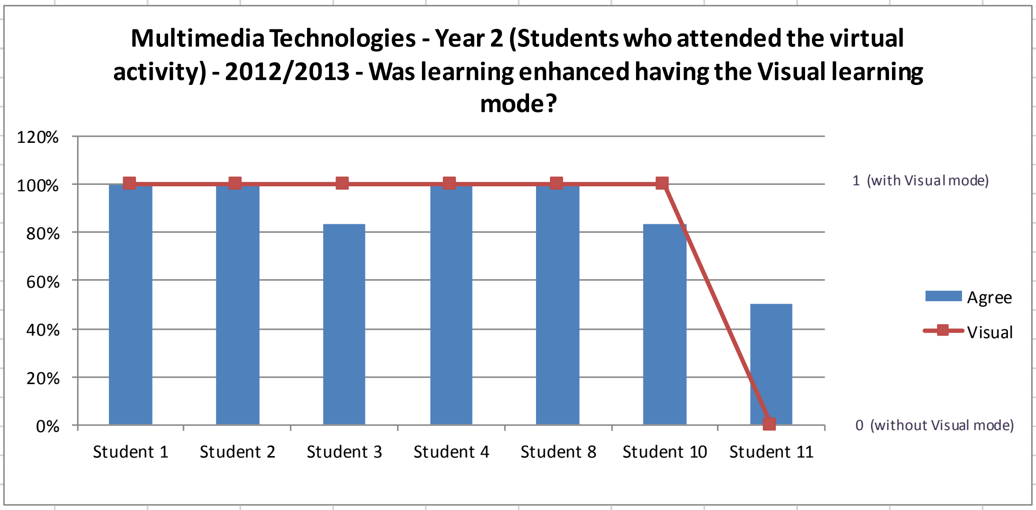
Subject	Multimedia Technologies		Date	28-Jan-13
Description	Attended the Activity		Number of Students	7
Year	2		Number of Questions	11

Student Name and No.	Learning Modes		Questions with 'Agree'/'Fully agree' answer											Correlation				Correlation %			
	Visual	Kinesthetic												Difficult Subject	Enhanced Learning	Enhanced Affective Quality	Enhanced Engagement	Difficult Subject	Enhanced Learning	Enhanced Affective Quality	Enhanced Engagement
Student 1	1	1	1	2	3	4	5	6	7	8	9	10	11	Y	Y	Y	Y	100%	100%	100%	100%
Student 2	1	1	1	2	3	4	5	6	7	8	9	10	11	Y	Y	Y	Y	100%	100%	100%	100%
Student 3	1	0	1	4	5	6	7	8	9					Y	Y	N	N	100%	83%	0%	33%
Student 4	1	1	1	2	3	4	5	6	7	8	9	10	11	Y	Y	Y	Y	100%	100%	100%	100%
Student 5	0	1																			
Student 6	0	1																			
Student 7	1	1																			
Student 8	1	1	1	2	4	5	6	7	8	9	10	11		Y	Y	Y	Y	100%	100%	100%	67%
Student 9	0	0																			
Student 10	1	1	1	3	4	5	6	8	9	10	11			Y	Y	Y	Y	100%	83%	100%	67%
Student 11	0	0	2	5	6	8	10	11						Y	Y	Y	N	100%	50%	100%	33%
Student 12	1	0																			
Student 13																					

1. What is the number of students who found the subject difficult but their learning was enhanced after the application of virtual worlds?	100%
2. What is the number of students who found the subject difficult but their affective quality was enhanced after the application of virtual worlds?	86%
3. What is the number of students who found the subject difficult but their engagement was enhanced after the application of virtual worlds?	71%
4. What is the number of students who found the subject difficult but their learning was not enhanced after the application of virtual worlds?	0%
5. What is the number of students who did not find the subject difficult but their learning was enhanced after the application of virtual worlds?	0%

Multimedia Technologies - Year 2 (Students who attended the virtual activity) - 2012/2013 - Was learning enhanced having the Visual learning mode?

Student	Student 1	Student 2	Student 3	Student 4	Student 8	Student 10	Student 11
Agree	100%	100%	83%	100%	100%	83%	50%
Visual	1	1	1	1	1	1	0



Multimedia Technologies – Year 2 (2012/2013) – Students not attending the VW scenario:

Technology Enhanced Learning in Higher Education

Subject	Multimedia Technologies
Description	Not Attended the Activity
Year	2

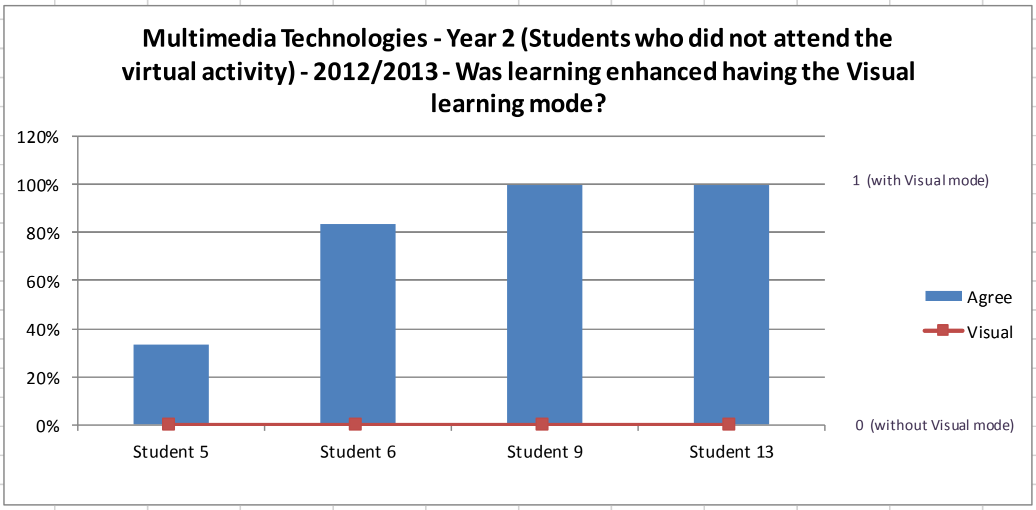
Date	28-Jan-13
Number of Students	4
Number of Questions	10

Student Name and No.	Learning Modes		Questions with 'Agree'/'Fully agree' answer										Correlation				Correlation %			
	Visual	Kinesthetic											Difficult Subject	Enhanced Learning	Enhanced Affective Quality	Enhanced Engagement	Difficult Subject	Enhanced Learning	Enhanced Affective Quality	Enhanced Engagement
Student 1	1	1																		
Student 2	1	1																		
Student 3	1	0																		
Student 4	1	1																		
Student 5	0	1	1	2	4	7							Y	N	Y	N	100%	33%	50%	0%
Student 6	0	1	3	5	6	7	8	9	10				N	Y	Y	Y	0%	83%	50%	100%
Student 7	1	1																		
Student 8	1	1																		
Student 9	0	0	1	2	3	4	5	6	7	8	9	10	Y	Y	Y	Y	100%	100%	100%	100%
Student 10	1	1																		
Student 11	0	0																		
Student 12	1	0																		
Student 13			1	2	3	4	5	6	7	8	9	10	Y	Y	Y	Y	100%	100%	100%	100%

1. What is the number of students who found the subject difficult but their learning was enhanced after the application of virtual worlds?	67%
2. What is the number of students who found the subject difficult but their affective quality was enhanced after the application of virtual worlds?	100%
3. What is the number of students who found the subject difficult but their engagement was enhanced after the application of virtual worlds?	67%
4. What is the number of students who found the subject difficult but their learning was not enhanced after the application of virtual worlds?	33%
5. What is the number of students who did not find the subject difficult but their learning was enhanced after the application of virtual worlds?	100%

Multimedia Technologies - Year 2 (Students who did not attend the virtual activity) - 2012/2013 - Was learning enhanced having the Visual learning mode?

Student	Student 5	Student 6	Student 9	Student 13
Agree	33%	83%	100%	100%
Visual	0	0	0	



Multithreading Techniques (Concurrency and Parallelism) – BSc (Year 3) (2012/2013):

Technology Enhanced Learning in Higher Education

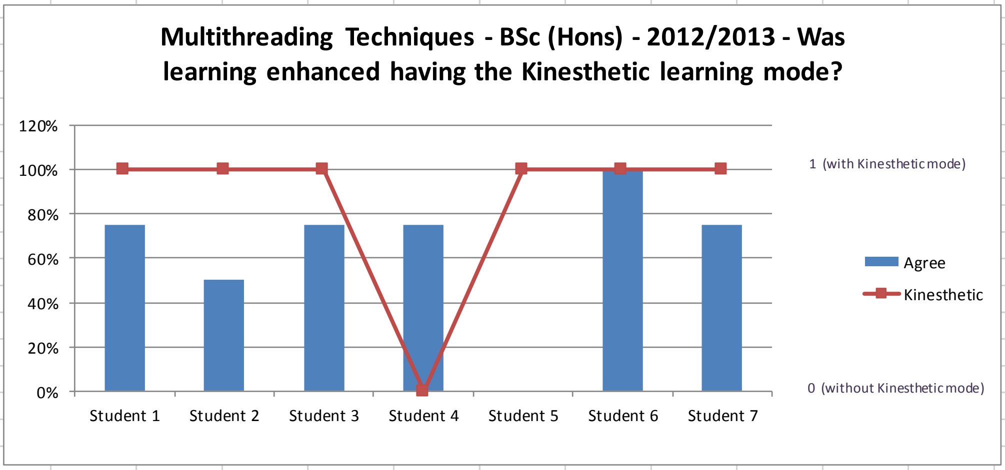
Subject	Multithreading Techniques	Date	18 Oct. 2012
Description		Number of Students	7
Year	3	Number of Questions	8

Student Name and No.	Learning Modes		Questions with 'Agree'/'Fully agree' answer								Correlation				Correlation %			
	Visual	Kinesthetic									Difficult Subject	Enhanced Learning	Enhanced Affective Quality	Enhanced Engagement	Difficult Subject	Enhanced Learning	Enhanced Affective Quality	Enhanced Engagement
Student 1	1	1	1	2	3	5	6	7			Y	Y	Y	Y	100%	75%	50%	100%
Student 2	1	1	1	5	6	7					N	Y	Y	Y	0%	50%	50%	100%
Student 3	0	1	1	2	5	6	7				N	Y	Y	Y	0%	75%	50%	100%
Student 4	1	0	1	2	3	5	7				Y	Y	Y	N	100%	75%	50%	0%
Student 5	1	1	6								N	N	N	Y	0%	0%	0%	100%
Student 6	1	1	1	2	3	4	5	6	7	8	Y	Y	Y	Y	100%	100%	100%	100%
Student 7	1	1	2	3	4	5					Y	Y	N	N	100%	75%	0%	0%

1. What is the number of students who found the subject difficult but their learning was enhanced after the application of virtual worlds?	100%
2. What is the number of students who found the subject difficult but their affective quality was enhanced after the application of virtual worlds?	75%
3. What is the number of students who found the subject difficult but their engagement was enhanced after the application of virtual worlds?	50%
4. What is the number of students who found the subject difficult but their learning was not enhanced after the application of virtual worlds?	0%
5. What is the number of students who did not find the subject difficult but their learning was enhanced after the application of virtual worlds?	67%

Multithreading Techniques - BSc (Hons) - 2012/2013 - Was learning enhanced having the Kinesthetic learning mode?

Student	Student 1	Student 2	Student 3	Student 4	Student 5	Student 6	Student 7
Agree	75%	50%	75%	75%	0%	100%	75%
Kinesthetic	1	1	1	0	1	1	1



Multithreading Techniques (Concurrency and Parallelism) – BSc (Year 3) (2013/2014):

Technology Enhanced Learning in Higher Education

Subject	Multithreading Techniques		Date	06 Nov. 2013
Description			Number of Students	6
Year	3		Number of Questions	11

Student Name and No.	Learning Modes		Questions with 'Agree'/'Fully agree' answer: Before the application of virtual worlds											
	Visual	Kinesthetic												
Student 1	1	1	2	4	5	8	10	11						
Student 2	1	1	1	3	6	11								
Student 3	1	1	1	2	3	6	7	9						
Student 4	0	0												
Student 5	1	1	1	4	5	7	9							
Student 6	0	0	1	2	4	5	7	8	10	11				
Student 7	1	0	1	2	4	5	7	8	9	10	11			

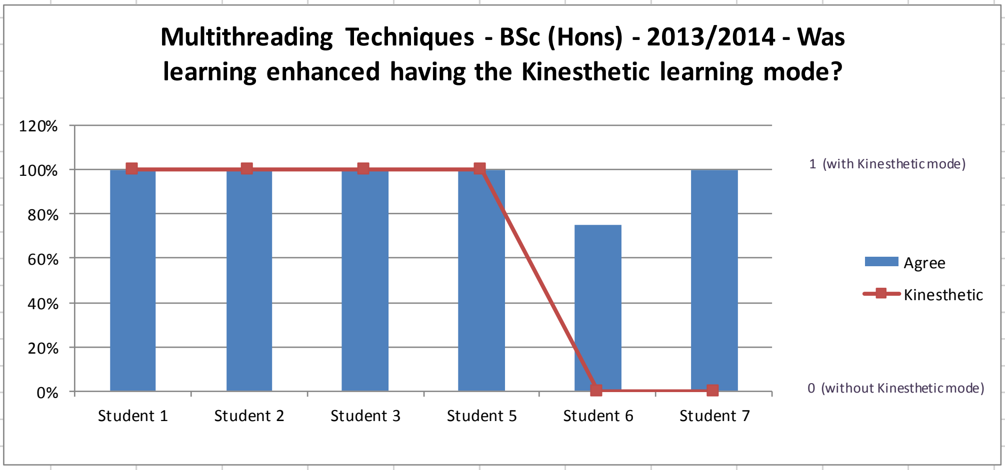
Student Name and No.	Questions with 'Agree'/'Fully agree' answer: After the application of virtual worlds											
Student 1	2	4	5	8	9	10	11					
Student 2	1	2	4	5	6	7	8	9	10	11		
Student 3	2	4	5	8	10	11						
Student 4												
Student 5	2	4	5	8	10	11						
Student 6	1	2	4	5	7	8	9	11				
Student 7	1	2	4	5	6	8	9	10	11			

Student Name and No.	Correlation				Correlation %			
	Difficult Subject Before VW	Enhanced Learning After VW	Enhanced Affective Quality After VW	Enhanced Engagement After VW	Difficult Subject Before VW	Enhanced Learning After VW	Enhanced Affective Quality After VW	Enhanced Engagement After VW
Student 1	N	Y	Y	Y	0%	100%	100%	100%
Student 2	Y	Y	Y	Y	60%	100%	100%	100%
Student 3	Y	Y	Y	Y	100%	100%	100%	100%
Student 4								
Student 5	Y	Y	Y	Y	60%	100%	100%	100%
Student 6	N	Y	Y	Y	40%	75%	100%	100%
Student 7	Y	Y	Y	Y	60%	100%	100%	100%

1. What is the number of students who found the subject difficult (before the application of virtual worlds), but their learning was enhanced (after the application of virtual worlds)?	100%
2. What is the number of students who found the subject difficult (before the application of virtual worlds), but their affective quality was enhanced (after the application of virtual worlds)?	100%
3. What is the number of students who found the subject difficult (before the application of virtual worlds), but their engagement was enhanced (after the application of virtual worlds)?	100%
4. What is the number of students who found the subject difficult (before the application of virtual worlds), but their learning was not enhanced (after the application of virtual worlds)?	0%
5. What is the number of students who did not find the subject difficult (before the application of virtual worlds), but their learning was enhanced (after the application of virtual worlds)?	100%

Multithreading Techniques - BSc (Hons) - 2013/2014 - Was learning enhanced having the Kinesthetic learning mode?

Student	Student 1	Student 2	Student 3	Student 5	Student 6	Student 7
Agree	100%	100%	100%	100%	75%	100%
Kinesthetic	1	1	1	1	0	0



Research Methods – BSc (Year 3) (2013/2014):

Technology Enhanced Learning in Higher Education

Subject	Research Methods
Description	
Year	3

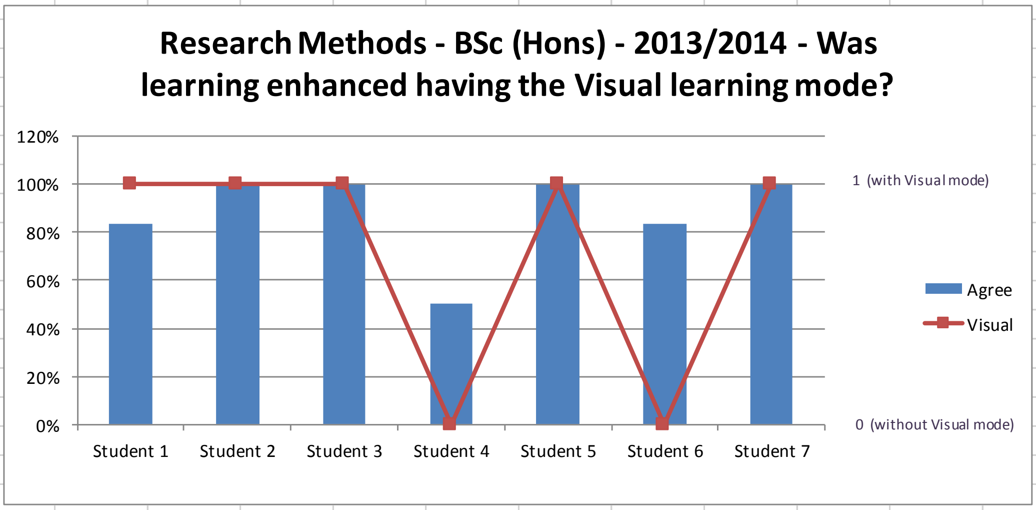
Date	04 Dec. 2013
Number of Students	7
Number of Questions	11

Student Name and No.	Learning Modes		Questions with 'Agree'/'Fully agree' answer – Before the application of virtual worlds												Questions with 'Agree'/'Fully agree' answer – After the application of virtual worlds												Correlation				Correlation %			
	Visual	Kinesthetic																									Difficult Subject Before VW	Enhanced Learning After VW	Enhanced Affective Quality After VW	Enhanced Engagement After VW	Difficult Subject Before VW	Enhanced Learning After VW	Enhanced Affective Quality After VW	Enhanced Engagement After VW
Student 1	1	1	1	3	4	5	6	7	9	10	11				1	3	4	5	6	7	9	10	11				Y	Y		Y	67%	83%		100%
Student 2	1	1	1	2	3	4	5	6	7	8	9	10	11		1	2	3	4	5	6	7	8	9	10	11		Y	Y		Y	100%	100%		100%
Student 3	1	1	1	4	7	9									1	3	5	6	7	8	9	10	11				Y	Y		Y	67%	100%		100%
Student 4	0	0	1	4	6	7	9	10	11						1	3	4	5	6	10							Y	Y		Y	67%	50%		100%
Student 5	1	1	1	3	4	5	6	7	8	9	10	11			3	4	5	6	7	8	9	10	11				Y	Y		Y	67%	100%		100%
Student 6	0	0	2	3	4	5	6	8	10	11					2	3	4	5	6	7	8	10	11				Y	Y		Y	67%	83%		100%
Student 7	1	0	2	3	5	7	9	11							3	4	5	6	7	8	9	10	11				N	Y		Y	33%	100%		100%

1. What is the number of students who found the subject difficult (before the application of virtual worlds), but their learning was enhanced (after the application of virtual worlds)?	100%
2. What is the number of students who found the subject difficult (before the application of virtual worlds), but their affective quality was enhanced (after the application of virtual worlds)?	N/A
3. What is the number of students who found the subject difficult (before the application of virtual worlds), but their engagement was enhanced (after the application of virtual worlds)?	100%
4. What is the number of students who found the subject difficult (before the application of virtual worlds), but their learning was not enhanced (after the application of virtual worlds)?	0%
5. What is the number of students who did not find the subject difficult (before the application of virtual worlds), but their learning was enhanced (after the application of virtual worlds)?	100%

Research Methods - BSc (Hons) - 2013/2014 - Was learning enhanced having the Visual learning mode?

Student	Student 1	Student 2	Student 3	Student 4	Student 5	Student 6	Student 7
Agree	83%	100%	100%	50%	100%	83%	100%
Visual	1	1	1	0	1	0	1

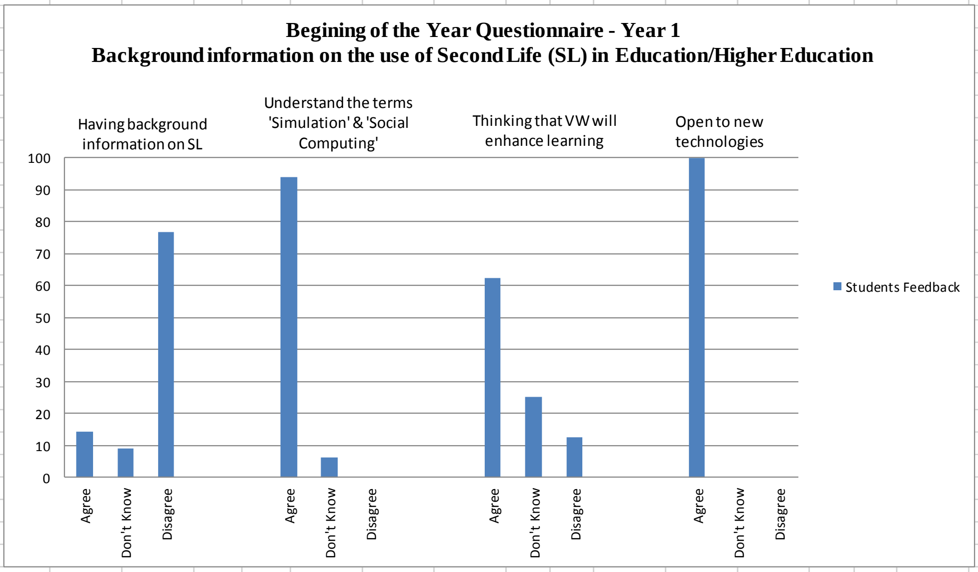


A3.6 Further Data Analysis – Total scores for modules/category

Start of the year questionnaires on Second Life (2012/2013):

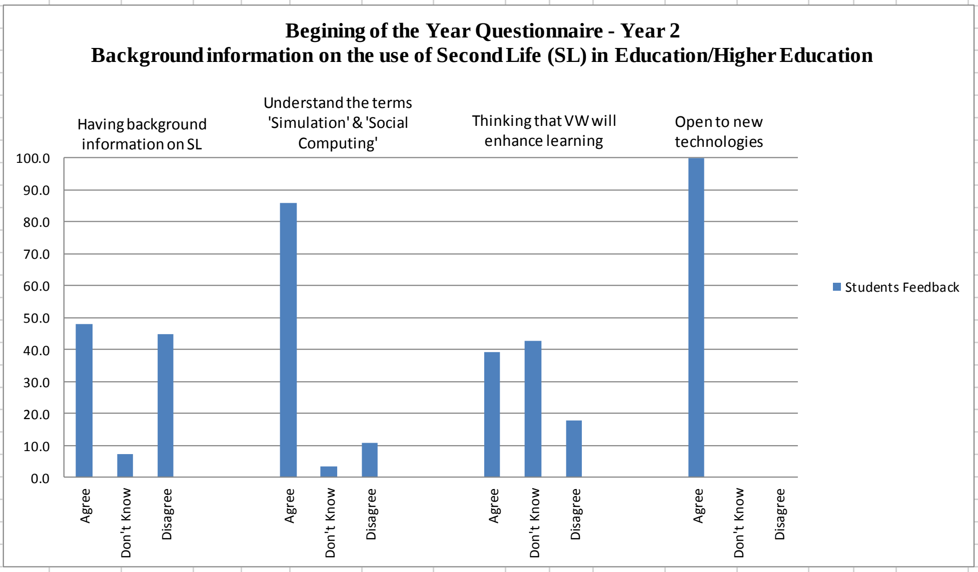
Begining of the Year Questionnaire - Year 1
Background information on the use of Second Life (SL) in Education/Higher Education
Students Feedback

Having background information on SL			Understand the terms 'Simulation' & 'Social Computing'			Thinking that VW will enhance learning			Open to new technologies		
Agree	Don't Know	Disagree	Agree	Don't Know	Disagree	Agree	Don't Know	Disagree	Agree	Don't Know	Disagree
14.3	8.9	76.8	93.8	6.3	0.0	62.5	25.0	12.5	100.0	0.0	0.0



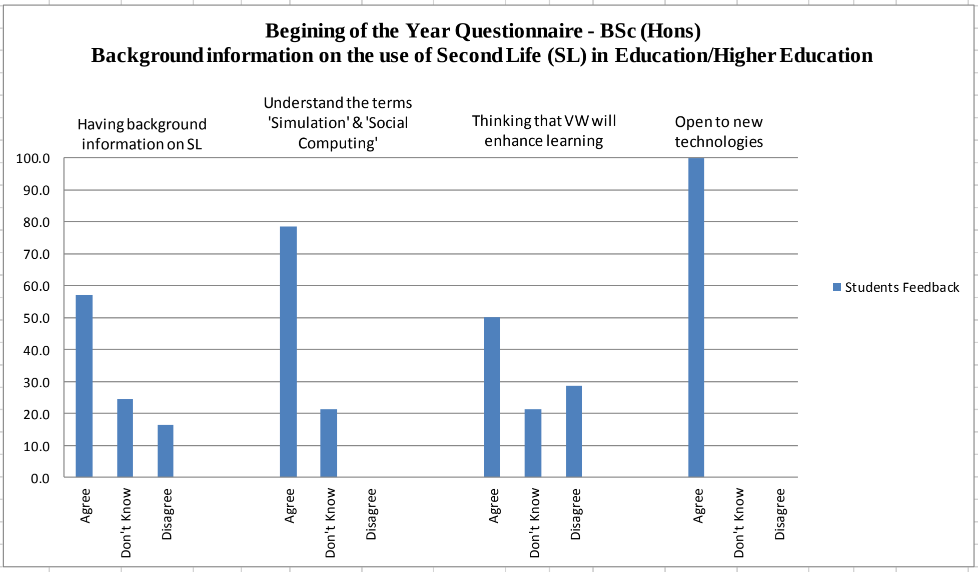
Begining of the Year Questionnaire - Year 2
Background information on the use of Second Life (SL) in Education/Higher Education
Students Feedback

Having background information on SL			Understand the terms 'Simulation' & 'Social Computing'			Thinking that VW will enhance learning			Open to new technologies		
Agree	Don't Know	Disagree	Agree	Don't Know	Disagree	Agree	Don't Know	Disagree	Agree	Don't Know	Disagree
48.0	7.1	44.9	85.7	3.6	10.7	39.3	42.9	17.9	100.0	0.0	0.0



Begining of the Year Questionnaire - BSc (Hons)
Background information on the use of Second Life (SL) in Education/Higher Education
Students Feedback

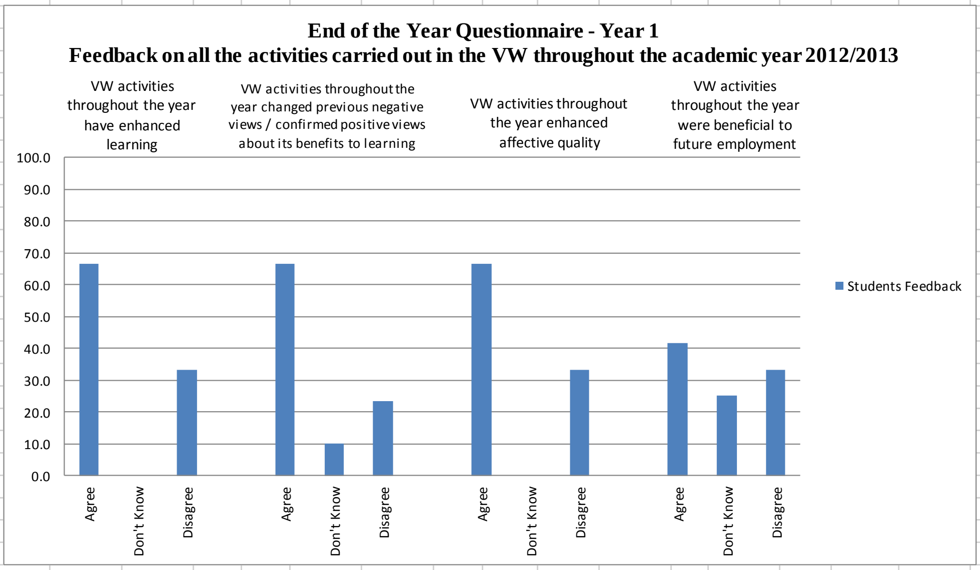
Having background information on SL			Understand the terms 'Simulation' & 'Social Computing'			Thinking that VW will enhance learning			Open to new technologies		
Agree	Don't Know	Disagree	Agree	Don't Know	Disagree	Agree	Don't Know	Disagree	Agree	Don't Know	Disagree
57.1	24.5	16.3	78.6	21.4	0.0	50.0	21.4	28.6	100.0	0.0	0.0



End of the year questionnaires on Second Life (2012/2013):

End of the Year Questionnaire - Year 1
Feedback on all the activities carried out in the VW throughout the academic year 2012/2013
Students Feedback

VW activities throughout the year have enhanced learning			VW activities throughout the year changed previous negative views / confirmed positive views about its benefits to learning			VW activities throughout the year enhanced affective quality			VW activities throughout the year were beneficial to future employment		
Agree	Don't Know	Disagree	Agree	Don't Know	Disagree	Agree	Don't Know	Disagree	Agree	Don't Know	Disagree
66.7	0.0	33.3	66.7	10.0	23.3	66.7	0.0	33.3	41.7	25.0	33.3

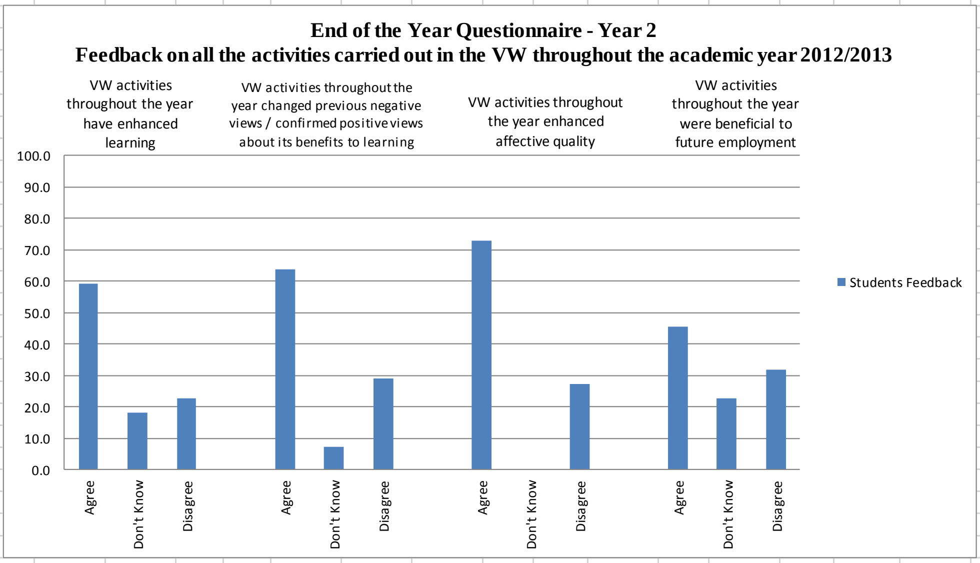


End of the Year Questionnaire - Year 2

Feedback on all the activities carried out in the VW throughout the academic year 2012/2013

Students Feedback

VW activities throughout the year have enhanced learning			VW activities throughout the year changed previous negative views / confirmed positive views about its benefits to learning			VW activities throughout the year enhanced affective quality			VW activities throughout the year were beneficial to future employment		
Agree	Don't Know	Disagree	Agree	Don't Know	Disagree	Agree	Don't Know	Disagree	Agree	Don't Know	Disagree
59.1	18.2	22.7	63.6	7.3	29.1	72.7	0.0	27.3	45.5	22.7	31.8

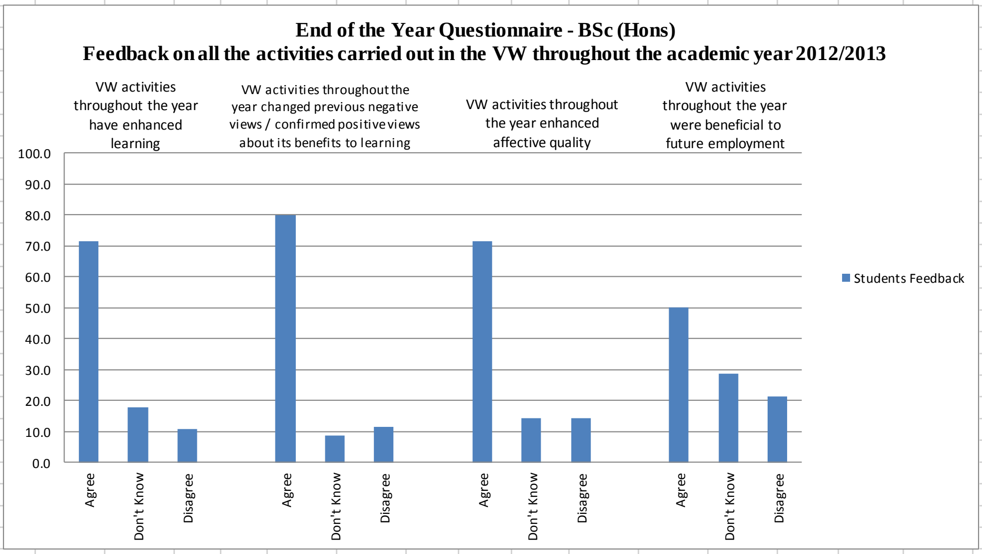


End of the Year Questionnaire - BSc (Hons)

Feedback on all the activities carried out in the VW throughout the academic year 2012/2013

Students Feedback

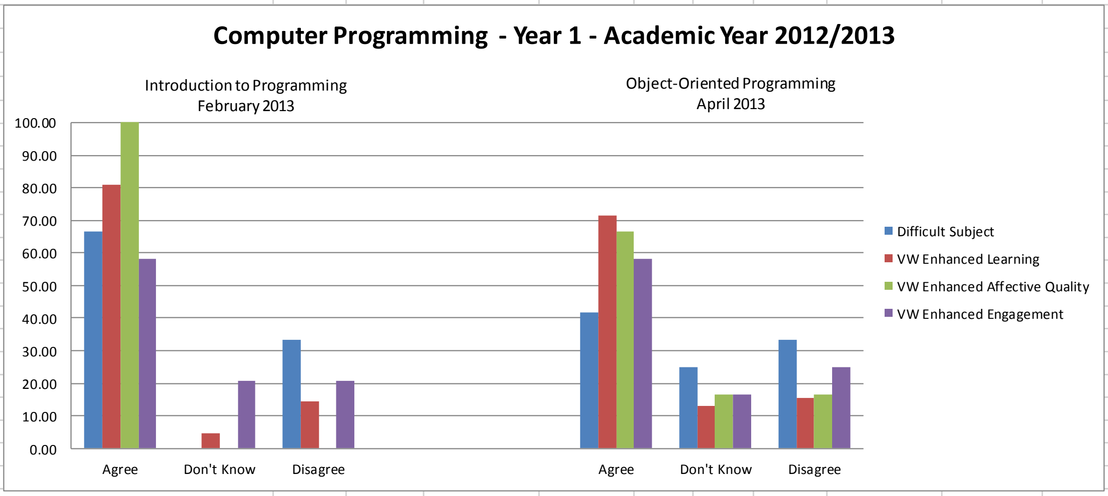
VW activities throughout the year have enhanced learning			VW activities throughout the year changed previous negative views / confirmed positive views about its benefits to learning			VW activities throughout the year enhanced affective quality			VW activities throughout the year were beneficial to future employment		
Agree	Don't Know	Disagree	Agree	Don't Know	Disagree	Agree	Don't Know	Disagree	Agree	Don't Know	Disagree
71.4	17.9	10.7	80.0	8.6	11.4	71.4	14.3	14.3	50.0	28.6	21.4



Computer Programming – Year 1:

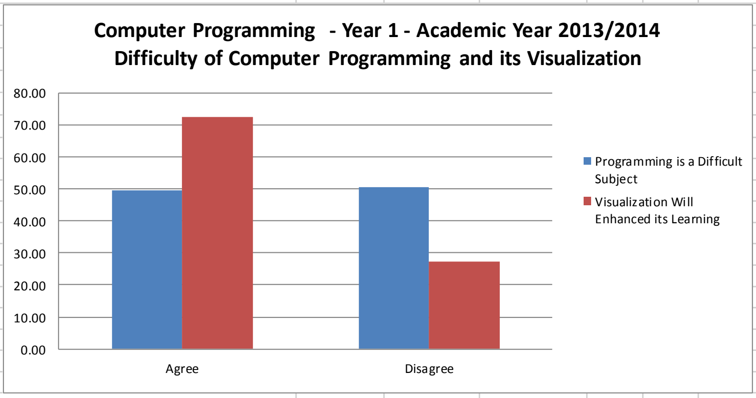
Computer Programming - Year 1 - Academic Year 2012/2013

	27 Feb. 2013			15 Apr. 2013		
	Agree	Don't Know	Disagree	Agree	Don't Know	Disagree
Difficult Subject	66.67	0.00	33.33	41.67	25.00	33.33
VW Enhanced Learning	80.95	4.76	14.29	71.43	13.10	15.48
VW Enhanced Affective Quality	100.00	0.00	0.00	66.67	16.67	16.67
VW Enhanced Engagement	58.33	20.83	20.83	58.33	16.67	25.00



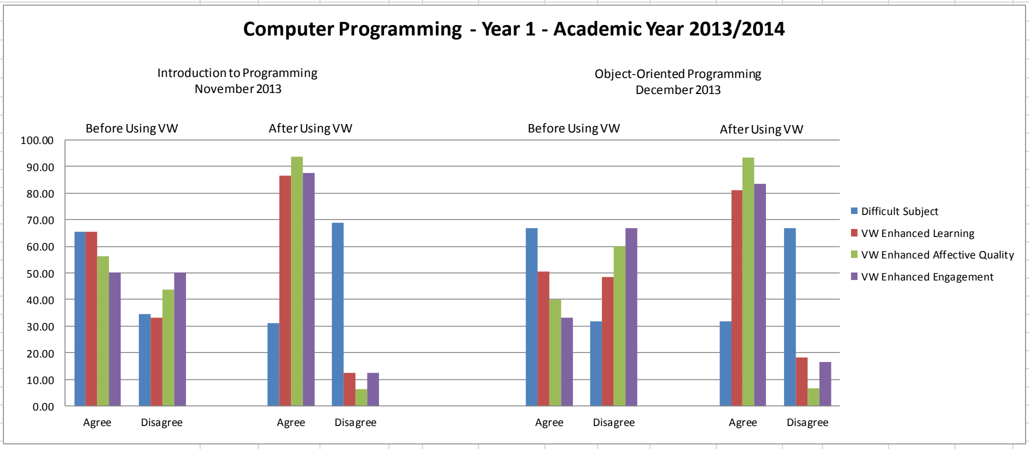
Computer Programming - Year 1 - Academic Year 2013/2014
Difficulty of Computer Programming and its Visualization

	07 Oct. 2013	
	Agree	Disagree
Programming is a Difficult Subject	49.41	50.59
Visualization Will Enhanced its Learning	72.55	27.45



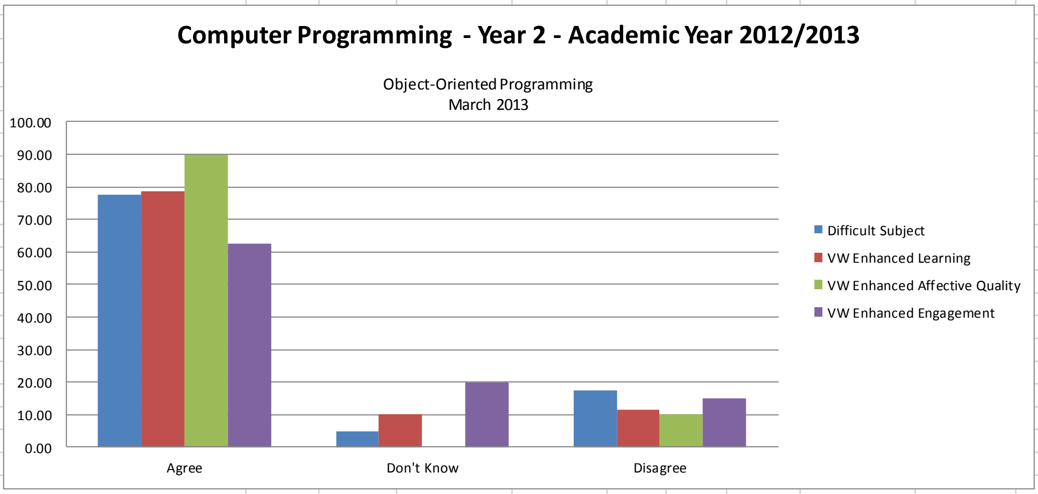
Computer Programming - Year 1 - Academic Year 2013/2014

	12 Nov. 2013 Before using VW		12 Nov. 2013 After using VW		10 Dec. 2013 Before using VW		10 Dec. 2013 After using VW	
	Agree	Disagree	Agree	Disagree	Agree	Disagree	Agree	Disagree
Difficult Subject	65.63	34.38	31.25	68.75	66.67	31.67	31.67	66.67
VW Enhanced Learning	65.63	33.33	86.46	12.50	50.48	48.57	80.95	18.10
VW Enhanced Affective Quality	56.25	43.75	93.75	6.25	40.00	60.00	93.33	6.67
VW Enhanced Engagement	50.00	50.00	87.50	12.50	33.33	66.67	83.33	16.67



Computer Programming - Year 2 - Academic Year 2012/2013

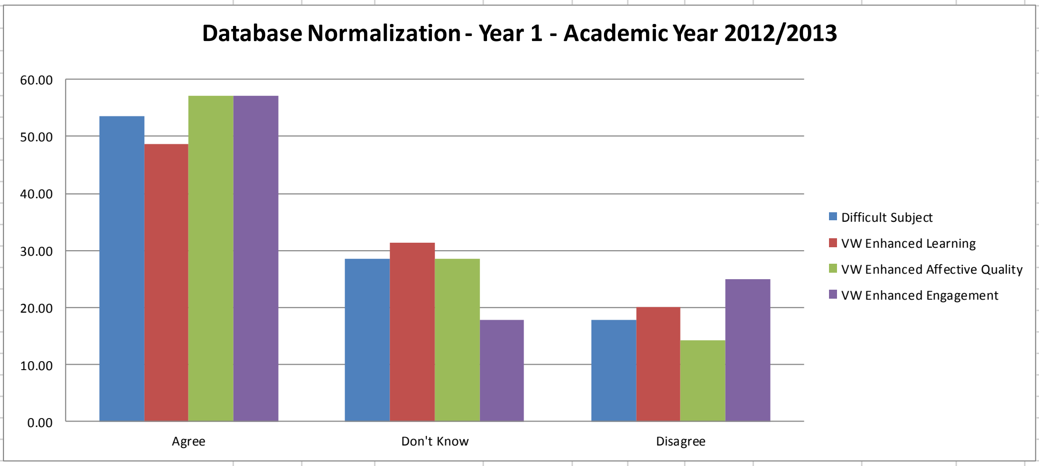
	04 Mar. 2013		
	Agree	Don't Know	Disagree
Difficult Subject	77.50	5.00	17.50
VW Enhanced Learning	78.57	10.00	11.43
VW Enhanced Affective Quality	90.00	0.00	10.00
VW Enhanced Engagement	62.50	20.00	15.00



Database Normalisation – Year 1:

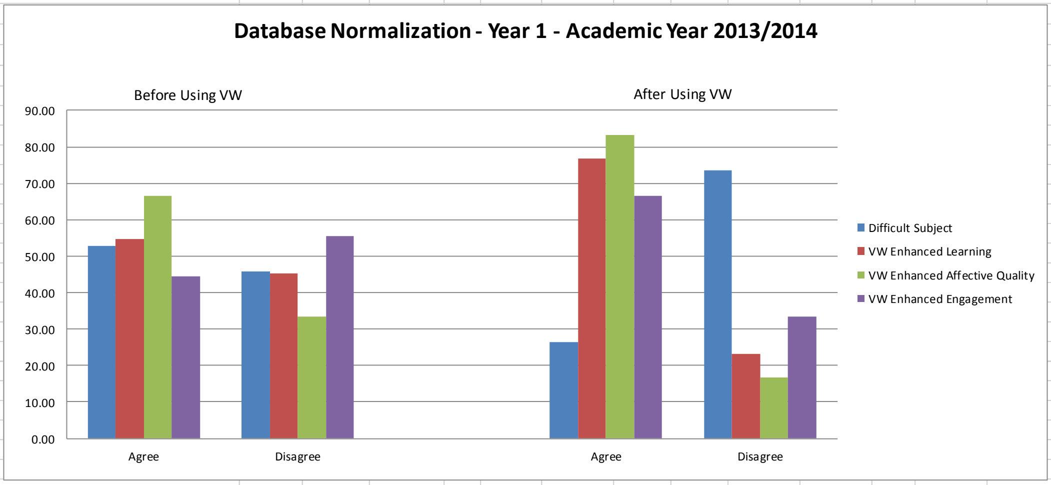
Database Normalization - Year 1 - Academic Year 2012/2013

	27 Feb. 2013		
	Agree	Don't Know	Disagree
Difficult Subject	53.57	28.57	17.86
VW Enhanced Learning	48.57	31.43	20.00
VW Enhanced Affective Quality	57.14	28.57	14.29
VW Enhanced Engagement	57.14	17.86	25.00



Database Normalization - Year 1 - Academic Year 2013/2014

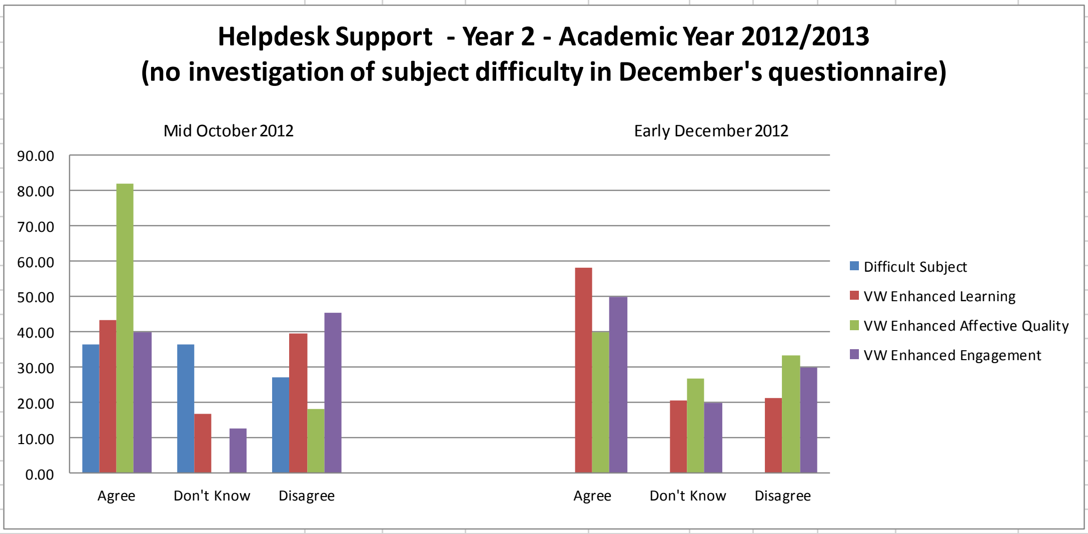
	18 Nov. 2013		18 Nov. 2013	
	Before using VW		After using VW	
	Agree	Disagree	Agree	Disagree
Difficult Subject	52.78	45.83	26.39	73.61
VW Enhanced Learning	54.63	45.37	76.85	23.15
VW Enhanced Affective Quality	66.67	33.33	83.33	16.67
VW Enhanced Engagement	44.44	55.56	66.67	33.33



Helpdesk Support – Year 2:

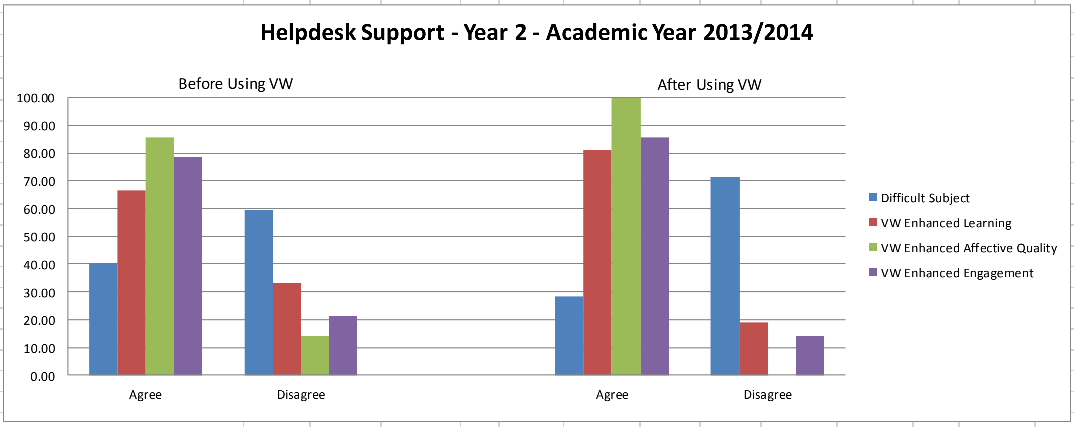
Helpdesk Support - Year 2 - Academic Year 2012/2013

	Mid Oct. 2012			December 2012		
	Agree	Don't Know	Disagree	Agree	Don't Know	Disagree
Difficult Subject	36.36	36.36	27.27			
VW Enhanced Learning	43.51	16.88	39.61	58.13	20.63	21.25
VW Enhanced Affective Quality	81.82	0.00	18.18	40.00	26.67	33.33
VW Enhanced Engagement	40.00	12.73	45.45	50.00	20.00	30.00



Helpdesk Support - Year 2 - Academic Year 2013/2014

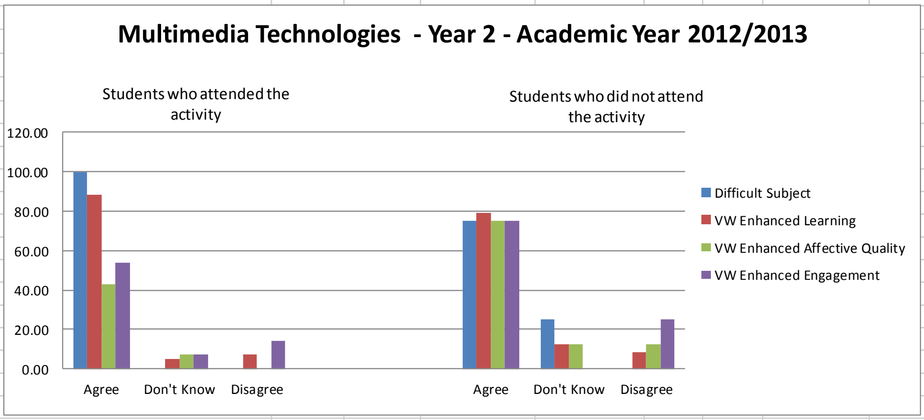
	18 Oct. 2013 Before using VW		18 Oct. 2013 After using VW	
	Agree	Disagree	Agree	Disagree
Difficult Subject	40.48	59.52	28.57	71.43
VW Enhanced Learning	66.67	33.33	80.95	19.05
VW Enhanced Affective Quality	85.71	14.29	100.00	0.00
VW Enhanced Engagement	78.57	21.43	85.71	14.29



Multimedia Technologies – Year 2:

Multimedia Technologies - Year 2 - Academic Year 2012/2013

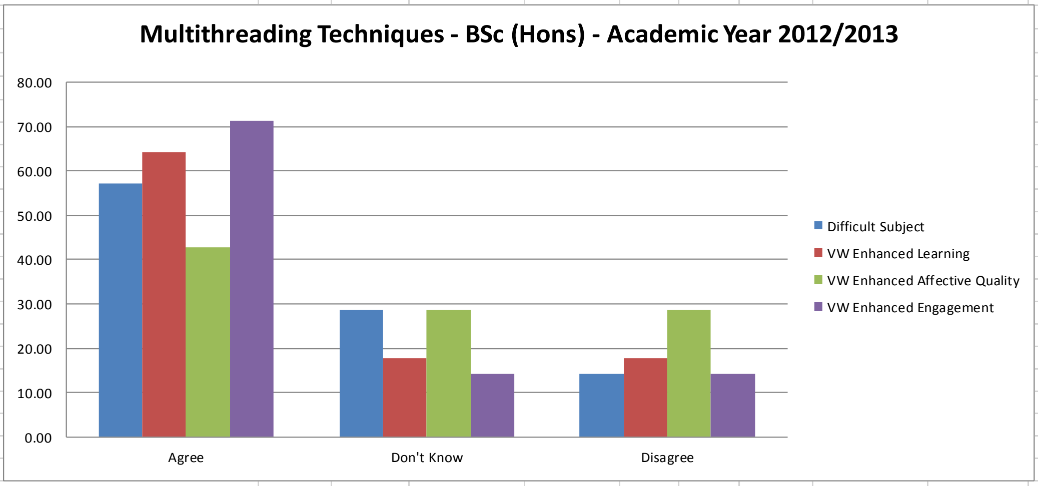
	Students who attended the activity			Students who did not attend the activity		
	Agree	Don't Know	Disagree	Agree	Don't Know	Disagree
Difficult Subject	100.00	0.00	0.00	75.00	25.00	0.00
VW Enhanced Learning	88.10	4.76	7.14	79.17	12.50	8.33
VW Enhanced Affective Quality	42.86	7.14	0.00	75.00	12.50	12.50
VW Enhanced Engagement	53.57	7.14	14.29	75.00	0.00	25.00



Multithreading Techniques (Concurrency and Parallelism) – BSc (Year 3):

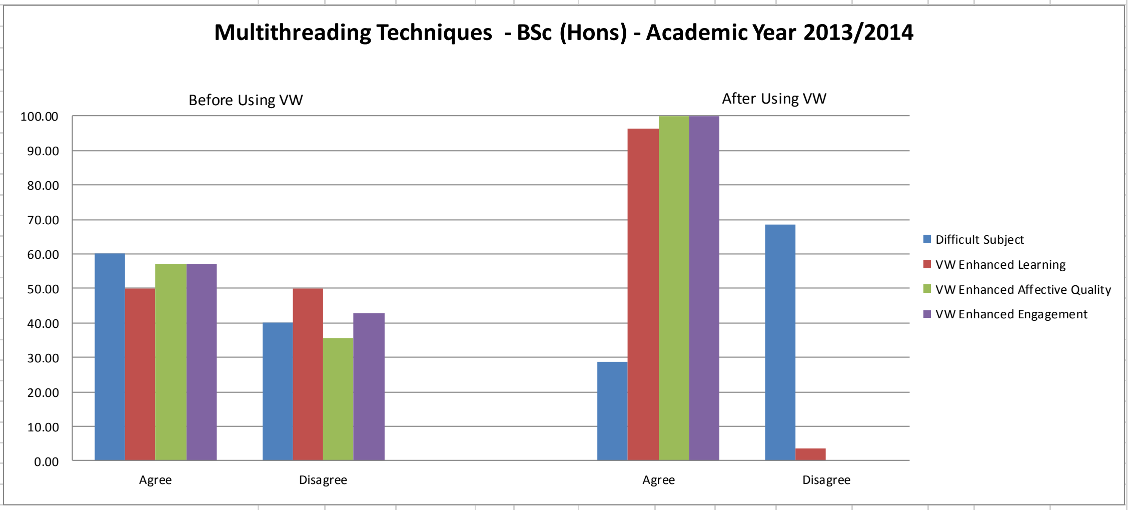
Multithreading Techniques - BSc (Hons) - Academic Year 2012/2013

	18 Oct. 2012		
	Agree	Don't Know	Disagree
Difficult Subject	57.14	28.57	14.29
VW Enhanced Learning	64.29	17.86	17.86
VW Enhanced Affective Quality	42.86	28.57	28.57
VW Enhanced Engagement	71.43	14.29	14.29



Multithreading Techniques - BSc (Hons) - Academic Year 2013/2014

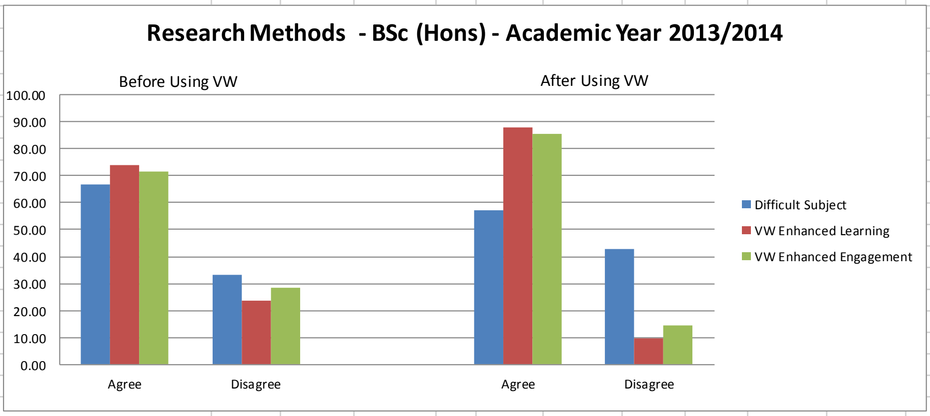
	18 Nov. 2013		18 Nov. 2013	
	Before using VW		After using VW	
	Agree	Disagree	Agree	Disagree
Difficult Subject	60.00	40.00	28.57	68.57
VW Enhanced Learning	50.00	50.00	96.43	3.57
VW Enhanced Affective Quality	57.14	35.71	100.00	0.00
VW Enhanced Engagement	57.14	42.86	100.00	0.00



Research Methods – BSc (Year 3):

Research Methods - BSc (Hons) - Academic Year 2013/2014

	18 Nov. 2013		18 Nov. 2013	
	Before using VW		After using VW	
	Agree	Disagree	Agree	Disagree
Difficult Subject	66.67	33.33	57.14	42.86
VW Enhanced Learning	73.81	23.81	88.10	9.52
VW Enhanced Engagement	71.43	28.57	85.71	14.29



A3.7 Students' Grade Sheets with Statistics

Academic Year 2010/2011:

Tracking Sheet 2010/2011 HE Applied Computing

Foundation Degree Computing - Year 2

Project (10 Credits, JLC)

Surname	First Name	Project Proposal (Task 1) - 10%	Interim Report / presentation (Task 2) - 10%	Final Written Report (Task 3) - 20%	Deliverables (Task 4) 40%	Project Diary (Task 5) - 10%	Final demonstration / Presentation / Evaluation (Task 6) - 10%	Final Mark
Full Time								
XXXX	XXXX	64	68	74	75	63	74	72
XXXX	XXXX	54	40(56)	40(48)	58	55	83	54
XXXX	XXXX	57	68	40(62)	77	62	78	65
XXXX	XXXX	60	62	68	68	66	56	65
XXXX	XXXX	64	68	54	75	61	74	68
XXXX	XXXX	64	68	74	75	65	74	72
XXXX	XXXX	64	68	74	75	68	74	72
XXXX	XXXX	51	52	47	58	55	78	56
XXXX	XXXX	44	34	34	0	0	0	15
XXXX	XXXX	52	40(45)	57	67	50	58	58
	Max Mark	64.0	68.0	74.0	77.0	68.0	83.0	72.2
	Min Mark	44.0	34.0	34.0	0.0	0.0	0.0	14.6
	Average	57.4	56.8	56.2	62.8	54.5	64.9	59.7
	StDev	7.0	14.0	15.6	23.2	20.0	24.4	17.2
	Mode	64.0	68.0	74.0	75.0	55.0	74.0	#N/A
	Average All Units	56.64						
	% of Unit Avg. to All Avg.							105.44

Visual Programming (5 Credits, JLC)

Surname	First Name	Ass 1 (Assignment - 40%)	Ass 2 (Assignment - 30%)	Ass 3 (Assignment - 30%)	Final Mark
XXXX	XXXX	58	42	54	52
XXXX	XXXX	47	37	48	44
XXXX	XXXX	68	55	54	60
XXXX	XXXX	58	49	53	54
XXXX	XXXX	45	39	33	40
XXXX	XXXX	84	82	70	79
XXXX	XXXX	82	69	70	75
XXXX	XXXX	51	43	61	52
XXXX	XXXX	39	35	45	40
XXXX	XXXX	76	80	72	76
	Max Mark	84.0	82.0	72.0	79.2
	Min Mark	39.0	35.0	33.0	39.6
	Average	60.8	53.1	56.0	57.1
	StDev	16.0	17.8	12.5	14.9
	Mode	58.0	#N/A	54.0	39.6
	% of Unit Avg. to All Avg.				100.73

Multimedia Technologies Applications and Development (10 Cred, BA)

Surname	First Name	Ass 1 (Assignment - 25%)	Ass 2 (Assignment - 30%)	Ass 3 (Assignment - 35%)	Oral Examination - 10%	Final Mark
XXXX	XXXX	69	63	59	54	62
XXXX	XXXX	62	59	62	65	61
XXXX	XXXX	65	71	57	59	63
XXXX	XXXX	79	78	72	72	76
XXXX	XXXX	50	55	48	66	52
XXXX	XXXX	69	69	73	74	71
XXXX	XXXX	79	65	74	75	73
XXXX	XXXX	63	63	41	75	57
XXXX	XXXX	64	57	39	0	47
XXXX	XXXX	74	69	40(65)	61	59
	Max Mark	79.0	78.0	74.0	75.0	75.6
	Min Mark	50.0	55.0	39.0	0.0	46.8
	Average	67.4	64.9	56.5	60.1	62.1
	StDev	8.7	7.0	13.9	22.3	9.1
	Mode	69.0	63.0	#N/A	75.0	#N/A
	% of Unit Avg. to All Avg.			99.75		

Human Computer Interface (5 Credits, BA)

Surname	First Name	Ass 1 (Report -40%)	Ass 2 (Evaluation Report -30%)	Ass 3 (HCI Design -30%)	Final Mark
XXXX	XXXX	61	48	48	53
XXXX	XXXX	36	34	55	41
XXXX	XXXX	59	57	55	57
XXXX	XXXX	38	71	48	51
XXXX	XXXX	37	37	46	40
XXXX	XXXX	78	66	55	68
XXXX	XXXX	68	63	57	63
XXXX	XXXX	52	45	47	48
XXXX	XXXX	38	38	15	31
XXXX	XXXX	61	55	40(47)	53
	Max Mark	78.0	71.0	57.0	67.5
	Min Mark	36.0	34.0	15.0	31.1
	Average	52.8	51.4	46.6	50.5
	StDev	14.9	13.0	12.3	11.0
	Mode	61.0	#N/A	55.0	#N/A
	% of Unit Avg. to All Avg.				89.20

Helpdesk Support for ICT (5 Credits, JLC)

Surname	First Name	Ass 1 (Assignments - 25%)	Ass 2 (Assignments - 25%)	Ass 3 (Assignment - 50%)	Final Mark
XXXX	XXXX	55	58	58	57
XXXX	XXXX	62	54	53	56
XXXX	XXXX	68	58	62	63
XXXX	XXXX	77	72	67	71
XXXX	XXXX	58	62	48	54
XXXX	XXXX	64	58	58	60
XXXX	XXXX	59	63	54	58
XXXX	XXXX	57	52	47	51
XXXX	XXXX	38	33	0	18
XXXX	XXXX	40(49)	38	66	53
	Max Mark	77.0	72.0	67.0	70.8
	Min Mark	38.0	33.0	0.0	17.8
	Average	57.8	54.8	51.3	53.8
	StDev	11.8	11.6	19.3	13.9
	Mode	#N/A	58.0	58.0	#N/A
	% of Unit Avg. to All Avg.			90.57	

Academic Year 2011/2012:

Tracking Sheet 2011/2012 HE Applied Computing

Foundation Degree Computing - Year 1

		System Analysis			Computer Hardware			Introduction to Programming			Introduction to Database Development			Business Information Systems			Cyber Security and Ethics			Web Technologies Application and Development		
		6 Credits			6 Credits			6 Credits			6 Credits			6 Credits			6 Credits			6 Credits		
		JLC			BA			JLC			JLC			JLC			JLC			BA		
Surname	First Name	Ass 1 (Report -60%)	Ass 2 (Exam -40%)	Final mark	Ass 1 (Practical - 50%)	Ass 2 (Report - 50%)	Final mark	Ass 1 (System - 60%)	Ass 2 (Practical Exam - 40%)	Final mark	Ass 1 (Report - 25%)	Ass 2 (Implementation - 75%)	Final Mark	Ass 1 (Report - 40%)	Ass 2 (Implementation - 60%)	Final Mark	Ass 1 (Presentation - 50%)	Ass 2 (Portfolio - 50%)	Final Mark	Ass 1 (Presentation - 40%)	Ass 2 (Website - 60%)	Final Mark
Full Time																						
XXXX	XXXX	62	65	63	65	62	64	52	61	56	41	71	64	51	52	52	67	64	66	63	63	63
XXXX	XXXX	65	84	73	73	73	73	82	76	80	56	81	75	68	80	75	77	79	78	78	83	81
XXXX	XXXX	65	79	71	73	78	76	82	64	75	56	71	67	73	65	68	73	79	76	68	66	67
XXXX	XXXX	62	80	69	65	68	67	76	71	74	50	51	51	60	68	65	67	64	66	76	54	63
XXXX	XXXX	58	51	55	53	70	62	61	67	63	48	75	68	38	70	57	70	58	64	60	68	65
XXXX	XXXX	68	63	66	66	61	64	76	65	72	41	71	64	71	65	67	56	79	68	61	52	56
XXXX	XXXX	68	77	72	66	62	64	76	56	68	51	71	66	71	65	67	56	64	60	74	75	75
XXXX	XXXX	62	65	63	77	50	64	76	60	70	48	56	54	51	46	48	53	58	56	68	40(60)	51
XXXX	XXXX	68	60	65	66	50	58	61	40	53	51	71	66	41	47	45	56	43	50	44	64	56
XXXX	XXXX	68	59	64	66	61	64	61	55	59	48	49	49	51	52	52	53	58	56	40(41)	40	40
XXXX	XXXX	62	68	64	65	67	66	82	40	65	50	58	56	63	73	69	67	64	66	64	79	73
XXXX	XXXX	58	77	66	53	73	63	61	65	63	48	75	68	67	65	66	53	58	56	61	63	62
Part Time																						
XXXX	XXXX										61	66	65									
XXXX	XXXX				77	68	73	76	40	62				60	77	70				64	78	72
XXXX	XXXX				77	67	72	82	40	65				60	77	70				78	72	74
	Max Mark	68.0	84.0	72.6	77.0	78.0	75.5	82.0	76.0	79.6	61.0	81.0	74.8	73.0	80.0	75.2	77.0	79.0	78.0	78.0	83.0	81.0
	Min Mark	58.0	51.0	55.2	53.0	50.0	58.0	52.0	40.0	52.6	41.0	49.0	48.8	38.0	46.0	44.6	53.0	43.0	49.5	40.0	40.0	40.0
	Average	63.8	69.0	65.9	67.3	65.0	66.1	71.7	57.1	65.9	49.9	66.6	62.4	58.9	64.4	62.2	62.3	64.0	63.2	64.2	64.1	64.1
	StDev	3.7	10.2	4.7	7.7	8.1	5.1	10.2	12.5	7.6	5.6	9.9	7.7	11.1	11.2	9.7	8.7	10.7	8.5	11.4	13.5	10.9
	Mode	62.0	65.0	63.2	66.0	62.0	63.5	76.0	40.0	65.2	48.0	71.0	63.5	51.0	65.0	51.6	67.0	64.0	65.5	78.0	63.0	#N/A
	Average All Units	64.27																				
	% of Unit Avg. to All Avg.			102.54			102.91			102.51			97.16			96.82			98.28		99.69	

Tracking Sheet 2011/2012 HE Applied Computing

Foundation Degree Computing - Year 2

Project — 10 Credits — JLC

Surname	First Name	Project Proposal (Task 1) - 10%	Interim Report / presentation (Task 2) - 10%	Final Written Report (Task 3) - 20%	Deliverables (Task 4) 40%	Project Diary (Task 5) - 10%	Final demonstration / Presentation / Evaluation (Task 6) - 10%	Final Mark
Full Time								
XXXX	XXXX	63	32	74	78	50	80	69
XXXX	XXXX	65	68	77	72	54	84	71
XXXX	XXXX	71	77	68	70	63	78	71
XXXX	XXXX	65	58	69	72	54	84	69
XXXX	XXXX	65	48	61	72	55	84	66
XXXX	XXXX	68	56	83	88	72	78	79
XXXX	XXXX	65	68	77	72	59	84	72
XXXX	XXXX	40	48	40	51	52	84	51
XXXX	XXXX	65	68	77	72	60	84	72
XXXX	XXXX	48	51	52	40	48	68	48
XXXX	XXXX	71	77	68	70	63	78	71
Part Time								
XXXX	XXXX							
	Max Mark	71.0	77.0	83.0	88.0	72.0	84.0	79.2
	Min Mark	40.0	32.0	40.0	40.0	48.0	68.0	47.9
	Average	62.4	59.2	67.8	68.8	57.3	80.5	67.0
	StDev	9.6	13.9	12.6	12.9	7.0	5.0	9.3
	Mode	65.0	68.0	77.0	72.0	54.0	84.0	70.5
	Average All Units	***63.00***						
	% of Unit Avg. to All Avg.							**106.39**

Visual Programming — 5 Credits — JLC

Surname	First Name	Ass 1 - Practical (40%)	Ass 1 - TCA (30%)	Exam (30%)	Final Mark
Full Time					
XXXX	XXXX	58	59	46	55
XXXX	XXXX	50	49	34	45
XXXX	XXXX	78	60	54	65
XXXX	XXXX	57	36	53	50
XXXX	XXXX	63	55	70	63
XXXX	XXXX	84	78	55	74
XXXX	XXXX	73	76	75	75
XXXX	XXXX	63	39	48	51
XXXX	XXXX	74	81	50	69
XXXX	XXXX	66	68	41	59
XXXX	XXXX	84	60	44	65
Part Time					
XXXX	XXXX	84	63	63	71
	Max Mark	84.0	81.0	75.0	74.5
	Min Mark	50.0	36.0	34.0	44.9
	Average	69.5	60.3	52.8	61.7
	StDev	11.7	14.3	11.9	9.9
	Mode	84.0	60.0	#N/A	#N/A
	% of Unit Avg. to All Avg.				**97.97**

E-Commerce — 10 Credits — BA

Surname	First Name	Ass 1 (Report -25%)	Ass 2 (Presentation -25%)	Ass 3 (Website -50%)	Final Mark
Full Time					
XXXX	XXXX	0	59	59	44
XXXX	XXXX	10	48	51	40
XXXX	XXXX	43	73	80	69
XXXX	XXXX	60	59	55	57
XXXX	XXXX	58	51	66	60
XXXX	XXXX	74	78	79	78
XXXX	XXXX	65	71	67	68
XXXX	XXXX	62	40(49)	51	51
XXXX	XXXX	72	64	79	74
XXXX	XXXX	54	61	40(42	49
XXXX	XXXX	62	76	57	63
Part Time					
XXXX	XXXX				
	Max Mark	74.0	78.0	80.0	77.5
	Min Mark	0.0	40.0	40.0	40.0
	Average	50.9	61.8	62.2	59.3
	StDev	24.3	12.2	13.2	12.2
	Mode	62.0	59.0	51.0	#N/A
	% of Unit Avg. to All Avg.				**94.08**

Object Oriented Programming — 10 Credits — JLC

Surname	First Name	Ass1 (Development - 40%)	Ass2 (Development - 30%)	Exam (30%)	Final Mark
Full Time					
XXXX	XXXX	65	64	53	61
XXXX	XXXX	65	64	50	60
XXXX	XXXX	84	84	61	77
XXXX	XXXX	57	62	49	56
XXXX	XXXX	57	62	72	63
XXXX	XXXX	84	84	77	82
XXXX	XXXX	61	62	86	69
XXXX	XXXX	57	62	35	52
XXXX	XXXX	65	64	69	66
XXXX	XXXX	65	64	24	52
XXXX	XXXX	84	64	42	65
Part Time					
XXXX	XXXX				
	Max Mark	84.0	84.0	86.0	81.9
	Min Mark	57.0	62.0	24.0	51.9
	Average	67.6	66.9	56.2	64.0
	StDev	11.0	8.5	18.8	9.4
	Mode	65.0	64.0	#N/A	#N/A
	% of Unit Avg. to All Avg.				**101.56**

Tracking Sheet 2011/2012 HE Applied Computing

BSc (HONS) Computing - Year 3

		Mutli Tasking Systems				Creative Computing				Work-Based Research Project					Advanced Web-based technology			
		6 Credits				6 credits				18 Credits					6 Credits			
		BA				BA				BA					BA			
Surname	First Name	Ass 1 (Assignment - 40%)	Ass 2 (Assignment - 30%)	Written Examination - 30%)	Final Mark	Ass 1 (Practical - 50%)	Ass 2 (Presentation - 25%)	Ass 3 (Report - 25%)	Final Mark	Action Plan (10%)	Project Log (10%)	Presentation (10%)	Report (70%)	Final Mark	Ass 1 (Web Site - 40%)	Ass 2 (Report -30%)	Ass 3 (Written Exam -30%)	Final Mark
Full Time																		
XXXX	XXXX	72	74	67	71	72	59	64	67	77	69	78	68	70	75	67	66	70
XXXX	XXXX	68	65	78	70	75	67	55	68	68	56	72	76	73	79	73	88	80
XXXX	XXXX	58	50	43	51	43	41	72	50	51	40(51)	68	57	56	43	62	57	53
XXXX	XXXX	50	55	68	57	59	61	65	61	52	64	57	64	62	66	72	68	68
XXXX	XXXX	52	43	68	54	64	69	65	66	52	64	57	64	62	65	67	59	64
XXXX	XXXX	57	49	62	56	72	73	71	72	72	58	79	74	73	84	75	79	80
XXXX	XXXX	58	67	52	59	52	54	69	57	72	58	79	74	73	55	72	69	64
XXXX	XXXX	68	72	74	71	74	74	71	73	77	69	78	68	70	79	71	88	79
XXXX	XXXX	67	64	77	69	76	75	74	75	74	70	73	73	73	81	71	88	80
XXXX	XXXX	71	60	62	65	52	73	73	63	68	35	73	75	70	87	69	79	79
	Max Mark	72.0	74.0	77.7	71.0	76.0	75.0	74.0	75.3	77.0	70.0	79.0	76.0	72.8	87.0	75.0	88.0	80.1
	Min Mark	50.0	43.0	42.7	51.0	43.0	41.0	55.0	49.8	51.0	35.0	57.0	57.0	55.8	43.0	62.0	57.0	52.9
	Average	62.1	59.9	65.0	62.3	63.9	64.6	67.9	65.1	66.3	58.3	71.4	69.3	68.1	71.4	69.9	74.1	71.8
	StDev	8.0	10.4	10.9	7.7	11.8	10.9	5.8	7.9	10.6	12.1	8.4	6.2	6.0	14.0	3.8	11.9	9.4
	Mode	68.0	#N/A	#N/A	71.0	72.0	73.0	65.0	#N/A	77.0	69.0	78.0	68.0	70.0	79.0	67.0	88.0	#N/A
	Average All Units	***66.81***																
	% of Unit Avg. to All Avg.				**93.25**				**97.40**					**101.94**				**107.41**

Academic Year 2012/2013:

Tracking Sheet 2012/2013 HE Applied Computing

Foundation Degree Computing - Year 1

		System Analysis			Computer Hardware			Introduction to Programming			Introduction to Database Development			Business Information Systems			Cyber Security and Ethics			Web Technologies Application and Development		
		6 Credits			6 Credits			6 Credits			6 Credits			6 Credits			6 Credits			6 Credits		
		JLC			BA			JLC			JLC			JLC			JLC			BA		
Surname	First Name	Ass 1 (Report -60%)	Ass 2 (Exam -40%)	Final mark	Ass 1 (Practical - 50%)	Ass 2 (Report - 50%)	Final mark	Ass 1 (System - 60%)	Ass 2 (Practical Exam - 40%)	Final mark	Ass 1 (Report - 25%)	Ass 2 (Implementation - 75%)	Final Mark	Ass 1 (Report - 40%)	Ass 2 (Implementation - 60%)	Final Mark	Ass 1 (Presentation - 50%)	Ass 2 (Portfolio - 50%)	Final Mark	Ass 1 (Presentation - 40%)	Ass 2 (Website - 60%)	Final Mark
Full Time																						
XXXX	XXXX	63	65	64	66	66	66	61	48	56	53	57	56	59	42	49	60	61	61	55	67	62
XXXX	XXXX	71	74	72	72	65	69	52	58	54	53	68	64	62	48	54	65	73	69	75	68	71
XXXX	XXXX	63	75	68	40(59)	67	54	68	50	61	54	59	58	59	57	58	58	60	59	58	73	67
XXXX	XXXX	71	49	62	72	65	69	52	57	54	53	68	64	62	48	54	66	73	70	75	68	71
XXXX	XXXX	71	68	70	72	65	69	52	56	54	53	68	64	62	48	54	62	73	68	75	68	71
XXXX	XXXX	61	71	65	66	66	66	65	54	61	51	56	55	59	54	56	56	63	60	55	64	60
XXXX	XXXX	63	64	63	67	67	67	68	76	71	54	61	59	59	57	58	63	65	64	58	73	67
Part Time																						
XXXX	XXXX	68	51	61							64	71	69				68	67	68			
XXXX	XXXX	68	72	70							64	71	69				68	67	68			
	Max Mark	71.0	75.0	72.2	72.0	67.0	68.5	68.0	76.0	71.2	64.0	71.0	69.3	62.0	57.0	57.8	68.0	73.0	69.5	75.0	73.0	70.8
	Min Mark	61.0	49.0	61.2	66.0	65.0	53.5	52.0	48.0	53.6	51.0	56.0	54.8	59.0	42.0	48.8	56.0	60.0	59.0	55.0	64.0	60.4
	Average	66.6	65.4	66.1	69.2	65.9	65.4	59.7	57.0	58.6	55.4	64.3	62.1	60.3	50.6	54.5	62.9	66.9	64.9	64.4	68.7	67.0
	StDev	4.1	9.5	3.9	3.1	0.9	5.4	7.6	9.1	6.3	4.9	6.0	5.4	1.6	5.6	3.1	4.3	5.2	4.2	10.0	3.3	4.3
	Mode	63.0	#N/A	#N/A	72.0	65.0	68.5	52.0	#N/A	#N/A	53.0	68.0	64.3	59.0	48.0	53.6	68.0	73.0	67.5	75.0	68.0	70.8
	Average All Units	***62.66***																				
	% of Unit Avg. to All Avg.			**105.51**			**104.42**			**93.57**			**99.12**			**86.91**			**103.56**		**109.66**	

Tracking Sheet 2012/2013 HE Applied Computing

Foundation Degree Computing - Year 2

Surname	First Name	Development Project							Visual Programming			ICT Service Support			Multimedia Technologies applications and development					Object Oriented Software Development			
		12 Credits							6 Credits			6 Credits			6 Credits					6 Credits			
		JLC							JLC			JLC			BA					JLC			
Surname	First Name	Project Proposal (Task 1) - 10%	Presentation (Task 2) - 10%	Deliverables (Task 3) 40%	Final Written Report (Task 4) - 40%	Final Mark			Ass 1 - Practical (60%)	Exam (40%)	Final Mark	Ass 1 (Report - 50%)	Ass 2 (Portfolio - 50%)	Final Mark	Ass 1 (Report - 40%)	Ass 2 (Practical - 60%)	Final Mark			Ass1 (Design - 30%)	Ass2 (Implementation - 30%)	Exam (40%)	Final Mark
Full Time																							
XXXX	XXXX	49	51	64	75	66			63	63	63	61	67	64	68	63	65			68	65	54	62
XXXX	XXXX	74	77	83	79	80			82	67	76	78	84	81	78	67	71			68	75	88	78
XXXX	XXXX	72	63	76	76	74			81	60	73	78	84	81	78	67	71			68	75	78	74
XXXX	XXXX	56	56	51	71	60			62	52	58	61	67	64	69	63	65			68	65	76	70
XXXX	XXXX	59	66	58	52	57			80	40	64	78	71	75	78	67	71			63	69	30	52
XXXX	XXXX	76	63	76	76	75			60	42	53	61	67	64	69	63	65			68	65	59	64
XXXX	XXXX	60	55	71	54	62			40	64	50	58	60	59	67	59	62			68	65	72	69
XXXX	XXXX	60	55	59	46	54			59	40	51	61	50	56	68	63	65			68	65	41	56
XXXX	XXXX	0	55	59	48	48			40	29	36	55	52	54	65	49	55			36	36	45	40
XXXX	XXXX	56	56	51	71	60			57	55	56	61	69	65	69	63	65			68	65	42	57
XXXX	XXXX	59	66	58	52	57			80	41	64	75	75	75	78	65	70			59	66	58	61
XXXX	XXXX	0	55	71	54	56			40	43	41	58	52	55	67	59	62			50	55	67	58
Part Time		Project Proposal (Task 1) - 10%	Interim Report / presentation (Task 2) - 10%	Final Written Report (Task 3) - 20%	Deliverables (Task 4) 40%	Project Diary (Task 5) - 10%	Final demonstration / Presentation / Evaluation (Task 6) - 10%	Final Mark							Ass 1 (Assignment - 25%)	Ass 2 (Assignment - 30%)	Ass 3 (Assignment - 35%)	Oral Examination - 10%	Final Mark	Ass1 (Development - 40%)	Ass2 (Development - 30%)	Exam (30%)	Final Mark
XXXX	XXXX	78	71	67	61	68	73	67							78	68	67	67	70	75	68	68	71
XXXX	XXXX								68	51	61												
XXXX	XXXX								68	40	57												
	Max Mark	76.0	77.0	83.0	79.0	79.9			82.0	67.0	76.0	78.0	84.0	81.0	78.0	67.0	71.4			75.0	75.0	88.0	78.1
	Min Mark	0.0	51.0	51.0	46.0	48.3			40.0	29.0	35.6	55.0	50.0	53.5	65.0	49.0	55.4			36.0	36.0	30.0	39.6
	Average	51.8	59.8	64.8	62.8	62.2			62.9	49.1	57.3	65.4	66.5	66.0	71.4	62.7	66.2			63.6	64.2	59.8	62.3
	StDev	25.5	7.3	10.4	12.7	9.6			15.1	11.5	11.0	9.0	11.5	9.8	5.2	5.0	4.7			10.2	9.8	17.0	10.3
	Mode	56.0	55.0	76.0	76.0	60.0			40.0	40.0	#N/A	61.0	67.0	64.0	78.0	63.0	71.4			68.0	65.0	#N/A	#N/A
	Average All Units	***62.80***																					
	% of Unit Avg. to All Avg.					**99.03**					**91.31**		**105.89**			**99.89**					**102.15**		

Tracking Sheet 2012/2013 HE Applied Computing

BSc (HONS) Computing - Year 3

		Mutli Tasking Systems				Creative Computing				Work-Based Research Project					Advanced Web-based Technology			
		6 Credits				6 credits				18 Credits					6 Credits			
		BA				BA				BA					BA			
Surname	**First Name**	Ass 1 (Assignment - 40%)	Ass 2 (Assignment - 30%)	Written Examination - 30%)	Final Mark	Ass 1 (Practical - 50%)	Ass 2 (Presentation - 25%)	Ass 3 (Report - 25%)	Final Mark	Action Plan (10%)	Project Log (10%)	Presentation (10%)	Report (70%)	Final Mark	Ass 1 (Web Site - 40%)	Ass 2 (Report -30%)	Ass 3 (Written Exam -30%)	Final Mark
Full Time																		
XXXX	XXXX	53	55	46	52	48	58	59	53	58	15	67	58	55	57	47	49	52
XXXX	XXXX	65	58	56	60	73	74	75	74	69	65	66	74	72	69	62	62	65
XXXX	XXXX	58	48	54	54	64	53	57	60	48	51	55	55	54	52	58	41	51
XXXX	XXXX	56	53	75	61	53	62	62	58	61	67	75	72	71	67	47	66	61
XXXX	XXXX	62	66	69	65	58	69	75	65	68	70	69	74	73	72	74	69	72
XXXX	XXXX	58	73	45	59	71	72	65	70	55	69	65	66	65	62	74	73	69
XXXX	XXXX	55	65	66	61	74	75	74	74	58	55	71	72	69	76	72	64	71
	Max Mark	65.0	73.0	75.0	65.3	74.0	75.0	75.0	74.3	69.0	70.0	75.0	74.0	72.5	76.0	74.0	73.0	71.7
	Min Mark	53.0	48.0	45.0	51.5	48.0	53.0	57.0	53.3	48.0	15.0	55.0	55.0	53.9	52.0	47.0	41.0	50.5
	Average	58.1	59.7	58.7	58.8	63.0	66.1	66.7	64.7	59.6	56.0	66.9	67.3	65.3	65.0	62.0	60.6	62.8
	StDev	4.1	8.7	11.6	4.7	10.3	8.6	7.8	8.3	7.3	19.5	6.2	7.9	8.0	8.5	11.9	11.4	8.9
	Mode	58.0	#N/A	#N/A	#N/A	#N/A	#N/A	75.0	#N/A	58.0	#N/A	#N/A	74.0	#N/A	#N/A	47.0	#N/A	#N/A
	Average All Units	<u>**62.90**</u>																
	% of Unit Avg. to All Avg.				**93.45**				**102.88**					**103.88**				**99.79**

Academic Year 2013/2014:

Tracking Sheet 2013/2014 HE Applied Computing													
		Foundation Degree Computing - Year 1											
		Systems Analysis and Databases			Software Design and Development			Computing Applications			Web Technologies and Platforms		
		30			30			30			30		
		JLC			JC			JH			BA		
Surname	First Name	Ass 1 (TCA - 40%)	Ass 2 (Practical - 60%)	Final mark	Ass 1 (TCA - 40%)	Ass 2 (Practical - 60%)	Final mark	Ass 1 (Presentation - 60%)	Ass 2 (portfolio - 40%)	Final mark	Ass 1 (Presentation - 25%)	Ass 2 (Practical - Website Programming -75%)	Final mark
Full Time													
XXXX	XXXX	63	55	58	73	65	68	63	47	57	61	81	76
XXXX	XXXX	68	67	67	76	67	71	47	41	45	64	83	78
XXXX	XXXX	77	65	70	72	67	69	47	41	45	58	81	75
XXXX	XXXX	75	81	79	57	74	67	61	45	55	62	73	70
XXXX	XXXX	78	71	74	78	70	73	47	43	45	65	81	77
XXXX	XXXX	37	78	62	43	67	57	62	43	54	61	68	66
XXXX	XXXX	58	55	56	44	50	48	47	36	43	66	74	72
XXXX	XXXX	83	81	82	86	83	84	60	57	59	61	77	73
XXXX	XXXX	53	73	65	51	77	67	59	55	57	57	68	65
XXXX	XXXX	56	54	55	57	63	61	64	46	57	63	78	74
XXXX	XXXX	43	45	44	63	44	52	64	44	56	62	58	59
XXXX	XXXX	37	79	62	48	74	64	61	44	54	61	68	66
XXXX	XXXX	58	80	71	58	82	72	59	56	58	59	74	70
XXXX	XXXX	63	72	68	64	70	68	62	41	54	57	64	62
XXXX	XXXX	88	65	74	84	84	84	64	51	59	67	84	80
XXXX	XXXX	56	67	63	63	66	65	47	43	45	64	78	75
XXXX	XXXX	78	82	80	72	84	79	60	57	59	58	78	73
	Max Mark	88.0	82.0	81.8	86.0	84.0	84.2	64.0	57.0	58.8	67.0	84.0	79.8
	Min Mark	37.0	45.0	44.2	43.0	44.0	47.6	47.0	36.0	42.6	57.0	58.0	59.0
	Average	63.0	68.8	66.5	64.1	69.8	67.5	57.3	46.5	53.0	61.5	74.6	71.3
	StDev	15.5	11.2	10.0	13.3	11.1	9.9	7.0	6.4	5.9	3.1	7.3	5.8
	Mode	63.0	55.0	#N/A	72.0	67.0	#N/A	47.0	41.0	58.8	61.0	81.0	70.3
	Average All Units	***64.58***											
	% of Unit Avg. to All Avg.		**106.58**				**104.56**			**82.02**		**115.51**	

Tracking Sheet 2013/2014 HE Applied Computing

Foundation Degree Computing - Year 2

		Development Project					Visual Programming			ICT Service Support			Multimedia Technologies applications and development			Object Oriented Software Development			
		12 Credits					6 Credits			6 Credits			6 Credits			6 Credits			
		JLC					JLC			JLC			BA			JLC			
Surname	First Name	Project Proposal (Task 1) - 10%	Presentation (Task 2) - 10%	Deliverables (Task 3) 40%	Final Written Report (Task 4) - 40%	Final Mark	Ass 1 - Practical (60%)	Exam (40%)	Final Mark	Ass 1 (Report - 50%)	Ass 2 (Portfolio - 50%)	Final Mark	Ass 1 (Report - 40%)	Ass 2 (Practical - 60%)	Final Mark	Ass1 (Design - 30%)	Ass2 (Implementation - 30%)	Exam (40%)	Final Mark
Full Time																			
XXXX	XXXX	61	63	52	57	56	53	50	52	53	52	53	62	72	68	71	63	51	61
XXXX	XXXX	63	64	55	51	55	40(61)	50	44	53	57	55	65	75	71	75	65	52	63
XXXX	XXXX	56	59	53	57	56	51	48	50	56	63	60	62	72	68	71	61	29	51
XXXX	XXXX	62	62	52	58	56	52	50	51	56	61	59	62	77	71	71	65	68	68
XXXX	XXXX	61	62	54	50	54	40(55)	41	40	53	47	50	64	65	65	20	48	50	40
XXXX	XXXX	64	66	57	52	57	40(62)	54	46	53	59	56	66	71	69	84	77	54	70
Part Time																			
XXXX	XXXX	66	75	76	78	76				68	61	65	71	81	77	71	72	54	65
XXXX	XXXX	66	75	76	78	76				68	81	75	71	81	77	71	72	53	64
	Max Mark	66.0	75.0	76.0	78.0	75.7	53.0	54.0	51.8	68.0	81.0	74.5	71.0	81.0	77.0	84.0	77.0	68.0	69.9
	Min Mark	56.0	59.0	52.0	50.0	53.9	51.0	41.0	40.4	53.0	47.0	50.0	62.0	65.0	64.6	20.0	48.0	29.0	40.4
	Average	62.4	65.8	59.4	60.1	60.6	52.0	48.8	47.1	57.5	60.1	58.8	65.4	74.3	70.7	66.8	65.4	51.4	60.2
	StDev	3.2	6.0	10.4	11.4	9.4	1.0	4.3	4.5	6.6	10.0	7.7	3.8	5.4	4.4	19.4	8.9	10.7	9.8
	Mode	61.0	62.0	52.0	57.0	75.7	#N/A	50.0	#N/A	53.0	61.0	#N/A	62.0	72.0	68.0	71.0	65.0	54.0	#N/A
	Average All Units	***59.49***																	
	% of Unit Avg. to All Avg.					**101.89**			**79.23**		**101.07**			**124.81**			**109.89**		

Tracking Sheet 2013/2014 HE Applied Computing

BSc (HONS) Computing - Year 3

		Mutli Tasking Systems				Creative Computing				Work-Based Research Project					Advanced Web-based Technology			
		6 Credits				6 credits				18 Credits					6 Credits			
		BA				BA				BA					BA			
Surname	**First Name**	Ass 1 (Assignment - 40%)	Ass 2 (Assignment - 30%)	Written Examination - 30%)	Final Mark	Ass 1 (Practical - 50%)	Ass 2 (Presentation - 25%)	Ass 3 (Report - 25%)	Final Mark	Action Plan (10%)	Project Log (10%)	Presentation (10%)	Report (70%)	Final Mark	Ass 1 (Web Site - 40%)	Ass 2 (Report -30%)	Ass 3 (Written Exam -30%)	Final Mark
Full Time																		
XXXX	XXXX	72	65	68	69	71	66	68	69	52	58	71	64	63	74	40(62)	72	63
XXXX	XXXX	82	78	79	80	68	75	67	70	75	75	68	76	75	68	73	82	74
XXXX	XXXX	81	75	77	78	72	71	68	71	73	68	78	78	77	76	72	81	76
XXXX	XXXX	54	55	60	56	57	53	51	55	53	57	36	40	43	45	40(48)	48	44
XXXX	XXXX	68	67	78	71	40(40)	62	67	52	58	68	76	72	71	68	64	65	66
XXXX	XXXX	61	58	62	60	53	52	52	53	51	58	58	65	62	47	51	55	51
Part Time																		
XXXX	XXXX														67	64	63	65
	Max Mark	82.0	78.0	79.0	79.9	72.0	75.0	68.0	70.8	75.0	75.0	78.0	78.0	76.5	76.0	73.0	82.0	76.3
	Min Mark	54.0	55.0	60.0	56.1	53.0	52.0	51.0	52.3	51.0	57.0	36.0	40.0	42.6	45.0	51.0	48.0	44.4
	Average	69.7	66.3	70.7	69.0	64.2	63.2	62.2	61.4	60.3	64.0	64.5	65.8	65.0	63.6	64.8	66.6	62.7
	StDev	11.0	9.1	8.5	9.4	8.6	9.4	8.3	9.2	10.9	7.4	15.6	13.9	12.5	12.5	8.8	12.7	11.6
	Mode	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	68.0	#N/A	#N/A	58.0	#N/A	#N/A	#N/A	68.0	64.0	#N/A	#N/A
	Average All Units	**64.52**																
	% of Unit Avg. to All Avg.				**106.90**				**95.20**					**100.70**				**97.21**

Appendix-4: Examples of the scripting tasks performed by students for the programming module.

<u>Learn Programming in a 3D Visual Environment</u>

<u>Learn Programming in Second Life</u>

<u>See the immediate effect of your programming instruction pictured</u>

<u>1) Moving an object right by 01 meter when touching it:</u>

// The ‘default’ function is the outer function, that is similar to the ‘main’ section in C++. This includes all the events (touch, click, start…etc.) that could happen to an object.//

```
default
{
```

// the ‘touch’ event will be achieved by left clicking on the object or by right clicking then clicking on ‘Touch’//

```
touch_start(integer total_number)
{
```

// Setting the new position of the object by adding 1 to the Y-Axis and zeros to both X & Z-Axis. This will move the object one step in the Y-Axis direction <X,Y,Z>.//

// the llGetPos() function will capture the current position of the object. This will be used to set the new position of the object by moving it one step towards the Y-Axis from its current position. //

```
llSetPos(llGetPos()+<0,1,0>);
}
```

```
}
```

2) Applying the (For Loop) on the above example to achieve a 5-steps move for the object on the X-Axis:

```
default
{
        // the loop variable  i  is going to replace the X-Axis position within llSetPos
          function <X,Y,Z> , and because the loop is going to be repeated 5 times (from
          0 to 4), the object will be moved 5 steps on the X-Axis. //

        touch_start(integer total_number)
        {
                integer i;
                for (i=0; i<5; i++)
                        llSetPos(llGetPos()+<i,0,0>);
        }
}
```

3) Replacing the For-Loop in Example-2 with the Do- while Loop to achive the same result (5 steps move on the X-Axis):

```
default
{
         touch_start(integer total_number)
        {
                 vector pos1 = llGetPos();
                 vector pos2;

                do
                {
```

```
                //In each loop cycle, the object is moved one step on the X-Axis
                  <1,0,0> and the new position is stored within the variable Pos2.
                  //

                llSetPos(llGetPos()+<1,0,0>);
                pos2 = llGetPos();
            }
            while (pos2.x > (pos1.x+5));

            // The loop will continue to be executed until we reach the condition that
              the X-Axis value of the new position is 5 times greater than that of the
              original position. This means that the do-while loop was executed 5
              times and has moved the object 5 steps on the X-Axis. //

        }
}
```

4) Moving an object left by 01 meter as soon as you save the code:

```
default
{

        // The state_entry event will be executed as soon as you save the code. It does
          not require you to click on the object. //

        // While a positive value within the <X,Y,Z> part of the llSetPos function means
          moving the object forward, a negative value means moving it backward. //

        // In this example, the object will be moved one step backward on the X-Axis. //

        state_entry()
        {
```

```
                llSetPos(llGetPos()+<-1,0,0>);
        }
}
```

5) Displaying a message to the avatar when the object is touched:

```
default
{

        // In this example, a message will appear for you from the object when it is
          touched (by left clicking on the object or by right clicking then clicking on
          'Touch'). //

        touch_start(integer total_number)
        {
                llSay(0, "hello… I am touched.");
        }
}
```

6) Moving an object right by 02 meters as soon as the avatar types "move right" in the Chat box:

```
default
{

        // When you save the code (executing the state_entry event), the object owner
          will be identified and the function to listen to your chat will be reset. This is
          how the object will listen to its owner through the chatting channel. //

        state_entry()
        {
                key id;
```

```
            id = llGetOwner();
            llListen(0,"", id, "");
        }

        // The listen function captures words in the Chat Box channel and save them in
           the variable called message.//

        // When the words 'move right' are typed by the object owner in the chat box,
           the object will capture them because it is listening to this channel and will
           perform a 2 steps move on the X-Axis. //

        listen(integer channel, string name, key id, string message)
        {
            if (message == "move right")
            {
                llSetPos(llGetPos()+<2,0,0>);
            }
        }
}
```

<u>7) Making an object runs after the avatar when it is touched:</u>

```
default
{
        touch_start(integer total_number)
        {
            key id;

            llSetStatus(STATUS_PHYSICS, TRUE);

            //Little pause to allow server to make potentially large linked object physical.//

            llSleep(0.1);
```

```
            // Look for the object owner within 20 metres in 360 degree (PI) arc.//

            id = llGetOwner();
            llSensor("", id, AGENT, 20.0, PI);
        }

        //If the avatar (the object owner) has been found.  The llDetectedPos  function
          will detect the avatar position and then the object will move to that target
          position (the position of the avatar). //

        // The sensor function is the function that will search for the object owner.

        sensor( integer detected )
        {
            vector pos = llDetectedPos(0);
            llMoveToTarget(pos,0.4);
        }


        //If the avatar (the object owner) has not been found (probably too far), the
          system is going to display a message. //

        no_sensor( )
        {
          llSay(0, "The object owner is not available" );
         }

    }
```

8) Making an object runs after the avatar as soon as the avatar types “catch me” in the Chat box:

```
default
{

        // When you save the code (executing the state_entry event), the object owner
           will be identified and the function to listen to your chat will be reset. This is
           how the object will listen to its owner through the chatting channel. //

        state_entry()
        {
                key id;
                id = llGetOwner();
                llListen(0,"", id, "");
        }

        // The listen function captures words in the Chat Box channel and save them in
           the variable called message.//

        // When the words ‘catch me’ are typed by the object owner in the chat box, the
           object will capture them because it is listening to this channel and will move
           to that target position (the position of the avatar).//


        listen(integer channel, string name, key id, string message)
        {
                if (message == "catch me")
                {
                        llSetStatus(STATUS_PHYSICS, TRUE);

                        // Little pause to allow server to make potentially large linked object
                physical.//
```

```
                    llSleep(0.1);

                    // Look for the object owner within 20 metres in 360 degree (PI)
          arc.//

                    llSensor("", id, AGENT, 20.0, PI);
          }
}

//If the avatar (the object owner) has been found.  The llDetectedPos  function
  will detect the avatar position and then the object will move to that target
  position (the position of the avatar). //

//The sensor function is the function that will search for the object owner.//

sensor( integer detected )
{
          vector pos = llDetectedPos(0);
          llMoveToTarget(pos,0.4);
}

//If the avatar (the object owner) has not been found (probably too far), the
  system is going to display a message. //

no_sensor( )
{
       llSay(0, "The object owner is not available" );
 }
}
```

Appendix-5: Quotes from students' feedback on the application of virtual world technologies to visualise complex theory concepts in their Computer Science subjects.

A5.1 Helpdesk Support:

The academic year 2012/2013 (Group-B):

"*...Most of the enquiries can be dealt with through quick chat sessions and it can be all done anonymously… it is entirely possible to deliver quality service via such an environment… There do exist serious limitations regarding the level of service that can be given. As an online service needing a computer to use, it is highly likely that in the case of a serious malfunction of a user's hardware or software, which means the user will be entirely unable to access the helpdesk service*".

"*…Virtual helpdesks are different to real world helpdesks in that support can be available for longer periods of time and more effective technical support can be provided to people that are less confident when interacting with people face-to-face. Through experiences of simulating virtual helpdesk scenarios and comparing the results to a similar scenario on a real world helpdesk, it is apparent that these issues can be solved more effectively online*".

A5.2 Multimedia Technologies:

The academic year 2012/2013 (Group-B):

"*…All of the feedback from the live session, and the emails afterwards, were taken into account during the creation of the finished product. Having a broad audience reviewing our work ensured that the work was analysed from different points of view and ideas on good digital stories. As a result of this the feedback we received was diverse, but all relevant, to the improvement of our video.*"

"*...Receiving feedback is also different compared to the real life situation. Second Life gives us the possibility to present our work for people from all over the world fast and easy. Then we can get an instant live feedback from a really broad range of people where in a real life, it would be very difficult to achieve. It is likely that the immediate nature of this feedback will make it more genuine, although there is always the possibility of people not taking it seriously*".

The academic year 2013/2014 (Group-E):

"*…the group were able to gather live feedback as a group from a broad audience. Due to the meeting being organised within SecondLife, the feedback the group were able to obtain was varied and offered insight on how the product both excelled and failed. By taking this feedback into account the group was able to develop and improve the quality of the final product in order to meet the set requirements for promoting TechGenius*".

"*…This is different to gaining feedback from an audience face to face. Unlike a meeting in the virtual world, a face to face meeting involves an unfamiliar environment. This unfamiliar environment is generally an office which makes meetings very formal. Due to the meeting being formal the audience may feel intimidated and therefore are less likely to offer honest feedback… The presenter can feel pressured and intimidated when giving feedback to peers and therefore are less likely to showcase the overall potential of TechGenius. Due to this the group found that obtaining feedback through a virtual world such as SecondLife had huge advantages when it came to improving the overall potential and finish*".

Appendix-6: Communication with a Computing lecturer observing students' attitude before and after the application of virtual worlds in their 'Programming' and 'Database Normalisation' modules.

The questions asked on both modules were as follows:

From: Belsam Attallah
Sent: 11 June 2014 14:53
To: XXXX
Subject: The difficulties in the theory concepts of Programming for HE Computing – Year 1&2 students

Dear XXXX,

Reference our earlier discussions at the start of the academic year, where you highlighted the difficulties faced by your HE Computing students in understanding the theory concepts and the structure of this subject, and as you are aware, I am carrying out a study on the degree of complexity in a number of HE Computing subjects, I would be very grateful if you could kindly answer the following questions as a contribution to this study please.

Your kind input is very useful as I need to know whether students' learning and achievement have improved as a result of my guest lecturer's sessions, which were used to embed elements of the virtual world into the curriculum delivery of this unit (as a technology-enhanced tool to support the learning of the HE Computing students).

* Answers added in red below each question

<u>Before applying the scenario in the virtual world:</u>

1. As a lecturer for this unit, do you consider Programming a difficult subject in HE Computing?

"*For the students, it is often perceived as a traditionally difficult subject, which many are apprehensive about*".

2. As a lecturer for this unit, how fundamental is this subject to the Computing studies?

   "*It is one of the most basic skills in Computing. It is as fundamental as being able to speak English. In other words, it is a key skill, as it crosses many subject boundaries*".

3. As a lecturer for this unit, do you think that it is difficult from your perspective to illustrate the theory concepts of Programming (input, output, loops…etc.) to students in the normal/physical classroom situation using the traditional resources available, e.g. white/smart broad and the projector?

   "*It is particularly difficult to convey the principles of programming in a classroom setting because of the limitation of that environment. Being an abstract concept, programming is best visualised*".

4. As a lecturer for this unit, do you think that, as a result of the difficulties faced in this subject in Year-1 of the course, the students consider the Programming subject even more challenging in Year-2, and consequently face more difficulties?

   "*In order to progress to advance programming, it is essential that students gain an in-depth practical working knowledge of basic principles. If this is not achieved, students would lose confidence and this is expressed as they do not like the subject*".

5. Do your students consider this subject to have a high degree of complexity/difficulty?

   "*It is possibly the most feared subject in Computing. Students tend to 'polarise' rapidly, i.e. some grasp the ideas very quickly, some struggle significantly, and early on the course classes are often at the either end of the spectrum. This makes the teaching quite difficult to manage*".

6. Do your students face difficulties in understanding the theory concepts of the programming process?

   "*This would vary, but particularly iteration tends to be more of a problem for many*".

7. In a number of literature sources, researchers, not only in the UK, explained that the Programming subject is the main cause of students failing their Year-1 or withdrawing from the HE Computing course to find alternatives with less or no programming involved. As the lecturer for this unit for a large number of years now, to what extent do you consider this statement to be valid?

   "*It has been the situation that some students prefer a path of least resistance, i.e. no problem solving. This, however, will limit their future options significantly*".

8. Do your students face difficulties in putting the concepts of this subject into practice and achieve a fully functional program for a given scenario?

   "*It is often the case that students appear to understand the theory, but when asked to apply the knowledge to a given problem specification, they find it difficult to know how to approach the problem and which tools to use to solve it*".

9. Do you think that visualising the theory concepts of this subject for students would facilitate their understanding and learning?

   "*Of course I do, and this is how I try to approach my teaching, particularly for those students who are experiencing significant difficulty*".

10. Do you think that additional non-traditional learning resources or methods are needed to enhance students' knowledge and understanding of the programming process?

    "*Certainly, ways in which students may experience a situation and see the outcome will be more memorable and entertaining for them*".

11. Do you think that there is a level of 'surface' understanding as opposed to 'deep' in the subject, which has later affected the students' overall achievement in this unit?

"*Quite often students will mimic understanding or try and approach their learning by rote. This will not achieve the desired level of competence or give them confidence to progress*".

12. What type of feedback/comments have you had from your students regarding the difficulties of this subject?
"*Students will say they do not like the subject when what they mean is they cannot understand the subject. The two phrases go hand and glove. However, there is a great amount of satisfaction when students are able to produce a working application that solves a problem. Students sometimes say they have tried programming before and could not get to grips with it, and consequently, their mind is already made up before they come into higher education. This perception can be very difficult to change*".

13. Did you get similar feedback/comments from the students in the previous years regarding the difficulties of this subject?
"*It a consistent and well-known problem with programming*".

14. Do the students react positively before and after the delivery of this subject?
"*This has been answered earlier. Students would say they have understood but they are not always able to apply this knowledge*".

<u>During and after applying the scenario in the virtual world:</u>

1. Based on your observations as the unit lecturer, did you notice any further engagement in this unit by your students?
"*The virtual world scenarios added a new dimension to the illustration of the concepts, and the students appeared to enjoy the virtual interpretation of what was previously written/drawn on the whiteboard*".

2. Do you believe that the students were able to contribute better to the requirements of the programming process compared to the examples delivered in the normal/traditional classroom situation?

"*The visualisation reinforced some of the more challenging concepts*".

3. What type of feedback/comments have you had from the students following their experience in the virtual world? Did they mention that they would like (or prefer) to learn this subject in the virtual world, or these virtual activities did not help their understanding and learning?
   "*The virtual scenarios had a positive impact on areas of particular difficulty*".

4. As the lecturer of this unit, do you think that the virtual world is a useful environment to visualise the difficult theory concepts of the Programming subject?
   "*In order to convey the basic principles of programming, I aim to clarify the ideas in a number of ways*".

5. As the lecturer of this unit, do you think that the virtual scenarios designed for this unit were useful to enhance the students' learning and achievement, in addition to improving their overall experience?
   "*The virtual world is a powerful tool that can be used to make the constructs more memorable, and this can only enhance the subject and make it more appealing. Rather than asking the students to imagine situations, they are able to experience them*".

6. Were the students able to put the concepts of this subject well into practice and achieve a fully functional program for a given scenario? How was this compared to the situation before applying the virtual activities?
   "*The virtual world scenarios have facilitated the students' learning and achievement*".

7. As the lecturer of this unit, do you think that using this virtual scenario yourself will facilitate delivering the Programming subject for the students?
   "*Scenario ideas are a useful addition to learning aids*".

8. Do you have any recommendations to further develop or extend the scenarios designed in the virtual world (Second Life) for this unit?

"*Yes, and these would be based on ideas that were previously explained and written on paper or the whiteboard*".

9. What advantages do you think this experience has over the teaching methods that you currently use?
   "*The virtual experience has allowed students to understand how their programming skills can be used within a simulated environment, and to recognize the significant potential of this basic knowledge. An additional benefit would be that students suddenly realise how pervasive programming is and that all applications are underpinned by the same ideas*".

10. Do you have any comments on the observations you have made to students' reaction as a result of the integration of this new technology into their curriculum?
    "*Initial suspicion and some reluctance were gradually replaced by interest and then acknowledgement of the value of this addition to their curriculum*".

"*I would like to add some comment regarding the context of the environment. The response is sometime influenced by the limitations of the network infrastructure*".

Your valuable contribution and cooperation is greatly appreciated.

Looking forward to hearing from you.

Many thanks and kind regards,

Belsam Attallah
HE Lecturer in Computing

From: Belsam Attallah

Sent: 11 June 2014 14:44

To: XXXX

Subject: The difficulties in the theory concepts of Database Normalisation for HE Computing – Year 1 students

Dear XXXX,

Reference our earlier discussions at the start of the academic year, where you highlighted the difficulties faced by your HE Computing students in understanding the theory concepts of this subject, and as you are aware, I am carrying out a study on the degree of complexity in a number of HE Computing subjects, I would be very grateful if you could kindly answer the following questions as a contribution to this study please.

Your kind input is very useful as I need to know whether students' learning and achievement have improved as a result of my guest lecturer's sessions, which were used to embed elements of the virtual world into the curriculum delivery of this unit (as a technology-enhanced tool to support the learning of the HE Computing students).

Before applying the scenario in the virtual world:

1- As a lecturer for this unit, do you consider the Database Normalisation a difficult subject in HE Computing?
"*Normalisation is one of the more challenging aspects of the database subject*".

2- As a lecturer for this unit, how fundamental is this subject to the Database Unit?
"*It is an essential concept to grasp, otherwise, the database will suffer from poor implementation*".

3- As a lecturer for this unit, do you think that it is difficult from your perspective to illustrate the theory concepts of Database Normalisation to students in the normal/physical classroom situation using the traditional resources available, e.g. white/smart broad and the projector?

"*Normalisation is an abstract subject that tends to be illustrated by raw data that is manipulated to follow the rules*".

4- Do your students consider this subject to have a high degree of complexity/difficulty?

"*Students often believe they understand normalisation because they have heard of the term before. When examined, it is often clear they do not understand*".

5- Do your students face difficulties in understanding the theory concepts of the Database Normalisation process?

"*Yes, quite often. Many datasets have to be worked through in order to achieve a degree of understanding. In addition, the top-down bottom-up process can add to the complication of this subject*".

6- Do your students face difficulties in putting the concepts of this subject into practice and achieve a fully normalised database for a given scenario?

"*They will often believe they have normalised the data using an intuitive approach as opposed to following the clear rules for this process. Again resulting in a poor model*".

7- Do you think that visualising the theory concepts of this subject for students would facilitate their understanding and learning?

"*A difficult subject to visualise, but this would certainly help for some students*".

8- Do you think that additional non-traditional learning resources or methods are needed to enhance students' knowledge and understanding of the database normalisation process?

"*Can be perceived as a very dry subject and therefore, non-traditional methods would enhance the learning experience*".

9- Do you think that there is a level of 'surface' understanding as opposed to 'deep' in the subject, which has later affected the students' overall achievement in this unit?

"*Students normally believe that they have normalised the database when they have not*".

10- What type of feedback/comments have you had from your students regarding the difficulties of this subject?
"*Traditionally, they feel uncomfortable with the process, which has to be meticulously carried out*".

11- Did you get similar feedback/comments from the students in the previous years regarding the difficulties of this subject?
"*It tends to be considered as a painful process that should be avoided in favour of making the database in application*".

12- Do you think that a role-play activity might help with a difficult concept of this kind (Anthropomorphism)?
"*Role-playing may well help to place more emphasis on the importance of a clear understanding of this fundamental process*".

13- Do the students react positively before and after the delivery of this subject?
"*Prior to delivery, they tend to think it is very straightforward, quite often because they do not fully understand the stages of the process. After the delivery, they appreciate the need but tend to find the implementation quite challenging*".

<u>During and after applying the scenario in the virtual world:</u>

1- Based on your observations as the unit lecturer, did you notice any further engagement in this unit by your students?
"*Because significant emphasis was placed on this concept, students did appreciate its importance*".

2- Do you believe that the students were able to contribute better to the requirements of the database normalisation process compared to the examples delivered in the normal/traditional classroom situation?

"*Visualisation assisted understanding in some students*".

3- What type of feedback/comments have you had from the students following their experience in the virtual world? Did they mention that they would like (or prefer) to learn this subject in the virtual world, or these virtual activities did not help their understanding and learning?
"*It made a positive impact, and students were interested to see the change in the objects following each stage of the normalisation process*".

4- As the lecturer of this unit, do you think that the virtual world is a useful environment to visualise the difficult theory concepts of the Database Normalisation subject?
"*An additional tool to illustrate the subject*".

5- As the lecturer of this unit, do you think that the virtual scenario designed for this unit was useful to enhance the students' learning and achievement, in addition to improving their overall experience?
"*Many of our students are visual learners, and therefore, the virtual scenario helped them to understand the rules more fully and see the outcome of the reduction of duplication that normalisation brings*".

6- Were the students able to put the concepts of this subject well into practice and achieve a fully normalised database for a given scenario? How was this compared to the situation before applying the virtual activities?
"*Students felt more able to attempt the normalisation process*".

7- As the lecturer of this unit, do you think that using this virtual scenario yourself will facilitate delivering the subject for the students?
"*It can be used as an alternative and/or supportive method to facilitate understanding*".

8- Do you have any recommendations to further develop or extend the scenario designed in the virtual world (Second Life) for this unit?

"*Yes, there is much potential based on the variety of the datasets that could be used*".

9- What advantages do you think this experience has over the teaching methods that you currently use?
"*Objects and situations are always much more interesting than raw data*".

10- Do you have any comments on the observations you have made to students' reaction as a result of the integration of this new technology into their curriculum?
"*The different ways of approaching this subject not only stressed its significance to the unit, but also ensured that the students had more fun with what is a rather bland topic*".

"*Final thought - it my experience that not only students but also lecturers that have difficulty with this subject!*".

Your valuable contribution and cooperation is greatly appreciated.

Looking forward to hearing from you.

Many thanks and kind regards,

Belsam Attallah
HE Lecturer in Computing

Appendix-7: Examples of quizzes/formative assessments carried out to judge students' understanding and learning

<u>1- Multithreading techniques (Concurrency and Parallelism), BSc (Hons), 2013/2014</u>

(Peer marked in-class alongside explanations by the module lecturer)

BSc (Hons) Applied Computing
Formative Assessment

<u>Multi-Tasking Systems Unit</u>

<u>Concurrency and Parallelism Techniques</u>

Date: 16 October 2013

Student Name:

Score (out of 10): 1

Q1: Define 'Concurrency' in a computer system.

Concurrency is when one task is completed after the other, in sequence.

0

Q2: Define 'Parallelism' in a computer system.

Parallelism is when more than one task is completed after other, ~~in sequence~~.

0

Q3: Define the 'Address Bus' in a computer system and state which hardware and software that use it.

The Address Bus is located in the North Bridge and controls the allocation of tasks sent from the OS, RAM and CPU, including program counter

0

Q4: Define the 'Data Bus' in a computer system and state which hardware and software that use it.

0

Q5: What is the relationship between the 'Address Bus' and the 'Program Counter'. 0

The address bus allocates the program information and instructions and the program counter tells the address bus which instruction it is on and which is next.

Q6: What is the Difference between a 32-bit Operating System and a 64-bit Operating System.

64 bit operating systems can control more instructions than 32. The CPU must be 64 or 32 bit.

0

Q7: Which part of the computer system controls 'Concurrency and Parallelism' and how.

0

Q8: Are all the tasks in RAM get the same timeslot (length of time) when executing in the CPU and why.

No the scheduler determines the time in which the tasks needs to executed

1

Q9: Define the 'CPU Cache' in a computer system and explain its use.

CPU cache is used as virtual memory

0

Q10: Which part of the software application is moved to RAM when being executed by the user and when does it leave RAM.

0

BSc (Hons) Applied Computing
Formative Assessment

Multi-Tasking Systems Unit

Concurrency and Parallelism Techniques

Date: 16 October 2013

Student Name:

Score (out of 10): 2

Q1: Define 'Concurrency' in a computer system.

0 This is when processes within a processor are executed in a queing fashion, one after another. It operates on a first in first out method.

Q2: Define 'Parallelism' in a computer system.

1 This is when mutiple proccesses are execute at the same time across mutiple cores of a processer.

Q3: Define the 'Address Bus' in a computer system and state which hardware and software that use it.

0 The address bus passes the address of memory to the ~~processor~~ processor on request.

- Needed to mention OS, HDD and RAM

Q4: Define the 'Data Bus' in a computer system and state which hardware and software that use it.

0 Once the processor has sent the address, it gets the data passed back to it via the databus

- Mention instructions & data - HDD and CPU

1

Q5: What is the relationship between the 'Address Bus' and the 'Program Counter'.

The program counter is incremental and lable each
0 of the address sent out so these addresses can be
resered to. Keeps addresses Syncronised
- Need to mention that it is for the next instruction to be executed.

Q6: What is the Difference between a 32-bit Operating System and a 64-bit Operating System.

The amount of data that can be passed along the data
0 bus
- Address bus and addressable RAM

Q7: Which part of the computer system controls 'Concurrency and Parallelism' and how.

The operating System by organising the process que
0
- Moving information from the RAM & CPU

Q8: Are all the tasks in RAM get the same timeslot (length of time) when executing in the CPU and why.

0 Yes, useally around 20ms in Windows. This allows each
process to finish. if it goes over this the process will timeout.
- Need to mention slots that have been cut

Q9: Define the 'CPU Cache' in a computer system and explain its use.

Its the memory that the cpu has internally. It is used
1 by the processor as a faster alternative than RAM.
The program counter uses this cache

Q10: Which part of the software application is moved to RAM when being executed by the user and when does it leave RAM.

The entry point of the application is loaded first. Any
0 of the application that Stays the Same everytime the app
is Started Stays in ram
- Need to mention about returning out of RAM

BSc (Hons) Applied Computing
Formative Assessment

Multi-Tasking Systems Unit

Concurrency and Parallelism Techniques

Date: 16 October 2013

Student Name:

Score (out of 10): 3.

Q1: Define 'Concurrency' in a computer system.

1 Concurrency is a term used to describe the method used to process information/data. In concurrency, data is processed in "chunks" one after another giving the illusion of parallel processing.

Q2: Define 'Parallelism' in a computer system.

1 In Paralellism, data is processed using multiple cores (2 or more) which means data can be processed similtaneously although each core is still processing concurrently individually.

Q3: Define the 'Address Bus' in a computer system and state which hardware and software that use it.

0

Q4: Define the 'Data Bus' in a computer system and state which hardware and software that use it.

0

Q5: What is the relationship between the 'Address Bus' and the 'Program Counter'.

0

Q6: What is the Difference between a 32-bit Operating System and a 64-bit Operating System.

0 ~~32 bits~~ Each operating system is designed to work with different architecture. 32 bits system can only utilised up to 3gb ram. 64 bit is designed for newer software designed for using multi core systems.

Q7: Which part of the computer system controls 'Concurrency and Parallelism' and how.

0 The CPU controls concurrency and parallelism. This ~~done~~ is dictated by how the software is designed thus determining how the CPU executes.

Q8: Are all the tasks in RAM get the same timeslot (length of time) when executing in the CPU and why.

0

Q9: Define the 'CPU Cache' in a computer system and explain its use.

1 The CPU cache is a small amount of memory that the CPU dedicates to its current task if needed. This ensures the RAM is free of extra tasks.

Q10: Which part of the software application is moved to RAM when being executed by the user and when does it leave RAM.

0

BSc (Hons) Applied Computing
Formative Assessment

Multi-Tasking Systems Unit

Concurrency and Parallelism Techniques

Date: 16 October 2013

Student Name:

3

Score (out of 10): 3

Q1: Define 'Concurrency' in a computer system.

The CPU allows programs to be dealt with in chunks, allowing programs to run almost simultania

0

Q2: Define 'Parallelism' in a computer system.

2 programs completing operations parallel to each other

0

Q3: Define the 'Address Bus' in a computer system and state which hardware and software that use it.

holds the address of stored data

Hardware – CPU, RAM, HDD, ~~etc~~

Software – any

0

Q4: Define the 'Data Bus' in a computer system and state which hardware and software that use it.

Transfers data between RAM & CPU

Hardware – CPU, RAM, HDD.

Software – Any.

0

Q5: What is the relationship between the 'Address Bus' and the 'Program Counter'.

Program Counter tells address bus how far along a process is needed to be fetched

0

Q6: What is the Difference between a 32-bit Operating System and a 64-bit Operating System.

the amount of addresses possible.

0

Q7: Which part of the computer system controls 'Concurrency and Parallelism' and how.

CPU, ~~by deciding~~. OS

0

Q8: Are all the tasks in RAM get the same timeslot (length of time) when executing in the CPU and why.

The time allocated is based on the operation, if no operation is being completed (idle) the CPU immediately moves on. 1

Q9: Define the 'CPU Cache' in a computer system and explain its use.

~~to~~ CPU Cache is memory in the CPU. It allows information to be stored here instead of RAM which speeds things up. 1

Q10: Which part of the software application is moved to RAM when being executed by the user and when does it leave RAM.

The main components of the program and it leaves when program is closed 1

BSc (Hons) Applied Computing
Formative Assessment

Multi-Tasking Systems Unit

Concurrency and Parallelism Techniques

Date: 16 October 2013

Student Name: [

Score (out of 10): 6

Q1: Define 'Concurrency' in a computer system.

Concurrency is defined as a systems ability to run multiple programs in turn in quick succession, so as to create the illusion of multiple Programs running simultanously. See Fig 1.

	CPU core	
Word=P1	P1	Time
Access=P2	P2	↓
	P1	
	P2	

✓

Q2: Define 'Parallelism' in a computer system.

Parallelism can be defined as multiple threads running simultanously on multiple cores. Each core can also participate in concurrency. See Fig 2.

	Core 1	Core 2
Word = P1	P1	P2
Access = P2	P3	P4
Chrome = P3	P4	P1
IE = P4	P3	P2

(Program scheduling is exemplar & theoretical)

✓

Q3: Define the 'Address Bus' in a computer system and state which hardware and software that use it.

An address bus is a bus used to communicate a read/write /othe address to the relevent device, examples of which include the HDD & RAM. The OS Will retreive program data from RAM & HDD by using the bus to request specific data. This data will then be returned on the data bus for Processing. The width of the bus (32|64) but are dendant on system architecture

✗

mention Software

Q4: Define the 'Data Bus' in a computer system and state which hardware and software that use it.

A data bus is a bus that carries data around a system for Storage or processing. The North Bridge is an example of this, as it carries data from the RAM to the CPU. Tho

✗

* Mention the Intruction

Q5: What is the relationship between the 'Address Bus' and the 'Program Counter'.

The program counter (PC) stores the address of the next instruction to be retrieved from RAM, which is requested using the address bus. When this happens the PC is incremented to point to the next instruction ✓

Q6: What is the Difference between a 32-bit Operating System and a 64-bit Operating System.

How much data that can be carried round the system at once, as well as how much memory ~~stuff~~ can be addressed. How much data can be carried is known as a word and the max addressable RAM is as follows:

32	64
4GB	64GB

✓ ← wrong figure

Q7: Which part of the computer system controls 'Concurrency and Parallelism' and how.

The OS does via ~~its~~ the scheduler in its kernel, by maintaining a dispatch table, which pushes ready threads into each cpus Ready queue

X

*You have to mention the swapping between RAM & CPU

Q8: Are all the tasks in RAM get the same timeslot (length of time) when executing in the CPU and why.

Not all tasks get the same quantum due to: ✓

Different priorities
CPU starvation
They relinquish the slot

Q9: Define the 'CPU Cache' in a computer system and explain its use.

A cache for the CPU stores frequently ~~accessible~~ accessed data in the processor itself for quick access. The L1 & L2 caches for example.

* Stuff being use by current programs X
* physical

Q10: Which part of the software application is moved to RAM when being executed by the user and when does it leave RAM.

The entry point of a program, followed by the requested instructions. They leave the RAM when a process ends.

✓

BSc (Hons) Applied Computing
Formative Assessment

Multi-Tasking Systems Unit

Concurrency and Parallelism Techniques

Date: 16 October 2013

Student Name: L

Score (out of 10): 1

0.

Q1: Define 'Concurrency' in a computer system. 0

(made up)

when ~~one~~ two things run at different times.

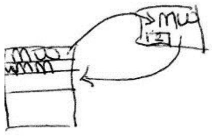
Q2: Define 'Parallelism' in a computer system.

(made up)

when ~~Same~~ 2 things run at the same time. 0

Q3: Define the 'Address Bus' in a computer system and state which hardware and software that use it.

address bus sends the data to ~~out from~~ from the CPU. ~~out~~ RAM.



CPU RAM used by.

0

Q4: Define the 'Data Bus' in a computer system and state which hardware and software that use it.

Data bus sends the RAM. ~~CPU~~ the infomation of certain actions within a program running.

CPU RAM used by.

0

Q5: What is the relationship between the 'Address Bus' and the 'Program Counter'.

Address bus is the current program being used 1

Program carter is the next program to run through.

Q6: What is the Difference between a 32-bit Operating System and a 64-bit Operating System.

64-bit can deal with more at once.

0

Q7: Which part of the computer system controls 'Concurrency and Parallelism' and how.

(guess) CPU. through the use of data buses. 0

Q8: Are all the tasks in RAM get the same timeslot (length of time) when executing in the CPU and why.

yes the will get the same length of time because it follows the ~~FIFO~~ ~~first~~ list (FILO). 0

Q9: Define the 'CPU Cache' in a computer system and explain its use.

Memory. 0

Q10: Which part of the software application is moved to RAM when being executed by the user and when does it leave RAM.

the main template and functions come when clicked ~~on~~ on.

0

BSc (Hons) Applied Computing
Formative Assessment

5

Multi-Tasking Systems Unit

Concurrency and Parallelism Techniques

Date: 16 October 2013

Student Name:

Score (out of 10): ~~8~~ 4

Q1: Define 'Concurrency' in a computer system. 1

it is when a system works by Doing tasks in an order and rapidly swiths between them so they apper to Run in parell

Q2: Define 'Parallelism' in a computer system. 1

~~them to programs~~ it is when a system work by Doing 2 operations simaltatisly. this is used in ~~a~~ a multicore cpu

Q3: Define the 'Address Bus' in a computer system and state which hardware and software that use it.

The Address bus is used ~~...~~ by the cpu to give tasks an address in Ram to be then fetch and excuted 0

Q4: Define the 'Data Bus' in a computer system and state which hardware and software that use it. 0

This controls the data sent betwen the cpu and the Ram. the software is the operating system

Q5: What is the relationship between the 'Address Bus' and the 'Program Counter'. 0

the program counter keep track of all the programs ~~im~~ that is Running. the address bus gives the programs the address(s)

Q6: What is the Difference between a 32-bit Operating System and a 64-bit Operating System.

A 32 bit OS work by 32 bit's of Addresses which can work up to 4gb of RAM. 64 bit OS has alot more so it can work up to 64gb of RAM. 1

Q7: Which part of the computer system controls 'Concurrency and Parallelism' and how.

the cpu controls this it Decides How it is going to ~~to~~ compute the ~~ba~~ Data it is getting from the system. a multi core ~~c~~cpu ~~that~~ will work on task simultasly 0

Q8: Are all the tasks in RAM get the same timeslot (length of time) when executing in the CPU and why.

0

Q9: Define the 'CPU Cache' in a computer system and explain its use.

It is used for short term memory for the cpu. to keep calculation answers. ~~from the Attc.~~ it work faster then sending it to Ram 1

Q10: Which part of the software application is moved to RAM when being executed by the user and when does it leave RAM.

~~a~~ small part of it the address and ~~the~~ each section is sent when the user ~~ta~~ clicks on it. and is excuted

0

2- Computer Programming, Year1, 2012/2013

(Peer marked in-class alongside explanations by the module lecturer)

1. Describe a function

   Ans: Piece of code that defines how the program will act ✓

2. What is the function that all programs must have? Explain the purpose of that function.

   Ans: ✗

3. What is the general syntax for a function?

   Ans: ✗

4. Explain the term 'argument'.

   Ans: ✗

5. What is another word for 'argument'.

   Ans: ✗

6. What does it mean 'to call a function'?

   Ans: ✗

7. Explain the term 'return data type'.

   Ans: Program Returns value ~~that~~ of the defined data type e.g. int = Return 0 So program returns 0

8. How can you recognize a function.

   Ans: red/~~blue~~ blue words in code [Cin, Cout, Return] ✗

9. Where in the program can user defined functions be written?

   Ans: ✗

10. What does the phrase 'prototype a function' mean?

    Ans: ✗

11. How do you prototype a function?

    Ans: ✗

12. Name three attributes that software testers should have.

    Ans: Sequence, Selection, Iteration ? ✗

13. How would you call a data called sum() and pass two constants to it?

    Ans: ✗

14. In a function called sum() show how it would receive 2 integers.

    Ans: Cin Function where the user enters the ~~an~~ integers to be added

    e.g. Cin >> number ✗

    2

0 1. Describe a function

Ans: A Load of code that tells the program what to do

1 2. What is the function that all programs must have? Explain the purpose of that function.

Ans: ~~Include iostream, enables the program to allow input and output~~
int main(), allows the code to recognise syntax and reserved words

0 3. What is the general syntax for a function?

Ans: ~~#include~~ (funcionname)

0 4. Explain the term 'argument'.

Ans: when two functions conflict

0 5. What is another word for 'argument'.

Ans: dis pute

1 6. What does it mean 'to call a function'?

Ans: when the code requires ~~of~~ a function to work

1 7. Explain the term 'return data type'.

Ans: when you need a specific data type to be returned by the function

0 8. How can you recognize a function.

Ans: it will ~~be~~ be at the beginning of a program, ~~before ... ()~~ after #include...

9. Where in the program can user defined functions be written?

0 Ans: any where after 'main()'

10. What does the phrase 'prototype a function' mean?

0 Ans: run the code before it is fully finished to test the function

11. How do you prototype a function?

0

Ans:

12. Name three attributes that software testers should have.

0 Ans:

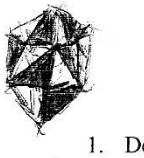
13. How would you call a data called sum() and pass two constants to it?

0 Ans:

14. In a function called sum() show how it would receive 2 integers.

0 Ans:

3 / 14 YOU GET A GOLD STAR



1. Describe a function

1/2 Ans: a block of code which can be called

block of code that carries out a particular task

2. What is the function that all programs must have? Explain the purpose of that function.

0 Ans: main

3. What is the general syntax for a function?

0 Ans: funct() { }

Return Datatype Function Name() { }

4. Explain the term 'argument'.

0 Ans: ~~Someth~~ Data the function works with

5. What is another word for 'argument'.

0 Ans: parameter

6. What does it mean 'to call a function'?

1/2 Ans: it will call an piece of code within the function

When we want the code to be executed.

7. Explain the term 'return data type'.

1/2 Ans: will return an datatype

8. How can you recognize a function.

0 Ans: By the syntax ()

9. Where in the program can user defined functions be written?

1/2 Ans: in Main Before / After Main

10. What does the phrase 'prototype a function' mean?

0 Ans: a testing function Declaring it

11. How do you prototype a function?

0 Ans: copy ~~line~~ function and stick it above main and add a ;

12. Name three attributes that software testers should have.

0 Ans: Persistance, problem solving, patience

13. How would you call a data called sum() and pass two constants to it?

0 Ans: Sum (1, 2)

14. In a function called sum() show how it would receive 2 integers.

0 Ans: Sum (int x, ~~y~~ int y)

2/ ~~14~~ 15

1/14

1. Describe a function

½ Ans: Main is a function, they return a value to program

2. What is the function that all programs must have? Explain the purpose of that function.

1 Ans: void func1(); int main()

3. What is the general syntax for a function?

0 Ans: void func1(); int main()

4. Explain the term 'argument'.

0 Ans:

5. What is another word for 'argument'.

0 Ans:

6. What does it mean 'to call a function'?

0 Ans:

7. Explain the term 'return data type'.

½ Ans: return date type (int) functionName

8. How can you recognize a function.

0 Ans:

9. Where in the program can user defined functions be written?

0 Ans:

10. What does the phrase 'prototype a function' mean?

−1 0 Ans:

11. How do you prototype a function?

0 Ans: Try to run it and check it is it working

12. Name three attributes that software testers should have.

0 Ans:

13. How would you call a data called sum() and pass two constants to it? whole numbers.

0 Ans:

14. In a function called sum() show how it would receive 2 integers.

0 Ans:

1. Describe a function (1)

Ans: They will return a value to the program after doing something. ~~...~~ 0 if everything works any other number if it doesn't

2. What is the function that all programs must have? Explain the purpose of that function.

Ans: Main ~~.~~ (1)

3. What is the general syntax for a function?

Ans: data type functionName (1)

4. Explain the term 'argument'.

Ans:

5. What is another word for 'argument'.

Ans:

6. What does it mean 'to call a function'?

Ans: Put it in the program for it to work (1/2)

7. Explain the term 'return data type'.

Ans: it will return a value to the function if it is 0 everyt works if not something has gone wrong. (1/2)

8. How can you recognize a function.

Ans: open and closed curly brackets (1/2)

9. Where in the program can user defined functions be written?

Ans:

$\frac{6\frac{1}{2}}{14}$

10. What does the phrase 'prototype a function' mean?

Ans: declaring it (1)

11. How do you prototype a function?

Ans: declare it before main (1)

12. Name three attributes that software testers should have.

Ans:

13. How would you call a data called sum() and pass two constants to it?

Ans:

14. In a function called sum() show how it would receive 2 integers.

Ans:

1. Describe a function ½

Ans: A chunk of ~~block~~ code essentially, that ~~is~~ needs to be called or it won't run.

2. What is the function that all programs must have? Explain the purpose of that function. 1

Ans: Main. the function that is ~~call~~ first ran.

3. What is the general syntax for a function? ½

Ans: data-type function-name (arguments [if any])

4. Explain the term 'argument'. 1

Ans: data that a function expects to be passed when called

5. What is another word for 'argument'. 1

Ans: parameter

6. What does it mean 'to call a function'? 1

Ans: Basically ask it ~~to~~ to run from any code.

7. Explain the term 'return data type'. 1

Ans: The data type that a function will return to ~~th~~ whatever called it

8. How can you recognize a function. 1

Ans: By the syntax (see #3)

9. Where in the program can user defined functions be written? 1

Ans: Any where thats not inside a function! & if definition is BELOW main, the function declaration must be above it.

10. What does the phrase 'prototype a function' mean? 1

Ans: To be able to ~~call one~~ build a function and run it.

11. How do you prototype a function? 1

Ans: e.g int myfunction();

12. Name three attributes that software testers should have. 1/3

Patience

Ans:

13. How would you call a data called sum() and pass two constants to it? 0

in the declaration define ~~to~~ two ~~data~~

Ans:

14. In a function called sum() show how it would receive 2 integers. 1

Ans: when calling it you would pass it two integers 1/3

e.g. sum (num1, num2);

you are a star (13)

1. Describe a function

1. Ans: a chunk of code that carries out a section of the program

2. What is the function that all programs must have? Explain the purpose of that function.

1 Ans: main() This is the first function the program goes to when first loading

3. What is the general syntax for a function?

0.5 Ans: int main() ← parameters
return type ↑ ↑ function name

4. Explain the term 'argument'.

1. Ans: A Something that is passed into a function to be used

5. What is another word for 'argument'.

1. Ans: Parameter

6. What does it mean 'to call a function'?

1. Ans: To carry out a section of code within the function

7. Explain the term 'return data type'.

1. Ans: The type of data that is being returned to the calling function

8. How can you recognize a function.

1. Ans: By a pair of brackets at the end with no semi-colon

9. Where in the program can user defined functions be written?

0.5 Ans: Underneath main()

10. What does the phrase 'prototype a function' mean?

1. Ans: To be able to call the function by declaring it

11. How do you prototype a function?

1. Ans: Before main() put the first line of the function but with a semi-colon

12. Name three attributes that software testers should have.

0.5 Ans: Persistence
Problem finding

13. How would you call a data called sum() and pass two constants to it?

0.5 Ans: ~~sum(x, y)~~. sum(x, y)

14. In a function called sum() show how it would receive 2 integers.

2. Ans: sum(int x, int y)

Appendix-8: Additional observations by the researcher in other modules.

The virtual activity of the Computer Hardware Module – Year 1:

This virtual activity was carried out in the meeting room of the Computing virtual building. Students' feedback was as follows:

Question	Percentage of 'Agree' answer
Did you find out that investigating the requirements of computer hardware solutions in Second Life is easier than the face-to-face appointment with employers?	87.5%
Did you felt that you had more self-confidence in running interviews and managing very technical discussions in computing with employers in virtual worlds compared to the physical world?	75% *(25% answered 'I do not know')*
Did you believe that talking to an avatar in virtual worlds removes the possible barriers to conversation with high-rank people in the physical world?	100%
After carrying out 3 interviews with employers in Second Life to investigate the proper hardware solutions for their businesses, do you believe that if you are given the choice in a similar situation, you will chose virtual worlds again?	62.5% *(25% answered 'I do not know')*
Did you believe that the Second Life virtual world is a useful tool to enhance the learning and achievement of Computing students?	75% *(25% answered 'I do not know')*
Will you think of using Second Life in the future after you complete the unit?	37.5 *(50% answered 'I do not know')*

As the above students' feedback was highly positive for the first five questions, a group discussion was held in the following session to discuss the overall experience and to indirectly investigate the potential reasons behind the low percentage for the last question. During the session, the students confirmed the positive feedback they previously provided, and the majority of them clarified that as the technology was entirely new to them they were not sure of what its other applications could be in their specialist area.

<u>The virtual activity of the Development Project Module – Year 2:</u>

This activity was carried out in the main hall of the 'Tech Genius' virtual helpdesk in Second Life, where the presentations were displayed on one of the large white boards. These presentations were part of a major assessment for this module.

The module lecturer said: "*We have many very able students on our courses but not all of them feel so confident about presenting in a real-time environment… It was a very exciting exercise and the students really rose to the challenge. Their avatars were required to dress smartly and they designed them to look presentable. One even came wearing a top hat!*"

Student-9 of Group-B said: "*Presenting our work in a virtual world has brought another dimension to the development project. Afterwards, we discussed the differences in techniques compared to the real world and the possibilities it may have for other applications*". Student-2 of Group-B said: "*It was definitely a different experience carrying out our presentations in a virtual setting. It went surprisingly well and made me feel more confident*". Student-11 of Group-B said: "*The virtual world presentation was better than I expected although it can easily be plagued with technical problems*".

The virtual activity of the Managing Information Module – BSc (Hons):

Students' feedback was as follows:

Statement	Percentage of 'Agree' answer
The environment in which a message is delivered is important.	100%
Cues can cause a problem in communication.	71.4%
Cues can sometimes be confusing	71.4%
A message can be delivered more effectively if some cues are available.	57.1%
A virtual space communication scenario can be used as a substitute for a real world situation	57.1%
I would feel more confident in delivering a difficult message to staff having had the opportunity to carry out a rehearsal in a virtual space.	71.4%
A virtual space is an appropriate environment in which to practice dealing with situations which are non-routine.	71.4%

People I have not met before are easier to communicate with in a virtual space.	57.1%
A virtual space can help foster a better inter-personal relationship.	57.1%
Simulation is an effective way to train existing or potential managers.	71.4%