LOW EMPATHISING AND HIGH SYSTEMISING TENDENCIES IN HIGHER EDUCTION COMPUTING STUDENTS: THE AFFORDANCES OF VIRTUAL WORLDS IN THEIR EDUCATION

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Abstract

Background. The increasing societal reliance on emerging technologies is demanding much more from those planning a career in the computing industry than technical ability alone. Many contemporary job roles require business contact, increasing the relevance of soft skills to competent practice. However, the association between those who are inherently drawn to a career in computing and low empathising, high systemising (LEHS) tendencies may compromise their future professional success. It is therefore important that the needs of these students are considered, as part of their higher education experience, in order to ensure that fundamental soft skills can be developed as early as possible.

Aim. To evaluate the ability of virtual world (VW) technology, through its characteristics of immersion, identity and interaction, to foster the soft skills identified as presenting the most difficulty for those with a LEHS disposition, during their technical education.

Method. A variety of bespoke VW activities, with a focus on dealing with non-routine situations, improving communication, encouraging play and imagination and developing social relationships, were introduced to an undergraduate applied computing programme. Associations were made between the students' cognitive style and scholastic performance, the students' perception of the intervention and the observations of others.

Result. Achievement was generally found to be better in areas of the course incorporating VW activities. LEHS students considered that their communication had improved the most, followed by their ability to accept non-routine situations, albeit with a delayed reaction. A positive, but less significant, impact was reported for the other skills. However, for those experiencing more extreme difficulties in these areas, the contribution of VW activities was transformational.

Conclusion. The research provided evidence of the VW as an engaging environment for developing non-technical skills through technical experiences, but also revealed a number of adoption barriers. These techniques, applicable to other STEM areas or any subject discipline that requires an emphasis on sought-after soft skills, could be implemented by alternative methods, although they may not be quite as effective as they are in the VW.

Keywords

Low Empathising, High Systemising, Soft Skills, Virtual Worlds, Education, STEM

Copyright

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Acronyms

AQ	Autism-Spectrum Quotient
ASC/D	Autism Spectrum Condition/Disorder
BCS	British Computer Society
CinR	Change in Routine
COTS	Commercial Off The Shelf
FE	Further Education
HE	Higher Education
HEI	Higher Education Institution
ICT	Information and Communication Technology
LEHS	Low Empathising, High Systemising (students with an AQ>16)
NLEHS	Non Low Empathising, High Systemising (students with an AQ≤16)
NVC	Non-Verbal Communication
NVW	Non-Virtual World
P&I	Play and Imagination
RW	Real World
SL	Second Life
SR	Social Relationships
STEM	Science, Technology, Engineering and Mathematics
TCA	Time Constrained Assessment
TEL	Technology Enhanced Learning
ToM	Theory of Mind
VC	Verbal Communication
VW	Virtual World

1 Introduction

1.1 Background to the Study

The premise of Occam's razor, that 'entities should not be multiplied beyond necessary' has always been fundamental to software development where, for reasons of effectiveness and efficiency, it is always sensible to keep things simple. Unfortunately, the modern environment in which Information and Communication Technology (ICT) products and services operates, has turned out to be anything but simple. Although the computing industry continues to offer an extensive range of career opportunities, emerging technologies and the increasing societal reliance on them, means that the demands on those who are drawn to this competitive profession are becoming ever more challenging.

A recovering economy is just one of the many factors driving the need to reduce costs and improve efficiency, which businesses are often seeking to achieve through the judicious application of ICT. An example of one such vision is the Internet of Things (IoT), in essence the ability of virtually every electronic device to be connected to the Internet and seen as an ecosystem in itself (Loizou, 2015). Therefore, the capability of professionals to both supply and support computing services can be fundamental to the subsequent success or failure of an organisation, regardless of the sector in which it operates.

As the range of technology tools deployed by companies increases, so do the demands on employees who are expected to become ever more proficient in their use. Consequently, it is important that ICT specialists are able to call upon a broad range of non-technical, as well as technical, skills to enable them to appreciate, supply and/or effectively support the diverse and often sophisticated needs of an organisation, including its workforce.

1.2 Skills Framework for the ICT Profession

Originating from the British Computer Society (BCS) Industry Structure Model, first published in 1986, the Skills Framework for the Information Age (SFIA) was developed in 2003. It was designed to create a common terminology for ICT roles by providing definitions for those typical of the industry, including the skills required to fulfil them. This presents a clear career pathway for ICT professionals, while also helping businesses to match the skills of the workforce to their own particular requirements.

More recently SFIA was extended to SFIAplus to incorporate detailed training and development resources (British Computer Society, 2015). Appendix A provides a summary of the SFIA skills framework, which describes the range of attributes considered to contribute to professional capability. Such models are the key to driving professionalism within the computing industry, but they also help to moderate a widely-held view of the ICT professional.

In spite of the term ‘geek’ having undergone something of a transformation in recent times, being voted Collins Online Dictionary ‘word of the year’ in 2013 (Collins, 2013), there has long been a general perception of a computing specialist’s cleverness being inextricably linked to some level of social awkwardness (Silberman, 2001). However, the definition of a geek (Collins, 2015) is now *dually* given as:

> *‘a person who is knowledgeable and enthusiastic about a specific subject’*
>
> *‘a boring and unattractive social misfit’*

Whether used a term of self-pride or in a disparaging way by others, the image of a computer enthusiast was compellingly illustrated in David Fincher’s film *The Social Network* (2010) in which Mark Zuckerberg, the founder of Facebook, was depicted as the stereotypical Silicon Valley geek, gifted with technology but inherently devoid of social graces (Buchan, 2011). Although Zuckerberg himself subsequently questioned the factual accuracy of the film, it did appear that he was generally in agreement with the image portrayed by Jesse Eisenberg, the actor who played him (Biz Buzz, 2010), so confirming the popular view of a ICT professional, which research indicates may have some basis.

1.3 Cognitive Style and Science, Technology, Engineering and Mathematics

In a study of undergraduates at Cambridge University, Baron-Cohen et al. (2001) suggested that computer scientists, engineers, mathematicians, and physicists have a tendency to think in a way that could be considered as being ‘more autistic’ than that of their peers in the arts, humanities and social sciences.

- Here, autism is defined as ‘abnormalities in social and communication development, in the presence of marked repetitive behavior and limited imagination’ (American Psychiatric Association [APA], 1994 cited by Baron-Cohen et al., 2001, p. 5).

- The milder, Asperger syndrome is defined as ‘the individual meeting the same criteria for autism but with no history of cognitive or language delay, and not meeting the criteria for Pervasive Development Disorder (PDD)’, (ICD-10; World Health Organization, 1994 cited by Baron-Cohen et al., 2001, p. 5).

The psychometric instrument applied in the study was an Autism-Spectrum Quotient (AQ), designed to measure the degree to which adults with normal intelligence exhibit the traits associated with the autistic spectrum. The results indicated that the score of scientists was generally higher than that of non-scientists. Within the sciences themselves, the mathematics, physical scientists, computer scientists, and engineers scored higher than the more life-based sciences, such as medicine. Autism is now generally considered not to be a separate condition (Wing, 1997), rather autistic traits are seen as the representation of a different cognitive style, forming a continuum across the general population, with autism at one extreme (Baron-Cohen, 2009).

Other studies have examined the association between cognitive style and subject choice from the perspective of empathising and systemising tendencies, where empathising can be described as the desire to identify mental states and respond with an appropriate emotion, and systemising as the urge to analyse or construct systems. For example, Focquaert et al. (2007) suggested that individuals in the sciences have a cognitive style that is more systemising-driven than empathising-driven, whereas individuals in the humanities have a cognitive style that is much more empathising-driven than systemising-driven, see also Section 2.2.

Baron-Cohen (2009, p. 72) used the Empathising-Systemising (E-S) theory to explain the cluster of non-social, as well as the social, features of autistic spectrum conditions (ASCs):

> *'Below average empathy is a simple way to explain the social and communication difficulties, while average or even above average systemising is a way of explaining the narrow interests, repetitive behavior, and resistance to change/need for sameness. This is because when you systemize, it is easiest to keep everything constant, and only vary one thing at a time. That way, you can see what might be causing what, rendering the world predictable.'*

These research findings have formed the basis of a number of educational interventions, such as teaching empathy through strong systemising (Golan and Baron-Cohen, 2006). Recent years have also witnessed a rise in the number of studies that evaluate the effectiveness of technology for specific learning needs (Hopkins et al., 2011; Grynszpan et al., 2014). The above research has helped to inform this investigation by highlighting the issues associated with low empathising, high systemising (LEHS) tendencies, see Figure 1.1, and subject specialism. It has also suggested the set of soft skill that may require some extra attention for HE (Higher Education) computing students, the rationale for which is discussed further in Section 1.5.

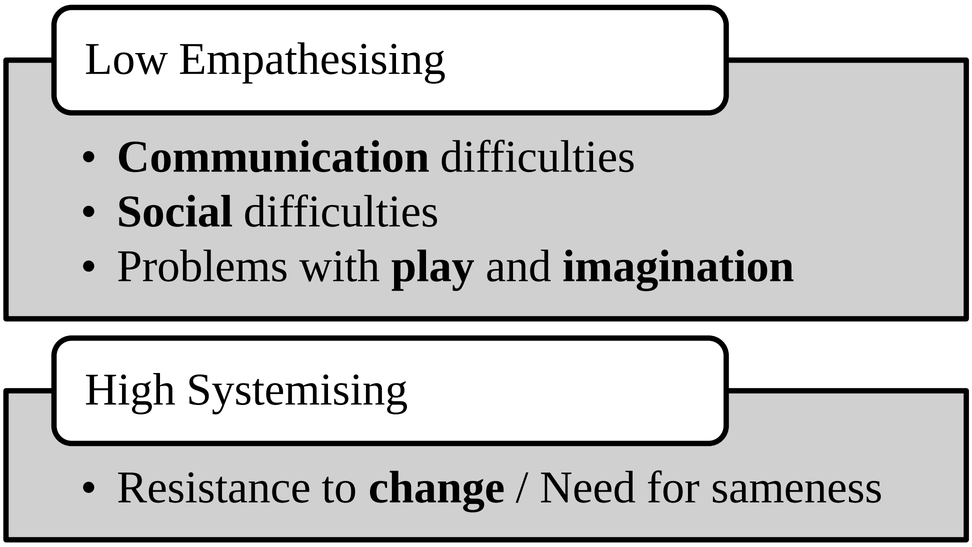

Figure 1.1 LEHS characteristics

1.4 Contemporary ICT Recruitment

In terms of recruitment, employers have traditionally sought candidates with the most suitable technical skills for their business computing requirements, but there is an increasing awareness of the need to stipulate non-technical skills in order to help meet the demands of a more dynamic and global market (Joseph et al., 2010). A definition of technical and non-technical skills, commonly known as ‘hard’ and ‘soft’ skills respectively, is provided by Ahmed et al. (2012, p. 44), the former being described as the technical requirements and knowledge needed to perform a task, the latter as the collection of personality traits and attitudes that drive behaviour. Soft skills are needed to complement the hard skills required for many of the ‘mixed skill’ opportunities in the contemporary job market, such as software project managers, web/multimedia programmers and systems consultants (Lewis, 2008).

What exactly constitutes soft skills is to a large extent subjective. However, in an analysis of five hundred job advertisements for examples of software development positions: systems analyst, software designer, computer programmer and software tester, a range of soft skills actively sought by employers across Australia, North America and Europe was shown by Ahmed et al. (2012). A summary of the findings is provided in Figure 1.2.

The discovery that communication was the only soft skill high in demand across all regions and job roles, lead to the observation that other soft skills had been neglected despite their importance to the job role. This may well suggest an employer's lack of understanding with respect to the value of soft skills and/or their relevance to computing roles. However, the employer may simply have assumed the necessary soft skills to be innate. Or, an assessment of candidate soft skills may have been planned as part of the interview process. Further work to determine the employer perspective would have been interesting.

1 Communication skills	2 Interpersonal skills	3 Analytical and problem-solving skills
4 Team player	5 Organisational skills	6 Fast learner
7 Ability to work independently	8 Innovative	9 Open and adaptable to changes

Figure 1.2 Soft skills sought by employers (adapted from Ahmed et al., 2012, p. 46)

1.5 Critical Soft Skills for ICT Professionals

The soft skills identified for this study therefore relate to a below average ability to empathise and an average, or even above average, ability to systemise, the intention being to use the latter as a strength though which to raise the profile of the former. Resistance to any change in routine, problems with verbal/non verbal communication, difficulties with play and imagination or with social relationships can be considered a particular concern when such skills are deemed essential to professional competency.

> *'Successfully applying technical knowledge in practice often requires an ability to tolerate ambiguity and to negotiate and work well with others from different backgrounds and disciplines. These overarching considerations are important for promoting successful professional practice in a variety of career paths.'*
>
> Association for Computing Machinery (2013, p. 15).

There follows a brief overview of the importance of these four basic soft skills to a computing professional, illustrated by some examples of workplace roles in which they can be considered a prominent feature.

Change in routine: the definition of a project is ‘a temporary endeavour undertaken to create a unique product, service or result’ (Project Management Institute, 2015), an example being a software project in which objectives are set to achieve a defined goal. This frequently requires people, who do not normally work together, to create a project team. They may come from another department, from different organisations and/or from different geographical locations. Therefore, being open and adaptable to change is an essential requirement for those engaged in software projects and/or their management. Schmidt (2013) argues that graduates joining the workforce with incomplete skills are among the causes leading to [ICT] projects failing, going over budget or behind schedule.

Verbal and non-verbal communication: the natural enemy of the software developer is the software tester who will often have to explain that ‘their baby is ugly’ (Patton, 2006, p. 21). Effective communication, combined with tact and diplomacy, is therefore important if conflict is to be avoided and teamwork sustained.

P**lay and imagination:** research indicates that when working individually a successful computer programmer will be required to have strong problem-solving skills (Sterling and Brinthaupt, 2003). Creativity was also found to be desirable, whether they were working individually or as part of a group. The use of imagination in play is considered to be the foundation of creative thought, play also being seen as a characteristic of problem-solving (Isenberg and Jalongo, 2014).

Social relationships: systems analysts require a great deal of human interaction with both end users and clients.

> *‘Without a doubt, it is more interesting than computer programming (not that programming is dull) because it involves studying the interactions of people, and disparate groups of people, and computers and organizations.’*
>
> (Yourdon, 2006, p.1).
>
> *‘… analysis is frustrating, full of complex interpersonal relationships, indefinite, and difficult. In a word, it is fascinating. Once you’re hooked, the old easy pleasures of system building are never again enough to satisfy you.’*
>
> (DeMarco, 1979 cited by Yourdon, 2006).

This apt description of the role by Edward Yourdon, developer of a number of systems analysis and design techniques, provides some insight into the range of skills required for this specialism, some of which may present a particular change for LEHS students.

1.6 Identification of the Problem

Therefore, a puzzle for those involved in the HE of computing students is how to ensure that targeted soft skills can be developed in a way that is perceived to be a genuine enhancement to a HE experience and subsequently of value in a professional capacity. This warrants a brief discussion of the traditional methods used to inculcate soft skills a) within the institution in which the research was conducted and b) within other Higher Education Institutions (HEIs). The proposed adaptive techniques for addressing the specific skills identified for this study, by means of Virtual World (VW) technology, will also be examined.

1.6.1 Traditional Methods for Inculcating Soft Skills

At the institution in which the research was conducted, the HE computing qualifications were the Foundation and Bachelor of Science Honours Degrees (FdSc/BSc (Hons)) in Applied Computing. It should be noted that during the period of the research two parallel sets of these courses were running, in partnership with two different HEIs; one under teaching out arrangements, the other under a new syllabus. The two HEIs are referred to as HEI1 and HEI2 respectively. However, for clarity of expression, all other course-related terminology will be that used by HEI 1 e.g. ‘units’ as opposed to ‘modules’.

It is acknowledged that work-based learning can be quite difficult to define precisely (Basit et al., 2015), but the ethos adopted for these courses was to combine formal higher level learning with the expertise gained through work-related activities and from work-placement experiences. This was designed to develop self-awareness while encouraging individuals to take responsibility for their own education, both as students and subsequently as employees with a commitment to lifelong learning. The fundamental aim being for graduates to be capable of making an immediate and effective contribution to the workplace in their first appointment.

A range of transferrable skills were specified within each unit description, along with recommendations on how they should be managed by the unit lecturer i.e. taught, facilitated and/or assessed. These skills were then embedded as part of the learning and teaching process. An example of the skills mapping for a systems analysis unit on Level 4 (Year 1) of the institution's FdSc is shown in Appendix A. A dedicated professional skills unit was also incorporated, for which students were required to build a portfolio of evidence throughout the course of their studies to demonstrate the development of their personal and professional skills. An example of the skills employed within this level 5 (Year 2) unit of the FdSc also appears in Appendix A. These combined implicit and explicit approaches were designed to allow students to develop a range of skills, through their practical implementation, as part of the learning process and to encourage an appreciation of the importance and significance of those skills to the ICT profession.

The literature suggests that a variety of other approaches have been adopted by HEIs to inculcate soft skills, such as offering a specific course on soft skills in computer science and software engineering (Hazzan and Har-Shai, 2014) and the use of a public debate format for computer science students (Stuetzle, 2015). A Systems Analysis and Design workshop that placed an emphasis on soft skills, with online activities involving teamwork, interviews with simulated clients, team-based peer reviews and presentation delivery was introduced by Yadin (2012). While Carter (2011) incorporated an extensive set of soft skills into a service learning course for students in the Mathematical, Information and Computer Sciences. Interestingly, Purao and Suen (2010) devised a metric for assessing the soft skills of aspiring information systems developers. However, it appears that previous studies have not concerned themselves with identifying and/or addressing the soft skills that could present a particular problem for students with a LEHS disposition.

The purpose of this investigation therefore was to assess the value of a fresh approach that would not necessarily replace, but potentially enhance current methods to foster specific soft skills in computing students. The novelty resides in focusing on areas of difficulty in a way that would be naturally appealing to them. Therefore, customised scenarios based on topics of a technical nature were developed for a VW in which students could practise relevant soft skills, the rationale for which is now briefly discussed.

1.6.2 The Potential of VWs for Soft Skill Development

Schroeder (2008, p. 1) defines VWs as 'persistent virtual environments in which people experience others as being there with them - and where they can interact with them'. The academic community have been quick to recognise the potential of VWs for learning and teaching (Doyle, 2010), hence the abundance of literature on their past and continuing educational affordances across a broad range of subject disciplines, such as social work

(Reinsmith-Jones et al., 2015), international health care training (Schoonheim et al., 2014), language (Duquette, 2013) as well as computing (Sajjanhar and Faulkner, 2014).

As with all emerging technologies, VWs have had their fair share of detractors. Some have questioned their continued relevance to education (Smith-Robbins, 2011), while others believe that their widespread adoption is still far from becoming a reality (Cruz et al., 2015). It is, of course, sensible to pay attention to any specific areas of concern, particularly regarding technical issues, such as the potential for client and server-side problems (Warburton, 2009). However, certain criticisms, 'unless you are a veteran MMORPG [Massively Multiplayer Online Role-Playing Game] player or a MOO/MUD [MUD Object-Oriented/Multi-User Dungeon] advocate, learning how to merely navigate a VW can be a substantial obstacle' (Smith-Robbins, 2011), can be seen as a positive advantage for computing students (Bay, 2014). There are also a number of specific features (Warburton, 2009, p. 421) that made this technology particularly suited to the study:

- **'Visualisation and contextualisation'** which permits a **change in routine** to learning and teaching via the creation and/or replication of an infinite amount of imaginative content [Salmon, 2009].

- The potential for **'immersion'** within a 3-D environment. Here, virtual embodiment, in the form of an avatar can incorporate rich modes of **verbal and non verbal communication** as well as 360° feedback (Hinrichs and Wankel, 2012, p. 9). This helps to create a sense of presence, which can 'impact on the affective, empathic and motivational aspects of the experience' (Warburton, 2009, p. 421). In a discussion of body semantics Slater and Sanchez-Vives, (2014) describe the ability of the brain, depending on the perceived level of body 'ownership', to influence the behaviour of a certain body type.

- The ability to carry out **'identity play'**, on an individual or collective basis, to stimulate **play and imagination**.

- The possibility of **'extended or rich interactions'** permits experimentation with strategies that may be applied in the real world (RW) to the development of **social relationships.**

VWs also offer:

- The ability to **'simulate'** experiences that are able to build the tacit knowledge that would otherwise be impracticable in the classroom due to RW constraints.

- An environment that is conceived and constructed by the resident avatars, 'Your world. Your imagination' (Second Life, 2015), provides content production which can be tailored to specific needs, thereby promoting a sense of learning ownership. It is for this reason, and the other factors discussed in Sections 2.4 and 3.4.1, that Second Life (SL) was selected for this particular study.

1.7 Research Aims and Objectives

There have been increasingly earnest discussions about the need to close the soft skills gap between graduate ability and employer expectations (Robles, 2012), particularly for computing students (Shaw et al., 2014; Naiem, 2015).

The rationale for this study, therefore, was to determine the viability of VW technology to assist in the development of the essential soft skills that enable students with LEHS tendencies to perform more effectively in a professional capacity. The VW was selected to engage those with a technical bias, ostensibly to equip to them with coping strategies that could provide a basis for further development in the RW. The literature search suggests that this is a novel approach to the problem, which does not appear to have been attempted. The study is entitled:

'*Low empathising and high systemising tendencies in higher education computing students: the affordances of Virtual Worlds in their education'*

The overarching aim was to assess whether the educational affordances of VW technology could have an affective impact on the learning needs of HE computing students with LEHS tendencies. The intention was to identify, describe and analyse any influence uncovered, with a view to developing associated theory and making recommendations for a more personalised learning environment. It is important to stress that the planned investigation made no prior assumptions regarding the extent or direction of any influence the VW experiences might have.

In order to meet this aim the following objectives were set as research questions (RQs):

RQ1: *Does learning in a VW help to diminish the need for routine in LEHS computing students?*

RQ2: *Are VW learning activities able to influence the verbal and non-verbal communication skills of computing students with LEHS tendencies and if so, in what way?*

RQ3: Is the use of play and imagination in the VW helpful to learning for LEHS computing students?

'Imagination', in this context, is described as the ability to put oneself in someone else's shoes, to imagine their thoughts or feelings. 'Play' is seen as a spontaneous and active process that allows freedom for the imagination, which in turn promotes innovation and creativity.

RQ4: *Are VW learning experiences influential in developing the social skills of LEHS computing students and if so, in what way?*

The research was directed by an evaluation framework, described more fully in Section 3.5, and VW activities were embedded in the curriculum of undergraduate students studying Applied Computing. As a guiding principle and also as a means of detecting emergent patters, all participants were asked to perform an AQ test (Wired, 2001). The rationale and ethical considerations of this are discussed further in Sections 2.2.3 and 3.4.4 respectively.

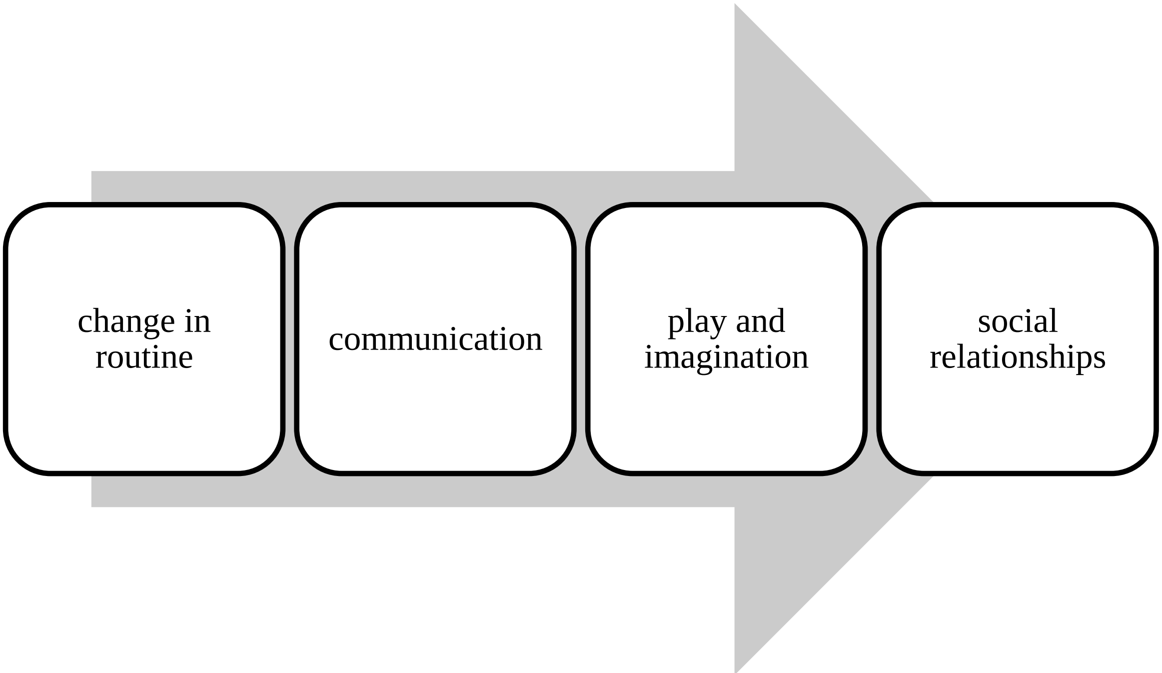

Figure 1.3 Soft skills targeted for VW experiences

1.8 Research Location, Scope and Approach

This study was undertaken at a further education (FE) college in the South West of England rated by the Office for Standards in Education (Ofsted) in 2013 as outstanding. At the time of the study the institution offered HE provision under a variety of arrangements, including franchise and license. The HE administrative structure was autonomous, but individual faculties took responsibility for their own HE course co-ordinators and lecturing staff (the researcher being the Course Co-ordinator/Personal Tutor/Lecturer for Computing). Although the institution generally required the lecturing staff to teach across different educational levels, there was some HE specialisation. The institution created a HE ethos via dedicated teaching and recreational areas, bespoke facilities and specialist support staff. However, student numbers tended to be smaller than those generally found within HEIs, the estimation of an average computing class being twenty to twenty-five students and, unlike the standard lecture theatre experience offered by many HEIs, a classroom setting generally formed the basis for tuition.

As previously mentioned in Section 1.61, the HE computing provision consisted of a FdSc and BSc (Hons) in Applied Computing, the duration of the former being two years full-time, the latter informally described as a ‘top-up’, being one year full-time. Both courses were also offered on a part-time basis, but because of the complexity of the mode of attendance for part-time students and their very low numbers, the research was directed towards full-time students only. The courses had a predominately vocational focus, instilled by the Course Co-ordinator and reinforced in the recruitment of lecturing staff with recent past and/or current commercial experience within the ICT industry. The establishment and maintenance of industry contacts was considered a priority ‘IS academics must be in continual communication with the industry and a partnership between the two groups is essential’ (Woratschek and Lenox, 2002, cited by McGill, 2008). This not only added to the credibility of staff and the HE computing courses, but was the basis on which this study was conceived i.e. the need to address any weaknesses in the preparation of undergraduates for a career in the ICT industry.

The institution attracted computing students from a variety of backgrounds, many meeting the criteria for widening participation. The majority of HE students were recruited from the institution itself, these were referred to as ‘internal progression’ students and would have achieved a Level 3 qualification or ‘A’ levels. However, intakes also tended to include those who, due to a range of personal circumstances, had not been able to finish their degrees elsewhere. There were many reasons why computing students decided to make this institution their preferred choice for HE computing. These included the reputation of the course and the success of its students, largely achieved through the additional support that could be offered to smaller student numbers. This in turn, promoted a culture of trust and honesty of opinion, thereby strengthening any research study. See also Appendix C for examples of how these values were instilled within the course.

The approach taken for this research was to conduct an initial pilot study with a BSc (Hons) group, referred to as Group A, in order to test the evaluation framework. Having confirmed the viability of the research, a group of FdSc students, referred to as Group B, was selected for the main investigation with the intention of monitoring them throughout the three years of their course. Additional supporting studies were also conducted with two separate FdSc groups, referred to as Groups C and D, at different stages of their course, to establish whether or not the findings from the main study group were confirmed.

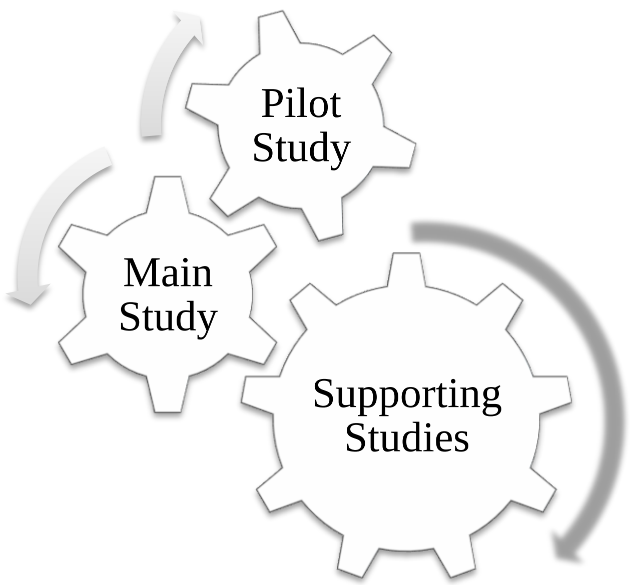

Figure 1.4 Participant groups

1.9 Thesis Structure

Chapter 1 presents a brief introduction to the research, including the background to the study, its rationale and the perceived nature of the problem. The main aims of the research are explained, including the objectives designed to meet them in the form of research questions, as well as its location and scope.

Chapter 2 consists of a focused literature review, relating to the problem investigation in the core of the thesis, Chapters 3-5. The literature review examines and combines a number of underpinning themes associated with the preparation of HE computing students for the workplace. The characteristics associated with LEHS traits are explained, along with a discussion of the various instruments used to measure such traits. The soft skills identified for the study are explained in the context of contemporary computing roles. The potential of a technology-based intervention, in the form of tailored VW experiences, is examined both from a pedagogical perspective and with reference to other studies that have been conducted in the VW to inculcate soft skills.

Chapter 3 includes a discussion of the researcher's philosophical stance and the general principle used to guide the study, addressing the constraints, dilemmas and ethical choices involved. Potential evaluation models are examined and the case made for the framework that formed the foundation of this study. The selected research methodology is described and justified. An explanation of the research methods employed to collect the data is also provided, with an appraisal of their effectiveness.

Chapter 4 presents a detailed and illustrated overview of each of the research activities carried out as part of the study. It is shown how the bespoke nature of scenarios was informed by the aims and objectives of the investigation and aligned to the requirements of the curriculum. Background information is provided on each of the participant groups in order to provide a context for the investigation.

Chapter 5 shows how data collected from the study was analysed. Quantitative and qualitative outcomes from each of the participant groups are discussed in relation to the research questions and the results summarised. An overview of findings from the combined groups is provided at end of the chapter, along with two separate case studies.

Chapter 6 discusses the study outcomes with respect to its aims and objectives, in the context of its limitations. Conclusions are drawn, that also incorporate some emergent themes. The contributions to existing knowledge are explained, on the basis of which suggestions are made for associated professional practise. Finally, a number of ideas are proposed for further work in this area.

A visual representation of the thesis structure is presented in Appendix A.

Summary

The purpose of this chapter has been to describe what is perceived to be an authentic issue in the HE of computing students; how best to support the development of some essential soft skills that tend to be more challenging for those with LEHS tendencies. A justification has been made for the introduction of VW techniques to help students acquire the skills they will need to excel in an increasingly complex working environment. The demands on ICT professionals are often underestimated, since the diverse requirements of individual job roles are not always made explicit. It is true that many years of experience can and should improve the skills set of any ICT professional, but the duty of an HE educator is to remain alert and responsive to the changing needs of employment in order to ensure that undergraduates are suitably prepared for those needs.

This thesis contends that computing students, many of whom exhibit LEHS tendencies, need extra support in specific soft skills if they are to provide the best service and cope with situations in the workplace that could otherwise be extremely stressful for them. The influence of a more holistic pedagogical approach, tailored to complement their studies, can be evidenced both in their attainment and in the perception (their own and that of others) of their readiness for the rigours of a workplace environment.

In the following chapter a literature review will consider the themes that have influenced this research; LEHS traits and subject choice, the skills mix required for the computing industry, the characteristics of VWs that facilitate tailored educational experiences. These themes will be drawn together to demonstrate the context for this research and the role it was designed to play in enhancing the HE experience of computing students.

2 Literature Review

The purpose of this chapter is to discuss the nature of emphasising and systemising traits and why it is important to address a deficit in the former and an average or above ability in the latter as part of a beneficial HE experience. This is followed by an examination of contemporary employer requirements for soft as well as hard skills. In order to demonstrate the wide range of skills sought, examples of the following will be given: highly specialised situations for which 'hyper-systemisers' are actively recruited, the requirements of specific job roles and circumstances in which more generalised abilities would apply. An evaluation of the pedagogical application of VW technology is conducted, with a view to assessing its capacity to provide a suitable environment for teaching empathising through a systemising approach where appropriate. Finally, a brief review of a number of studies is carried out in which VWs have been used to teach soft skills for various subject disciplines. Knowledge in the above areas was assessed for relevance, quality, controversy and gaps in order to reveal the background to this inquiry.

2.1 Low Empathising, High Systemising Tendencies Explained

Although the term 'empathy' is now in common use and a much researched topic of twenty-first century neuroscience, its origins are relatively recent. Translated from the German 'einfühlung' meaning 'feeling into', it first appeared in the English Language in 1909, the psychologist Edward Bradford Titchener of Cornell University having been widely credited for its initial use (Titchener, 1909). At the time, it was seen as a sort of projection of imagined bodily movements and associated feelings, into an object (Lanzoni, 2012) or another person, a vehicle that artists might use. A more modern definition considered both the emotional and cognitive factors of empathy as 'an affective response that stems from the apprehension or comprehension of another's emotional state or condition, and that is similar to what the other person is feeling or would be expected to feel' (Eisenberg 2010, p. 1).

However, the precise nature of the feeling continues to be debated. Decety and Michalska (2010) observe the distinction between empathy, the ability to feel as another and sympathy, the ability to feel concern for another. They also contend that the cognitive aspects of both are associated with processes in the concept of 'theory of mind' (ToM). This is described by Frith and Frith (2005) as an inherent ability to be able to explain the behaviour of another based on their beliefs and desires, in other words their mind. It is believed that those with autism have particular difficulty with ToM, which explains their social and communication difficulties. However, it is not thought to explain their non-social issues such as the focused interests, the need for routine and concern with detail (Baron-Cohen et al., 2009). Decety and Lamm (2006), see the affective response of empathy as being similar to that felt by the target of empathy and derived from an *emotional sharing*, while Baron-Cohen and Wheelwright (2004) suggest that the affective response does not have to be similar, but *appropriately adjusted* by the person feeling it. With reference to previous studies Grynberg and Pollatos (2015, p. 55) argue that empathy is ‘a multidimensional construct that involves both affective and cognitive components that refer, respectively, to the ability to share another person’s emotional states and to infer that person’s experiential states’.

Systemising is described as the urge to understand, analyse and possibly construct any predictable rule-based system. This could include many types of system such as mechanical systems e.g. window locks, or natural systems e.g. weather, or tidal patterns. It has been theorised that those with an average or superior ability in this area ‘hyper-systemise’ (Baron-Cohen, 2008; 2009).

While both traits facilitate understanding, thereby allowing sensible predictions to be made, they work in very dissimilar situations. While empathy enables an individual to interpret the behaviour of another with sensitivity to their feelings, systemising allows an individual to predict how any system will behave with a view to controlling it.

The Empathising-Systemising (E-S) theory (Baron-Cohen, 2009) is based on the notion of differences observed in the general population of brain type. The contention is that individuals are able to be classified in relation to their empathising (E) and systemising (S) abilities. A summary of brain types (adapted from Baron-Cohen, 2009) is provided in Appendix B. It has been argued that on average, females have a brain of type E, while males have a brain of type S. However, an important element of this theory was that gender could not be considered to be a valid predictor of brain type, since it is possible for some females to have a ‘male’ brain and some males to have a ‘female’ brain (Baron-Cohen and Hammer, 1997).

Although the E-S theory has been criticised from a number of perspectives (Baron-Cohen, 2009; Buchen, 2011), it has given rise to studies that use various measures to examine the relationship between gender, cognitive style and academic discipline.

2.2 The Measurement of Empathising-Systemising Traits

2.2.1 Empathy Quotient (EQ) and Systemising Quotient (SQ)

The Empathy Quotient (EQ) and the Systemising Quotient (SQ) were devised as instruments to test the E–S theory (Baron-Cohen and Wheelwright, 2004; Baron-Cohen et al., 2003).

- The EQ was developed as a new measure of empathy since, among the paucity of instruments available to detect individual differences in this area at the time, those that did had not always focused solely on empathy. Research suggests that this is a valid, reliable scale, with possible clinical applications for the subscales (Lawrence et al., 2004).

- The SQ was created using examples from everyday life in which systemising could be applied to varying degrees. The intention was to improve the reliability of results, based on the assumption that a high systemiser would be tempted to use their systemising skills more frequently across the range of examples than a low systemiser, which would then be reflected in their higher score.

These measures were used in the research carried out by Billington et al., (2007) in which scientists scored higher on the SQ, and lower on the EQ, compared to those in the humanities. While on average, males showed stronger systemising tendencies and females stronger empathising tendencies, the results suggested systemising in individuals to be a predictor of entry into the physical sciences, independent of gender. These findings have been echoed in the work of Manson and Winterbottom (2011; 2012).

Similar findings had been produced in an earlier study using short versions of the EQ and SQ, a 22 item EQ-Short and a 25 item SQ-Short , to measure fundamental cognitive styles (Wakabayashi, et al., 2006). The shorter versions were designed for faster assessment and to highlight the key elements on both scales.

2.2.2 Social Responsiveness Scale

Other tests exist for detecting autistic-like traits within the general population, such as the Social Responsiveness Scale (SRS) devised by (Constantino and Gruber, 2007). The Second Edition (SRS-2) includes a self-reporting element for adults over nineteen (Bruni, 2014). This has been deemed to be a reliable indicator (Wigham et al., 2012), albeit too succinct for a diagnosis (Booker and Starling, 2011).

2.2.3 Autism Quotient

An early study, based on the prediction derived from a theory of the 'broader cognitive phenotype of autism' (Baron-Cohen et al., 1998, p. 6) suggested an association between ASCs and occupations in engineering, physics and mathematics. The theory was further tested in a study at Cambridge University using the AQ, as previously mentioned in Section 1.3. This is a brief, self-reporting questionnaire in which individuals score between 0-50 (Baron-Cohen et al., 2001 pp. 18:21) and a relatively simple way of establishing the 'normal' distribution of autistic traits. The results, when administered to a large population (Baron-Cohen, 2008), are shown in Appendix B.

While, in any such tests, the accuracy of self-perception is liable to be questioned, there is some value in the detection of patterns. Therefore, for reasons of brevity, reliability and as a means of confirming that the correct skill set was identified for the study, the AQ was chosen to establish the pattern of LEHS tendencies in the participating groups, the ethical implications of which are explored in Section 3.4.4.

While the relatively new concept of 'geek chic' has helped to improve the status of those with LEHS tendencies in the public psyche, it is nevertheless the role of HE to ensure that generations of students are as well prepared as they can be for careers that demand so much of them.

2.3 Contemporary Employment in ICT

ICT is an extremely large, fast moving and constantly evolving industry incorporating various areas of specialism. The many options available to those who, it appears, are innately drawn to a computing career include:

- Within organisations that use ICT; roles exist in the development of ICT solutions, as well as the installation and maintenance of computer systems.
- Within organisations that produce hardware; roles exist in the manufacture and design of ICT hardware.
- Within organisations that produce software; roles exist in the programming and design of software, both for the general market, usually referred to as Commercial Off the Shelf (COTS) solutions, as well as for bespoke client applications.

Other opportunities exist in consultancy and contracting services, as well as for self employment. Therefore, the need for specialists is diverse, as are the range of skills that professionals need to embody in order to perform these roles effectively. As discussed in Section 1.3 there is an undisputed, albeit double-edged, relationship between LEHS tendencies and an interest in computing, many believing that without such traits there would be no ICT industry. In order to provide some context for the discussion of computing employment, some highly specialised roles are first presented. This is followed by a review of exemplar roles from mainstream computing; games development and ICT service support. Finally, generic situations requiring multiple areas of expertise are considered.

At one extreme staff are sought specifically for the value that LEHS traits bring to an organisation, which may well extend to that of an ASC. Fundament to these specialised opportunities is the commitment of employers to accommodate the specific needs of their employees in order to capitalise from their unique abilities, examples of which are provided in Appendix B. One of the most interesting accounts of working with those high on the autistic spectrum is that quoted in Hodson (2013). Observations from the article 'working in an autism-oriented office [of consultant software testers]' highlight:

- The need to minimize distractions, meaning possibly a darker environment
- The requirement to issue clear instructions, avoiding the use of metaphor and simile
- The honesty of the consultants
- The directness of their criticism, which can be disarming
- Their ability to quickly identify the problems behind structures

However, in most circumstances, new staff are usually expected to adapt to the culture of the workplace and those with LEHS tendencies may find it difficult to function quite as well as they should within mainstream employment. Although representative examples will be briefly discussed, it should be remembered that changes in the complexity of software processes and products are constantly creating new roles and demanding new skills (Varona et al., 2012).

In a survey carried out on the content of jobs advertised for game developers McGill (2008, p. 89) established five categories of qualifications: Experience, Education, Intrapersonal Skills and Personal Abilities, Technical Skills and Supporting Knowledge Areas. The latter three were considered to be interdependent and when a comparison was made between them, Intrapersonal Skills and Personal Abilities accounted for 24% of the qualities sought in a game developer, technical skills accounted for 42% of the qualities, and supporting knowledge areas accounted for 34%. Of the Intrapersonal Skills and Personal Abilities subcategories: problem-solving skills, communication skills, interpersonal skills, work ethic, attitude/disposition, organisational/time management, and leadership skills, communication and interpersonal skills accounted for 34% suggesting therefore that these should be viewed as important elements of any computing curriculum.

The IT Infrastructure Library, commonly known as ITIL, the 'international repository of IT wisdom' (Greiner, 2007, p. 9) is acknowledged as a best practise approach for delivering IT Services and IT Service Management, focusing on the processes, functions and capabilities required to support ICT Services in business. ITIL continues to remain so successful because of its practical approach to service management. The 'people' aspect of the 4Ps of service management; people, processes, products and partners, is mentioned as being critical, since effective processes depend on them. It stresses that 'people' should be seen as a resource and a capability, developed by education and training. Among the competence and skills for service management, the following attributes are stated as being integral to all roles:

- An awareness of the business is essential in order to understand how ICT can help achieve the objectives of the area in which it is operating.
- Customer service skills are important for service desk staff, but for any situation in which a member of IT staff may come in contract with the business, such as desktop technicians and user acceptance testers.
- The knowledge to carry out their role, including associated policies/procedures.

Other attributes will be dependent on the particular role, but management skills are suggested, as is the ability to communicate effectively both verbally and in writing. Also mentioned is the ability to negotiate and persuade, as well as some analytical skills to enable the required interpretation of metrics (Gallacher and Morris, 2012, p. 152-153).

Companies with fewer than 250 employees, known as small and medium-sized enterprises (SMEs), do not usually have the resources to employ many specialists and therefore tend to expect their ICT staff to be multi-skilled. In such a situation where ICT staff will come into regular contact with a range of both internal and external people, strong communication and interpersonal skills are essential, as is the capacity to respond effectively to the changes generated by the evolving technical needs within an organisation.

2.4 Virtual Worlds and Pedagogical Approaches

The importance of aligning technology with pedagogy cannot be overstated (Morgan and Adams, 2009), as discussed further in Section 3.5. The characteristics of VWs and the richness of their environment may offer the opportunity of a fresh approach to the development of the essential soft skills required by computing graduates. In more elaborate terms, Castronova (2005, p. 26) explains that VWs ‘hold immense promise as places where humans can enhance their Earth experiences with ones drawn directly from our glorious collective history and imagination, all without bearing some of the burdens that adhere to the Earth bodies we were born with’.

Comas and Tschang (2013, p. 186) describe VWs as ‘terra fabricae’, from the Latin translation of ‘fabricated’ or ‘synthestic’ worlds (Castronova, 2005, p. 26), in order to emphasise the increasingly fragile nature of the boundary with the RW (‘terra firma’), as well as their growing significance. This is aptly illustrated in a cultural scenario, designed to support English as a foreign language, in which Google Street View was integrated into a VW, allowing student avatar embodiments to walk the streets of London under the guidance of an English-speaking instructor (Shih, 2014; 2013).

An examination of the history of VWs (Downey, 2014) reflects a general consensus of their origins going back as far as the 1970s (Bartle, 2004; Damer, 2008), passing through three generations to fashion the characteristics of VWs today. Dass et al. (2011) argue that one of the major influences in that development was the novel approach of SL in permitting its users to create content which, in turn, attracted the attention of educationalists. Consequently, there are now many other VW options available such as OpenSimulator (OpenSim), Open (formerly ‘Project’) Wonderland, Active Worlds and InWorldz (Floyd and Frank, 2012). There are also the more specialist options, such as ViRPlay, a 3D virtual environment for teaching object-oriented design through role play (Jimenez Diaz et al., 2012).

Linden Lab’s SL was first released in 2003, evolving from a vision of the former RealNetworks Chief Technology Officer Philip Rosedale (TED, 2008). This was to create a 3-D VW based on the idea of a ‘metaverse’, described in the science fiction novel Snow Crash (Stephenson, 1992). It was the increasing adoption of broadband and powerful processors that enabled this ambition to be realised (Wired, 2006). SL offers a mature and popular platform for learning as well as research (Hunsinger and Krotoski, 2012), yet continues to incorporate innovation (Weinerberg, 2014). In particular, the building and scripting functions of SL make it an ideal platform to teach subjects such as computer science and interactive multimedia (Zhang, 2007).

Any other VW may, of course, be different. The default scripting language in both SL and OpenSim is Linden Scripting Language (LSL). The greater flexibility of using C#, J# or VBScript in OpenSim therefore offered a viable alternative for this investigation, albeit with some security implications. In a recent study, Coban et al., (2015) found both environments suffered from a similar number of technical problems. Other differences in VWs relate to the privacy of personal work, the quality of experience and firewall issues (Allison et al., 2010).

2.4.1 VWs and Pedagogy for Soft Skills

Pedagogy, the method and practice of teaching, is often suitably described as both an art and a science. In order to improve learning outcomes, different educational strategies will often need to be applied in different combinations for different groups of students. Account should also be taken of the most effective learning and teaching requirements for certain skills and/or subject knowledge as well as student background, learning styles and personal characteristics.

There is evidence of the many learning theories that have been applied within VWs (Dass et al., 2011), such as collaborative learning (Shen and Eder, 2009), action learning (Dickenson et al., 2010), active learning (Wang and Braman, 2009) and problem-based learning (Good et al., 2009). However, it seems that two main themes have surfaced based on the (social) constructivist and situated learning perspectives (Savin-Baden et al., 2010; Dass et al., 2011).

S**ocial constructivism** arose from Vygotsky's original rejection of Piaget's assertion that learning could be separated from the social context. But by the 1980s the work of Vygotsky and Dewey had merged with that of Piaget's into the broader approach of constructivism, simply meaning that learning is an active process in which new knowledge is constructed from current and past experiences. While difficult to implement within a classroom setting, this learning theory is particularly well suited to the unlimited possibilities afforded by a VW and was therefore considered to have potential for this investigation. A successful example is that of a communal constructivism study designed to test the emergence of the learning theory through the use of VW tools (Girvan and

Savage, 2010), in which collaboration constructed knowledge for the group as well as for others.

S**ituated learning** was summarised as a process of ‘legitimate peripheral participation’ (Lave and Wenger, 1991) in which the importance of social interaction is stressed as being integral to the learning process.

Learners become involved in a community of practise:

- Starting as newcomers on the periphery of the group
- Moving towards the centre as they become more active through engagement with the culture
- Finally assuming the role of an expert.

Fundamental to the concept is that learning, being a product of the activity, context or culture in which it occurs is usually unintentional, which has a particular relevance to this study. A classroom setting is generally not conducive to situated learning activities, because of the physical limitations and therefore knowledge is often perceived as being abstract and out of context. However, the many tools available in VWs are able to facilitate the promotion of this learning theory through a variety of techniques (Falconer, 2013), including situated role-play learning (Wakefield et al., 2012) and situated problem-solving (Cram et al., 2011). Others have applied the perspective via Kolb’s Experiential Learning, which suggests a four stage cycle, essentially: ‘doing, observing, thinking, planning’, followed by ‘incorporating’ (Kolb, 1984). It has been described by Kolb as a ‘complex relational process’ requiring not only consideration of the learner and subject matter, but also a ‘reflection on the deep meaning of ideas’ and the skills with which to apply them (Kolb et al., 2014, p. 204). This type of facilitated learning supports students in applying their knowledge and conceptual understanding to RW problems and situations.

It is therefore not surprising that the affordances of VWs have allowed these particular learning theories to be embraced. The following provides some further examples of the benefits of using VW technology and why it was selected for this investigation:

- In a study designed to evaluate the role of VWs in helping budding entrepreneurs to acquire valuable experiential learning, Noke and Chesney (2014) found that skills required in the RW could be shaped in the VW, but within an environment that provided the safety of being able to make mistakes without the potentially serious consequences.

- A similar argument was made by Jarmon et al. (2009) in which VWs were found to foster the RW application of concepts studied in an interdisciplinary communication course. Although the study was limited by a small data set, the findings were indicative of successful experiential learning.

2.5 Virtual World Characteristics

The educational opportunities in VWs that can lead to learning are promoted though their inherent characteristics (Dalgarno and Lee, 2010), which are both varied and supportive. Therefore, a brief discussion of these unique and inextricably linked features: Immersion, Identity and Interaction, otherwise known as the '3Is' (Comas and Tschang, 2013) is justified.

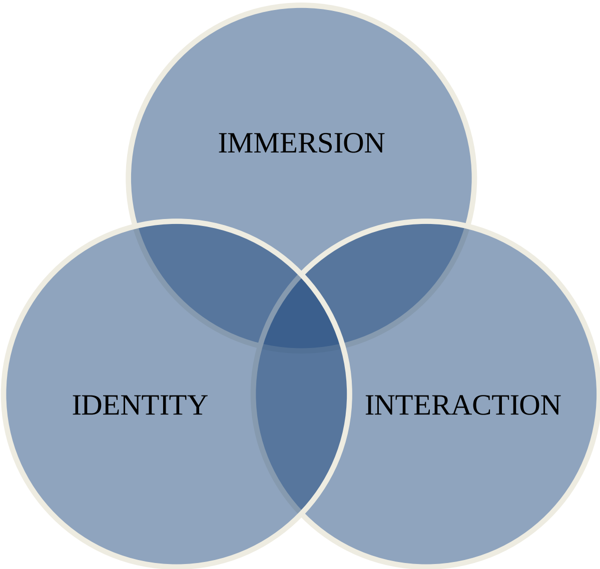

Figure 2.1 The 3I's of VWs (adapted from Comas and Tschang, 2013, p. 191)

Immersion: VWs will generally aim to provide an immersive environment in which the user is able to feel presence, widely described as a sense of 'being there' (Schroeder, 2011). However, the terms 'immersion' and 'presence' are sometimes confused and/or used interchangeably (Bowman and McMahan, 2007), so it is important to clarify the distinction. 'Immersion' can be simply described as what the technology delivers from an objective perspective, whereas 'presence' is a subjective human reaction created by immersion (Slater, 2003). It is subjective in that it is possible for the same immersive system to suggest different levels of presence in different people, whereas different immersive systems may create the same level of presence in different people. As observed by Mennecke et al. (2011) a sense of presence, as well as a sense of social interaction, is required to foster effective communication within a VW.

Identity: The ability of an individual to be able to depict their own or an alternative identity through the personification of an avatar is a particularly engaging learning device. The effect of virtual embodiment is strengthened by contemporary research into mirror neurones. These are the specialised brain cells that allow individuals to learn and also to empathise by performing an action or observing another perform that action (Schmeil et al., 2012).

Dunn and Guadagno (2012) found that users will select avatars that are consistent with and advantageous for their gender. However, those who are already on what they describe as the less than advantageous side of the personality spectrum e.g. are introverted, neurotic or have low self-esteem, are likely to choose avatars that will compensate in some way for such personality shortcomings. Green et al. (2014) suggested that the qualities chosen for an avatar could be used as a role model for desired qualities, such as empathy. M.B. Skins (Second Life, 2015) could therefore represent a possible addition to the National Health Service's 'aging suit' (Bennett, 2014) as a means of sensitizing staff.

> *'The persona thing intrigues me. It's a chance for all of us who aren't actors to play [with] masks. And think about the masks we wear ever day.'*
>
> (McDee cited by Turkle, 2011, p. 256).

Nagy et al. (2014) have proposed a conceptual model of virtual identity with individual, micro and macro dimensions as a basis for analysing the personality variation between online and offline identity in VW users.

Interaction: The persistent nature of VWs means that they are always available for interaction which may take many forms such as playing, socialising, collaborating and transacting (Comas and Tschang, 2013). Wallace and Maryott (2009) commented on the ability of VWs to foster a sense of community, thereby enhancing learner engagement while at the same time reducing any negative feelings that could instigate a desire to drop out. Interestingly, a study by Grinberg et al. (2014) suggested that a user's social experience within a VW outweighed their spatial experience in creating a sense of immersion. Other studies (Nadolski et al., 2012) have stated the merits of being able to reproduce a workplace situation, where individuals can interact with groups and/or objects in order to communicate and collaborate on the production of artefacts. There is evidence to indicate a transfer of behaviour from the VW to the RW, Yee and Bailenson (2009, p. 207) proposing that 'avatars are unique in their ability to recreate and direct us in turn'. It is suggested that this also applies to learning as well as soft and social skills (de Freitas and Routledge, 2013, p. 953), although Bossard et al. (2008) consider that certain conditions are necessary for a transfer to occur.

2.6 Teaching Soft Skills in the Real World and the Virtual World

As previously mentioned in Section 1.61, a number of educational approaches have been devised and implemented in the RW to promote the acquisition of soft skills for computing students. But the challenge for HE is in selecting an approach that encourages their development in a way that can be tailored to meet the needs of those with LEHS tendencies.

Duncan et al. (2012) suggest that collaborative and experiential learning, generally associated with higher order learning skills, are the more common uses made of VWs. Therefore, it would seem reasonable that any soft skill lending itself to this type of learning, such as those suggested for this study, would be suitable for teaching or training in VWs. Research into teaching medical students communication skills in a VW (Lowes et al., 2013) indicates that the effectiveness of VW role-plays improved over time with respect to the students' own perception of their achievement and their ability to convey best practice across different scenarios. However, in a study designed to investigate the feasibility of training healthcare and health care service provision staff in general counselling and communications skills, Abshier (2012) found some limitations to using VWs. A particular issue was the lack of the subtle gestures needed for effective non-verbal communication. This had also been observed in the work of Gallagher-Lepak et al., (2009). The AI robots used by Ng et al. (2013) within SL to allow students to acquire software project specifications and thereby practise their communication and fact finding skills, required a more extensive dialogue database in order to be effective. Previous research has also investigated the teaching of negotiation skills. Core et al. (2006) proposed virtual humans with rich mental models to support a learner's understanding of this complex human interaction by demonstrating the effect of their actions and how they might improve performance. Another approach was that of Air Gondwana, a multimedia program incorporating SL (Butler, 2008), which was designed to teach the theory and practise of negotiation at a basic level to a broad student audience. It had the additional benefit of enabling a large/diverse teaching team, who were not necessarily comfortable with delivering soft skills, to have a means of demonstrating such skills. Blythe et al. (2010) found that, by participating in social practises within a VW, medical students learned to read/notice the world as a medical professional.

Many adolescents are now spending their time playing video games (Adachi and Wiloughby, 2013) and are therefore as familiar with the VW as they are with the RW. A generation of learners, now comfortable with technology, expect it to form part of their educational experience (Kapp and O'Driscoll, 2010). Boyle et al. (2016) reported the accepted usefulness of games, developed to address specific curricular objectives. Having adopted a games-based approach to teach software engineering, Connolly et al., (2007, p. 416) remarked on the 'highly engaging' features that have attracted the interest of educationalists. Performance students commented on the 'game-like' space of Orientation Island in SL (Kuksa and Childs, 2014 p. 73), which was designed by Linden Lab to induct new users. Such affordances offered by VWs enable learning to be experienced in circumstances that might be difficult, traumatic, less pleasant or sometimes even impossible to achieve within a RW setting (Ball and Pearce, 2009).

However, a view that particularly resonates with this research is that of Steils et al. (2014) who consider that any technology with the potential for improving student learning should be embraced. They discuss ways in which the use of VW in HE may facilitate the adoption of a 'liquid curricula'. This is explained by simply placing an emphasis on the stances and experiences of both students and staff in order to achieve greater educational versatility. In this way HE is able to benefit from the authentic experiences of others, which has remained a consistent goal in the development of the many scenarios devised for this investigation.

Summary

'Computing', whether it takes the form of supporting organisations in the use of ICT as part of their business processes or the supply of hardware and/or software, is essentially a service industry and the quality of that service is largely influenced by the application of soft skills within a social context. Through the use of naturally appealing technology, deeper and more meaningful learning can be achieved in a way that is 'almost impossible to fully forget' (Blatner, 2009, p. 1) and this can form the basis for educational and professional achievement as well as personal development. The following chapter will discuss the philosophical approach underpinning this study as well as the methodology and methods of data collection that have been informed by the researcher's stance.

3 Research Philosophy, Ethics, Methodology and Methods

The purpose of undertaking any research is to increase existing knowledge, expand knowledge in areas where little or perhaps nothing is known and so improve our understanding of the world. The acquisition of knowledge and the development of understanding are achieved through the collection and interpretation of facts, allowing a picture of the world to be constructed. This chapter therefore begins with an examination of the motivation for carrying out the study as well as the research goals. However, before undertaking any research, it is important to hold a view of what knowledge is and how sense can be made of our surroundings. Therefore, the underlying philosophical principles relating to research are discussed, including those that have been particularly influential in forming the views on which this investigation is based. An overview and justification for the evaluation framework chosen to guide this study is given, with reference to other models used in similar investigations. An appraisal of the selected methodology is then carried out and the tools used for data collection, the research methods are explained.

The process, aptly summarised by Cohen et al. (2011), is that an ontological assumption: what is reality? leads to an epistemological stance: how do you know something? which generates a methodological approach: how to go about finding out? subsequently suggesting the tools of investigation. As with any research the results, however compelling, will only be of value if there is confidence in the manner in which it has been conducted, hence the need to maintain both validity and reliability. Hence, this chapter will also address a number of ethical considerations, including the integrity of the researcher and the treatment of participants.

3.1 Research Motivation and Goals

The subject under investigation has been of longstanding interest to the researcher from a personal as well as a professional perspective. Given that the computing industry attracts those with LEHS tendencies, see Sections 1.3 and 2.2, many employment opportunities tend to be offered on the implicit assumption that potential ICT staff have all the necessary skills to be able to perform effectively. HE appears to treat the soft skills for computing students in much the same way as for other undergraduate subject disciplines. It is the contention of this thesis that the needs of computing students should be recognised and therefore certain soft skills require the extra attention that a different learning and teaching approach may bring. Since the central focus of a computing curriculum is perceived to be the development of technical competencies, the challenge for an educator is to find ways of generating in students the confidence they need to be able to effectively apply some of the essential soft skills required in the workplace. This can only be achieved by means of the very skills that are inherently difficult for them.

The research proposed therefore that the incorporation of VW technology, fashioned specifically for those with LEHS tendencies, could be an amenable vehicle for staff to engage students in developing their own coping strategies. This includes an ‘empathising through systemising’ approach mentioned in Section 1.3. A focus on the development of specific soft skills was designed to promote a greater consideration of self, while generating an appreciation of the social environment in which the computing specialism operates. As observed by Turkle (2011), virtual identities can be evocative objects.

The potential affordances of VWs provided the motivation for this research, but also the fascination, in particular the planning, design and creation of bespoke scenarios to target areas of perceived difficulty. It was an opportunity to find possible answers to some of the issues relating to the HE of computing students that appear yet to be fully identified and/or addressed. On a personal and professional basis, there was also the prospect of gaining some insight into the areas that have shaped this problem, such as the association between LEHS tendencies and subject discipline. A fundamental concern being to devise a solution to the puzzle of how an educator might create a novel approach to the development of skills that are perceived to be challenging, by making them part of an engaging technical experience.

The primary inspiration for the study was the researcher’s profound interest in the enabling influence of computing, as well as the desire to help those who were aiming to become the facilitators for this in their future careers. A reflection of the study motivation has offered some insight into what could be brought to the process, apart from simple curiosity or some enthusiasm for carrying out research.

3.2 The Acquisition of Wisdom

The word ‘philosophy’ is derived from the Greek ‘philo-sophia’, literally ‘love of wisdom’ (Jifa, 2012, p. 1) and is concerned with the abstract. An organised approach to the acquisition of wisdom is what separates research from arbitrary learning. The Knowledge Hierarchy, which consists of Data, Information, Knowledge, Wisdom (DIKW) also variously referred to as the ‘Information Hierarchy’ and the ‘Knowledge Pyramid’ (Rowley, 2007) is representative of the way in which wisdom is acquired through research, see Appendix C. Although the stages of the DIKW model have been criticised as being ‘unsound and methodologically undesirable’ Frické (2009, p. 131) it does provide a useful basis for a structured approach to any research activity.

- Within this study the stages were based on a proposal which enabled a research paradigm to be devised indicating what and how **data** should be collected.
- Through a context formed by the work of the researcher, and that of others, relations within the data in given situations were identified providing **information**.
- Through patterns of reoccurring behaviour an understanding began to emerge, which allowed questions to be answered about what was happening in a particular context. A critical analysis of the findings helped to develop **knowledge**.
- Supporting group studies were used to understand why such patterns were occurring as a means of commenting on the theoretical model and achieving **wisdom**.

As observed by Ackoff (1989), the first four stages of the model relate to the past, only the fifth relating to the future, since it is wisdom that allows us to move forward.

3.3 The Philosophical Perspective

It is essentially a philosophical perspective, ‘a lens though which we view the world’ (Collins, 2010, p. 38) that informs the manner in which our surroundings can be made meaningful. The nature of belief systems is often obscure and they can be difficult to put into words, but even those who consider themselves to be essentially ‘unphilosophical’ will usually conduct their lives according to some basic underlying principles (Walliman, 2011, p. 15).

However, those operating on a subconscious belief system are not necessarily aware of their own prejudices. Hence, the need for researchers to reflect upon their own paradigm, as well as that which tends to be used within their subject discipline, before embarking on any research. Such observations are particularly relevant to this investigation, since the researcher’s past experience was within the field of physiological inquiry which adopted a prescribed view of knowledge acquisition from a positivist/empirical perspective, using a quantitative methodology.

An acknowledged paradigm is what makes us human. It generates the confidence to create new ideas, to confirm or counter the ideas of others and even to challenge the prevailing views within our own profession. Therefore, a consideration of ontology, epistemology as well as methodology has been carried out, because of the inevitable bearing that the researcher's assumptions will have on the way in which the research is planned and conducted.

According to Silverman (2013) philosophy for pedagogical purposes divides into the three main elements of metaphysics (ontology), epistemology and ethics. In reality, however, there is an obvious interrelationship; ethics (how one should live) requires knowledge, and therefore is inseparable from epistemology (the gaining of knowledge) which is based on an understanding of metaphysics (what there is).

3.3.1 The Researcher's Stance

When dealing with aspects of social research it is important to distinguish between the positivist view: that laws exist independent of those who make up society, and the interpretivist view: that laws are established by the individuals and groups that create them (Walliman, 2011). The approach of the positivist is to objectively test questions or propositions, often by means of a quantitative methodology, usually technical in nature, which creates outcomes that should be repeatable. The contrasting approach of the interpretivist is aligned to human behaviour and its interactions. Therefore the qualitative researcher will be more concerned with an interpretation of specific problems (El-Farargy, 2012). This is further clarified by Collins (2010, p 38) as being *'associated with the philosophical position of idealism, and is used to group together diverse approaches, including social constructionism, phenomenology and hermeneutics; approaches that reject the objectivist view that meaning resides within the world independently of consciousness'*. These stances are extremes and no one premise can be taken as incontrovertibly true. Others have taken the view that embracing the common attributes of perspectives, rather being divided by their differences, is what brings true meaning to research (Weber, 2004).

The approach taken with respect to this study is that of the post-positivist which considers the value of context within experimental design and is concerned with an external reality which is knowable, but not with absolute certainty. It concedes that things will exist beyond our own experiences of them, whilst also recognising that knowledge of the world is a social construct and therefore bias a potential concern. However, every effort has be made to minimize bias and achieve as close a representation to the truth as possible, through the application of techniques that focus on the validity and reliability of the research (Leavy, 2014). The contention of Popper (2002) that no theory should ever be considered proven irrespective of how much evidence there is to support it, rather it is acceptable until falsified, seemed to be the pragmatic view on which to base this research.

3.4 Ethics

All researchers are bound by both moral and legal codes, irrespective of the discipline in which an investigation is carried out. Prior to this study a variety of ethical issues were appraised in view of the requirements for conducting what was essentially a work-based research activity.

University Code of Good Research Conduct					
Honesty	Rigour	Transparency	Open Communication	Care	Respect

Figure 3.1 Overview of UWE Code of Good Research Ethics

A combination of resources provided a foundation for the planning and implementation of ethical issues. UWE’s VW Observatory (UWE, 2015) provided a useful reference framework, although a number of additional sources of information were also consulted, such as The Research Ethics Guidebook, 2011, in order to ensure that ethical considerations remained an integral part of the research process.

Within this section it will be demonstrated how care was taken to apply the University research requirements, see Figures 3.1 and 3.2. The research ethics review process via the University/Faculty research ethics committees was followed. An Ethical Review Checklist was completed prior to any data collection, see Appendix C, submitted to the Faculty Research Office and approval granted. As human participants were involved, the starting premise would be to ‘first, do no harm’ and if at all possible do some good.

Table 3.1 UWE links for ethical considerations

Research Ethics Policy and Procedures http://www1.uwe.ac.uk/research/researchgovernance/codeofgoodresearchconduct.aspx Code of Good Research Conduct http://www1.uwe.ac.uk/research/researchethics/policyandprocedures.aspx

The implicit professional practise of an educator is to make the most of the students' learning experience by investigating and applying techniques that contribute to a meaningful education. It was noted by El-Farargy (2012) that this concept of professionalism is also conducive to a research role, in that many of the practitioner skills: observing activities, collecting information and making decisions, is what enables evidence to inform practice. While the tools of educational practise can indeed form a basis for research, a formal inquiry requires formal processes and procedures, particularly in relation to the individual values of the researcher and the treatment of participants.

3.4.1 Stakeholders Influence

Patton (2015, p. 12) asserted that 'any given design inevitably reflects some imperfect interplay of resources, capabilities, purposes, possibilities, creativity and personal judgements by the people involved' and this investigation involved a number of diverse stakeholders. It is therefore important to examine the ethical issues that relate to any influence they may have on the study outcomes:

- As with any awarding body **UWE** has an interest in achievement, but subject to strict policies and procedures.

- Costley et al. (2010) note the possibility of a vested interest in the process and outcomes by the organisation in which the research is carried out. Since 2011 it was declared policy to introduce Technology Enhanced Learning (TEL) into the HE curriculum, with VW experiences (in the form of SL) being actively promoted. Of course, positive outcomes from research activities tend to be desirable, but a negative outcome would have been equally acceptable. Therefore, the main interest from the **FE institution**'s perspective was simply in the successful completion of the research.

- The **researcher's** interest resided in the benefits achieved as a practitioner, whatever the findings.

- The main participants in the study were four cohorts of **HE Applied Computing students** for whom VWs offered a new dimension to the curriculum. In carrying out a variety of activities in the VW they were able to see the application of some of the skills they were being taught, such as in Program Design and Development (residents of SL use Linden Scripting Language with syntax similar to the C++ programming language that was familiar to the students). As a direct consequence of the research investigation, students also witnessed research in action, which helped to provide supplementary resources for their own studies, such as Research Methods. This also promoted creative thinking through the many discussions that were carried out on the possible application of VW technology within the workplace, while at the same time furthering their skills in critical evaluation and feedback. The fact that active and overt research was being carried out helped to increase the credibility of their lecturer(s), their course and in turn their qualification, while also providing the means to promote their nascent skills to the public.

- **Institution support staff** and **external contributors** would have no discernible influence either way.

- The **community of practise** would have the benefit of additional knowledge concerning the viability of VW techniques for helping LEHS students to develop their soft skills in areas of particular difficulty.

- Depending on the findings, **employers** may or may not see any direct benefit, although their potential employees would have had a novel experience to complement their studies.

3.4.2 Issues Relating to Insider Research

One fundamental issue to be addressed was that of being an insider-researcher for which the literature offers an amount of cautionary advice, largely based on personal experience. Drake (2010, p. 85) deemed the validity of insider-research to be dependent upon a 'reflexive consideration of the researcher's position'. While Mercer (2007, p. 1) aptly described the situation as 'wielding a double-edged sword' with the necessity of 'resolving delicate dilemmas' such as access, intrusiveness, familiarity and rapport.

Access is frequently a perceived problem in research and it is certainly beneficial to be in a situation which permits regular contact with participants, as in this study. **Intrusiveness** was minimized, however, as activities were embedded within the content of the current curriculum and the HE students were already familiar with the need to provide regular feedback on their experiences as part of the course administrative procedures. Mercer (2007) also observed the need for the researcher to be conscious of their own pre-conceptions, as well as those of the participants, which will be often based on a shared experience, citing **familiarity** as a potential problem. In this situation however, familiarity was an advantage since the researcher, in the role of Course Co-ordinator, always promoted a strong culture of objectivity among students, as well as staff. Other embedded values included that of critical reflection and honesty of opinion, which laid a firm foundation for the role that participants played in the research.

As with all student cohorts, **rapport** as well as trust and productive working relationships evolve over time. However, this is more readily facilitated when groups are small. Thus, the groundwork was set to establish trust and to regularly reassure that there would be no betrayal of this as part of the researcher's duty of care. Nevertheless, an ongoing consciousness of the researcher's relationship with the researched is absolutely essential in determining as accurate a representation of a situation as possible. This is certainly never static and will fluctuate depending on a range of influential factors (Mercer, 2007). Some of the factors influencing the collection of data are therefore listed in Table 3.2.

Table 3.2 Influencing factors for data collection

Factor	Consideration(s)
Time	The duration of the activity, not too short or long. Sufficient time to represent a realistic situation.
Timing of interactions	Feedback to be collected as close to the event as possible. But also with some sensitivity, such as not directly following an assessment.
Location of activities	Where physically the participants should be for each scenario.
Subject under discussion	The relevance of the soft skill under inspection to the technical concept selected for the scenario.

Other ethical issues of concern relate to the values of the researcher and the treatment of others (Walliman, 2010). As mentioned, working in a research capacity for approximately ten years instilled in the researcher a profound ethical sensibility, which was subsequently promulgated to a career in the ICT industry and more recently within HE. Values of honesty, frankness and personal integrity, have been engendered within the course ethos and promoted to students as an essential requirement for any future computing career, some examples of how this was achieved are provided in Appendix C.

Research involving people requires sensitivity to ethical behaviour and this study is no exception, particularly as it relates to an important aspect of the participant's lives, their education. While it is aimed at improving knowledge, it is also concerned with the question of whether that knowledge will be of benefit to others and. at the very least, do them no harm, the case for which has been argued above. Care has also been taken to ensure that a neutral stance was presented in whatever communication related to the research. The view of Mercer (2007) that conveying a personal opinion about the research topic will run the risk of data contamination was considered to be entirely valid. Therefore, it was regularly stressed that the researcher's sole interest lie in establishing any influence the application of VWs may have (albeit positive or negative) with respect to the intended purpose, and consequently participants should feel able to provide their free and honest opinions. Throughout the course of the study, the researcher remained conscious of the need to differentiate the research role from the academic.

3.4.3 Care of Participants

As part of their introductory VW session, see Section 4.3, all students were reminded of a number of issues; that behind every avatar is a real person and that undesirable or inappropriate behaviour would not be condoned. They were also reminded of their responsibility to comply with the behavioural and code of conduct policies they had agreed to in the RW when enrolling on their course, since such policies cover any misuse of the VW activities and the protection of privacy. They were also reminded that access to the computing facilities could be removed if there were any policy breaches, as well as the more serious penalties available under criminal and civil laws.

Despite the number of participants being relatively small, their backgrounds were extremely diverse. Therefore, care was taken to ensure that terminology was selected to avoid any issues of misunderstanding including discrimination, prejudice, or stereotyping of any kind. The selection of participants was particularly important and required due ethical consideration; which cohort should be piloted? which cohort would be the most representative of LEHS traits for a main study? would it be appropriate to highlight individual issues via case studies in order to amplify certain aspects of the findings? With respect of the latter situation, the researcher was aware that the discussion of certain individual circumstances in this report presented some sensitive ethical challenges. The distinctness of a case study which makes it of interest to the research creates some tension with the requirement for confidentiality and makes the anonymising of supporting evidence more difficult. It was therefore decided that the reporting technique had to convey the essential quantitative/qualitative information, but in a more stylised format.

Although it was not practicable to express the exact title of the research proposal to the participants at an early stage, the essence of the study was explained. However, it was decided that no results would be passed back to them prior to the publication of the material, because of the risk of data contamination. Therefore, participants were fully informed about the research activity, that it would be integrated into their studies and that they had the right to withdraw their participation in the research at any time. They were given the opportunity to discuss any issues of concern, as well as the time to fully consider their involvement, before providing their informed consent, see Appendix B. The students were reminded of the rights and responsibilities of both researcher and participants on a regular basis, since the ethics of research formed an integral part of their own studies. Their continued assent as participants in this research was verbally confirmed at milestones throughout the investigation.

In conducting the research, the methodologies were evaluated in terms of their potential for doing harm. Any risks identified were minimized to protect the reputation, dignity or privacy of the participants. Specific attention was paid to the ethics of conducting an AQ test and the VW research activities, as discussed in the section below.

3.4.4 Areas of Specific Concern

As mentioned in Section 2.2.3 the AQ test has been used in a large population as a means of identifying the position of individuals on a continuum. However, the ethical implications of its use in this project needed to be considered, such as the influence this could have on the students' self-esteem and/or their studies. Therefore, both the test and the interpretation of results were fully explained to the students in advance. The students were also informed that it was optional. As it was self-administered they were naturally aware of their own results, but anonymity was assured. The results could not be linked directly to them and/or available to anyone else, the data being protected as described in Section 3.4.5. It was stressed that it was not intended to be, and could not be considered accurate enough, to provide a full clinical diagnosis (Bruni, 2014; Ruzich et al., 2015). However, should this raise concerns for some individuals any issues would be discussed as part of the Personal Tutorial process and referral made to specialists within the institution where necessary. This happened on one occasion, when a student showed some concern about a high AQ score and was referred by the Personal Tutor to Learning Support. In the event, the test did not appear to cause any problems with the students' perception of themselves or affect their studies. Students were also assured that individual AQ scores would have no influence on my view of them as a Course Co-ordinator/Lecturer/Personal Tutor and that it simply provided a means to determine the effectiveness of the VW activities for current and future computing students.

In terms of VW experiences, equity of access to the VW for those with disabilities was considered. However, as in the RW, anything required to facilitate this would be made available e.g. larger screens, joy sticks etc. Another consideration was the out of body experience of learning through avatars. Questions raised about the stability of avatar identity and the possibility of the relationship with their owners becoming disassociated (Wang, 2011) are not necessarily unfounded. Bayne (2011; 2008, p. 201) describes the 'disorienting yet exhilarating context of interaction' when the boundaries between fantasy and reality are blurred. While there is no evidence of this having produced mental health problems or made students with mental health problems decompensate (Green et al., 2014), student reactions were monitored throughout the study. In terms of the design of learning spaces, care was taken to avoid any adverse reactions, such as claustrophobia, by the provision of clear exits.

To help prevent any possibility of bias arising from personal observation, actions, activities and behaviours, including a range of interpersonal interactions and any other processes that form part of the human experience, certain activities were recorded in various formats, for subsequent re-examination. The educational relationship with students, always conducted on a formal basis, was sustained in the research activities.

As previously mentioned in Section 3.4.2, a neutral stance on the value of VWs was always taken, along with the context of the introduction of this technology as an institution policy directive for HE. Inevitably, within the course of the study, details of a sensitive nature were revealed and confidentiality was always respected when requested. Even if confidentially was not requested the information was presented in such a way as to avoid any damage to the participants to which it related. Overt investigation was used at all times with participants made aware of the basic premise that the research entailed VW experiences in relation to RW experiences.

3.4.5 The Storage and Protection of Data

Due consideration was given to the storage and protection of data in accordance with the Data Protection Act, 1998. Data has been stored on password protected computers, with backups stored in a fire proof safe, along with any paper-based material. No other storage locations have been used, such as third party sites. Thesis drafts have not been passed to anyone except the PhD supervisory team who are aware of the confidentiality issues. The matter of safely disposing of records has been discussed with the participants and this will be carried out at the end of the study. This includes all raw data. The interim data between collection and final analysis, as well as the analysed data will be preserved as part of the thesis. The ethics of data collection was applied equally to the VW as in the RW and any identifying information, acquired from either environment was removed prior to the PhD submission except for material that has already been made available to the public e.g. as part of the course publicity.

3.5 Evaluation Framework

Until relatively recently there has been a paucity of frameworks for evaluating learning activities in VWs (Duncan et al., 2012) as well as designing them. It has been suggested that this may have been the result of allowing the technology to lead the pedagogy (de Freitas and Oliver, 2006), resulting in the development of projects that have not paid due attention to the learner, pedagogy, representation (of the learning experience) or context.

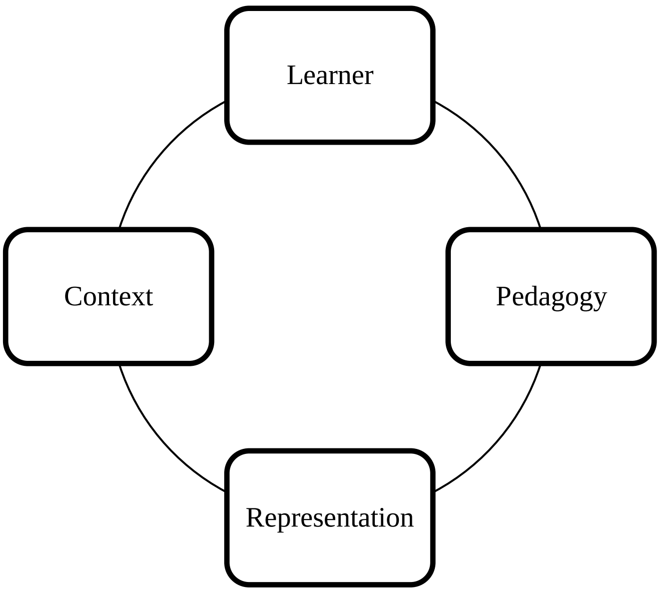

Figure 3.2 Four-dimensional Framework (adapted from de Freitas and Oliver, 2006)

These elements form the four-dimensional framework (de Freitas and Oliver, 2006), originally proposed to evaluate the potential of using games and simulation-based learning. Foronda et al., (2014) observe that some studies have applied frameworks for virtual simulation that have been used in the RW for designing, implementing and evaluating simulations (Jeffries, 2005).

Table 3.3 Research evaluation framework

Learner	In order to align learning activities with outcomes, attributes were profiled of the particular learner or learner group, whichever appropriate.	Sections 1.3, 4.2 Appendix D
Pedagogy	The learning activities were reviewed from a pedagogical perspective, the selected models focusing on task centred or socially constructed approaches. This was to ensure that the processes of learning were designed to support learning practice.	Sections 2.4.1, 4.4-4.7
Representation	The mode of representation mode was considered, particularly regarding aspects of: • interactivity • fidelity • immersion.	Sections 1.62, 2.5, 3.6.4
Context	Attention was paid to where the learning was taking place. It was particularly important to carefully plan the physical location of students for each virtual scenario. Other factors taken into account were whether the learning was formal or informal, conceptual or applied and the subject being studied.	Sections 1.8, 2.4, 4.3.1, 4.4-4.7

Others have developed models to address specific needs; to compare the user experience in a VW educational platform with traditional classroom learning (Chau et al., 2013), to assess collaborative virtual environments for collaborative learning (Tsiatsos et al., 2010), to assess the extent to which innovative virtual reality practices have been used within business sites in SL (Mackenzie et al., 2009), to evaluate games-based learning (Connolly et al., 2009) or to determine the effectiveness of training within a VW (Landers, 2012). Ma et al. (2013) used a modified four-dimensional framework in order to better guide and support their particular requirements for evaluating serious games in manufacturing. While the more recent E-leadership and Soft Skills Educational Games Design model (ELESS) has been suggested as a basis for any technology-enhanced learning (de Freitas and Routledge, 2013), the four-dimensional framework, encompassing both evaluation and design elements, was selected for this research. It has proved to be both reliable and adaptable, having been tried and tested in a number of different contexts, such as immersive learning experiences in a VW (de Freitas et al., 2010) and a VW simulation for family nurse practitioner (FNP) students (Cook, 2012). Each of the four dimensions will, of course, interrelate and together provided a robust conceptual framework for the study. It required the researcher to consider the elements described in Table 3.4.

3.6 The Research Methodology

The initial strategy was to operate within the most amenable vehicle for the study: an Action Research methodology, but also to remain open to other possibilities as the work progressed. Corey (1953), an early advocate of Action Research, described the psychological benefit afforded in those who (as part of their role in educational practise and their duty to improve that practise) immerse themselves in research in order to understand what improvement actually signifies. A more succinct definition is given by Escudero (1987, cited by Lucio-Villegas, 2015, p. 72) as ‘the ethical commitment to intervene in specific practices with an aim to improvement’. Action research continues to be used as a popular methodology for the education sector (Isaias and Issa, 2014), described by Cohen and Manion (2011) as being both complex and multifaceted, it has broad scope as a methodology, lending itself to a variety of circumstances, such as the need to resolve an identified problem and/or to change a situation that might achieve an improvement in outcomes.

On a more philosophical note, fundamental aspects of this investigation are the contention of McNiff (2013, p. 17) that action researchers ‘exercise their capacity for creativity of mind to create their own identities and allow other people to create theirs’, and a concern for ‘improving the social conditions of existence’ (Grundy, 1987, p 142, cited by Cohen and Manion, 2011). The combined ‘action’ and ‘research’ activities form a link between the contribution to individual practise and educational theory, from which a wider community may also benefit (Cohen and Manion, 2011). There has been a great deal of debate in the literature about what constitutes ‘true’ action research e.g. should it be collaborative? should it involve outsiders as well as insiders? but apart from the focus and scale of the research activity, the framework is not dissimilar to that of other methodologies; the specification of research objective(s), the design of the study, the identification/collection of supporting evidence and the analysis/interpretation of data (Coll and Chapman, 2000). Although not usually considered to be a methodology as such (Costley et al., 2010), the case study approach was also used to highlight certain aspects of the research.

3.6.1 Methods of Data Collection

The approach to data collection for this study was that of the frequently quoted Glaser dictum ‘all is data’ (Glaser, 2001, p. 145), in that every opportunity was taken to gather the diverse types of data that would best provide a more complete understanding of the research problem than either quantitative or qualitative data would on their own (Patton, 2015). An initial consideration was the number of students that should be involved. It is generally the case in quantitative research that the larger the sample size the greater the accuracy of results (Dawson, 2009). However, since student numbers in this situation were relatively small, it was felt that the data administration would not be excessive if four cohorts were involved. The intention was to provide as good a representation of HE computing students studying within an FE institution as was possible at that time.

The proposed evaluation framework was applied to the pilot study, as mentioned in Section 1.8; taking account of the particular characteristics of students and their learning needs, focusing on the pedagogy that would best provide the solutions for those needs and translating this into a VW representation within the context of a HE vocational computing course. The quantitative/qualitative analysis, discussed further in Chapter 5, indicated the study’s potential and showed the four-dimensional framework in its original format, to provide a robust framework.

Throughout the research, the ‘Rules of Evidence’, summarised in Appendix C, were kept in mind as being applicable to all supporting data for research, as well as a wide range of other areas. Other considerations were the nature of data which, depending on a variety of factors, may vary from day to day, and also its potential for corruption which may occur if feedback is acquired too distant from the event, mentioned in Sections 3.4.2 and 3.6.2, or if a recording is taken that is only partially representative of an experimental activity.

Data can be categorised as being qualitative and quantitative, depending on whether it can be viewed in numerical terms or only in words. This influenced the way in which it was captured and analysed, the focus being on achieving an accurate representation of a situation that could evolve into information that was meaningful. The following provides an overview and rationale for the qualitative and quantitative data collection methods used within the study including the primary and secondary research.

3.6.2 Methods of Primary Research

Primary research is that which is carried out firsthand and formed the majority of the work for this study, involving measurement, observing and recording. This, of necessity, was a heavy investment in preparation, planning and analysis, but nevertheless instrumental in providing the critical value to the research process. Also included were personal observations and experience, considered to be acceptable as methods of primary research. It was deemed important to collect the data in a social setting, close to the completion of an activity, so that the participant reactions to their experience could be recorded with as much accurately as possible. An underlying concern was that of possible 'feedback fatigue' from the participants which may have resulted in diminishing the value of the data acquired. Therefore, activities and feedback formats were varied and integrated into the curriculum as part of the normal learning process of critical reflection. Primary data was collected as four types: measurement, observation, interrogation and participation (Walliman, 2011):

Measurement: this consisted of the yearly grades for individuals and groups as well as the accompanying detail of relevant unit grades, assessments and elements within assessments. Individual positions on the AQ scale were also determined.

Observation: considered to be a key component of the research activities, anything witnessed by the researcher's own senses was recorded, often with some technical assistance, such as video capture software or a digital recorder. As observation is a central part of the educational practitioner's role this was not unduly time-consuming.

Interrogation: a significant amount of information was gathered through various methods of interrogation, either individually or as a group:

*Asking questions***;** this method was used as the most straightforward means of collecting both quantitative and qualitative data. It took the form of surveys, comprising a number of different formats, see Appendix F. Since the aim in all feedback was to minimize any disturbance of the curriculum, this was a relatively quick method for obtaining answers to the same questions from a number of participants. It also allowed for any difficult questions to be asked that gave the opportunity of a reasonable reply, since anonymity was assured. The data collection method was paper-based and therefore fairly easy to manage as well as being relatively inexpensive. Having considered the possibility of electronic surveys, the paper-based system offered several important advantages. It minimized any inconvenience for the participants, presenting a more immediate and comprehensive approach to the collection of data, where the researcher could directly resolve any perceived ambiguity. Therefore, both the completeness of responses and the number of returns could be confirmed at the point of submission. This was considered to have improved the quality of data, while maximizing the response rate, which was important for relatively low participant numbers.

It was decided to incorporate both closed and open format questions. The response to closed format questions required no particular writing skills, simply a reaction to the questions from a range of possible answers. These were given the focus of the study, being relatively quick for the participants to complete and also for the researcher to process, while providing a more objective means of analysis. The open format questions allowed the participants the freedom to respond in their own way, but these were considerably more time consuming for them and also subject to interpretation by the researcher.

Interviews; these were conducted to counteract the limitations of the survey method, particularly any reduced flexibility of response. This appeared to be the best opportunity to provide more comprehensive data by addressing any shortcomings in the data acquired and also to provide further insight regarding opinions/feelings/perceptions. Therefore, a semi-structured interview technique was used, consisting of structured and unstructured areas of standard and open questions.

Additional data was provided by class discussions that reviewed the VW experience as part of the curriculum, permission implicitly given by students on enrolment. A focus group sessions consisted of the ‘business’ teams that the participants had been divided into at the start of their course. By the time they were asked to take part in these they has been working on the course material from their ‘own business’ perspective, having devised their company name, logo, website etc. and consequently a strong ethos of accountability had developed. This in turn helped to strengthen the credibility of the data acquired. The face-to-face environment of the focus group also assisted in achieving better responses because of the affirming visual signals that could be conveyed, such as eye contact.

Participation: through participation in a variety of activities, using experimentation and simulation, much supplementary data was provided, Figure 3.3 depicts the generic process. Of the various types of *experimentation* that exist, those categorised as ‘true’ or ‘real’ experimental design were conducted ,as this is generally seen as the only research method that can adequately measure the cause-and-effect relationship.

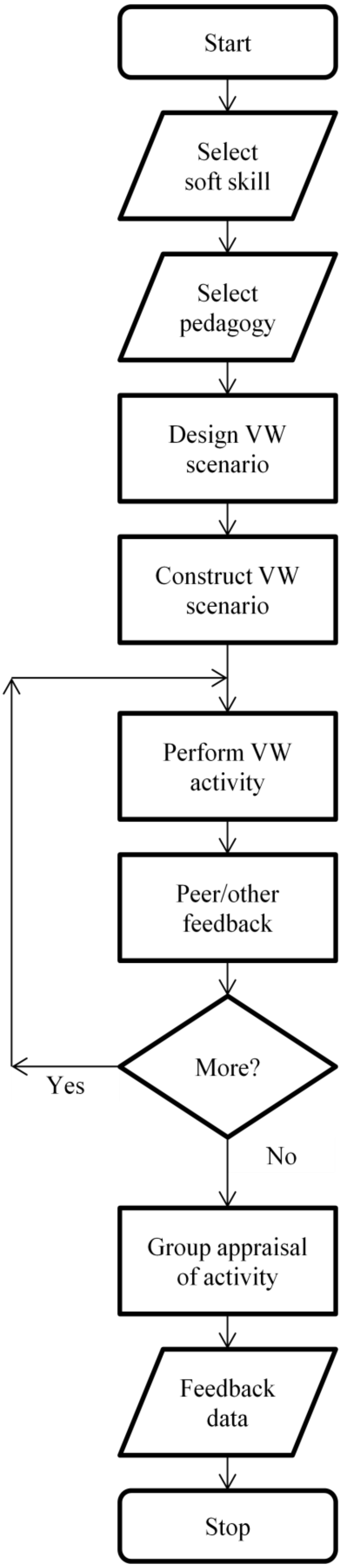

Figure 3.3 Flowchart: generic VW soft skill development activity

As previously mentioned in Section 1.7 the research study takes the form of questions that were non-directional, where any influence that learning in the VW might bring about was not being predicated as having a positive or negative impact. Manipulation took the form of RW or VW experiences with any observed difference between the groups being attributed by inference to the one variable that was different, the VW intervention. In order to be able to provide some degree of generalisation of the finding outside the scope of the experiment itself it, each of the experiments had been designed to be representative of situations in the RW.

Similar to experiments *simulations* were designed to isolate or inspect situations in detail, in order to gather data relevant to the study. The aim was to create models of scenarios to represent a phenomenon in order to explore and/or test the affordances of VWs. These were used as a basis for the collection of data using a variety of methods.

3.6.3 Methods of Secondary Research

Secondary research involves the collection of information from studies that other researchers had undertaken in a variety of areas that were of significance to that being investigated. Attention was paid to the quality of sourced material which included:

- Journals; both professional and trade, such as Computing and Computer Weekly
- The magazines, websites and other resources offered through the membership of professional bodies, such as the HE Academy and the BCS including a number of Special Interest Groups(SIGs), such as Artificial Intelligence, Animation and Games Development, e-Learning, Project Management (PROMS-G)
- A discriminatory view was taken, throughout the course of the study, of radio and television programs as well as press articles that had any current or recent bearing on the research activity. Consideration was given to the supporting evidence provided in arguments, the reputation of the source of the information such as the presenter or writer, with some extensive cross referencing of information, which occasionally revealed numerous interpretations of a phenomena.
- Other data of a secondary nature was that of the publicity initiated by the Course Co-ordinator, in liaison with the Marketing Department at the institution. Promoting the success of the applied computing course, identifying its unique selling points and highlighting the accomplishments of the students formed part of the course administration duties. Quotations and case studies were therefore

considered valid supporting evidence for the research, as were comments from others associated with the study such as lecturing and support staff including any external contributions, see Appendix E.

Details of the most relevant continued professional development appear in Appendix C. This helped to inform not just the technical aspects involved in the construction of VW scenarios, but also how they should be designed in order to fulfil the context of the learning requirements and optimise the outcomes.

3.6.4 Design Considerations

Design considerations formed a major element in the preparation of the VW scenarios, and also in the selection of existing SL spaces for the students to visit. Scenario design was also informed by the soft skill under development and the learning method through which this might be achieved. Wherever possible, scenarios were developed with systemisers in mind, see ‘the use of realism’ below. Saleeb and Dafoulas (2010) indicate that a student’s pleasure and satisfaction from an educational space is highly dependent and reliant on its architectural design characteristics, so care was taken to make VW spaces visually appealing. Account was also taken of Nicholls and Philip’s (2012) observation that it is possible to heighten student engagement by designing spaces that aim to capture the imagination and promote creative and critical thinking, independence and experiential collaborative learning. This was achieved by focusing on students’ contributions to the learning as individuals and group members, for scenarios such as in Section 4.6.2: PrimTime Education - A Walk in a Green Space. Leck (2013) suggested that learning is ‘stickier’ when students are more emotionally engaged. Therefore, as the study progressed, scenario design feedback was actively sought both from participating students and occasionally from those with a non technical background, see Sections 4.6.1 and 4.6.2.

The design features incorporated were intended to ensure that VW scenario components were structured in a way that enabled students to obtain experience of the desired soft skills. The following provides some examples, many of which were based on the principles suggested by Minocha and Reeves (2010):

Design that included RW conventions. Students were provided with a VW computer suite that included a SMART board (for data projection) and seating for an audience, see Section 4.5.2: Development Project Presentations in Second Life, to allow them to exercise their communication skills in a realistic setting.

The incorporation of an underpinning narrative. The structure of the space was linked to a story in Section 4.6.1: Being Served at a Buffet. This was intended to enhance learning by encouraging the students to take on roles, using play and imagination, to interact with the learning material.

The application of RW metaphors. In Section 4.6.2: PrimTime Education - A Walk in a Green Space, clouds were used as a metaphor to represent the design of a class in C++ i.e. an entity that has no substance in the computer and therefore cannot store data. The purpose of this device was to stimulate imagination by ‘understanding and experiencing one kind of thing in terms of another’ (Lakeoff and Johnson, 1980, p. 5).

The use of realism. The VW space that mirrored the RW Tech Genius Help Desk was designed to help prepare students for some potentially challenging social relationships in the RW by giving them ‘clues’ on how to behave in the VW. This is illustrated in Section 4.7.3: Coping with Pressure on the Help Desk, for example, where a stressful situation can be diffused by referring customers to the ‘bookshelf’, where supporting material could be found to help answer their questions.

Another scenario, designed to be representative of the RW, appears in Section 4.7.4: Ashgrove Surgery. Again, it was intended to be visually realistic enough to provide behaviour ‘clues’, thereby allowing students to exercise their social skills for eliciting/gathering information.

Realism was also applied to the traits of customer in Section 4.7.2: Dealing with Help Desk Customers. However, mental states were presented as though they were lawful and systemisable (which of course they are not), so that high systemisers could experience emotional recognition and devise appropriate reactions.

Effective user orientation was considered. In Section 4.6.2: PrimTime Education - A Walk in a Green Space the entry point was made explicit, in the form of a signed archway. The participants had to pause and select one of two pathways, defined by a red or blue leaf trail and a number of other devices were used to assist user orientation throughout the scenario, such as teleport posts and exit signs. However, it was important to create a good initial impression that stimulated play and imagination, as the students were required to carry out a group exercise in the VW to demonstrate their understanding at the end.

Consideration was given to the potential of adverse reactions to learning spaces. An open plan representation of a hospital was provided without walls in Section 4.6.3: The Rules of Database Normalisation. The minimalist design and arrangement of objects was designed to allow a number of students to exercise play and imagination by moving around freely and searching for the information they needed, without any claustrophobic sensations that a relatively small space might provoke.

Function to follow form. In Section 4.4.3: Iteration in Programming students generated and programmed an object to move incrementally, which visually illustrated the looping construct in C++. In this respect, the scenario design was intended to be a direct reflection of the learning activities and used to assess the students' ability to accept a change in learning and teaching routine.

Gerald and Antonacci (2009) suggest that by focusing on creating specific learning spaces for specific project needs, the course objectives/learning tasks can truly drive their development, as opposed to adjusting to what already exists.

3.7 Quantitative and Qualitative Data Analysis

The analysis of quantitative and qualitative data required two very different approaches, but were viewed as being essential to establishing a comprehensive picture. The purpose of collecting quantitative data is to measure, make comparisons, examine relationships and test ideas. Consequently, issues of validity and reliability remained a central focus, with every effort being made to ensure that methods succeeded in measuring what they claimed to measure, with stability, consistency and to minimize any errors or bias from participants or researcher. This analysis was conducted at the end of the study when all of the data was available. The qualitative data proved to be a more personal process. This required some awareness of the possibility of participants being influenced by the research process and also the influence of the researcher's experience to the investigation. Data was analysed as the research progressed with refinement and reorganisation in the light of emerging results. Overall, a variety of mathematical procedures were used, from simple calculations to more sophisticated statistical analysis.

Summary

This chapter has explored the notion of the completing paradigms within which research may be conducted, as described by Guba and Lincoln (1994, p.107) the 'worldview that defines, for the holder, the nature of the 'world', the individual's place in it, and the range of possible relationships to that world and its parts'. However, the design of any research is as much of an art as it is a science where 'no rigid rules can prescribe what data to gather to investigate a particular interest or problem' (Patton, 2015, p. 21). The planning of this investigation has been carefully considered with decisions made regarding what information is most needed and most useful. In the selection of a broad range of data gathering tools, it has been acknowledged that different research methods will illuminate certain aspects of a situation, while none on their own are able to produce the complete picture. This study has been dependent on the goodwill of others in agreeing to become involved and therefore, ‘moral behaviour in a research context’ (Wiles, 2013) has been an overarching concern in order to ensure that all participants, including the information they provided, were treated with honesty and respect from inception, through to completion and the publication of results.

The following chapter will explain how the research activities were designed to gather the required data to test the affordances of VWs, while also allowing for the ‘emergent and unexpected’ (Patton, 2015, p. 12). To demonstrate the context of the research, an important consideration with respect to the collection of data as well as the presentation of results, some background information on the participant groups will also be provided. As stated in Guba and Lincoln (1994 p. 108) ‘advocates of any particular construction must rely on *persuasiveness* and *utility* rather than *proof* in arguing their position.’

4 Research Activities

This chapter presents an overview of the research activities, in the context of an evolving HE computing curriculum. The participating groups are discussed in terms of their background, group ethos and also their role within the study, along with the activities they carried out in preparation for the VW intervention. Reference is also made to the research considerations, the assumptions made and the terminology used in Appendix D.

In order to capture the data required to answer the questions raised in the research objectives, a number of VW activities were devised. This included the creation of bespoke scenarios designed to fascinate, as well as support, computing students in the development of the identified soft skills. An explanation is given of the planning, design and implementation of the VW activities for each targeted skill, including any RW exercises that acted as controls. The scenarios and surveys associated with each scenario are listed in tables at the beginning of sections 4.4-4.7, but a range of supplementary data was also drawn from the exercises from, for example, personal observations and marketing initiatives.

> *'The growing acceptance that learning occurs in different 'places' presents both exciting and challenging opportunities for Higher Education.'*
>
> (Keppell et al., 2012, p. 2)

4.1 Overview of the Applied Computing Course

Since the inception of a FdSc in Computing in 2006/2007, this HE specialism at the FE institution in which the research was conducted has gone from strength to strength. A BSc (Hons) in Applied Computing was introduced as in 2008/2009 as a top-up to the FdSc. The ongoing monitoring of these courses by a Learning Partner Advisory Committee ensured that they remained current, by incorporating emerging technologies and reflecting contemporary employer requirements. These courses were run under a franchise agreement with HEI 1 until 2014/15. However, in parallel with the 'teaching-out arrangements' of these courses a revised HE computing provision, developed in conjunction with learning partner HEI2 and local employers, was launched in 2013/14. While significant changes were made to the programme structure, the core principles and practise of a work-based degree in applied computing were maintained. All courses were offered on a full-time and part-time basis. But for the reasons discussed, see Section 1.8 and Appendix C, the study focused on full-time students only. The full-time FdSc consisted of a two year programme (known as Levels 4 and 5 for HEI 1, Levels 1 and 2 for HEI2) and could be followed by a BSc (Hons) lasting one year (known as Level 6 for HEI 1, Level 3 for HEI2). For ease of expression and to aid understanding, all courses will be referenced in this report by their year of study i.e. Years 1, 2 or 3.

4.2 Schedule of VW Activities

As in any educational environment there tends to be variation between students cohorts, with each developing their own particular ethos. However, a prominent feature of HE computing students within this particular FE institution was diversity. This included background, ethnicity and learning needs. Again, for ease of reference, the four participant groups were named: Group A, Group B, Group C and Group D, reflecting the chronological order in which they started their HE and distinguished by their year of study e.g. Group A (3) refers to the BSc (Hons) year of the first group in this study to start their HE. More detailed background information can be found on all of the participating groups in Appendix D.

It was **Group A** that was selected to be the pilot study for the research. Disappointing Year 1 results had lead to the introduction of a teamwork strategy for Year 2, after which the students had made significant personal progress. The majority had achieved a unit grade average of 55% or above over the two years of their course, which was the progression requirement for Year 3. Therefore, with the agreement of the students, a limited range of VW activities were introduced in their final year as a pilot study in order assess the potential of a VW intervention.

Group B was made the focus of the study for a number of reasons: Year 1 of their course was taught using traditional methods: formal lectures, handouts, practical exercises (with examples), guest speakers, educational visits etc. However, it was apparent that these techniques did not particularly suit this group, many of whom had exhibited LEHS characteristics, discussed further in Appendix D. It was therefore decided to introduce the more practical VW activities in Years 2 and 3 of their course, with Year 1 acting as a control.

Groups C and D provided supporting data for the study. Group C(1-2) was the last course with HEI1, Group D(1) was the first course with HEI2. VW activities were introduced in all years for these groups. Table 4.1 provides a visual summary of the participant groups and their relevant course, the number of students per cohort and their years of study, including those in which VW activities were incorporated into the curriculum.

Table 4.1 Participant groups and VW intervention schedule

Courses	Group A HEI1 Pilot Study		Group B HEI1 Main Study		Group C HEI1 Support Study		Group D HEI2 Support Study	
Computing / Applied Computing	Year (No.)	VW	Year (No.)	VW	Year (No.)	VW	Year (No.)	VW
FdSc Yr 1	2010/11 (14)	No	2011/12 (12)	No	2012/13 (7)	Yes	2013/14 (17)	Yes
FdSc Yr 2	2011/12 (11)	No	2012/13 (11)	Yes	2013/14 (6)	Yes		
BSc (Hons)	2012/13 (7)	Yes	2013/14 (6)	Yes				

4.3 Student Preparation for Virtual World Activities

The introduction of a wide variety of novel experiences that were afforded by the incorporation of VW activities into the curriculum offered an exciting opportunity to help students come to terms with a significant change to their learning and teaching routine, also one of the soft skills under investigation. As with all change, it was important to manage the intervention carefully, particularly as other researchers (Ng et al., 2013) found that unfamiliarity with the SL platform and insufficient SL training had an adverse effect on student satisfaction. Therefore, the impact of initial experiences, with their tendency to form the basis of future views, was given due attention.

At the start of the study it was apparent that a number of students had some preconceived ideas about VWs (SL in particular), see SQ4 of Survey 4 in Section 5.3.1 and Appendix E (Survey Open Comments: Change in Routine: Group A: Survey 3 (AQ≤16), and therefore a domain guest speaker was invited to discuss the application of VW technology within HE. While the session appeared to be enjoyed, an amount of reticence was nevertheless apparent and the reaction to such techniques becoming part of the learning process remained mixed at this stage.

All groups were given instructions in the use of VWs. They were also provided with some independent navigation tasks, which helped to identify any difficulties. Although socialisation was not an issue, as students already knew each other in the RW (Minocha and Roberts, 2011;2008), certain individuals who were usually very quiet in the classroom, felt the freedom that the VW gave them irresistible *'[…] this unfortunately was manifested* *by some noticeably uncontrolled behaviour which needed harnessing'*, see Appendix E (HES1 Feedback - Student Soft Skills. Following the introduction of VW technology: Question 4). Such situations presented an opportunity to reinforce behavioural guidelines, see Section 3.4.3.

4.3.1 General Preparations for VW Activities

In each of the VW scenarios it was important to take the physical location of participants into account in order avoid any influence that knowing one another in a face-to-face environment may have on their VW interactions. The detail of this appears in each of the scenarios described in Sections 4.4-4.7, but the following examples show how physical location was dictated by the nature of the VW activity.

- Some situations were suitable for being entirely classroom based with all students performing the activity in the same physical location e.g. Section 4.6.3: The Rules of Database Normalisation, in which students assumed the role of database developers to search for the stored data within a hospital.

- In situations where students were required to interact with others in the VW they did so from a separate classroom in order to avoid any influence their peers may have had. The rest of the class observed the activity from their own room and later provided feedback when the whole class reassembled for the RW discussion e.g. Section 4.5.1: Conveying a Difficult Message.

- If students visited the space as a business team they were the only group in the classroom, unobserved by their peers. The other teams continued with their preparation for the exercise elsewhere. At the end of the activities the business teams came together to report/discuss their findings e.g. Section: 4.5.4: Conducting an Interview.

- In the time constrained assessment (TCA), Section 4.7.4: Ashgrove Surgery, the interview element that was conducted in the VW required a separate classroom and an additional member of the HE team for supervision. Individuals, adopting the role of a Systems Analyst, needed to physically move to this classroom for their own interview session at a designated time, while the rest of the class continued to work on their TCA.

- In other situations, students were able to select their own physical location, such as in Section 4.5.2: Development Project Presentations in Second Life.

A full briefing of the activity was given to the students at the start of each VW session, sometimes from a 'guest consultant' in the VW, see Section 4.7.3.

4.4 Soft Skill Activities: Change in Routine

Table 4.2 Activity listing for 'change in routine'

Skill	Group	Survey No.	Treatment/Activity Title (in italics)
Change in Routine	A(3)	3-4	Introduction of VW
	B(2)	6-7	Introduction of VW
	B(3)	8	Research Methods Unit (with VW Support)
	C(1)	15-16 17	Introduction of VW *Iteration in Programming*
	D(1)	22	*Iteration in Programming*

4.4.1 Introduction of VW (activities to the curriculum)

The planning of the HE curriculum delivery always incorporated a rich variety of elements designed to both inspire and engage students, while also aiming to reflect the response of both the computer industry and employers to emerging technology. Therefore, the HE team were expected to arrange a number of additional events each academic year that would provide a contemporary context to the students' studies and an enhancement to the curriculum, for example:

- Guest speakers, such as a games development expert from Microsoft, were invited on a regular basis to discuss their area of specialism.
- A variety of work-based opportunities were presented by visiting representatives of SMEs and other organisations, such as Designability (Bath Institute of Medical Engineering).
- A number of educational visits were also arranged, such as to Google's London headquarters, Wiltshire Council and Bristol Robotics Laboratory.

However, such initiatives had often been met with a distinctly poor response, students sometimes deciding not to attend if they were aware that a guest speaker had been invited. It was also not unusual for students who had initially committed to attending a planned visit, on the basis of which it was arranged and booked, not to turn up on the day. From the perspective of the staff, who had organised such events for their appeal as well as their relevance, this has been the cause of some frustration and occasionally embarrassment. However, it was not altogether surprising as LEHS students were, in effect, being removed from the comfort zone of a set routine.

4.4.2 Research Methods Unit (with VW support)

This was a critical unit of the BSc (Hons) course, as it provided the preparation for the Work-Based Research Project (WBRP) which had a significant bearing on the final degree classification.

The unit aims were broadly to enable the students to:

- Research, analyse and evaluate information.
- Provide an overview of quantitative and qualitative approaches, and discuss their philosophy and methods.
- Address statistical analysis of data to the level required to understand and interpret research papers. Learn key research terminology.
- Explain the principles of research design in their subject, including methodological and ethical issues and be able to plan and organise a small-scale research project in the workplace.

The constraints for this unit were:

- Completion within the first semester (12 weeks), which also included another 8 units.
- The unit was context-based, in other words student needed to have selected their WBRP in order to begin the assessment work for the Research Methods unit.

This meant that a substantial amount of knowledge had to be acquired early in the unit in order to allow adequate time for it to be applied. A clear understanding of the concepts was therefore essential. In the past this had been conveyed by lectures, practical exercises and independent study. There was a great deal of material to cover and a lot of abstract concepts to assimilate, as well as the unit terminology. Being academic in nature, the unit could come across as predominately theoretical and it was therefore a challenge for the lecturer to present it in a way that appealed to the practical nature of computing students.

The VW offered the opportunity for a significant change to the traditional learning and teaching of this important, but challenging unit.

The UWE Observatory created for the VW, see Figure 4.1, was used as a visual metaphor for the research process, which provided the students with a clear structure from the beginning. As the unit progressed, they were encouraged to explore the materials at different levels of the observatory. This was intended to help them to see a pathway through the overall process of conducting a WBRP, while also making the activities involved more memorable. VW demonstrations were carried out to highlight specific areas of interest, such as a VW location that had been used to collect research data, a variety of VW activities were incorporated into the unit and students were given independent study to perform in the VW as preparation for the following classroom session.

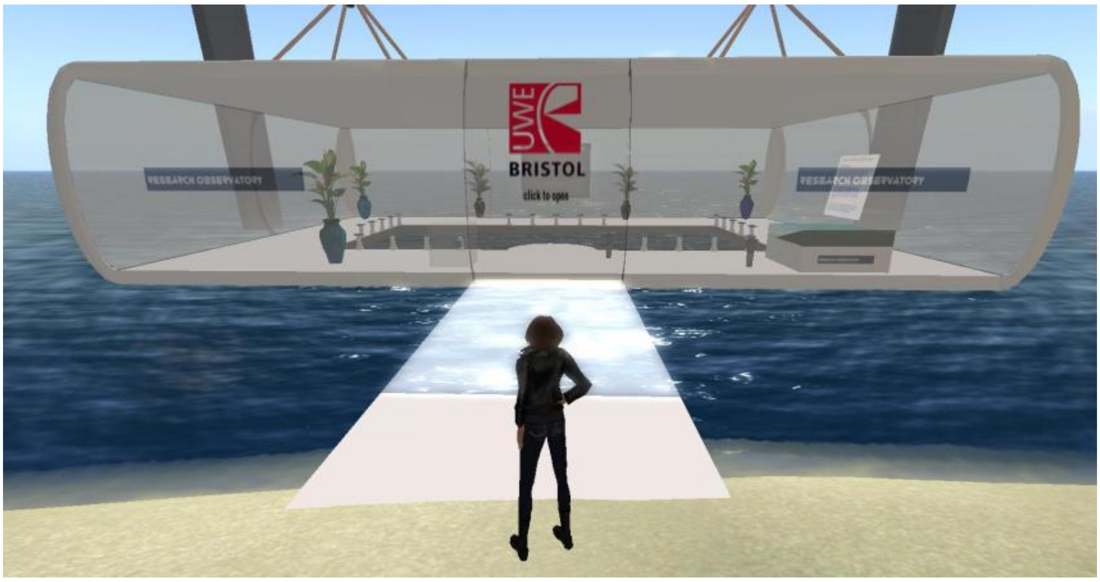

Figure 4.1 UWE’s Research Observatory

4.4.3 Iteration in Programming

Iteration is one of the three fundamental concepts of programming, the other two being ‘sequence’ and ‘selection’. It is generally perceived as being a particularly difficult topic, because of its abstract nature. An additional challenge can be the programming language in which it is taught and in C++, the language used in the course, the syntax is far from intuitive. It was not unusual to have to spend a number of weeks on this topic before an understanding was fully established. This concept was usually presented through an exposition, with practical examples that clearly demonstrated how it could be used, followed by workshops in which students applied the technique themselves in problem solving activities, see Figure 4.2.

This subject was first taught to the group by the unit lecturer in the traditional way to act as a control, see Figures 4.3 and 4.4. The materials used were the SMART board, the White Board, Handouts and/or Gapped handouts containing the theory, programming syntax, a range of program examples, short answer questions and differentiated independent exercises.

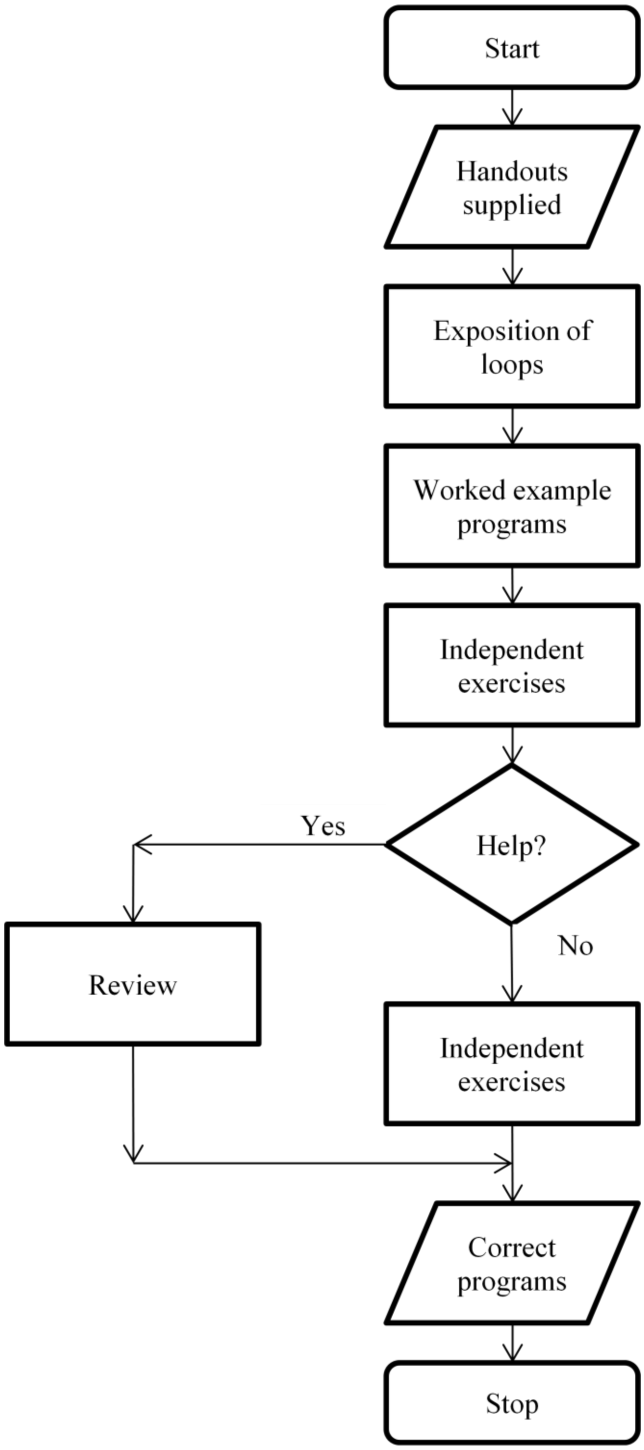

Figure 4.2 Flowchart: teaching program ‘iteration’ in the RW

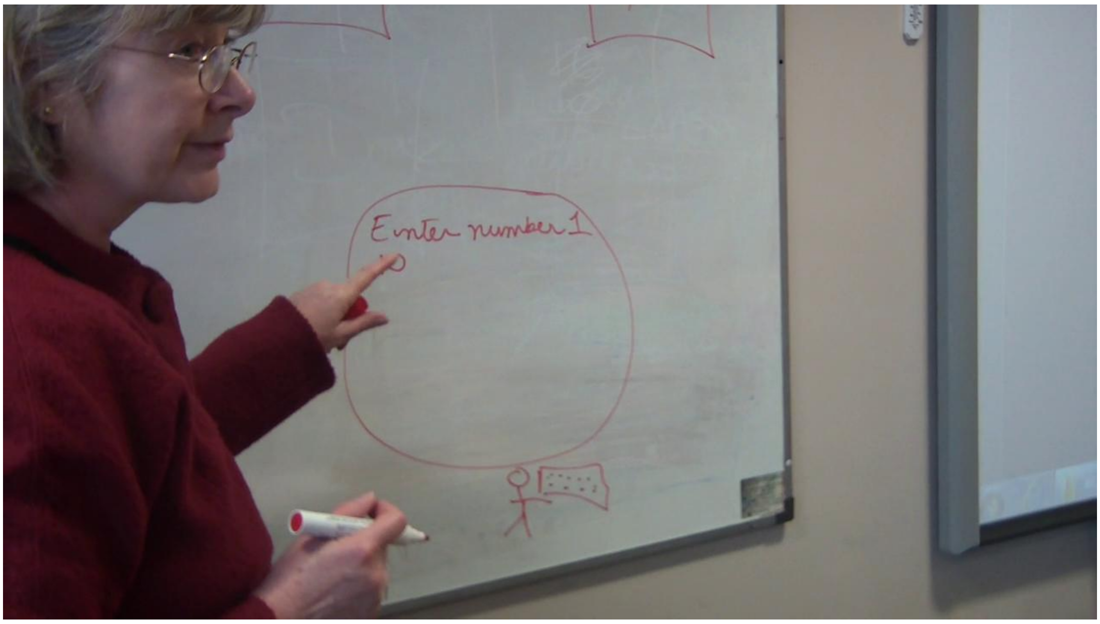

Figure 4.3 The tools for teaching program ‘iteration’ in the RW

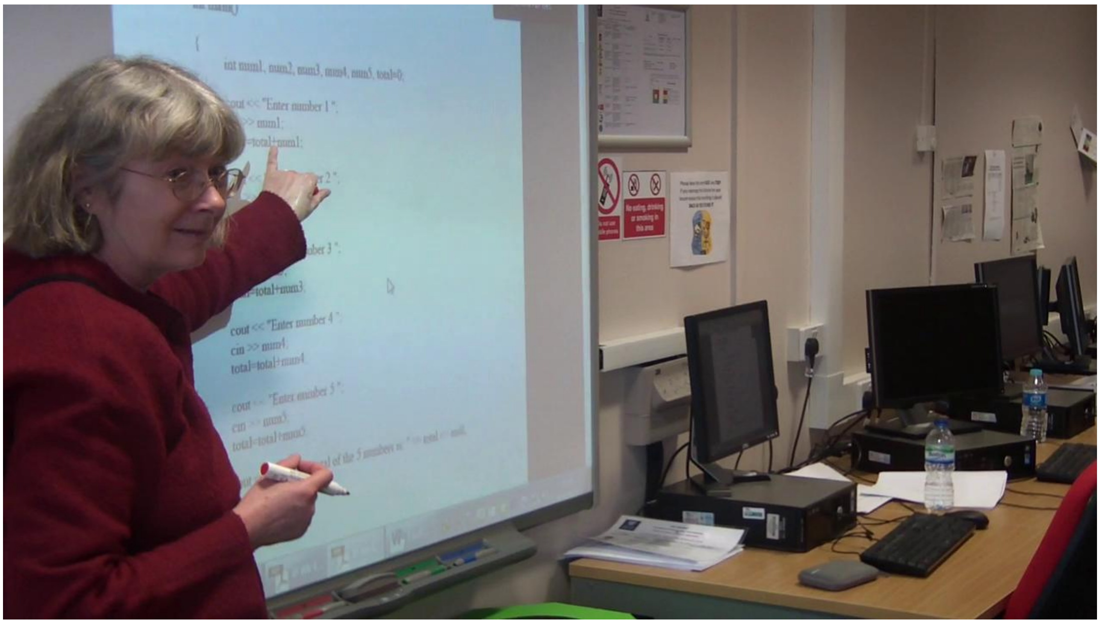

Figure 4.4 RW techniques for teaching program ‘iteration’

A technique to illustrate the concepts within a VW was discussed with HES1 who agreed to develop and supervise a practical classroom-based activity for use within a sandbox in the VW. This provided a significant change to the traditional way of studying this topic by allowing students to see the impact of iteration directly on the movement of the VW objects they were programming, a ‘cyndaquil’ and an ‘umbreon’, see Figure 4.5. This also gave them the freedom to experiment, see Figures 4.6-4.7.

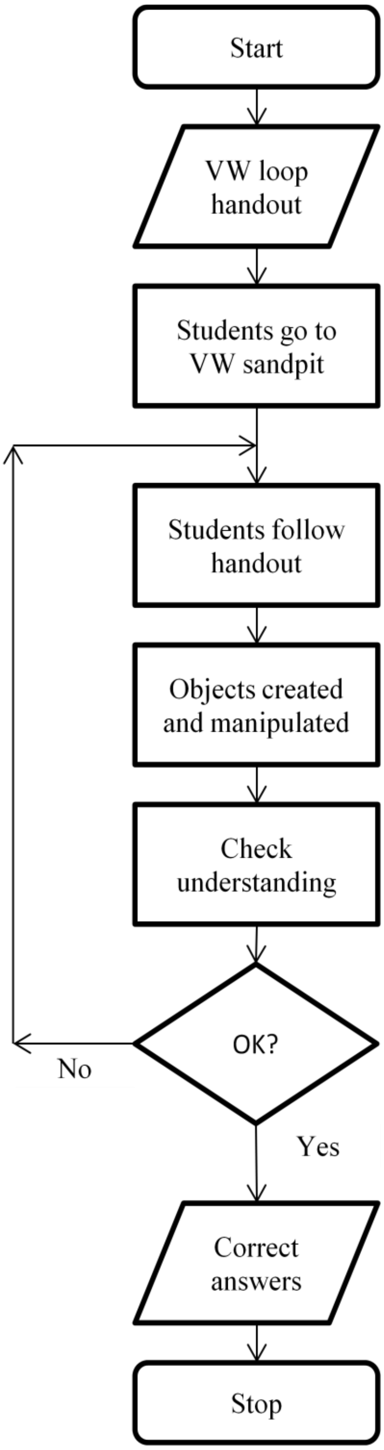

Figure 4.5 Flowchart: learning program 'iteration' in the VW

A theory of cognitive psychology is that mental models are formed in order to understand the world (Johnson-Laird and Byrne, 1993). This is an internal model of a system's properties and behaviour a person creates, which allows them to predict the system's responses to various actions and then select the most appropriate (Kieras and Bovair, 1984). It is therefore important that the mental model is accurate, as a faulty mental model could result in faulty actions. The effective establishment of a mental model achieved through a VW experience would therefore provide a reliable indication of whether the change in learning routine had been perceived as beneficial.

Figure 4.6 Students use a sandbox to carry out exercises on ‘iteration’

Figure 4.7 Students program a cyndaquil and umbreon

4.5 Soft Skill Activities: Communication (Verbal/Non-Verbal)

A VW Computing Department, see Figure 4.8, was created for a number of activities, including three of the scenarios mentioned in Table 4.3. This building also contained an interview room, a buffet room and the Tech Genius Help Desk service, the background to which is described in Section 4.7.1.

Table 4.3 Activity listing for ‘communication’

Skill	Group	Survey No.	Treatment/Activity Title (in italics)
Communication Verbal/Non-Verbal	A(3)	5	*Conveying a Difficult Message*
	B(2)	13	*Development Project Presentations in Second Life*
	B(2)	14	*Responding to Critical Feedback (Multimedia Project)*
	D(1)	25	*Conducting an Interview*

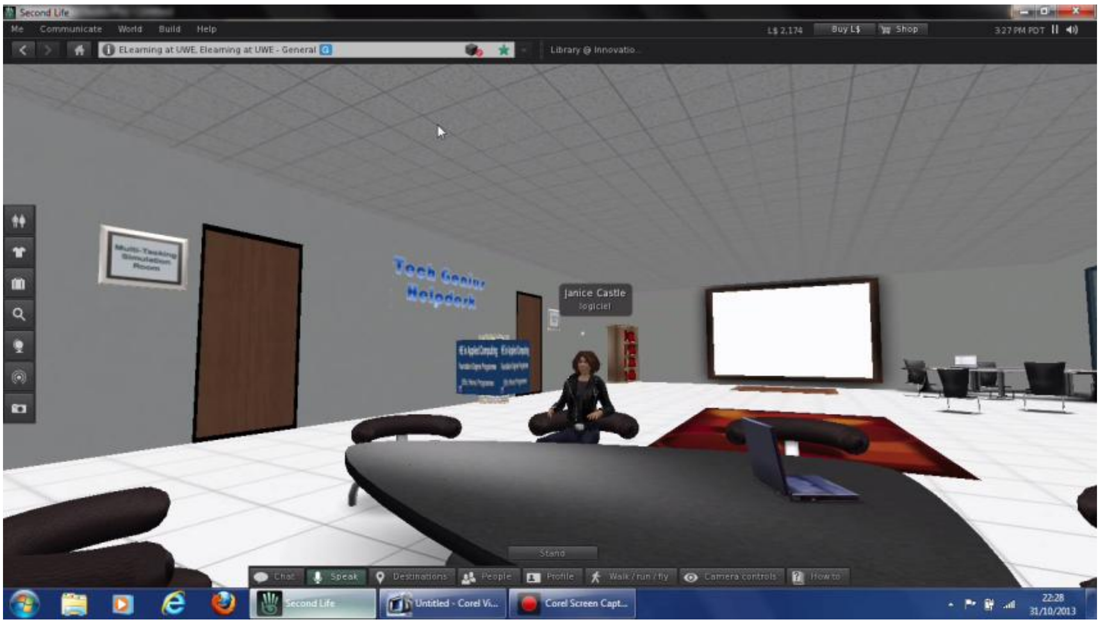

Figure 4.8 The Computing Department space in the VW

4.5.1 Conveying a Difficult Message

This activity was applied to an element of the Managing Information unit on the BSc (Hons), one of four such units, all business related and mapped to a Chartered Management Institute qualification. They had similar assessment formats with a relatively light weighting of three credits. An independent study exercise was issued in preparation for the VW session. Each student in the group moved to a separate classroom when required to play the role of a manager and convey a difficult message, drawn at random, to a member of their staff.

An example message would be:

> *'Our company has been compelled to introduce efficiency savings, which will mean closing down one of the sites. We are offering to relocate you to another site 200 miles away or you can choose to take voluntary redundancy.'*

The members of staff were played by volunteers, unknown to the students, who had been given instructions to adopt an uncooperative stance. The manager and member of staff met in the virtual Computing Department to discuss the situation. Since it quickly became clear that this activity was presenting a particular challenge for the majority of participants, the unit lecturer facilitated the process where necessary. At the end of each session, the VW 'manager' joined their peer group, who had been observing the interaction from a separate classroom, to discuss the meeting. The VW 'staff members' also provided feedback from their perspective on how the message was both conveyed and received.

4.5.2 Development Project Presentations in Second Life

This activity related to two units; Project Management and Development Project, the latter demonstrating the practical implementation of the former. The Development Project had a much higher weighing, of twelve credits, than the other units, reflecting its importance in the curriculum. It was assessed via a number of individually weighted components, two of which included presentations.

By this stage of the course students had already given a number of RW presentations, but for many these continued to be a stressful experience, with some extreme reactions to this form of communication. It was therefore decided to offer the opportunity of carrying out the assessed project proposal presentation within a VW, to which all students were in agreement. Instructions and practical exercises on how to display a Microsoft PowerPoint presentation in SL were provided by the unit lecturer well in advance of the activity. Students were given access to the virtual Computing Department so they were able to carry out as much rehearsal as necessary at a time and physical location of their choice. In order to execute this activity effectively they needed to consider all the practicalities of manipulating a slide show in the VW and conveying the verbal message, while also paying attention to expressive body language. This compelled everyone to pay greater attention to what they might have previously taken for granted in the RW.

This 'once removed' activity (Ball and Pearce, 2009, p. 47) was designed to focus on the important aspects of communication, permitting students to experiment with them in a less self-conscious way than may have been possible within the RW. On the day of the presentation students did not come to the classroom, choosing instead their own physical location from which to present, see Figure 4.9.

Figure 4.9 Presenting development project proposals

Students were informed of the importance of careful preparation as well as the need to arrive outside the virtual Computing Department building in advance of their scheduled time slot. The presentations were recorded and graded by the unit lecturer and HES1. Students were subsequently asked to complete a survey about their experience.

4.5.3 Responding to Critical Feedback (Multimedia Project)

An assessed element of the Multimedia Technologies unit required students to create a software product to promote the RW Tech Genius Help Desk service. In order to obtain some critical feedback with a view to improving the product prior to submission, they presented their work in the VW to an anonymous, non-technical audience. This classroom-based activity, treated as a formative assessment, was designed to provide the students with some practical presentation experience within the VW prior to their summative Development Project presentation.

The purpose of this scenario was to highlight the techniques that would help students to manage a successful presentation in the RW, by means of critical feedback from a live audience. This situation is representative of many in the RW situations where a presenter knows little or nothing about their audience and would have been extremely difficult, if not impossible, to reproduce within a classroom setting. While an amount of apprehension is to be expected when giving a formal presentation, the extent of anxiety experienced by some students could be quite debilitating for them. Therefore, the use of the VW for computer-mediated communication (Sherblom et al., 2009) was designed to improve the confidence of all students, particularly those with LEHS tendencies.

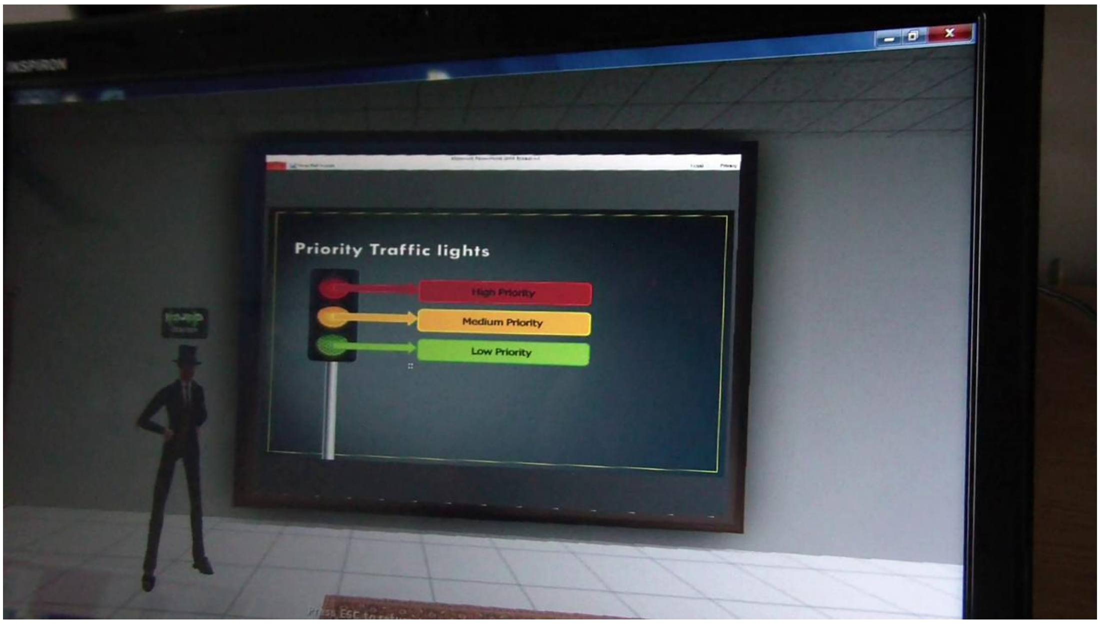

Figure 4.10 Students respond to critical feedback on their multimedia project

Following their presentation, the students were required to invite audience opinion and discuss the points raised, paying particular attention to their phraseology, see Figure 4.10. They needed to display appropriate reactions to constructive criticism and seek further clarification where necessary. They also needed to convey signals that encouraged feedback in order to gain the most benefit from the opportunity afforded by a live audience.

The session was facilitated by the unit lecturer, HES1, with the audience providing constructive feedback in a variety of formats, primarily as direct verbal communication, but also via e-mail, both of which required appropriate responses from the students. The immediacy of this environment was intended to create valuable learning opportunities by enhancing interactions within an environment that the students could consider as being relatively comfortable.

> *'The ever-present exhilaration of the experience of now gives rise to a feeling of being situated within the world not simply located within it'.*
>
> (Kuksa and Childs, 2014 p. 73).

4.5.4 Conducting an Interview

This session was designed as a VW communication activity that had to be initially planned and prepared by students in the classroom. It was developed for the Systems Analysis and Databases unit to allow them to practise their interview techniques, this being a fundamental component of fact-finding when conducting a RW system investigation.

Prior to the session, a control exercise was carried out in which students interviewed each other, playing different roles. Apart from the fact that the students were clearly not comfortable with this, it cannot adequately represent a RW situation in which an analyst would not necessarily know the person they were interviewing. However, it did allow the students to compare RW and VW activities of a similar nature.

Figure 4.11 The IEEE meeting room (since modified)

There are many situations that would need to be overcome by considered communication techniques in the RW. A member of the client's staff, for example, fearful of being replaced by a new system may be reluctant to provide the information that would facilitate the production of that system.

Working in their designated business groups, students played the role of a team of systems analysts who needed to elicit information from a client about a business problem by applying their knowledge of interviewing techniques. Thus, the interview required careful planning, in order to make the most of their allocated time with the client. Interviews were conducted in a formal setting, using one of the Meeting Rooms of the IEEE VW site, see

Figure 4.11. Only one team at a time was permitted to be present in the classroom for the interview, see Figure 4.12 and each team member was required to participate. The client was a volunteer BSc (Hons) student who agreed discuss the Year 3 project he was undertaking.

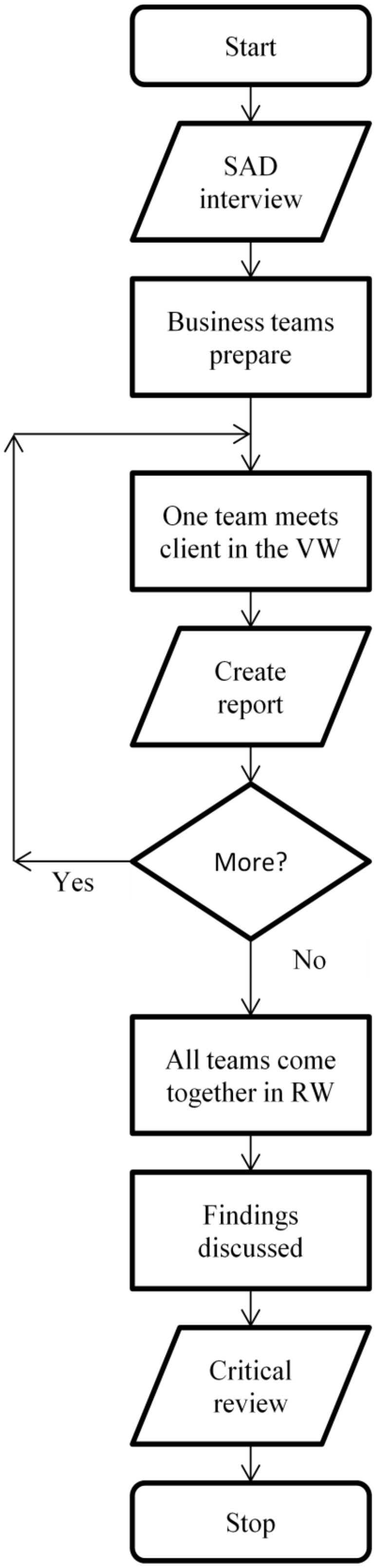

Figure 4.12 Flowchart: ‘conducting an interview’

As the client was unknown to the teams and English was not his first language, achieving a successful communication proved to be quite a challenging experience for them and highlighted a number of issues. At the end of the VW sessions the class came together in the RW and each of the teams were required to report their findings, which in turn demonstrated the effectiveness of their techniques. Interview strategies were compared and ideas put forward for improvements.

4.6 Soft Skill Activities: Play and Imagination

Table 4.4 Activity listing for 'play and imagination'

Skill	Group	Survey No.	Treatment/Activity Title (in italics)
Play and Imagination	A(3)	1-2	*Being Served at a Buffet*
	B(3)	9	*Being Served at a Buffet*
	B(2)	10	*PrimTime Education - A Walk in a Green Space*
	C(2)	18	*PrimTime Education - A Walk in a Green Space*
	C(1)	19	*The Rules of Database Normalisation*
	D(1)	21	*The Rules of Database Normalisation*
	D(1)	23-24	What do you think about programming so far? *PrimTime Education - A Walk in a Green Space*

4.6.1 Being Served at a Buffet

Within the Multi-Tasking Systems unit the nature of concurrency, parallelism and inter-process communication is explored, including their role in practical computing applications. Amongst the Learning Partnership it is acknowledged as being one of the most challenging units with a tendency to suffer from a poor grade profile, the main problem being the abstract nature of the concepts. One of the most fundamental topics of the unit is that of process management: the concept of a process and the scheduling of several processes. The skill of teaching this topic is to present the theory in a way that is easy to understand.

The researcher wondered if a VW scenario could be designed that would act as an analogy for the process management activities within a computer, the aim being to improve understanding while reducing the anxiety associated with the subject by stimulating play and imagination in the students. The idea of creating a VW buffet was suggested to the unit lecturer HES1, around which a narrative was built. Students were invited to attend the buffet, set up in the VW Computing Department, from their chosen physical location. Their avatars were asked to form an orderly queue to be served. However, the arrival of a very important person meant that the priority of service would change and therefore they would have to rejoin/remain in the queue and wait longer for their refreshments. HES1, agreed to implement and facilitate the scenario, with the researcher as observer, see Figure 4.13. Following a review of the design, as well as student feedback, HES1 added colour coded pairs of feet to the floor in order to emphasise the queue positions, thus highlighting an important element of the VW activity, see Figure 4.14.

Figure 4.13 Students attend a virtual buffet

This experiment was designed to turn a rather dry topic into a more playful experience. All of the students were required to use their imagination as part of the analogy in the developing scenario, choreographed by HES1,with pizza, ice cream and coffee available as virtual refreshments.

> *'Tell me, and I will forget. Show me, and I may remember. Involve me, and I will understand'.*
>
> (Confucius circa 450 BC).

It was Meyer and Land (2006) who introduced the idea of a threshold concept into project discussions on learning outcomes. A threshold concept can be perceived as something different to what is generally referred to in HE as 'core concepts'. It will often represent or lead to knowledge that is troublesome, described by (Perkins, 1999, p. 10) as knowledge that appears to be ‘counter-intuitive, alien or incoherent’. However, it may be troublesome for a number of reasons. This scenario was intended to facilitate a threshold concept by stimulating play and imagination. Although this capacity may possibly be more challenging to students with LEHS tendencies, the activity was designed to see if the exercise of these skills enabled the concepts to be more readily understood.

The VW activity benefited from being run twice, with modifications made following the feedback received. If students perceived any benefits to their own learning it was anticipated that this might prompt them to put themselves in the shoes of non-technical users with computer problems and offer solutions that were more readily understood by apply similar techniques.

Figure 4.14 Symbolic feet make the queuing process more obvious

4.6.2 PrimTime Education – A Walk in a Green Space

The inspiration for this scenario was drawn from the observation of Roe and Aspinall (2011) that going for a walk in a green space, or even just sitting or viewing green spaces from an office window, is likely to have a restorative effect and help with attention fatigue. The positive effects of ‘forest bathing’ were also reported by Takayama et al. (2014). The scenario relied strongly on students exercising their imagination through play. Created as a bespoke VW environment, the experiment was designed to act as a bridge between two software development units: Introduction to Programming which ends with program ‘structures’ and Object Oriented Software Development where the ‘structure’ concept evolves into the ‘class’, a fundamental element of advanced programming.

The idea aimed to reduce the stress associated with topics that could be considered candidates for threshold concepts. The scenario was designed to be ‘akin to a portal, opening up a *new* and previously inaccessible way of thinking about something […] a *transformed* way of understanding, or interpreting or viewing something without which the learner cannot progress’ (Meyer and Land, 2013, p. 174). As a control exercise, the subject of ‘structures’ had been originally taught in the Introduction to Programming unit without the VW intervention and ‘classes’ were introduced in the final stages of that unit as preparation for the more sophisticated programming techniques in the following unit.

The researcher first demonstrated the VW scenario to some non-technical peers, in order to test its effectiveness, and the design of the space was improved by their feedback.

Figure 4.15 The PrimTime Education virtual space

The exercise was conducted in ‘business teams’ with no peer observation. Only one team remained in the classroom at a time while the remaining teams worked elsewhere. The process flow is illustrated in Figure 4.16. On arriving at the symbolic ‘PrimTime Education, Threshold Concepts, Structures and Classes’ threshold, see Figure 4.15, each team was asked to select either a red or a blue leaf trail through the green space. The choice depended on whether they wanted to review the basic concept of variables or not. The red leaf trail provided information about computer data storage such as visual reminders in the form of named boxes and note cards. If, however, they started to follow the blue leaf trail their proximity to one of the flowers by the trail triggered a question about variables that they needed to answer correctly before proceeding.

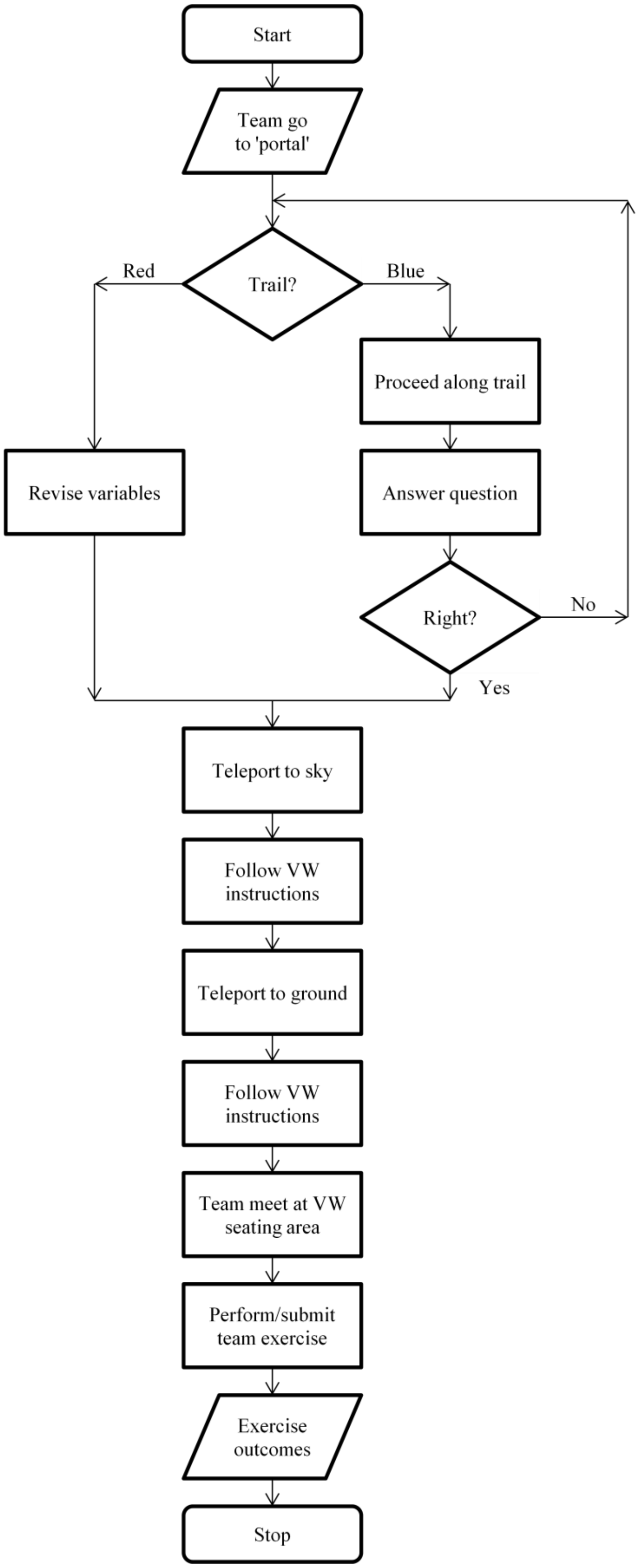

Figure 4.16 Flowchart: ‘PrimTime Education – a walk in a green space’

An incorrect answer advised them go back and follow the red leaf trail first. Both paths eventually led to a green teleport post which when touched, transported them into a beam in the sky, see Figure 4.17. Once among the clouds, students were directed to notice boards that clearly explained how to create a structure and then a class. A ‘flower’ example was used to show how each could be created and how the class would build on the structure. Students were also able to obtain more detailed information, on note-cards by touching the two cloud objects that represented a structure and a class respectively. The clouds were used as a metaphor for these user-defined data types, which at this stage have no substance being merely design templates that do not reserve any of the computer’s memory.

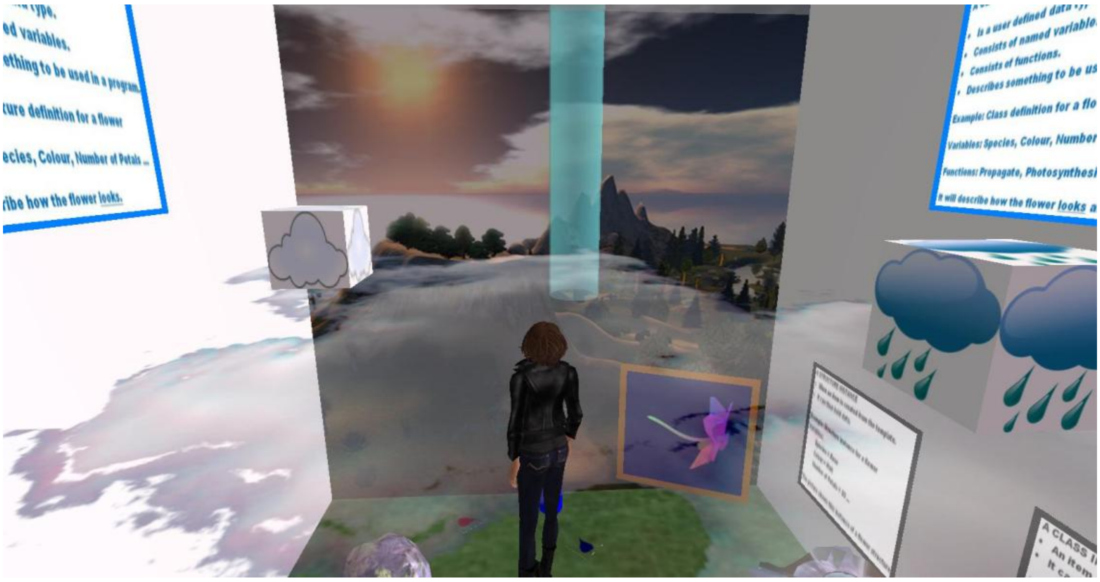

Figure 4.17 In the sky structures and classes may be designed

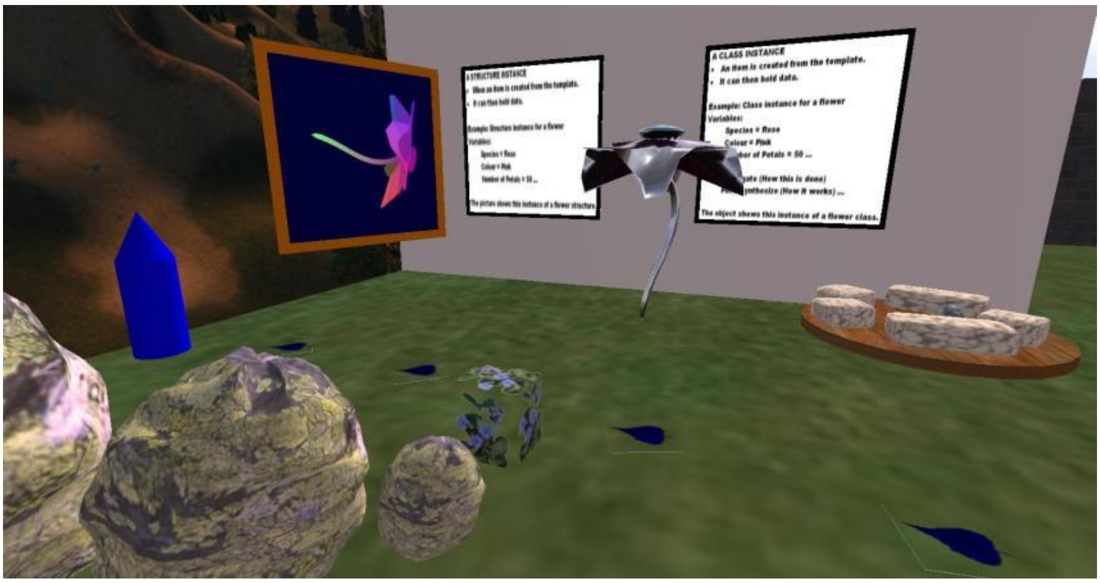

Figure 4.18 On the ground structures and classes can exist

Having achieved an understanding of how to create a structure and a class from the flower example, students then moved back to the ground by touching a blue teleport post. Here it was shown that both a flower structure and a flower class could be generated from the designed templates and have substance, the ground being a metaphor for this. ‘Instances’ of each would therefore reserve computer memory and contain relevant data, as described on the notice boards. A 2-D picture of a flower (with attributes only) was used to represent a structure, a 3-D animated flower (with attributes and methods) was used to represent a class. Following an exploration of the green space, a seating area was made available for the students to discuss the experience and carry out a group activity in order to confirm their understanding, see Figure 4.18.

4.6.3 The Rules of Database Normalisation

This topic was a component of the Introduction to Database Development unit (with HEI1) and also the Systems Analysis and Databases unit (with HEI2). While databases generally tend to be perceived by students as enjoyable, normalisation which is essential to creating an efficient database structure, is often the most feared and least understood topic. If this is not carried out correctly then the database will suffer from poor implementation and a variety of associated problems which are extremely difficult and time-consuming to correct once the data has been entered. Students often mistakenly believe that accurate normalisation can be performed intuitively. While initially this does appear to be the case, it quickly becomes apparent that normalisation exists for a reason when the data has to be entered. Therefore, it is important that the rules are clearly understood and meticulously followed.

The students were first taught the normalisation process by the unit lecturer in the RW, see Figure 4.20. This took the form of exposition and a worked example carried out as a class activity to illustrate the impact on data at each of the required stages to reach Third Normal Form. A succession of tables were created in Microsoft Excel as the activity processed and these were subsequently imported into Microsoft Access at the completion of the process, where the table relationships were identified and constructed.

In order to carry out the VW experiment, see Figure 4.21, the researcher proposed a hospital example that had been used with previous classes as a paper-based exercise. The visual representation of data was designed to stimulate play and encourage students to use their imagination when seeking information for the database elements. The idea was discussed with HES1, who agreed to modify an existing scenario by incorporating objects that would represent the stored data from the example data set: patient, drug, prescription and ward, see Figure 4.20.

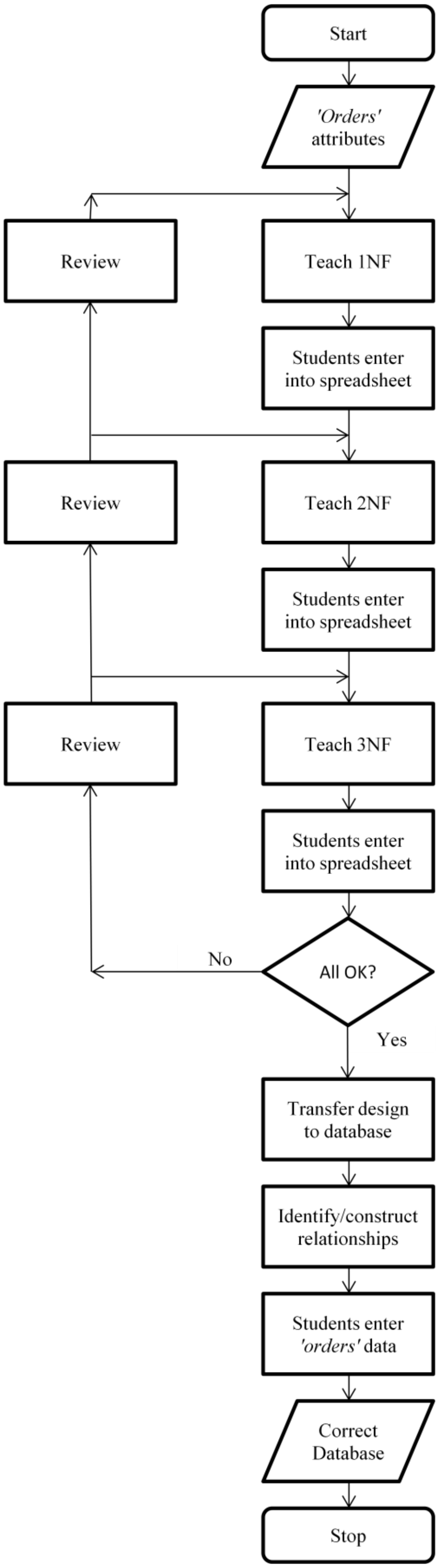

Figure 4.19 Flowchart: learning normalisation in the RW

The VW session was physically based in the classroom and facilitated by HES1 with each of the students adopting the role of database designer tasked with locating the stored data within the hospital with which to constructing the required data model. Through an initial exploration of the space they identified potential database components, such as entities and attributes, see Figure 4.20.

Students needed to recall the rules of normalisation as the process progressed and they were able to actually see many benefits to the exercise, such as the reduction of data duplication when objects were removed from the space. Again, the benefits of playing a role and interacting with a scenario helped to create an environment in which the students became part of the activity and explored the consequences of their actions. A class discussion followed on the effectiveness of the experiment in improving their understanding.

> *‘We like to experiment with the appearance of the avatar and through experimentation I think we can gain some understanding of who we really are. Philosophically, I think finding ourselves or who we really are, is the ultimate learning experience and all that we do in our lifetime contributes to it.’*
>
> (Margaret, weblog posting, cited by Bayne, 2011; 2008, p. 201).

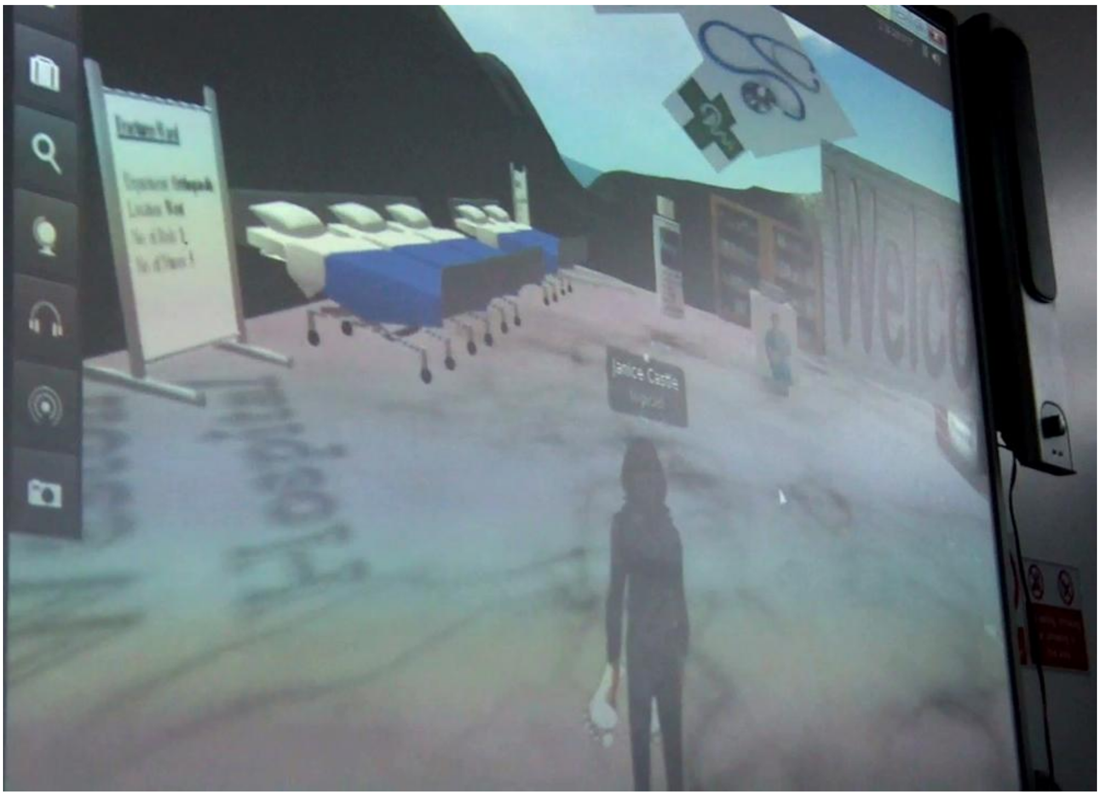

Figure 4.20 Preparing to normalise the hospital database

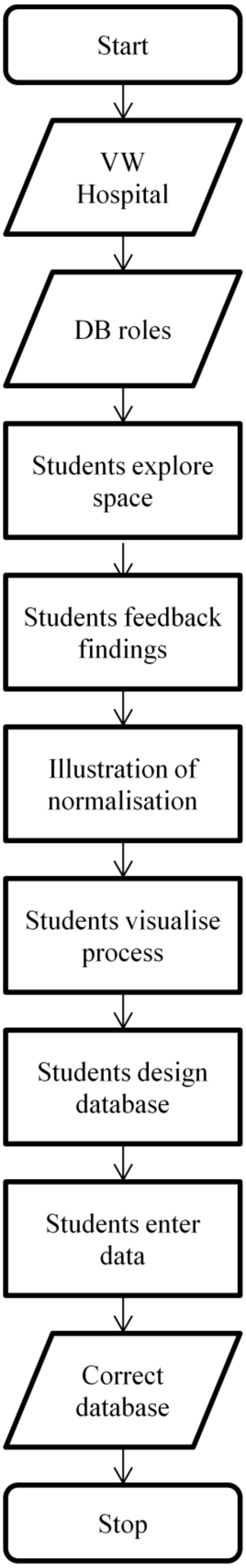

Figure 4.21 Flowchart: learning normalisation in the VW

The flowcharts demonstrate the differences in the number of processes involved in teaching normalisation in the RW and experiencing it as part of an activity in the VW.

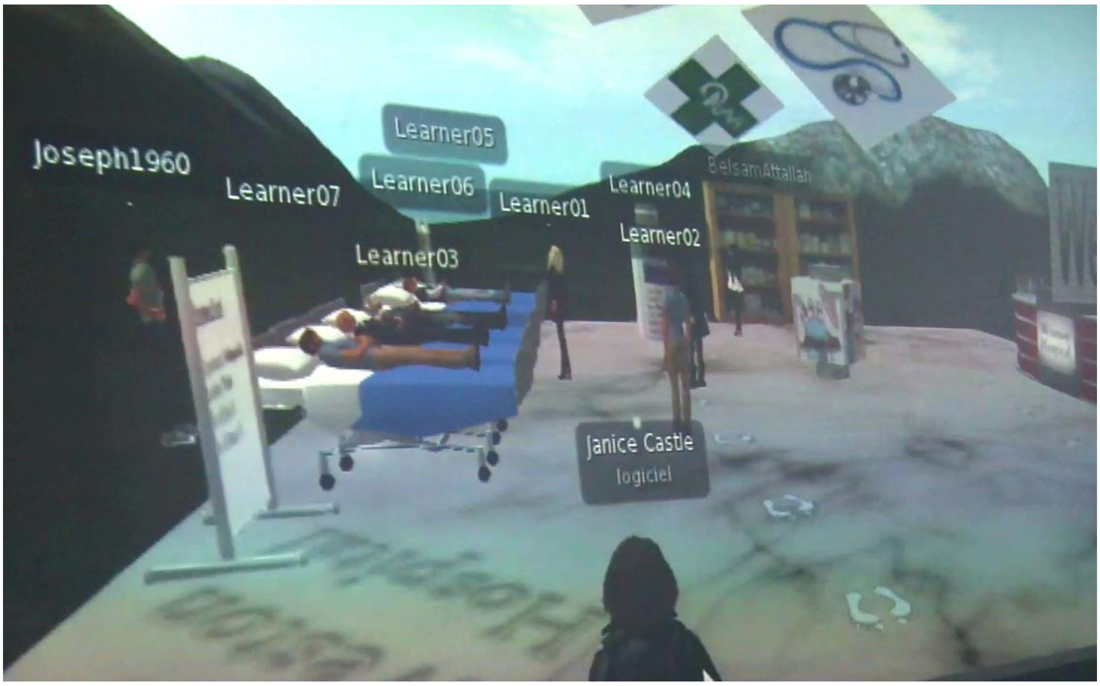

Figure 4.22 Students experience database normalisation

4.7 Soft Skill Activities: Social Relationships

Table 4.5 Activity listing for 'social relationships'

Skill	Group	Survey No.	Treatment/Activity Title (italic)
Social Relationships	B(2)	11-12	*Dealing with Help Desk Customers* *Coping with Pressure on the Help Desk*
	C(2)	20	*Dealing with Help Desk Customers*
	D(1)	26	*Ashgrove Surgery (Time-Constrained Assessment)*

4.7.1 Background to the Tech Genius Help Desk

In order to provide a context for the next two scenarios the background to the Tech Genius Help Desk will be briefly described. This was a RW project, conceived by SS1 in the LibraryPlus and developed in conjunction with HE computing, the purpose being to offer first line computing support to the institution's students and staff, a service which did not exist at the time. This also provided the opportunity for students to fulfil a requirement of the ICT Service Support unit in Year 2 for practical Help Desk experience.

A case study based on this RW scenario was written, see Appendix D, which subsequently formed the foundation of much of the assessed work across all years of the HE Applied Computing course.

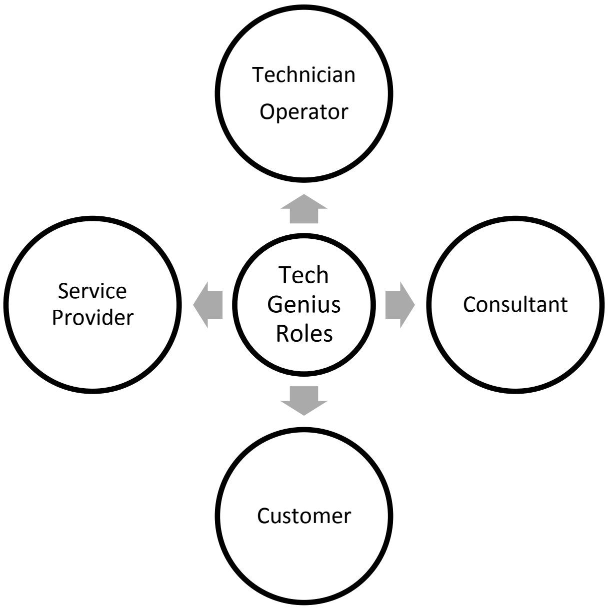

Figure 4.23 Roles adopted by students for the Tech Genius case study

The assessments based on the case study, an example of which is provided in Appendix D, were designed to encourage students to appreciate the computing problems of others by allowing them to observe situations from a number of different perspectives, see Figure 4.23.

Therefore, at times students acted as:

- ‘technician/operators’ of Tech Genius (e.g. Year 2: ICT Service Support unit)
- ‘consultants’ to Tech Genius, such as recommending sources of funding for them in the Year 3 Introduction to Financial and Non-Financial Resources unit
- ‘service providers’, by developing a bespoke call logging system software for the Year 2 Visual Programming unit
- ‘customers’ by providing the specification for their own Tech Genius web site to Year 1 students for their Web Technologies, Application and Development unit

Although this ambitious project proved to be valuable within the institution (Evans, 2013), going on to win the first prize of a best practise award (CoLRic, 2013), the RW operation of the Help Desk was initially a daunting prospect for many individuals.

Therefore, a simulation of the Tech Genius Help Desk was created in the VW and two VW scenarios were designed for the practical element of the ICT Service Support unit to help students manage customer relationships, an important aspect of a technical service. In both scenarios, a systemising approach was applied. The peer group observed each scenario as it developed from a separate room, the class coming together at the end to discuss their perception of how the situation was handled.

4.7.2 Dealing with Help Desk Customers

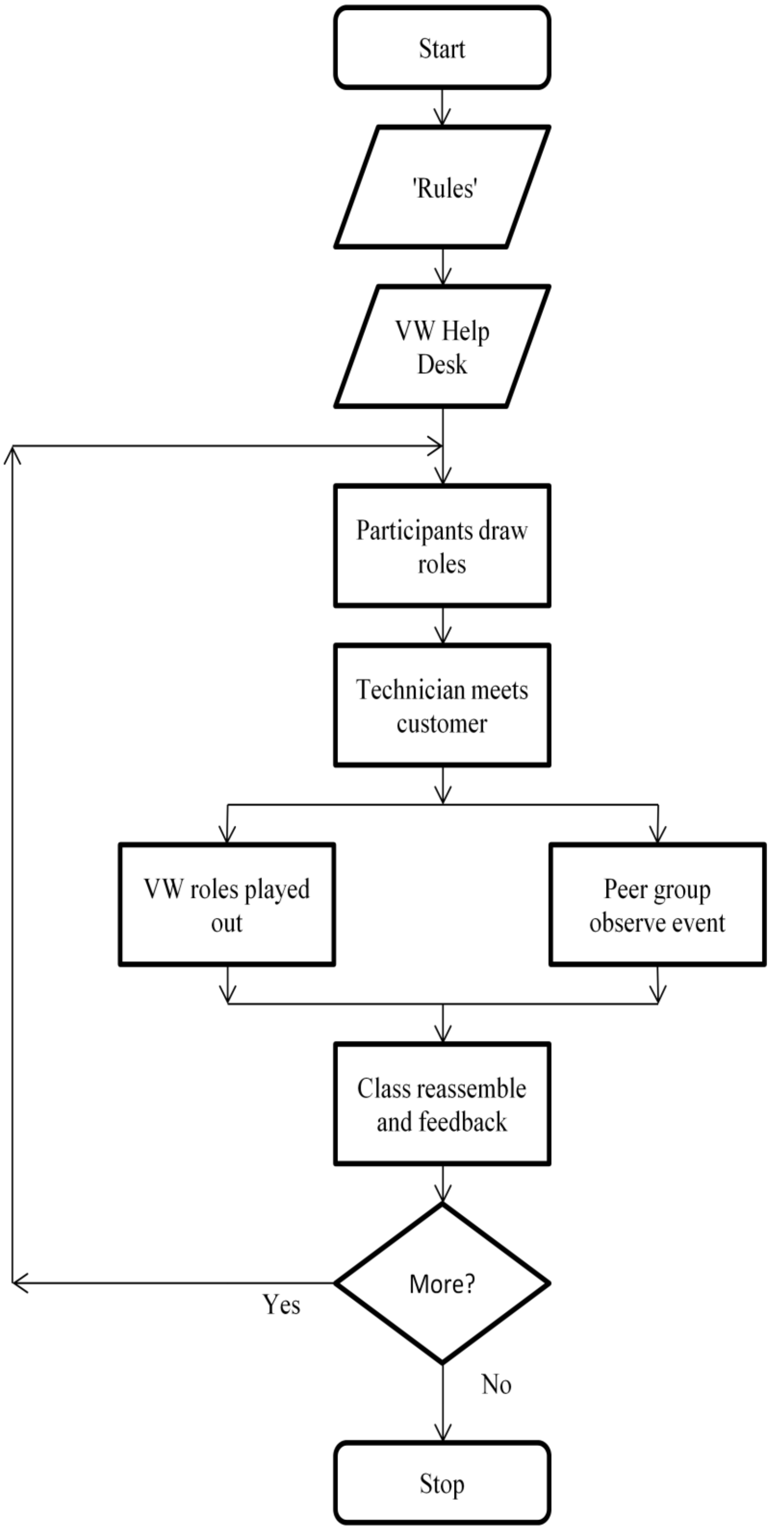

Figure 4.24 Flowchart: ‘dealing with help desk customers’

In this scenario ‘rules’ were associated with different types of challenging customer behaviour. The process is shown in Figure 4.24, the VW Help Desk in Figure 4.25.

An example scenario is given below:

> *‘Dealing with people who just do not seem to know how to say goodbye and who draw out every conversation well beyond the time necessary to complete the business in hand.*
>
> *‘These people are particularly difficult to manage. Most people try to abide by the unspoken rule that neither party will take much longer than necessary to complete the necessary interaction. Therefore such customers stand out as unusually annoying and insensitive. Sometimes the more you try and get rid of these people the more tenaciously they persist!’*

Figure 4.25 Tech Genius operators manage customer care in the VW

4.7.3 Coping with Pressure on the Help Desk

In order to create an initial impact for this session the unit lecturer wrote an introductory script for a volunteer ‘guest consultant’ in the VW. This provided some useful advice on how to handle stressful social situations when operating a Help Desk, see Figure 4.26.The pre-recorded video was embedded within a Microsoft PowerPoint presentation and seen by the whole group. However, each VW scenario took place in another classroom with the rest of the group observing from their own room.

Avatars had the following roles to play;

- one acted as a Tech Genius technician
- two played customers with typical computing problems drawn at random, each customer was tasked with exhibiting a challenging personality trait, again drawn at random.

'Rules' were applied to customer traits and their computer problems. Table 4.6 gives an example of the 'rules' associated with two customers with computer problems arriving at the Tech Genius Help Desk at exactly the same time.

Table 4.6 Customer management 'rules'

Customer Trait / Rules	Problem / Rules
Demanding • Is a manager • Feels the problem should have a higher priority than any other • Hasn't got time for a long explanation • Can someone else do it?	Creating an Automatic Contents Page • Is producing a large report for senior management • Needs to create an automatic Contents Page • Cannot work out how to do this • Requires a quick/simple solution
Angry • Does not like computers • Has wasted time • Resents having to ask someone else • Is concerned about understanding the explanation	Finding/Recovering a Lost File • Has lost a file • Says it has already been saved • Has looked 'everywhere' • Cannot remember how it 'went missing'

The technicians needed to manage both customers arriving simultaneously, by applying appropriate social skills and making use of the facilities available within the virtual Computing Department. In effect, they were required to: establish a priority for the problem, direct the customer to the mail box, if the problem was non-urgent, or to the helpful web site links displayed in bookcase, perhaps take them to the 'interview room' with guidance on researching the problem for themselves or even suggest that the customer relax with a coffee, while the other was being advised. The peer group's notes on the technician's performance formed the basis of a class discussion with the participants following the activities.

Figure 4.26 JimBT consultant guest speaker provides advice

4.7.4 Ashgrove Surgery

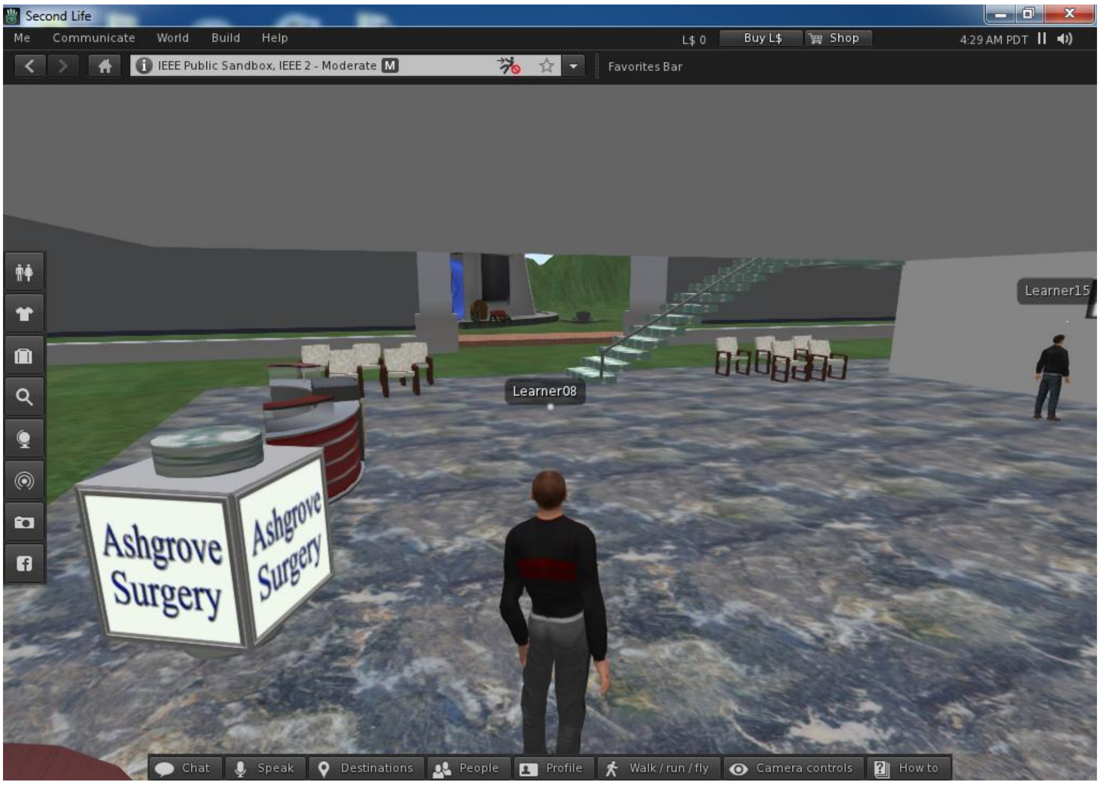

Figure 4.27 The TCA doctor's surgery simulation

TCAs were introduced as summative assessments. They were not considered to be formal examinations as such, but practical classroom activities carried out within a given time frame in an environment reflective of the workplace. Realistic summative assessments are always difficult to create for particular subject areas such as systems analysis. This is because it is generally not feasible to reproduce the important social aspect of a RW system investigation for a paper-based scenario.

Therefore, the researcher, also the Systems Analysis and Databases unit lecturer, devised a VW simulation that would be representative of the activities required in the RW for eliciting knowledge about a business problem. The proposal was discussed with HES1, who agreed to modify the hospital scenario to reflect a doctor’s surgery, see Figures 4.27, 4.29 and 4.30. The TCA was implemented according to the process flow in Figure 4.28.

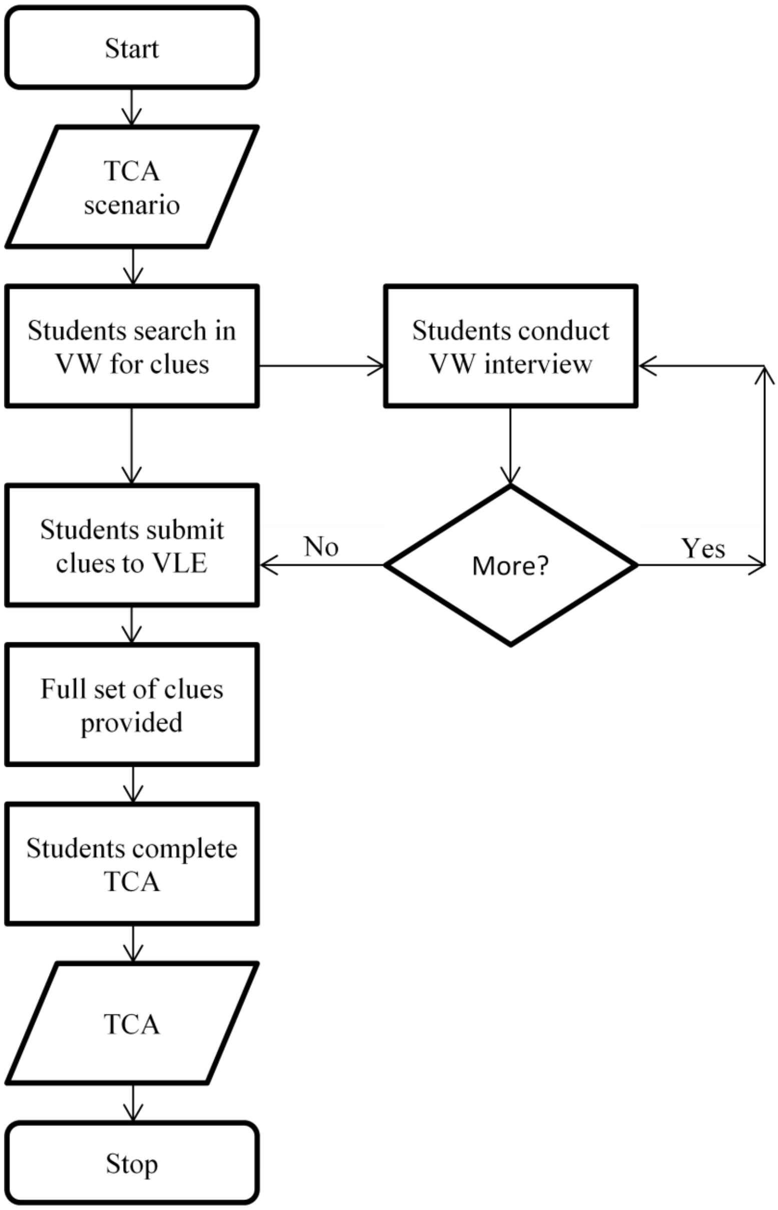

Figure 4.28 Flowchart: TCA process

This scenario was associated with two of the tasks in the summative assessment; the first task involved a VW fact-finding activity, the second task was linked to this activity in that it required a critical appraisal of fact-finding methods, using examples from the VW scenario. The work was designed to be carried out individually and students were briefed about the format of the VW component well in advance of the TCA. Adopting the role of a systems analyst each student visited the doctor's surgery in order to discover the information required for a database.

Figure 4.29 A bookshelf indicates where to find data

By applying a range of fact-finding methods they had to explore the space in order to discover clues about the data requirements of the system, in preparation for creating a first draft Entity Relationship Diagram which was another task of the assessment. One mandatory fact-finding method was to carry out brief interviews with two members of staff at the surgery. This VW element was conducted in a separate classroom, supervised by HES1. Similar to situations in the RW, students were given a limited time for their interviews. They were informed that the appointment times had been scheduled appointment and that they should not miss their own allocated time slot. Following the activity, they were required to list their findings, submit them to the Virtual Learning Environment (Moodle) and then proceed with the rest of the assessment.

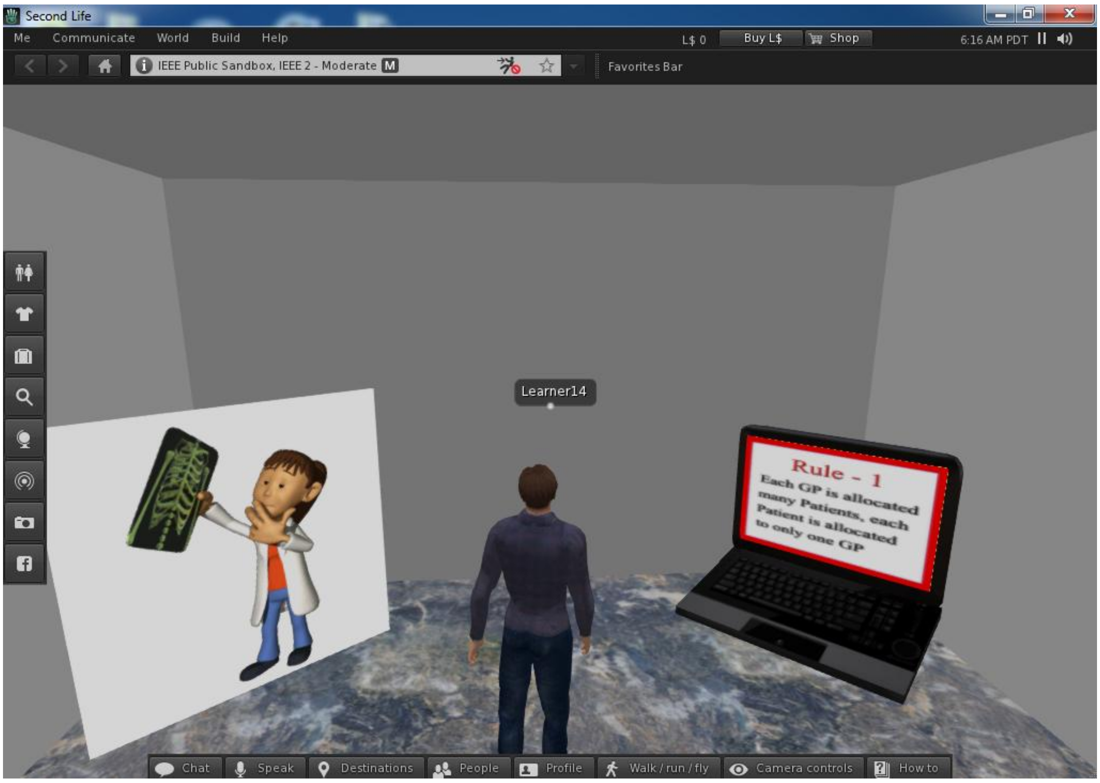

Figure 4.30 Searching for clues about data storage in the doctor's surgery

4.8 Reflections on the Research Activities

There were many challenges involved in the planning, design and development of these scenarios, not least ensuring compatibility with the curriculum. However, any investment becomes valueless if a session is subsequently troubled by technical difficulties and in this respect the VW brought as many problems as it did opportunities (Kludge and Riley, 2008). Both the ability and commitment of supporting IT services to resolve such issues is imperative, since the constraints of the lecturer's role and contact time meant that the VW sessions had to be technically viable as and when they were needed. However, the issues were sometimes exacerbated when students selected their own physical locations and/or equipment for certain activities, see Sections 4.5.2 and 4.6.1, with all the difficulties associated with providing remote support.

While lecturing staff always ensured that pre-prepared RW alternatives were available in the event of severe technical problems with the planned VW activities, it was acknowledged that using the VW for assessment could be high risk strategy. Therefore, some extensive contingency planning was necessary, such as the careful management of software upgrades, redirecting the cache to the students' personal 'home' drive, in an attempt to improve response time and the booking of institution laptops as a backup measure in the event of problems with the desktop PCs.

The time frame allocated to activities occasionally proved to be a problem, with some of the exercises taking longer than anticipated, particularly those within the larger scenarios, see Section 4.6.2, and therefore the parallel running of these for the ‘business groups’ may have been a better option. Where this is not possible, it is important to communicate the deadlines to participants in advance and to maintain them.

A variety of techniques were used to manage access to the space, such as dividing the class into observation/participation components. These are further detailed within Sections 4.4-4.7, but a major benefit of some scenarios/ activities was their availability for independent use, allowing students to their practise skills or review the material, see Sections 4.5.2 and 4.4.3 respectively.

Some VW activities required the allocation of extra resources, such as supervisory staff, volunteers for the scenario role-play activities and/or the booking of additional room to facilitate the exercise. This may not always be achievable, so there is also a need to find solutions in the RW that enable students to hone their soft skills, see Section 6.3.

Summary

The process of devising a diverse range of activities to answer the research questions, in addition to meeting the needs of a vibrant applied computing curriculum, required planning, creativity, technical skills and a significant amount of investment in time, as recognised by Sajjanhar (2012). But, in the process of conducting and observing the events, some of the affordances of VWs were gradually revealed.

The intervention brought authentic experiences into the classroom in a way that would have been impossible to reproduce in the RW. In doing so, it offered some profound insight into individual reactions, see Team 3 comment in Section 5.3.6, thereby creating a number of educational opportunities. By simply observing some of the activities carried out in the pilot study, even the researcher was surprised at the degree of difficulty some students experienced with particular skills, see Section 4.5.1, which in turn strengthened the resolve to progress the study.

One of the most notable impacts of the VW sessions was in the changed classroom atmosphere when challenging concepts were encountered. These were approached with a sense of anticipation rather than caution, also found by Bravo and García-Magariño (2015).

The decisions taken to incorporate four different cohorts at different stages of their course and to plan the scenarios for a variety of subject areas, including formative as well as summative assessments, generated a broad set of VW experiences, as well as a comprehensive range of data. The following chapter will provide the detailed analysis of the results obtained from these research activities.

5 Analysis and Results

This study aimed to investigate the students' utilisation of targeted soft skills as a result of VW experiences and any benefits that participating in the activities may have had as perceived by themselves or others. The analysis structure is presented in Table 5.1.

Table 5.1 Quantitative/qualitative evaluation overview

Data	Details
Quantitative	Inter-year grade comparison *(in years with/without VW activities)* Inter-unit grade comparison [similar units] *(in units with/without VW activities)* Unit assessment grade comparison *(for unit assessments with/without VW activities)* Assessment/Within assessment grade comparisons *(for assessments/components with/without VW activities)* Progression outcomes *(course/degree/employment, see Appendix E for tables)*
Quantitative/Qualitative	Survey analysis/results Survey open comments Discussion forum
Supplementary Qualitative	Observations: *Group-Based: Personal/Other/Student Publicity* *General: Internal/External Contributions/Publicity Articles*
Combined Results	Overview of quantitative/qualitative analysis for all groups
Case Studies	Evaluation of the VW intervention for serious communication difficulties

The quantitative analysis, presented in the chronological order of the course start date for each group, made a comparison of scholastic outcomes with and without the VW intervention, using course grades. In the qualitative analysis, presented under each soft skill and ordered by group, associations were made between the position of participants on the AQ continuum and any influence the VW intervention had on the targeted soft skills. Therefore, each of the survey summary tables provided at the beginning of Sections 5.3.1-

5.3.4, include the number of respondents with AQ scores above the average threshold and those equal to, or below the average threshold; 5(2) would therefore indicate 5 students with an AQ>16 and 2 students with an AQ≤16, and for simplicity of expression these classifications are referred to as LEHS and NLEHS students respectively.

The chapter concludes by bringing together data from all of the groups in order to form a basis for assessing the outcomes of the investigation. Two case studies are also presented in order to highlight the effects of a VW intervention on individuals for whom communication presented a more extreme personal challenge.

5.1 Autism Quotient Results: Groups A-D

Pilot Study: Group A

Figure 5.1 shows that 71% of this group reported an AQ score above the average threshold.

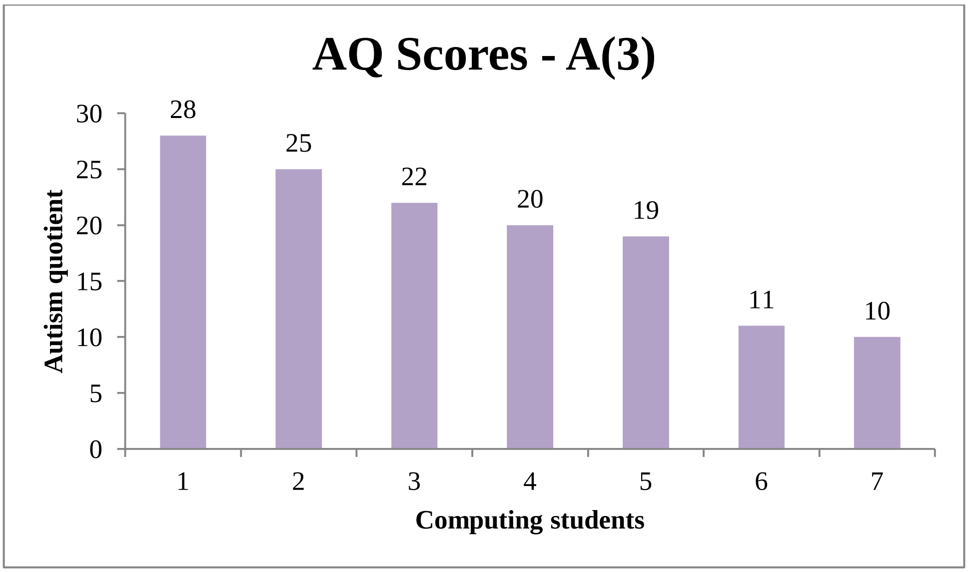

Figure 5.1 AQ scores: Group A(3)

Main Study: Group B

In Year 1, 25% of the group reported AQ scores that were above the average threshold, see Figure 5.2.

By Year 3, with a reduction of the group size, the proportion of students above the AQ threshold had increased to 33%, see Figure 5.3.

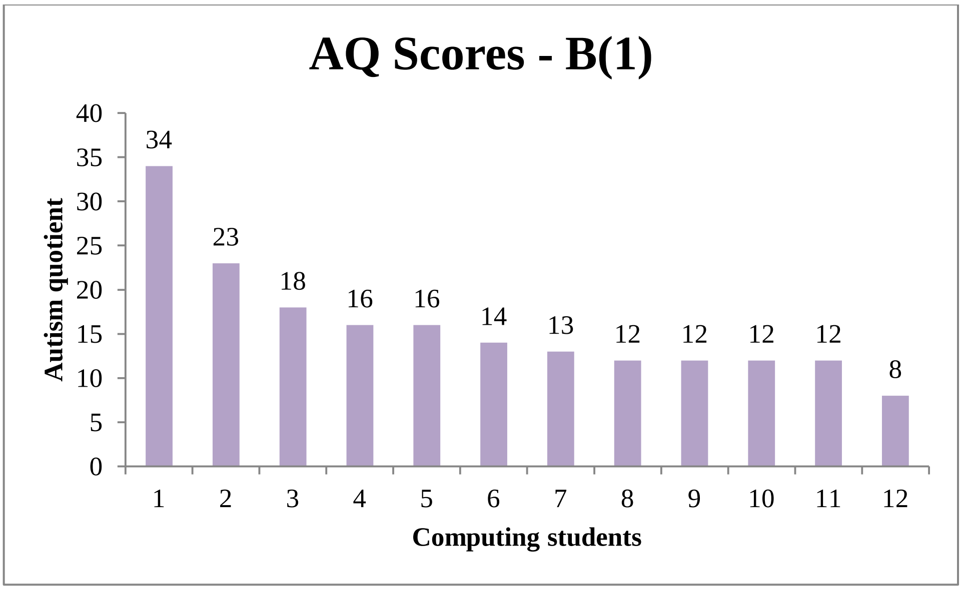

Figure 5.2 AQ scores: Group B(1)

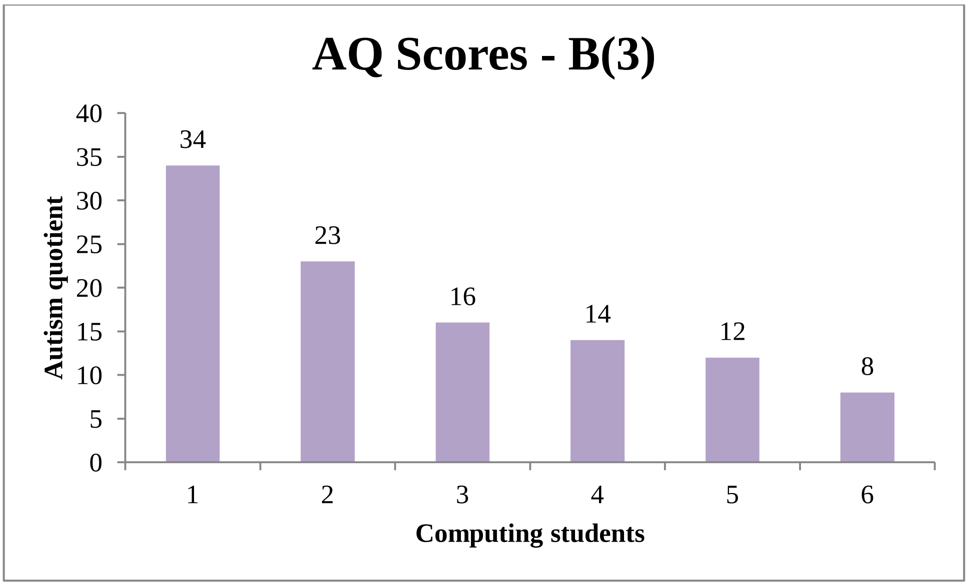

Figure 5.3 AQ scores: Group B(3)

Supporting Study: Group C

Just over half of this small group, 57%, had AQ scores above the average threshold, see Figure 5.4.

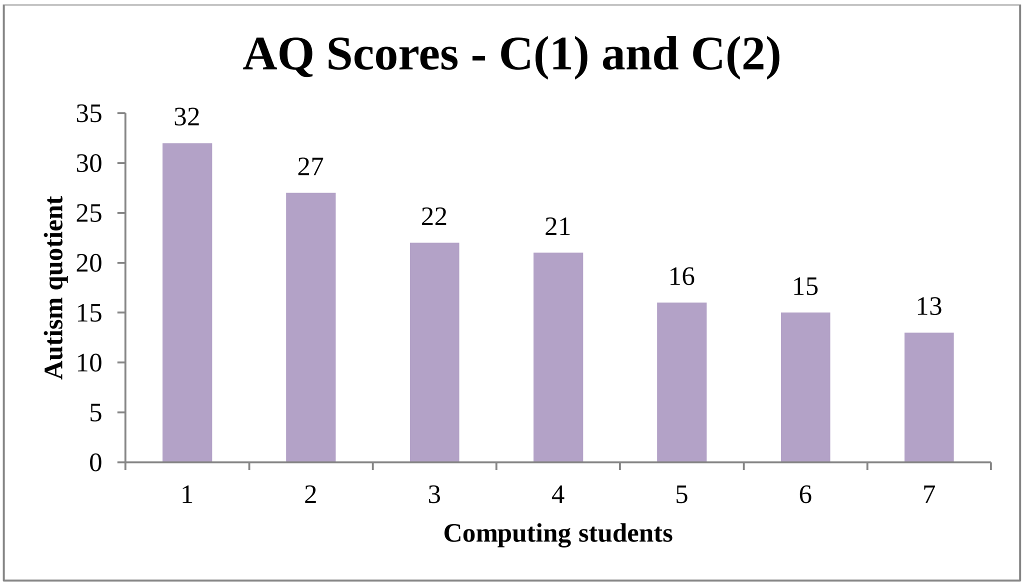

Figure 5.4 AQ scores: Group C(1-2)

Supporting Study: Group D

A high proportion of this group, 88%, had scores above the AQ average threshold, see Figure 5.5.

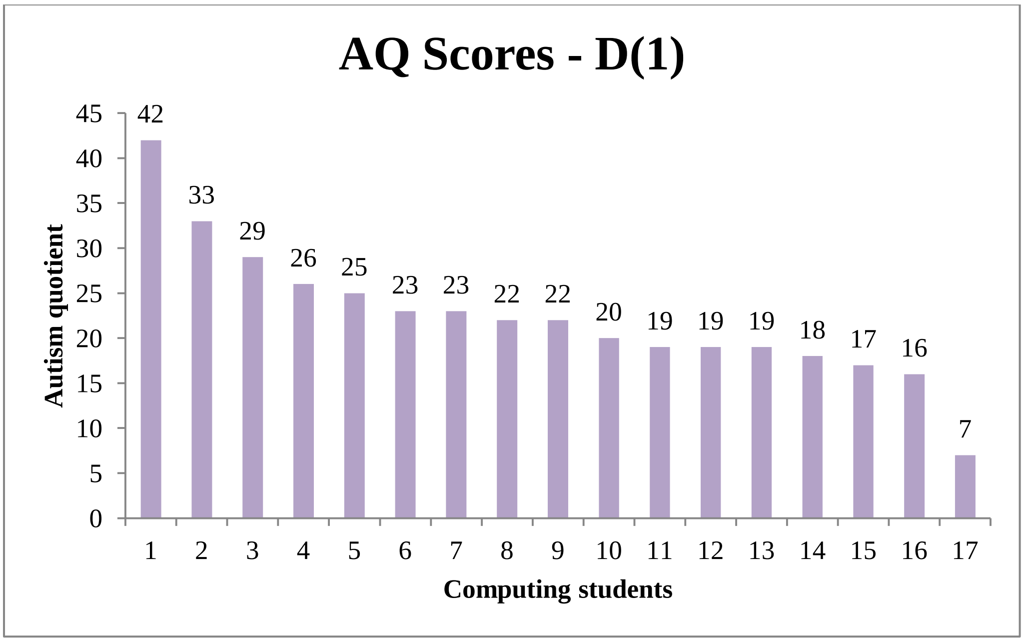

Figure 5.5 AQ scores: Group D(1)

5.2 Quantitative Analysis

The application of soft skills, targeted for this study, was a basic requirement in course units and embedded within the formative assessments. The soft skill mapping for units that included the VW treatment/activity is shown in Appendix F. A variety of grade comparisons, see Table 5.1, therefore reflected the students' ability to apply these soft skills with and without exposure to relevant VW exercises.

5.2.1 Group A

Although the introduction of VW activities began in Year 3 for this group, the data from Years 1 and 2 was examined in order to provide a comparative analysis of grade results, with and without the VW intervention. The course data for this group is shown in Table 5.2 and Figure 5.6.

Inter-year grade comparison:

Table 5.2 Average individual/group grades: Group A(1-3)

Student No	Group A(1)	Group A(2)	Group A(3)
1	57	61	54
2	46	54	70
3	38	73	56
4	59	60	65
5	45	64	71
6	46	75	69
7	61	69	69
8	58	56	
9	44	70	
10	60	54	
11	43	68	
12	33		
13	46		
14	31		
MEAN	48	64	65
SD	*9.96*	*7.54*	*7.01*
SEM	2.66	2.27	2.65
N	14	11	7

As previously mentioned in Section 4.2 an average unit grade of 55% or above for the two years of the FdSc was required for progression to the BSc (Hons). At the end of Year 1 the grade profile of the group gave some serious cause for concern, not just because the demonstration of a clear understanding of basic principles and practise forms the foundation for Year 2, but also because a low Year 1 grade profile can significantly add to the achievement pressure in Year 2 for making up the deficit. All assessment work was carried out on an individual basis in Year 1 and the average grade profile for the group was only 48%. The additional concern was that 64% of that group were already below the Year 3 progression threshold, with 21% not even achieving a pass criteria of 40% in order to progress to Year 2.

Following the teamwork intervention in Year 2 the average grade profile for the group increased to 64%. The VW activities were introduced in Year 3 and there was another improvement in the average grade profile to 65%.

While the grade improvement between Years 2 and 3 appears to be a minor, it should be noted that all assessment work was carried out individually in Year 3, while in Year 2 the students had the additional benefit of the supportive teamwork strategy. Therefore, the improvement in individual attainment in Year 3 compared to Year 1 can be seen as an important outcome.

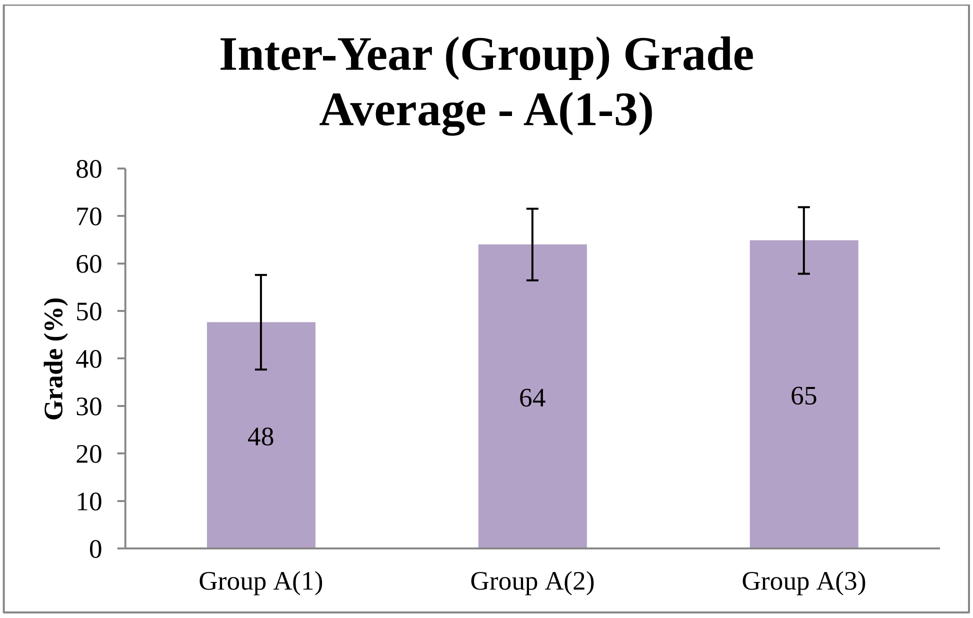

Figure 5.6 Grade comparison (inter-year): Group A(1-3)

ANOVA : an ANOVA was carried out on the sets of average individual grades for the three years of the course: $F(2,29) = 14.80$, $p < 0.05$ indicates that the probability is less than 5% that the average scores of each group's grades differ due to chance alone, see

Table 5.3. Therefore, it can be concluded that there is a significant difference among the three sets of results.

Table 5.3 ANOVA: Group A(1-3)

Anova: Single Factor				
SUMMARY				
Groups	*Count*	*Sum*	*Average*	*Variance*
Group A(1)	14	667	47.64	99.17
Group A(2)	11	704	64.00	56.80
Group A(3)	7	454	64.86	49.14

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	2196.89732	2	1098.45	14.80	0.00	3.33
Within Groups	2152.07143	29	74.21			
Total	4348.96875	31				

Having determined that an overall difference existed among the means of the three groups, it was important establish where that difference actually occurred.

Therefore, post-hoc (after-the fact) comparisons were made, the results shown in Tables 5.4-5.6.

Table 5.4 t-Test: two-sample assuming equal variances: Group A(1)/A(2)

t-Test: Two-Sample Assuming Equal Variances		
	Group A(1)	*Group A(2)*
Mean	47.6429	64.0000
Variance	99.1703	56.8000
Observations	14.0000	11.0000
Pooled Variance	80.7484	
Hypothesized Mean Difference	0.0000	
df	23.0000	
t Stat	-4.5178	
P(T<=t) one-tail	0.0001	
t Critical one-tail	1.7139	
P(T<=t) two-tail	0.0002	
t Critical two-tail	2.0687	
Bonferroni Correction	0.0167	TRUE

Table 5.5 t-Test: two-sample assuming equal variances: Group A(1)/A(3)

t-Test: Two-Sample Assuming Equal Variances		
	Group A(1)	*Group A(3)*
Mean	47.6429	64.8571
Variance	99.1703	49.1429
Observations	14.0000	7.0000
Pooled Variance	83.3722	
Hypothesized Mean Difference	0.0000	
df	19.0000	
t Stat	-4.0727	
P(T<=t) one-tail	0.0003	
t Critical one-tail	1.7291	
P(T<=t) two-tail	0.0006	
t Critical two-tail	2.0930	
Bonferroni Correction	0.0167	TRUE

Table 5.6 t-Test: two-sample assuming equal variances: Group A(2)/A(3)

t-Test: Two-Sample Assuming Equal Variances		
	Group A(2)	*Group A(3)*
Mean	64.0000	64.8571
Variance	56.8000	49.1429
Observations	11.0000	7.0000
Pooled Variance	53.9286	
Hypothesized Mean Difference	0.0000	
df	16.0000	
t Stat	-0.2414	
P(T<=t) one-tail	0.4062	
t Critical one-tail	1.7459	
P(T<=t) two-tail	0.8123	
t Critical two-tail	2.1199	
Bonferroni Correction	0.0167	FALSE

Two-tailed t-tests: two-tailed t-tests assuming equal variances were carried out to determine the difference between the groups of data, applying a Bonferroni correction. The analysis indicated that the significant pair-wise differences between the groups contributing to the overall significant difference among all three groups occurred between Groups A(1) and A(2) as well as between Groups A(1) and A(3), see Tables 5.4 and 5.5 respectively. As anticipated, there was no pair-wise difference between Groups (A2) and A(3), see Table 5.6, possibly due to additional teamwork element. As noted previously, the fact that all work in both Years 1 and 3 had been carried out on an individual basis strengthens the possibly of an impact created by the VW activities.

Inter-unit grade comparison (similar units):

Year 3 of the course included four management units, mapped to the Chartered Management Institute award. These units were all of a similar nature, requiring the students to understand and apply a range of management techniques. The individual grades for the unit that included a VW component, Managing Information (MI), was compared with the average individual grades for the combined units in which there was no VW activity, Managing Marketing Activities (MMA), Managing Performance (MP) and Introduction to Managing Financial and Non Financial Resources (IMFNFR), see Table 5.7.

Table 5.7 Individual/average management unit grades: Group A(3)

Student No.	AQ Score	Group A(3) VW (MI)	Group A(3) NVW (MMA/ MP/IMFNFR)
1	28	76	75
2	25	52	56
3	22	72	74
4	20	71	67
5	19	63	60
6	11	74	69
7	10	67	64

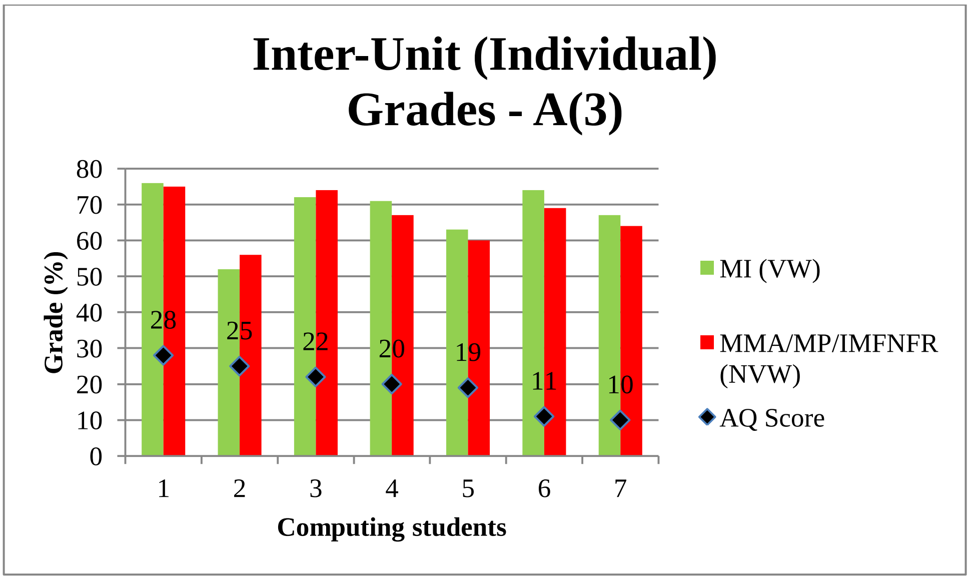

Figure 5.7 Grade comparison (management units): Group A(3)

71% of the students gained a better grade in the unit that included a VW activity, which applied to 60% of LEHS and 100% NLEHS students as shown in Figure 5.7.

Progression outcomes

- At the end of Year 1 a total of twelve students passed the year.
- At this stage one student left the course having decided to accept an offer of full time employment from his work experience placement. He achieved a Certificate of Higher Education.
- However, two students were required to delay their progression for a year in order to retake units.
- By the end of Year 2, eight students had improved their individual grade profile to the extent that they were able to progress to Year 3, including one who decided to take up an offer of employment having achieved a FdSc. Unfortunately, three students were not able to achieve the overall 55% average, despite expressing the wish to continue with their HE.
- In Year 3 all students achieved a BSc (Hons) with a much stronger profile than had been predicted at an earlier stage in their course. Three students received offers of employment or a placement with their University of choice and a further three were in ICT related full-time employment within six months of the completion of the course.

5.2.2 Group B

Inter-year grade comparison:

The VW intervention for this group was in Years 2 and 3 of their course. The ANOVA, as carried out as for Group A above, did not show a significant variation in their grades see Table 5.9. The teamwork strategy, introduced for the first time to a Year 1 of the FdSc, was designed to deal with some issues of concern as mentioned in Section 4.2 and explained further in Appendix D.

This strategy may have had a positive influence on the students’ attainment, since no unit retrievals or retakes were necessary at the end of the first year. In the hope of maintaining this momentum it was decided that it should continue into Year 2, and this was when the VW activities were also incorporated into the curriculum for this group.

The group grade average did improve over the three years of the course, see Table 5.8 and Figure 5.8, despite the fact that students were expected to work individually in Year 3 and, for the first time in their course, without the benefit of peer support.

Table 5.8 Average individual/group grades: Group B(1-3)

Student No	Group B(1)	Group B(2)	Group B(3)
1	59	61	65
2	75	75	74
3	68	72	74
4	63	61	50
5	57	63	66
6	60	62	59
7	64	62	
8	53	54	
9	52	59	
10	52	64	
11	66	53	
12	59		

MEAN	60	62	65
SD	*6.96*	*6.55*	*9.37*
SEM	2.10	2.07	4.19
N	12	11	6

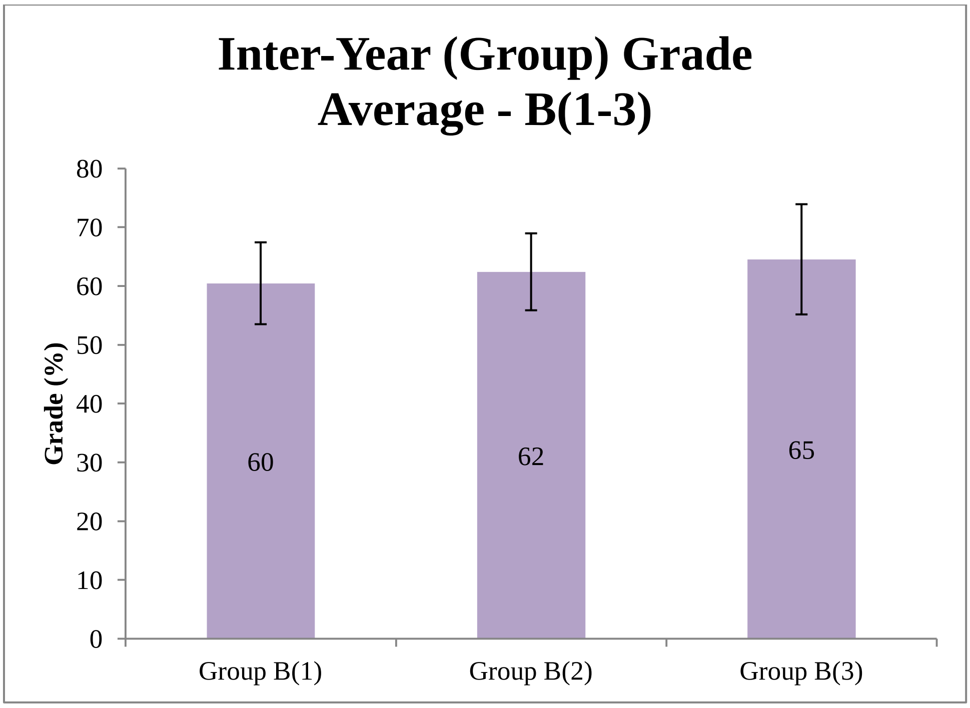

Figure 5.8 Grade comparison (inter-year): Group B(1-3)

Inter-unit grade comparison:

A comparison of individual grades in units with and without the VW intervention was carried out for both Year 2 and Year 3, see Tables 5.9 and 5.10, in order to see if there was any difference in attainment.

Table 5.9 Average individual/group grades in VW/NVW units: Group B(2)

Student No	Group B(2) VW	Group B(2) NVW
1	63	59
2	78	72
3	74	68
4	63	58
5	64	62
6	67	55
7	62	63
8	57	51
9	51	26
10	65	61
11	57	47
MEAN	64	56
SD	*7.72*	*12.43*
SEM	2.33	3.75
N	11	11

Table 5.10 Average individual/group grades in VW/NVW units: Group B(3)

Student No	Group B(3) VW	Group B(3) NVW
1	68	65
2	76	73
3	76	74
4	52	49
5	68	65
6	59	58
MEAN	66	64
SD	*9.27*	*9.41*
SEM	3.79	3.84
N	6	6

In Year 2 the t Stat (3.49), being larger than the t Critical two tail value (2.23), shows the difference between the two sets of data as being significant, see Table 5.11. This indicates a strong possibility that the positive influence on student attainment was created by the application of VW activities.

Table 5.11 t-Test: two-sample assuming equal variances: Group B(2)

t-Test: Paired Two Sample for Means		
	Group B(2) VW	*Group B(2) NVW*
Mean	63.545	56.432
Variance	59.645	154.464
Observations	11.000	11.000
Pearson Correlation	0.877	
Hypothesized Mean Difference	0.000	
df	10.000	
t Stat	3.489	
P(T<=t) one-tail	0.003	
t Critical one-tail	1.812	
P(T<=t) two-tail	0.006	TRUE
t Critical two-tail	2.228	

Table 5.12 t-Test: two-sample assuming equal variances: Group B(3)

t-Test: Paired Two Sample for Means		
	Group B(3) VW	*Group B(3) NVW*
Mean	66.167	64.115
Variance	85.967	88.504
Observations	6.000	6.000
Pearson Correlation	0.996	
Hypothesized Mean Difference	0.000	
df	5.000	
t Stat	5.696	
P(T<=t) one-tail	0.001	
t Critical one-tail	2.015	
P(T<=t) two-tail	0.002	TRUE
t Critical two-tail	2.571	

The same inference could be made for Year 3 where the t Stat (5.70) was also larger than the t Critical two tail value (2.57), see Table 5.12.

Inter-unit grade comparison (similar units):

A comparison of individual grades in two similar units: Introduction to Research Methods (Year 2) and Research Methods (Year 3), see Table 5.13 and Figure 5.9, with and without the VW intervention respectively, was carried out for the six students who progressed to Year 3 of the course

The former unit contained no VW elements, the latter used the UWE Research Observatory (UWE, 2014) as a framework and incorporated a number of VW experiences.

Table 5.13 Individual grades for research units (six completing students)

Student No.	AQ Score	IRM (NVW)	RM (VW)
1	34	55	58
2	23	65	71
3	16	52	64
4	14	52	48
5	12	54	66
6	8	65	73

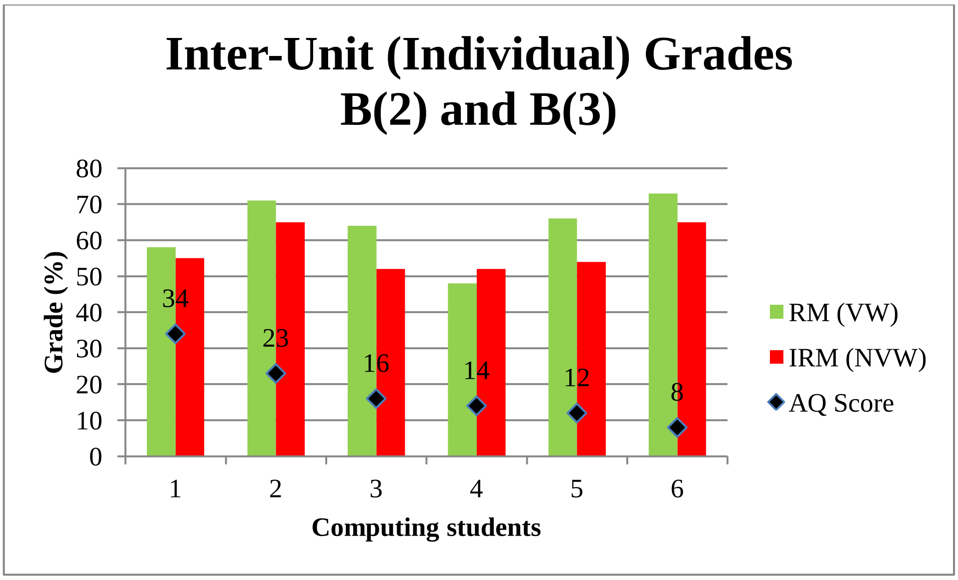

Figure 5.9 Grade comparison (research units): Group B(2)/B(3)

Apart from one anomaly, the grades were consistently higher for the unit that incorporated the VW activities, see Figure 5.9, with 83% of all students achieving a better grade, 100% of which were LEHS students and 75% NLEHS students.

Progression outcomes:

- At the end of Year 1, twelve students passed all of their units and were able to progress to Year 2 of the course. This reflected well on the teamwork strategy which continued into Year 2, when the VW activities were introduced.

- By the end of Year 2 eleven of the group achieved a grade average that allowed them to progress to Year 3.

- Of the six students who chose to do so, all achieved a BSc (Hons) with outcomes that far exceeded expectations. Two high profile offers of employment, one in software development and one in research, were made to students during the course, with two students obtaining excellent positions in software development and ICT consultancy directly following its completion. This was an accurate reflection of the considerable amount of personal progress they had achieved during the course of their studies.

5.2.3 Group C

Inter-year grade comparison:

VW activities were carried out in both years, so no inter-year comparisons could be made.

Table 5.14 Average individual/group grades: Group C(1-2)

Student Number	Group C(1)	Group C(2)
1	60	59
2	67	59
3	55	58
4	66	59
5	66	51
6	59	60
7	64	

MEAN	62	58
SD	*4.50*	*3.33*
SEM	1.84	1.49
N	7	6

The overall group average was higher in Year 1 than it was in Year 2, see Table 5.14 and Figure 5.10.

However, it can be seen, in the inter-unit grade comparison below, that the VW intervention in Year 1 may not have had any positive influence on outcomes.

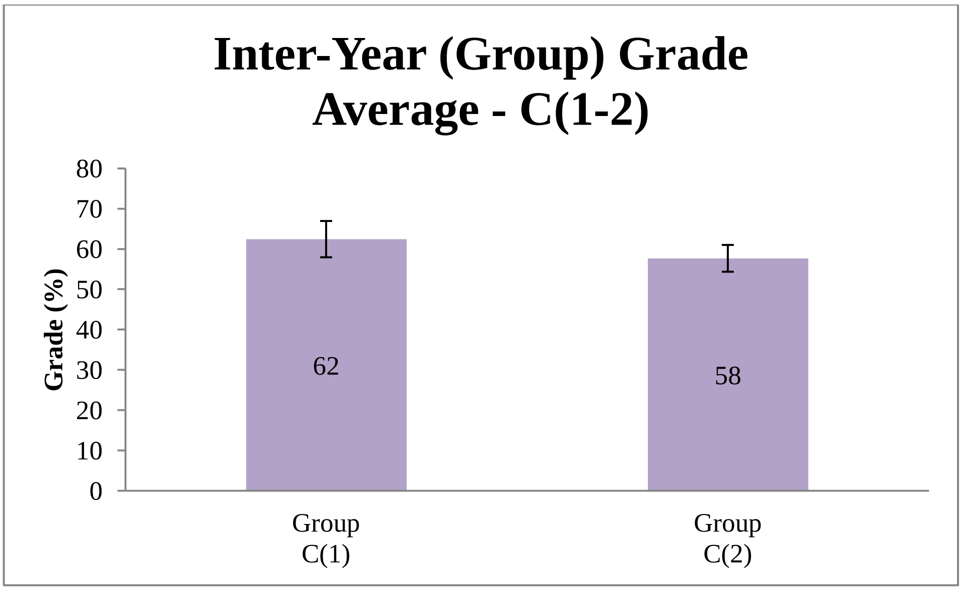

Figure 5.10 Grade comparison (inter-year): Group C(1-2)

Inter-unit grade comparison:

In Year 1 of the course the average grade for the group, in units that incorporated VW activities was 59% compared to 63% for those without VW activities, see Table 5.15. It needs to be stated however, that ongoing technical issues may have had a negative impact on the VW experiences, as well as student opinion.

Table 5.15 Average individual/group grades in VW/NVW units: Group C(1)

Student No	Group C(1) VW	Group C(1) NVW
1	56	60
2	59	69
3	60	54
4	59	67
5	59	68
6	58	60
7	65	64
MEAN	59	63
SD	*2.76*	*5.43*
SEM	1.04	2.05
N	7	7

It was also the case that both of the VW activities in this year were first versions of scenarios which were subsequently improved following feedback and this may also have contributed to the perceived value of the intervention.

Table 5.16 t-Test: two-sample assuming equal variances: Group C(1)

t-Test: Paired Two Sample for Means		
	Group C(1) VW	*Group C(1) NVW*
Mean	59.43	63.14
Variance	7.62	29.48
Observations	7.00	7.00
Pearson Correlation	0.10	
Hypothesized Mean Difference	0.00	
df	6.00	
t Stat	-1.68	
P(T<=t) one-tail	0.07	
t Critical one-tail	1.94	
P(T<=t) two-tail	0.14	FALSE
t Critical two-tail	2.45	

Although there was no significant difference between VW and NVW grades in Year 1 units, see Table 5.16, Year 2 showed a reversal of the situation with an average grade for units that included the VW activities of 61%, as opposed to 56% for units without, see Table 5.17.

Table 5.17 Average individual/group grades in VW/NVW units: Group C(2)

Student No	Group C(2) VW	Group C(2) NVW
1	61	58
2	63	57
3	60	57
4	66	55
5	52	51
6	65	58

MEAN	61	56
SD	*5.04*	*2.68*
SEM	2.06	1.10
N	6	6

The t Stat (3.48) being larger than the t Critical two tail value (2.57) shows the difference between the two sets of data as being significant, see Table 5.18, indicating the possibility of a positive influence created by the VW intervention.

Table 5.18 t-Test: two-sample assuming equal variances: Group C(2)

t-Test: Paired Two Sample for Means		
	Group C(2) VW	*Group C(2) NVW*
Mean	61.00	56.02
Variance	26.80	7.59
Observations	6.00	6.00
Pearson Correlation	0.78	
Hypothesized Mean Difference	0.00	
df	5.00	
t Stat	3.48	
P(T<=t) one-tail	0.01	
t Critical one-tail	2.02	
P(T<=t) two-tail	0.02	TRUE
t Critical two-tail	2.57	

As Year 2 progressed, the VW activities had grown in popularity and the students were interested in presenting a project that incorporated the VW and as well as the RW Help Desk as part of their Multimedia Technologies assessment. They asked if it would be possible to undertake the work as a class and, having discussed this with their unit lecturer, the assessment was rewritten and internally verified to ensure that it contained sufficient activities for a larger team, while also meeting the assessment criteria. Since the outcomes demonstrated the students' soft skills through their application of VW techniques, such as the social skills in persuading members of the student and staff community to become involved, the overall grades for this unit were included in the above comparison.

Unit assessment grade comparison:

Table 5.19 Grade difference for Multimedia Technologies assessments: Group C(2)

Student No.	AQ Score	MT Grade Difference VW-NVW
1	32	16
2	27	13
3	22	21
4	16	18
5	15	18
6	13	18

A grade comparison was made for Multimedia Technologies (MT), allowing for the weighting of the two assessment (VW/NVW) components, see Table 5.19. Figure 5.11 indicates a much better performance in the assessment that contained the VW element.

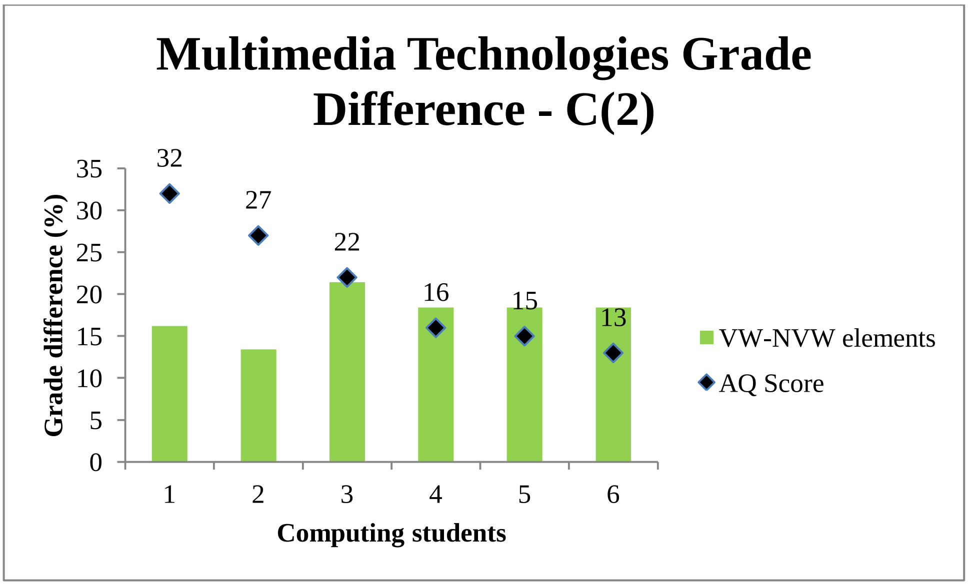

Figure 5.11 Grade difference for Multimedia Technologies assessments: Group C(2)

Progression outcomes

- Although this group required some initial academic focus, all students passed the first year, with one choosing to leave the course early with a Certificate of HE.
- At the end of the second year, six students were able to progress, and all chose to do so, having achieved the required minimum grade or above.

5.2.4 Group D

Since this was the first year of a new course, no inter-year comparisons could be made. However, the group grade average of 65% could be considered as being very respectable for the first year of a FdSc..

Inter-unit grade comparison:

A comparison of individual grades was carried out between the two units that included VW activities and the two that did not, see Table 5.20. The former produced better outcomes for the majority of students as indicated in Figure 5.12. The t Stat (2.64) being larger than the t Critical two tail value (2.12) shows the difference between the data sets as being significant, see Table 5.21, suggesting that this may have been due to the VW intervention.

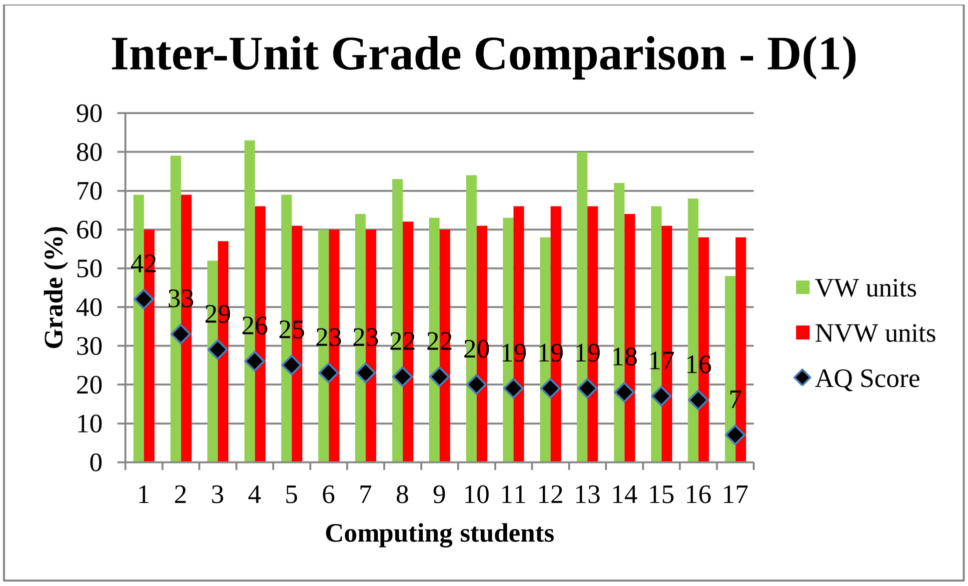

Figure 5.12 Grade comparison (between units): Group D(1)

Table 5.20 Average individual/group grades in VW/NVW units: Group D(1)

Student No	Group D(1) VW	Group D(1) NVW
1	63	66
2	69	61
3	69	60
4	73	62
5	74	61
6	60	60
7	52	57
8	83	66
9	66	61
10	58	66
11	48	58
12	63	60
13	72	64
14	68	58
15	79	69
16	64	60
17	80	66

MEAN	67.12	62.06
SD	*9.51*	*3.47*
SEM	2.31	0.84
N	17	17

Table 5.21 t-Test: two-sample assuming equal variances: Group D(1)

t-Test: Paired Two Sample for Means		
	Group D(1) VW	*Group D(1) NVW*
Mean	67.12	62.06
Variance	90.36	12.06
Observations	17.00	17.00
Pearson Correlation	0.61	
Hypothesized Mean Difference	0.00	
Df	16.00	
t Stat	2.64	
P(T<=t) one-tail	0.01	
t Critical one-tail	1.75	
P(T<=t) two-tail	0.02	TRUE
t Critical two-tail	2.12	

Within-assessment grade comparison:

A comparison of individual assessment component grades was made between the two linked VW tasks of the TCA and the NVW tasks, see Table 5.22.

Table 5.22 Grade comparison for TCA assessment elements: Group D(1)

Student No	AQ Score	Group D(1) SAD VW Elements	Group D(1) SAD NVW Elements
1	42	91	69
2	33	94	85
3	29	83	45
4	26	91	78
5	25	83	60
6	23	86	40
7	23	54	28
8	22	89	68
9	22	66	22
10	20	86	74
11	19	86	74
12	19	86	40
13	19	74	57
14	18	86	43
15	17	83	37
16	16	71	58
17	7	66	31

Again the grade difference between these components was shown to be in favour of the VW elements, see Figure 5.13.

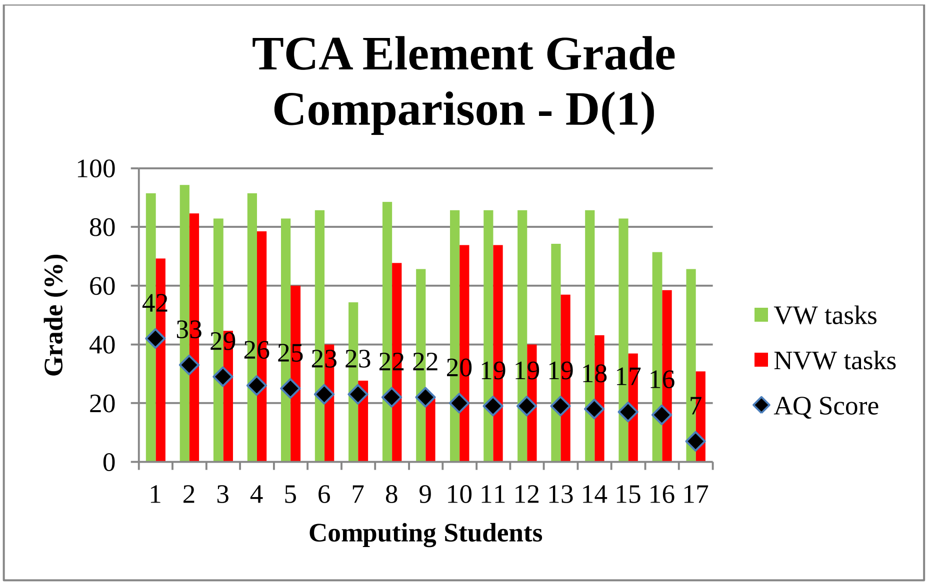

Figure 5.13 Grade comparison (assessment components): Group D(1)

The t Stat (8.12) being larger than the t Critical two tail value (2.12) shows a significant difference between the data sets, indicating a strong possibility that the VW treatment resulted in the improved outcomes, see Table 5.23.

Table 5.23 t-Test: two-sample assuming equal variances: Group D(1)

t-Test: Paired Two Sample for Means		
	Group D(1) SAD - VW	*Group D(1) SAD - NVW*
Mean	80.8403361	53.3936652
Variance	118.1272509	373.5990254
Observations	17.0000000	17.0000000
Pearson Correlation	0.7081016	
Hypothesized Mean Difference	0.0000000	
df	16.0000000	
t Stat	8.1203134	
P(T<=t) one-tail	0.0000002	
t Critical one-tail	1.7458837	
P(T<=t) two-tail	0.0000005	TRUE
t Critical two-tail	2.1199053	

Progression outcomes:

Progression to Year 2 of this new course was subject to passing all of the Year 1 units. However, it was always the intention of the HE team to ensure that students achieved the best grades possible in order to provide a sound basis for further study, an average of 50% being required in Year 2 for progression to Year 3.

As mentioned above, the group average grade of 65% can be considered a very respectable outcome for the first year of a degree course, particularly as it was new. It was apparent that many students felt confident in their developing skills and as a result were highly motivated. This was demonstrated in the eagerness of a number of students to undertake some practical commissions for the Work-Based Experience unit, something they were not required to start until Year 2.

5.3 Quantitative and Qualitative Analysis

A survey listing, followed by the original surveys questions can be found in Appendix E. These were designed to assess student opinion on the perceived value of the VW experience in their HE. Each survey was subsequently categorised as summary questions: SQ1, SQ2 etc., the answers represented as a positive or negative opinion, although in some instances a neutral option was available. A brief description of each survey appears at the beginning of Sections 5.3.1-5.3.4, along with the results and their interpretation.

5.3.1 Change in Routine

Group A

Surveys 3 and 4 gathered data before and after the VW intervention respectively.

	Change in Routine Survey 3 Before VW Respondents: 5 (2)	Positive (%) AQ>16 (AQ<=16)	Unsure (%) AQ>16 (AQ<=16)	Negative (%) AQ>16 (AQ<=16)
SQ1	You have prior knowledge of VWs	59 (53)	17 (40)	23 (7)
SQ2	You understand the term ‘simulation’	100 (100)	0 (0)	0 (0)
SQ3	You have a positive attitude to VWs in HE	50 (50)	30 (0)	20 (50)
SQ4	You have a positive attitude to a change in routine	100 (100)	0 (0)	0 (0)

	Change in Routine Survey 4 After VW Respondents: 5 (2)	Positive (%) AQ>16 (AQ<=16)	Unsure (%) AQ>16 (AQ<=16)	Negative (%) AQ>16 (AQ<=16)
SQ1	VWs provided you with a change in routine	88 (37)	12 (19)	0 (44)
SQ2	You see the change in routine as beneficial	100 (100)	0 (0)	0 (0)
SQ3	You have enjoyed the change in routine	80 (50)	20 (0)	0 (50)
SQ4	You (as others) had preconceptions about VWs	90 (75)	0 (0)	10 (25)

- Before the application of VW techniques, just over half the group said they knew something about VWs, with all indicating that they understood the term ‘simulation’.
- Half the group had a positive attitude towards VWs in HE, although all said they were happy with the idea of a change to (learning) routine.
- Following some VW activities, the majority of students acknowledged there had been a change to their learning routine, all considered that it had been beneficial, the majority of LEHS and half of the NLEHS students indicated that it had also been enjoyable.
- The majority of the group disclosed some preconceptions about VWs.

Group B

Surveys 6 and 7 were carried out before and after the introduction of VW activities respectively. Survey 8 was applied to the Research Methods unit, which incorporated VW elements throughout.

	Change in Routine Survey 6 Before VW Respondents: 3 (8)	Positive (%) AQ>16 (AQ<=16)	Unsure (%) AQ>16 (AQ<=16)	Negative (%) AQ>16 (AQ<=16)
SQ1	You have prior knowledge of VW	63 (48)	8 (2)	29 (50)
SQ2	You have heard and understood the term ‘simulation’	100 (87)	0 (0)	0 (13)
SQ3	You have a positive attitude to VW in HE	67 (31)	33 (63)	0 (6)
SQ4	Your attitude is positive to a change in routine	100 (100)	0 (0)	0 (0)

	Change in Routine Survey 7 After VW Respondents: 3 (7)	Positive (%) AQ>16 (AQ<=16)	Unsure (%) AQ>16 (AQ<=16)	Negative (%) AQ>16 (AQ<=16)
SQ1	VWs have provided you with a change in routine	67 (100)	0 (0)	33 (0)
SQ2	The change in routine has been beneficial	38 (65)	17 (12)	46 (24)
SQ3	You have enjoyed the change in routine	33 (86)	0 (0)	67 (14)
SQ4	You had preconceived ideas about the change in routine	67 (79)	0 (0)	33 (21)

		Before VW		After VW	
	Change in Routine Survey 8 Respondents: 2 (4)	Positive (%) AQ>16 (AQ<=16)	Negative (%) AQ>16 (AQ<=16)	Positive (%) AQ>16 (AQ<=16)	Negative (%) AQ>16 (AQ<=16)
SQ1	Research Methods is challenging	50 (75)	50 (25)	50 (50)	50 (50)
SQ2	This subject requires a novel approach to be engaging	83 (67)	17 (33)	83 (67)	17 (33)
SQ3	The change in teaching routine was beneficial	82 (71)	18 (29)	91 (100)	9 (0)
SQ4	One teaching environment is sufficient	100 (75)	0 (25)	100 (100)	0 (0)

Surveys 6 and 7

- The majority of the group said they had heard of VWs and understood the term ‘simulation’.
- While LEHS students appeared to have a more positive reaction to the introduction of VWs, NLEHS students were largely non-committal.
- All students subsequently declared a positive attitude towards a change in (learning) routine.

- Having agreed that learning in a VW provided a change in learning routine, the majority of LEHS students took a negative or non-committal view of its benefits, while NLEHS appeared more positive.
- When asked whether they had enjoyed the change in routine LEHS students were more strongly negative, with NLEHS students being more strongly positive.
- The majority of the group did also admit to having some preconceived ideas about the use of VWs in their HE.

Survey 8

- With reference to the Research Methods unit most of the students found the change in routine to have enhanced their learning.
- LEHS students did not consider the intervention to have made any difference to the perceived challenge of the unit, while NLEHS students found the unit easier.
- When asked about the preferred learning environment for this unit, only one student (LEHS) selected the RW, while the remaining students selected 'both', the RW and the VW, see Appendix E.

Group C

Survey 15 established the students' initial attitude to the proposed VW intervention. A combination of surveys 16 and 17 indicated the students' reaction to the change in learning routine with respect to programming.

	Change in Routine Survey 15 Before VW Respondents: 4 (3)	Positive (%) AQ>16 (AQ<=16)	Unsure (%) AQ>16 (AQ<=16)	Negative (%) AQ>16 (AQ<=16)
SQ1	You have prior knowledge of VWs	34 (13)	10 (12)	56 (75)
SQ2	You understand the term 'simulation'	100 (100)	0 (0)	0 (0)
SQ3	You have a positive attitude to VWs in HE	100 (33)	0 (34)	0 (33)
SQ4	You have a positive attitude to a change in routine	100 (100)	0 (0)	0 (0)

	Change in Routine Surveys 16 and 17 After VW Respondents: 3 (3), 4 (2)	Positive (%) AQ>16 (AQ<=16)	Unsure (%) AQ>16 (AQ<=16)	Negative (%) AQ>16 (AQ<=16)
SQ1	After VW	63 (50)	0 (0)	38 (50)
SQ2	The VW change in learning routine was helpful	71 (58)	10 (9)	19 (32)
SQ3	The VW enhanced my understanding	69 (17)	23 (33)	8 (50)
SQ4	The change in learning routine should continue	70 (60)	0 (0)	30 (40)

Survey 15

- All students were generally in favour of the prospect of VW activities being part of their HE experience.

Surveys 16 and 17

- LEHS students had a very positive reaction to the change in learning routine with respect to programming, although this was not quite as positive for NLEHS students.

- The majority of students felt that the change in learning routine should continue.

Group D

The summarized questions from Survey 22 looked at learning before and after the VW experience.

		Before VW		After VW	
	Change in Routine Survey 22 Respondents: 13 (2)	Positive (%) AQ>16 (AQ<=16)	Negative (%) AQ>16 (AQ<=16)	Positive (%) AQ>16 (AQ<=16)	Negative (%) AQ>16 (AQ<=16)
SQ1	Programming is a difficult subject	94 (100)	6 (0)	37 (50)	63 (50)
SQ2	Understanding is supported by the teaching methods	60 (36)	40 (64)	80 (79)	20 (21)
SQ3	The teaching methods employed made the subject memorable	74 (50)	26 (50)	87 (75)	13 (25)
SQ4	Teaching methods should vary	53 (50)	47 (50)	63 (75)	37 (25)

- All students reported a perceived improvement in both understanding and retention of a challenging programming concept following the exercise in the VW as opposed to the taught methods in the RW.

- The majority of students chose a combination of the VW and the RW as their preferred learning environment for programming. In some instances they decided to clarify their opinion, see Appendix E.

5.3.2 Communication: Verbal/Non-Verbal

Group A

Survey 5 was carried out following Scenario 1. This was designed to encourage students to reflect upon their own communication skills after experiencing one of the more challenging management situations of having to deliver a difficult message to a member of staff.

	Communication: Verbal/Non-Verbal Survey 5 After VW Respondents: 5 (2)	Positive (%) AQ>16 (AQ<=16)	Unsure (%) AQ>16 (AQ<=16)	Negative (%) AQ>16 (AQ<=16)
SQ1	A VW is suitable for a sensitive communication	30 (25)	25 (25)	45 (50)
SQ2	The communication setting is important	100 (100)	0 (0)	0 (0)
SQ3	Cues are important to a successful communication	73 (50)	14 (33)	13 (17)
SQ4	Rehearsing a communication in a VW is useful	47 (39)	26 (17)	27 (44)

- Following the VW activity all students appreciated the importance of selecting an appropriate setting for a communication.

- Slightly more NLEHS than LEHS students considered the VW to be a suitable venue for a sensitive communication.

- A higher proportion LEHS than NLEHS students acknowledged the value of cues in establishing a successful communication following the exercise.

- A prevalent positive reaction to being able to rehearse a communication within a VW was found in LEHS students, while that of NLEHS was slightly more negative.

Group B

A combination of Surveys 13 and 14 was used to assess the perceived value of the development of communication skills afforded by VW experiences, particularly with respect to giving presentations.

	Communication: Verbal/Non-Verbal Surveys 13 and 14 After VW Respondents: 3 (4) and 3 (7)	Positive (%) AQ>16 (AQ<=16)	Unsure (%) AQ>16 (AQ<=16)	Negative (%) AQ>16 (AQ<=16)
SQ1	You have enjoyed/benefited from presenting is a VW	40 (86)	10 (8)	50 (6)
SQ2	You now see the benefits of presenting in the RW	89 (42)	0 (17)	11 (42)
SQ3	Critical feedback has been easier to respond to in a VW	58 (89)	9 (11)	33 (0)
SQ4	The VW activity made me appreciate a range of communication skills	29 (71)	7 (19)	64 (10)

- NLEHS students felt that they had enjoyed and benefited from the VW experience of giving presentations, whereas LEHS took a more negative view.
- However, LEHS students reported a much greater appreciation of the benefits of presenting in the RW, after the VW exercise, which was not so keenly felt by the NLEHS students.
- NLEHS students were very positive about the ease of responding to critical feedback in the VW, the LEHS students being slightly positive, and reported an increased awareness of the range of communication skills highlighted by the VW experiences about which the majority of LEHS were negative.

Group C

N/A

Group D

Survey 25 gave an indication of how the students perceived their ability to elicit information through skilful communication following the interview scenario in the VW.

- The ability to express themselves was slightly improved after the VW exercise in LEHS students, but NLEHS students perceived no difference.

- LEHS students considered that their ability to communicate with others was a problem following the VW exercise, whereas NLEHS students perceived no difference.

		Before VW		After VW	
	Communication; Verbal/Non-Verbal Survey 25 Respondents: 11 (2)	Positive (%) AQ>16 (AQ<=16)	Negative (%) AQ>16 (AQ<=16)	Positive (%) AQ>16 (AQ<=16)	Negative (%) AQ>16 (AQ<=16)
SQ1	Expressing myself can be difficult	27 (50)	73 (50)	36 (50)	64 (50)
SQ2	Communicating with others is not a problem	73 (100)	27 (0)	56 (100)	44 (0)
SQ3	The learning environment aided my fact finding ability	93 (100)	7 (0)	68 (87)	32 (13)
SQ4	I am confident in fact finding	64 (100)	36 (0)	55 (100)	45 (0)

- The majority of students reported a reduction in their perceived fact finding ability following the VW exercise.

- The LEHS students' confidence was slightly diminished as a result, although no change in confidence was reported by NLEHS students.

5.3.3 Play and Imagination

Group A

	Play and Imagination Surveys 1 and 2 After VW Respondents: 5 (2)	Positive (%) AQ>16 (AQ<=16)	Unsure (%) AQ>16 (AQ<=16)	Negative (%) AQ>16 (AQ<=16)
SQ1	VW play/imagination assisted my understanding	80 (21)	11 (29)	9 (50)
SQ2	The VW environment was easy to use	70 (75)	20 (0)	10 (25)
SQ3	The VW activity was memorable	50 (50)	20 (0)	30 (50)
SQ4	I will consider VWs for other uses	20 (0)	30 (25)	50 (75)

Surveys 1 and 2 were combined to assess the value of a VW scenario that used elements of play and imagination to explain one of the one of the more challenging topics within the Multi-Tasking Systems unit.

- The majority of LEHS students felt that the skills involving play and imagination promoted by the VW scenario improved their understanding of the concepts.
- However, half of NLEHS students did not agree that the use of play and imagination in the VW improved their understanding .
- Most students found the VW easy to use.
- Half of all students considered the VW activity to be memorable.
- The majority of students were either unwilling or unable to consider other applications for VWs, the stronger negative reaction coming from NLEHS students.

Group B

Survey 9 established the perceived value of play and imagination in the students' understanding of a challenging multitasking systems concept.

		Before VW		After VW	
	Play and Imagination Survey 9 After VW Respondents: 2 (4)	Positive (%) AQ>16 (AQ<=16)	Negative (%) AQ>16 (AQ<=16)	Positive (%) AQ>16 (AQ<=16)	Negative (%) AQ>16 (AQ<=16)
SQ1	Multi-Tasking Systems is challenging	50 (100)	50 (0)	50 (50)	50 (50)
SQ2	Play and imagination has aided understanding	92 (50)	8 (50)	83 (88)	17 (12)
SQ3	The VW has aided my confidence in understanding	100 (37)	0 (63)	100 (100)	0 (0)
SQ4	Traditional teaching is sufficient for this subject	50 (63)	50 (37)	100 (63)	0 (37)

Survey 9

- Half the LEHS and all of the NLEHS students considered multitasking to be a difficult subject, however the perceived difficulty was reduced in the latter group following the VW experience.

- LEHS students felt that the application of play and imagination strongly aided their understanding before the VW scenario, but the effect was slightly reduced afterwards, whereas NLEHS students found play and imagination in the VW to have enhanced their understanding more so than in the RW.

- LEHS were fully confident in their ability to understand the subject before and after the VW scenario. The confidence in understanding for NLEHS was significantly improved by the VW scenario.

- Following the VW scenario all LEHS and the majority of NLEHS students felt that traditional teaching was sufficient for this subject.

Survey 10 was used to gauge reaction to incorporating play and imagination for some fundamental object-oriented programming concepts.

	Play and Imagination Survey 10 After VW Respondents: 3 (5)	Positive (%) AQ>16 (AQ<=16)	Unsure (%) AQ>16 (AQ<=16)	Negative (%) AQ>16 (AQ<=16)
SQ1	Object oriented programming is challenging	33 (100)	0 (0)	67 (0)
SQ2	VW play and imagination facilitated understanding	53 (92)	14 (8)	33 (0)
SQ3	VW has been enjoyable and built confidence	45 (93)	22 (7)	33 (0)
SQ4	VW is better than traditional teaching	33 (73)	22 (20)	45 (7)
SQ5	A mixed (RW/VW) environment suits this subject	22 (87)	33 (13)	45 (0)

Scenario 10

- The majority of LEHS did not consider object-oriented programming to be a difficult subject, although all of the NLEHS students did.

- Following the VW activity most students found that play and imagination facilitated their understanding, although the reaction was much stronger in NLEHS students.

- The VW activity was found to be enjoyable and build confidence for the majority of students, the reaction being significantly stronger in NLEHS students.

- The stronger reaction in favour of a VW experience came from NLEHS students.

Group C

Surveys 18 and 19 were combined to determine whether play and imagination, facilitated through a VW experience, helped students to better understand some of the more abstract concepts in programming and databases.

	Play and Imagination Surveys 18 and 19 After VW Respondents: 3 (3) and 4 (3)	Positive (%) AQ>16 (AQ<=16)	Unsure (%) AQ>16 (AQ<=16)	Negative (%) AQ>16 (AQ<=16)
SQ1	This is a difficult subject	57 (67)	29 (0)	14 (33)
SQ2	Using VW play/imagination helped my understanding	63 (69)	22 (7)	15 (24)
SQ3	The VW made the concepts memorable	36 (45)	64 (22)	0 (33)
SQ4	A mixture of VW/RW improved learning	36 (33)	28 (34)	36 (33)

- The majority of the members of this group were in agreement that the topics, in programming and databases, were difficult and considered the VW exercise to have improved their learning.
- LEHS students were ambivalent about it having made the concepts more memorable, although NLEHS students were more in agreement that it had.
- At this stage, the group appeared to be divided about their learning environment preference.

Group D

Survey 23 was designed to elicit the students' opinion of programming in the early stages of the Software Design and Development unit.

Surveys 21 and 24 were combined to evaluate the influence of play and imagination before and after the VW activities were carried out in the following units: Software Design and Development, Systems Analysis and Databases. The results of the preferred learning environment are shown in Appendix E.

	Play and Imagination Survey 23 Before VW Respondents: 15 (2)	Positive (%) AQ>16 (AQ<=16)	Negative (%) AQ>16 (AQ<=16)
SQ1	You perceive programming as enjoyable	53 (50)	47 (50)
SQ2	You believe programming is difficult	52 (38)	48 (63)
SQ3	Traditional teaching limits understanding	47 (50)	53 (50)
SQ4	My understanding may improve through play and imagination	80 (100)	20 (0)

Survey 23

- Approximately half the group had some initial concerns about programming and considered it to be an enjoyable.
- Slightly more NLEHS, than LEHS students, viewed programming as being a difficult subject.
- Students were largely divided about the limitations of traditional teaching methods.
- Generally, students expressed a willingness to explore the VW techniques in the anticipation that it might offer a better understanding of this subject through the application of play and imagination.

		Before VW		After VW	
	Play and Imagination Survey 21 and 24 Respondents: 15 (2), 13 (1)	Positive (%) AQ>16 (AQ<=16)	Negative (%) AQ>16 (AQ<=16)	Positive (%) AQ>16 (AQ<=16)	Negative (%) AQ>16 (AQ<=16)
SQ1	The activity relates to a difficult concept	78 (67)	22 (33)	48 (33)	52 (67)
SQ2	Play and imagination helps understanding	55 (42)	45 (58)	71 (100)	29 (0)
SQ3	I am confident in this subject	42 (0)	58 (100)	81 (100)	19 (0)
SQ4	The subject has been made memorable	60 (0)	40 (100)	81 (100)	19 (0)
SQ5	The environment has enhanced my learning	56 (0)	44 (100)	71 (100)	29 (0)

Surveys 21 and 24

- The perceived difficulty of these particular concepts, in Software Design and Development and Systems Analysis and Databases, was reduced in the majority of students following the VW activities.

- There was a strong increase in confidence in these topics, which most students considered were made more memorable by the VW scenarios.

- Most students found the VW environment to have enhanced their learning.

- The preferred learning environment for databases was a mixture of VW and RW for LEHS students, while NLEHS students chose the RW.

5.3.4 Social Relationships

Group A

N/A

Group B

The combined results from Surveys 11 and 12 were designed to establish whether the VW Help Desk simulations assisted with social skills.

	Social Relationships Survey 11 and 12 After VW Respondents: 3 (7)	Positive (%) AQ>16 (AQ<=16)	Unsure (%) AQ>16 (AQ<=16)	Negative (%) AQ>16 (AQ<=16)
SQ1	The VW simulation was effective	45 (64)	6 (14)	49 (22)
SQ2	Rehearsal/role-play helped with social relationships	55 (54)	9 (22)	36 (24)
SQ3	VW helped with personal traits	40 (43)	13 (20)	47 (37)
SQ4	VW helped with inter-personal skills	41 (52)	18 (20)	41 (28)
SQ5	VW built confidence in social interaction	44 (53)	9 (27)	47 (20)
SQ6	The VW activities were better than RW activities	33 (35)	0 (45)	67 (20)

- The majority of NLEHS students found the simulation to be effective, while LEHS took a slightly more negative view.

- The majority of students found that rehearsal/role-play helped with social relationships.
- NLEHS were slightly more positive about the VW assisting with the interpretation of personal traits and inter-personal skills as well as building confidence with social relationships, whereas LEHS students had slightly more negative bias in all of these aspects except for inter-personal skills, on which they were divided.
- LEHS generally did not think that VW activities were better than RW activities, whereas NLEHS students took a more positive view.

Group C

Survey 20 gauged the students' reaction to the perceived difficulty of social encounters.

		Before VW		After VW	
	Social Relationships Survey 20 Respondents: 3 (3)	Positive (%) AQ>16 (AQ<=16)	Negative (%) AQ>16 (AQ<=16)	Positive (%) AQ>16 (AQ<=16)	Negative (%) AQ>16 (AQ<=16)
SQ1	Social encounters are difficult	56 (78)	44 (22)	33 (67)	67 (33)
SQ2	Dealing with different personalities can be challenging	56 (67)	44 (33)	56 (67)	44 (33)
SQ3	I am confident in achieving this unit	100 (89)	0 (11)	100 (89)	0 (11)
SQ4	Social skills training has been useful	100 (100)	0 (0)	100 (100)	0 (0)

- The results indicated that the VW activity reduced the perceived difficulty of social encounters for the majority of students, but to a greater extent for LEHS students.
- All students considered the training in social skills to have been beneficial, although they did not see the environment (VW or RW) as having any particular influence on their confidence in achieving the ICT Service Support unit.

Group D

Since this group were largely above the average AQ threshold it was considered important to gather as much data as possible about the opinions, feelings and reactions of students regarding any influence that the VW activities had on building social relationships. Survey 26 therefore consisted of all open format questions, allowing the respondents to answer freely and qualify their comments as necessary. These questions have been categorized into summary questions with a positive or negative bias.

	Social Relationships Survey 26 After VW Respondents: 15 (2)	Positive (%) AQ>16 (AQ<=16)	Negative (%) AQ>16 (AQ<=16)
SQ1	Do you consider the VW experience improved your ability to elicit knowledge?	79 (83)	22 (17)
SQ2	Do you think the social skills acquired in the VW might be useful in the RW?	56 (100)	44 (0)
SQ3	Did the VW experience was valuable/beneficial in allowing you to reflect on your social skills?	73 (88)	27 (13)
SQ4	Would you like a full assessment within a VW for certain units?	53 (50)	47 (50)

- The results indicated a strongly positive reaction to the benefits in social skills afforded by the VW with reference to the elicitation of knowledge, the transferability of skills to the RW and an opportunity for the self-appraisal of social skills.
- LEHS were slightly positive about having a full assessment within a VW for certain units, NLEHS were undecided.

5.3.5 Survey Open Comments

Any accompanying open comments from the surveys appear in Appendix E. These have been analysed for positive and negative reactions to the affordances of VWs, with respect to the soft skills identified in this study, see Section 5.5.3.

5.3.6 Discussion Forum

The following is a summary of the discussion with Group D, in which the TCA was used as a reference framework, see Appendix E:

- Team 1 were generally enthusiastic and positive about the VW experience, commenting on the potential for better communication between a systems analyst and an end user, through the use of VW technology, which in turn should result in a more accurate representation of a system *'people learn more when they are watching something'*. They also saw some benefit in the development of their soft skills. The student below the AQ average threshold remarked on the fact that activities in the RW would be more demanding.

- Team 2 were more divided in their opinions, the most negative comments coming from the student with the highest AQ score (45), who took the scenario literally, as opposed to treating it as a simulation. This was also true of others with higher AQ scores. However, some members of the group saw the scenario as a welcome addition to the assessment, as opposed to having an exclusively paper-based activity.

- Team 3 found the scenario engaging and said that the visualisation helped them to think about the stored data components. One comment '*I know how a surgery works (something more unusual would be more engaging)'* raised an important point to be addressed as part of their education; that it is never wise to base the design of a new system on a personal assumption.

- Team 4 were divided in their opinion, the strongest view against the use of VW technology again coming from a student with a high AQ score (33). Some would have preferred the paper-based option, while others saw the value of the interactive VW scenario.

A recurring theme among each of teams involved in the discussion was the concern about technical issues, an example comment coming from a Team 4 member *'I don't really think [the college] is ready for [SL] yet in [sic]the fact that our computers aren't good enough'.*

5.4 Supplementary Qualitative Data

The supplementary qualitative data, categorised as Group-Based (personal/other/student publicity comments) and General (internal/external contributions/publicity articles) appears in Appendix E. A combined analysis of this appears in the next section.

5.5 Combined Results

5.5.1 Attainment

A comparison of average group grades in years with and without a VW intervention showed a significant improvement in achievement when the VW activities were incorporated, particularly for the years where work was carried out on an individual basis, see Sections 5.2.1 and 5.2.2.

A comparison of individual grades in units of a similar nature taught with and without the VW intervention, see Sections 5.2.1, 5.2, indicated that 77% of the students obtained a better grade in the unit that included VW experiences. When divided into LEHS and NLEHS components, 71% of the former 83% of the latter's grades were seen to have improved.

A within year comparison of individual grades for units with and without the VW intervention showed the difference in the improved achievement for units that included VW exercises as being significant, see Tables, 5.4-5.5, 5.12-5.13, 5.20 and 5.24, with the exception of group C(1), see Table 5.6, which was possibly due to severe technical issues. Apart from this anomaly, the average difference in attainment showed the tailored VW activities to have had a positive influence on all students, with a slower but gradual improvement in LEHS students as the study progressed, see Figure 5.14.

A comparison of formative assessments:

- between two assessments within a unit, one with and one without a VW component
- for a single assessment, containing VW and NVW elements

showed that the difference in attainment was statistically significant, see Tables 5.21 and 5.25 respectively. The improved results, appearing in elements that were associated with VW experiences, are illustrated in Figure 5.15.

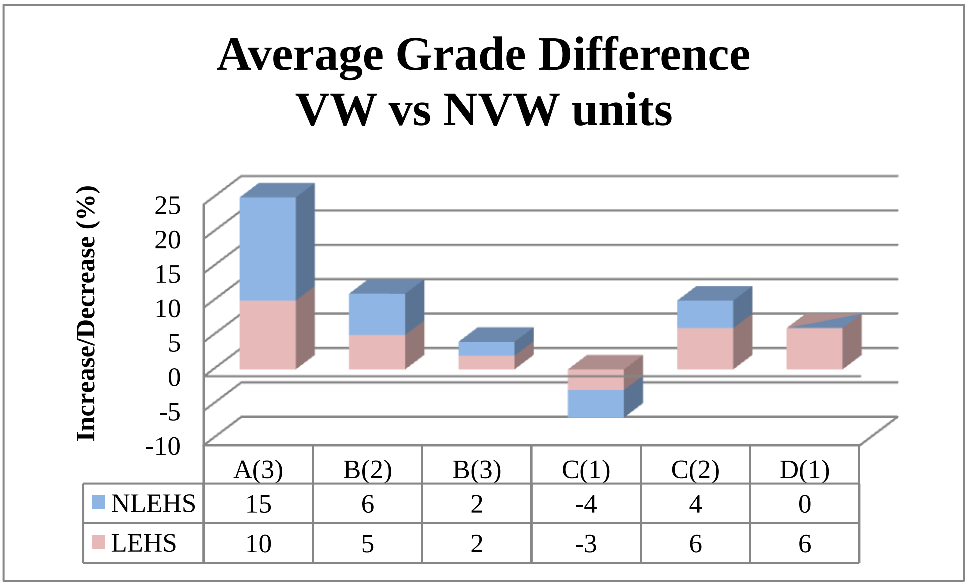

Figure 5.14 Unit grade differences (VW vs NVW)

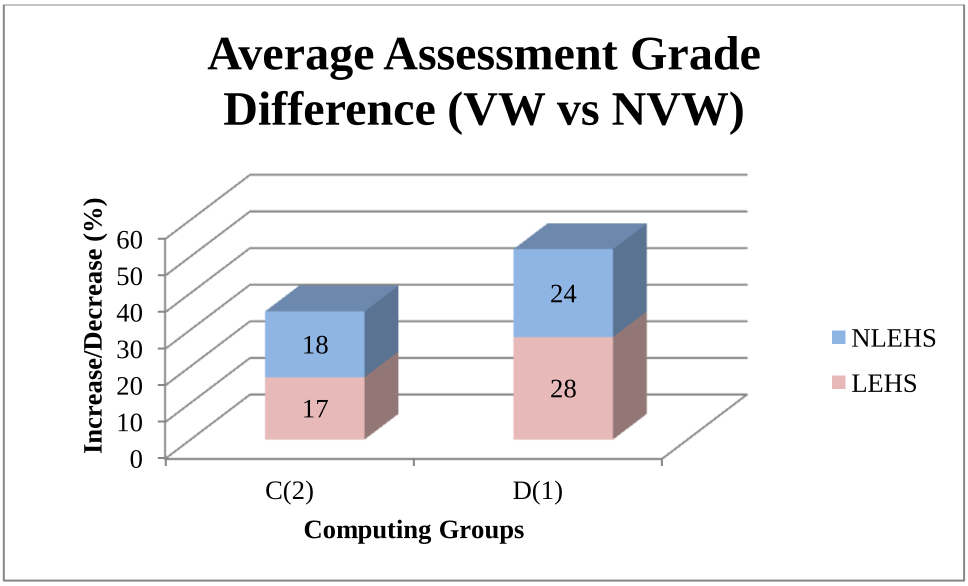

Figure 5.15 Assessment component grade differences (VW vs NVW)

5.5.2 Progression Outcomes

The following provides an overview of the progression outcomes within the four study groups with the introduction of VW activities to their curriculum.

Group A - VW introduced in Year 3; all students achieved a BSc(Hons) with a strong degree classification profile for the group. Prior to the completion of their course, three members of the group had received offers of employment or a course placement with their university of choice and a further three were in full time employment within six months of the completion of the course. All appointments were typical of the ICT industry.

Group B - VW introduced in Years 2 and 3; at the end of Year 2 all students achieved the minimum grade or above for progression to Year 3. At the completion of the course all students within Year 3 achieved a BSc (Hons) with a degree profile that exceeded expectations. They received a number of impressive employment offers in the ICT industry.

Group C - VW introduced in Years 1 and 2; all students achieved the minimum grade or above for progression to Year 3.

Group D - VW introduced in Year 1; in view of all the difficulties normally associated with the transition to HE, this group reflected an unusually high standard of attainment for the first year of a degree course in computing at the institution. This helped to establish a sound basis for Year 2 of the course.

5.5.3 Perceived Soft Skills Development

A thematic analysis was carried out on the survey data gathered in Section 5.3 to discover the students' perception of the key VW affordances in relation to each soft skill. The percentage of students giving a positive reaction is shown in Table 5.31and illustrated in Figures 5.16-5.19. Also included are the observations of others in relation to each soft skill, as well as analysis of open survey comments and those from the discussion forum. These outcomes are discussed further in Section 6.1.

Table 5.24 Student perception of VW affordances in relation to soft skills

VW Affordances	LEHS Students	NLEHS Students	All Students
Change in Routine			
Experiences were memorable	87%	75%	81%
Some initial prejudice	79%	77%	78%
Enhanced understanding	75%	48%	62%
Perceived as beneficial	75%	81%	78%
Should continue	70%	60%	65%
Considered to be enjoyable	57%	68%	63%
Communication			
VW highlighted the value of cues and venue	87%	75%	81%
Clarified the benefits of RW presenting	80%	42%	61%
Responding to critical feedback was easy	58%	89%	74%
Rehearsal in the VW was useful	47%	39%	43%
Play and Imagination			
Confidence in understanding was improved	91%	69%	80%
Understanding was improved	72%	66%	69%
The VW events were enjoyable	58%	97%	78%
Learning was made more memorable	56%	65%	61%
Social Relationships			
Improved eliciting information skills	79%	83%	81%
Provided insight to social skills	78%	100%	89%
Generated a self-awareness of social skills	73%	88%	81%
Consider skills to be transferrable to the RW	56%	100%	78%
Rehearsal/role play was helpful	55%	54%	55%

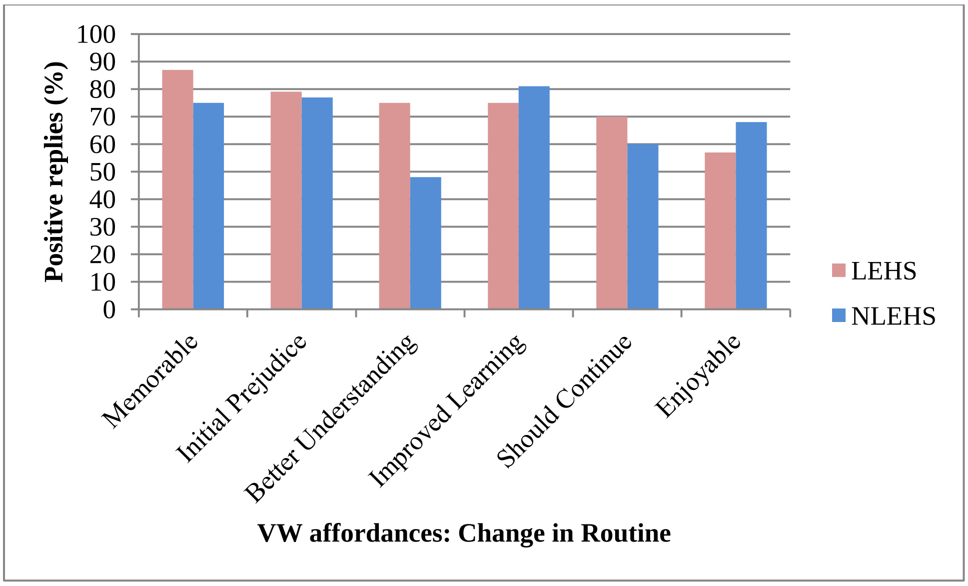

Figure 5.16 Student perception of VW affordances: Change in Routine

Observations

'The change in routine of learning iteration through the practical application of iteration in the VW, showing the consequences of programming actions, helped the students to assimilate the concept more readily'

Summary of Personal Observation, Scenario 15

'[Student A is] keen to learn and able to adapt his knowledge and skills to many different business areas and roles.'

[Employer 1] from [Company 1] cited by Weston College, 2014, p. 8.

'I benefited from the variety of teaching methods the course offered.'

[Student B] cited by Weston College, 2014, p. 32.

'Presenting our work in a virtual world has brought another dimension to the development project.

[Student A] cited by Weston College, 2013.

'[students have been able to develop their skills in] managing difficult situations or customers.'

SS1 Feedback - Tech Genius Help Desk (RW): Question 1

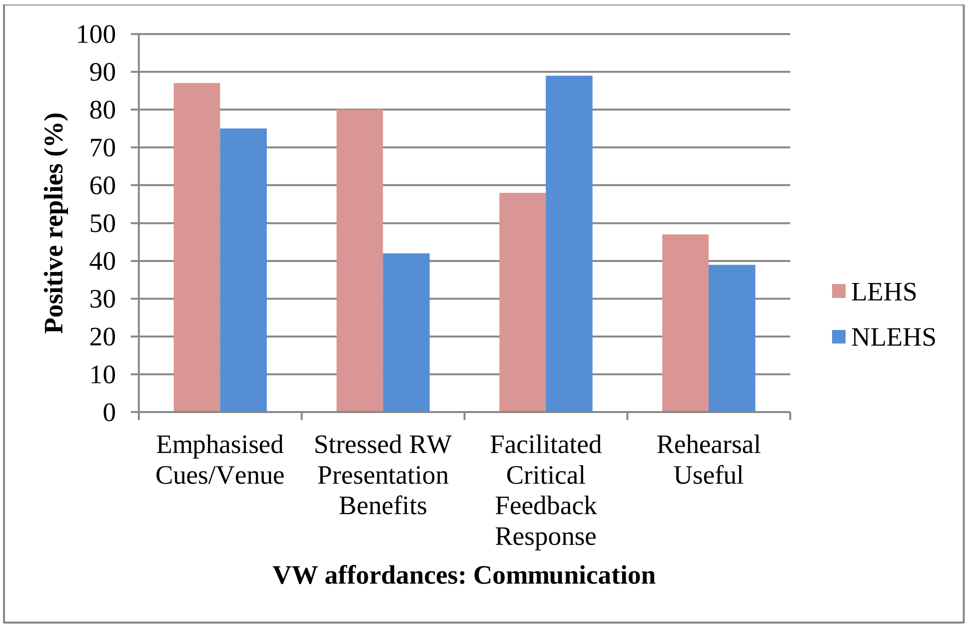

Figure 5.17 Student perception of VW affordances: Communication

Observations

'Students were able to judge the success of their own communication from the amount of information they were able to report that they had elicited at the end of the interview.'

'Certain [VW] scenarios served to highlight the benefits of [communication in] the RW'.

Summary of Personal Observation: Scenario 17 / Scenarios 8 and 9.

'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 B] cited by Weston College, 2013.

'Student[s] felt more confident in their presentation delivery and they become less resistant to carrying out this type of activity for their coursework.'

HES1 Feedback - Student Soft Skills. Following the introduction of VW technology: Question 1.

'[…] the verbal and non verbal communication in particular has been enhanced with noticeable improvements in the social relationship skills.'

HES1 Feedback - Student Soft Skills. Following the introduction of VW technology: Question 2.

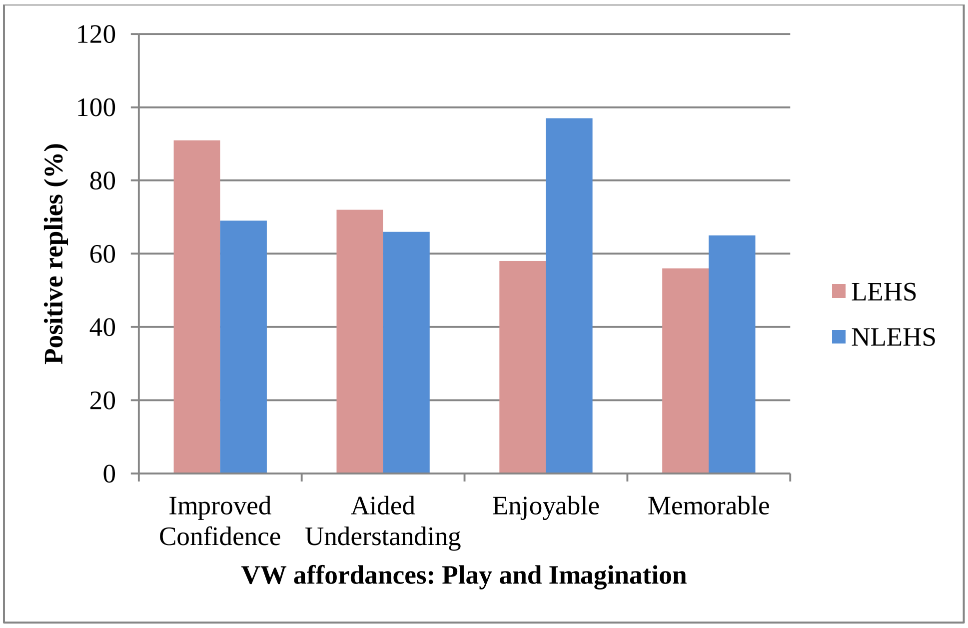

Figure 5.18 Student perception of VW affordances: Play and Imagination

Observations

'Through scenarios that applied play and imagination the level of anxiety associated with difficult topics was visibly reduced. Students became part of the event without any noticeable self-consciousness.'

Summary of Personal Observation: Scenario 2

'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.'

Field External Examiner's Report: 2013-2014, 'Observed Distinctive and Good Practise'.

'Certain skills such as imagination are difficult to convey using traditional methods'

HES1 Feedback - Student Soft Skills. Before the introduction of VW technology:

Question 5.

'[the most successful exercise … has been] the visualisation of programming instructions e.g. loops and the first 2 normal forms of the database normalisation process as these were very abstract concepts and the visualisation has aided their understanding and learning.'

HES1 Feedback - Student Soft Skills. Following the introduction of VW technology: Question 16.

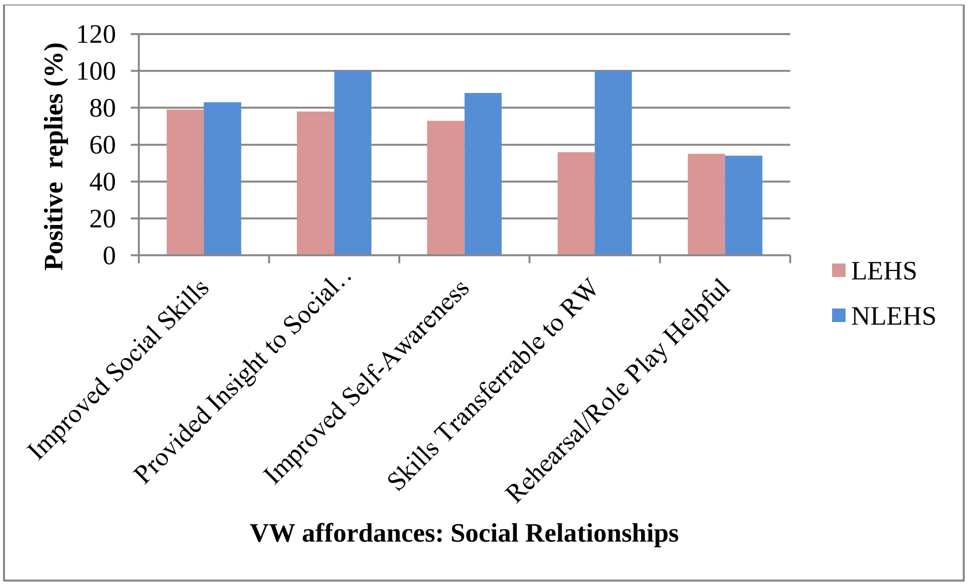

Figure 5.19 Student perception of VW affordances: Social Relationships

Observations

'The experience and skills [Student A] gained [...] have enabled him to fit into any situation.'

[Employer 1] from [Company 1] cited by Weston College, 2014, p. 8.

'They have definitely become more confident/outgoing as the project has continued [...].'

SS1 Feedback - Tech Genius Help Desk (RW): Question 3.

An analysis of open comments from the student surveys, see Figure 5.20, showed a mostly positive reaction to the VW intervention, many highlighting the learning benefits resulting from experiences in the VW:

'I found that learning in Second Life and in the virtual world was beneficial to my studies as it was different to anything I had done in educational environment before.'

'We were able to simulate and learn things that could not be simulated or explained within the classroom. It also showed us a new way of learning which made things more interesting.'

However, some persistent technical issues caused an amount of dissatisfaction and this was expressed in the majority of negative reactions:

'Less network lag on Second Life!'

'I think Second Life needs to be improved before it can be used in a professional way as it has many let downs such as low fps, graphics terrible, animations terrible. Overall it fails as usable software.'

This view was also confirmed by HES1 Feedback - Student Soft Skills. Following the introduction of VW technology: Questions 15 and 17 respectively:

'Technical issues e.g. slow network, low specification graphics adapters caused frustration for the students as they felt they are not learning as fast as in the RW.'

'Generally the outcomes were positive however [...] the technical issues have impacted the results of questionnaires [...].'

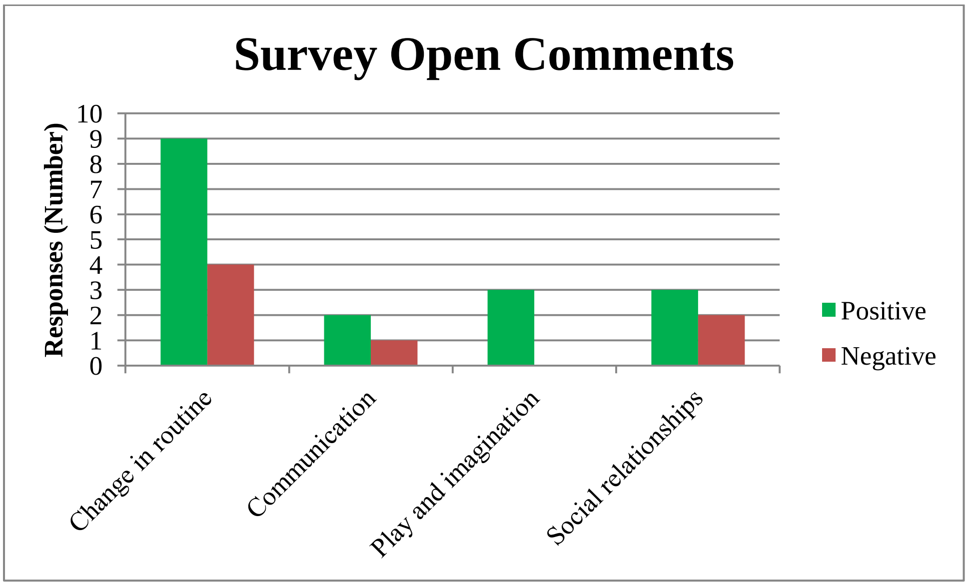

Figure 5.20 Survey open comments: Groups A-D

The discussion forum transcript was analysed for positive and negative comments relating to the soft skill set, see Figure 5.21. While the overall reaction was positive, thereby confirming the open comment survey above, there was a strong negative reaction to the use of play and imagination. The following provides comments from students who were higher on the AQ scale i.e. ≥ 32, in teams 2 and 4 respectively:

> *'[the VW] does not help me personally at all [...]too detached from [a] RW situation'*
>
> *'I was just focusing on trying to find the clues. I wasn't really thinking: this is a doctor's surgery'.*

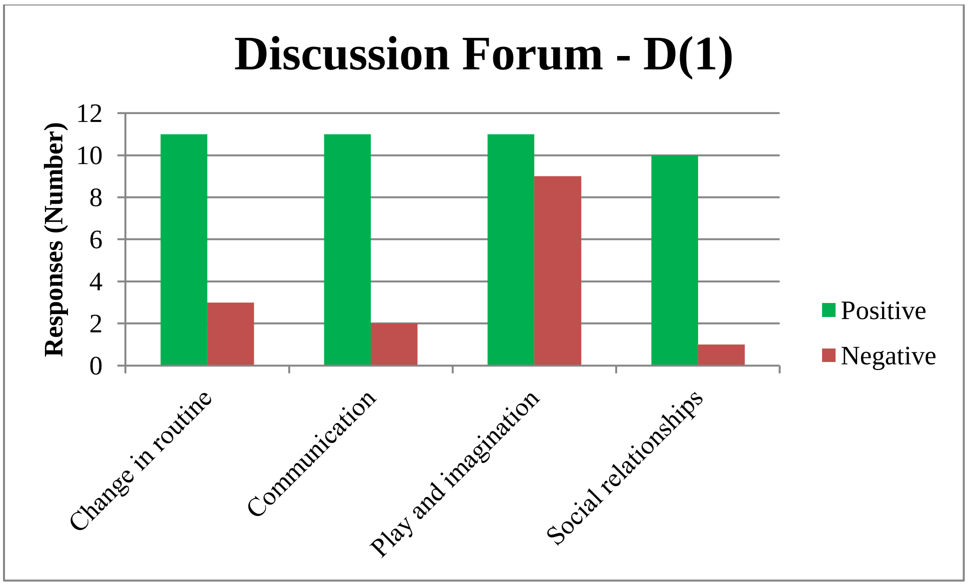

Figure 5.21 Soft skill perceptions: student discussion forum

5.5.4 Preferred Learning Environment

Two of the groups were asked to provide an opinion of their preferred learning environment based on their overall experiences. They were asked to consider the advantages and disadvantages of developing the targeted soft skills within the RW and the VW as they were presented during the course of their studies.

The results summarised in Appendix E, and illustrated in Figures 5.17-5.19, showed a tendency to select 'both' the RW and the VW, with some LEHS students selecting the VW only.

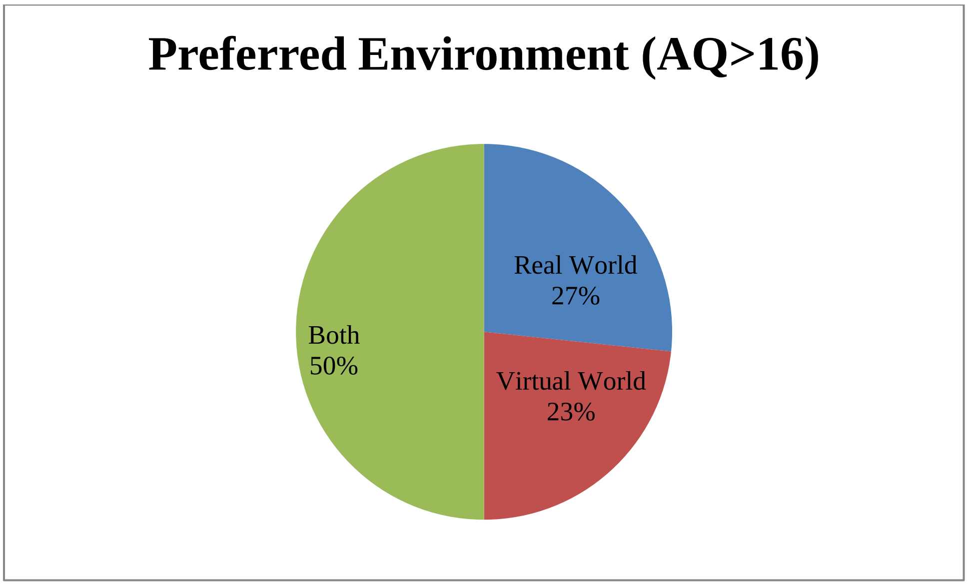

Figure 5.22 Preferred learning environment: LEHS students

Comments were not specifically sought as part of the survey, but some students took the opportunity to clarify their selection, see Preferred Learning Environment Summary in Appendix E, and a distinct bias can be seen in favour of the VW when ‘both’ are selected. None of these comments related to technical issues and regardless of the amount of disruption they caused, students seldom reported poor technology as a reason for inhibiting participation.

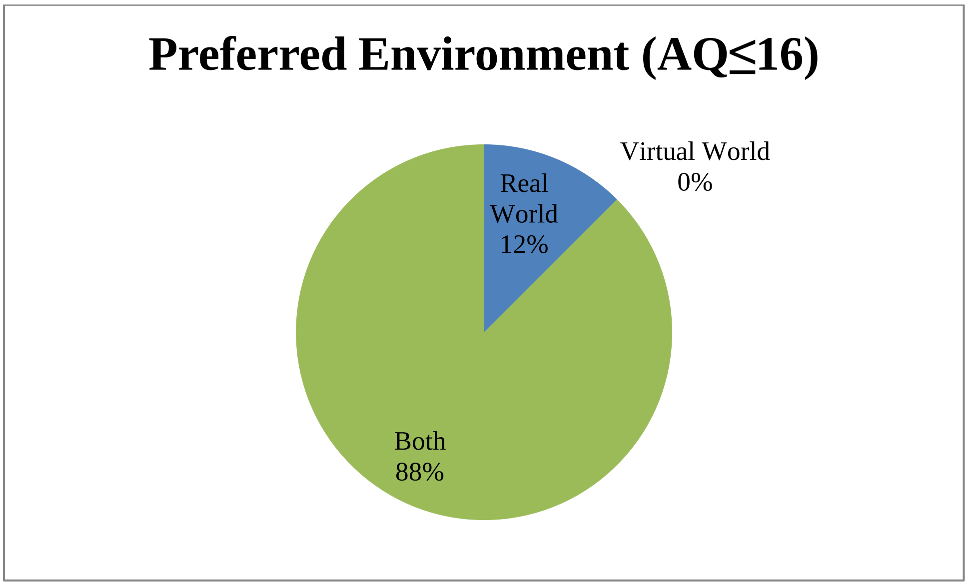

Figure 5.23 Preferred learning environment: NLEHS students

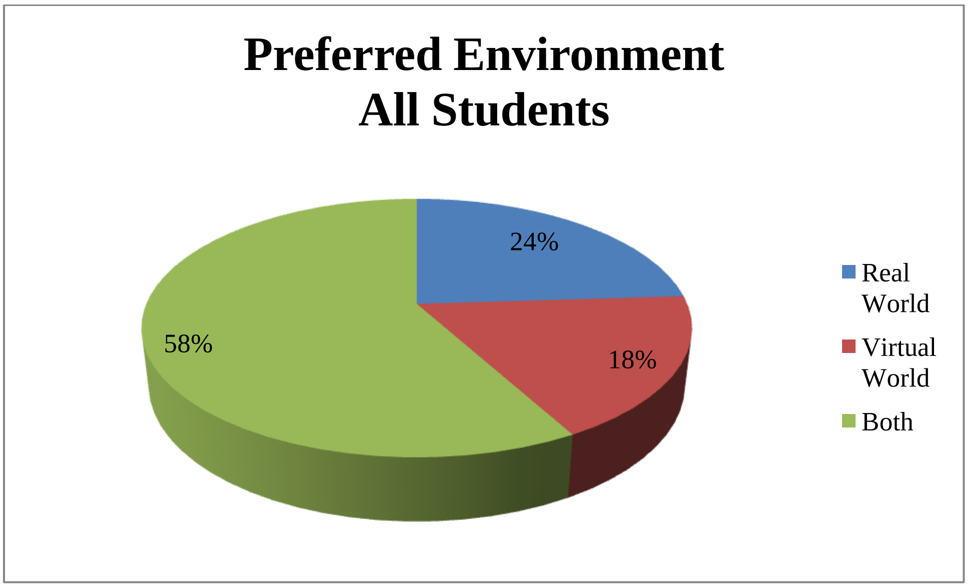

Figure 5.24 Preferred learning environment: All students

The environment selected generally reflected the positive reaction of the open survey comments. Within Group C, 70% of the LEHS students and 60% of NLEHS students said that their preference was for the VW activities to continue. However, a close examination of the data revealed that all students with an AQ score ≥32 selected the RW only as their preferred learning environment. This is discussed further in Section 6.3.

5.6 Case Studies

Two students on the FdSc, referred to as Student 1 and Student 2, experienced some serious difficulty with communication. These students had AQ scores of 27 and 22 respectively. The problem was of such concern that a brief discussion of the condition of selective mutism (SM) is warranted. Originally described as 'elective' mutism it has been known to occasionally occur with autism, but is not necessarily confined to those with an autism spectrum disorder. It can also happen when a person who is normally capable of speech does not speak in certain situations or to certain people (Viana et al., 2009).

It has been suggested that SM might be a manifestation of an anxiety disorder, such as social phobia (Smith and Sluckin, 2015) and has been described as having a reputation for being particularly difficult to resolve (Standart and Couteur, 2003). It is also considered to be an unusual condition. However, from a personal perspective, computing students often have to work on their communication skills as they will often clearly understand a concept, but find it difficult to explain to others. However, a consistent failure to speak in situations, where speaking is appropriately expected, is likely to present a major barrier to academic progress as well as career success.

As with any issue, the longer it persists the more difficult it becomes to resolve. Therefore it was of particular concern to confront the situation early in the course, in order to avoid the possibility of it becoming a self perpetuating issue, with all the accompanying problems that this may bring, such as social isolation. In the classroom it was important to pay attention to the verbal and non-verbal negative reinforcement that sustains this problem such as withdrawing requests for an individual to speak (Wong, 2010). However, a very positive contribution to their RW behaviour was seen through their embodiment as avatars, allowing the students to feel more comfortable about participation at an early stage.

Student 1 was able to give the presentations in the RW that were a basic requirement for course progression. Example survey questions to which the respondent 'fully agreed' were:

- You have enjoyed the scenario designed for you in the VW of Second Life to learn programming in a visual manner - Survey 17.
- You had less engagement in the activities of the database normalisation in the physical classroom - Survey 19.
- I find the [VW] training on the helpdesk duties helpful - Survey 20.

While alternative options to a FdSc had originally been recommended for Student 2 because of previous communication difficulties at the institution, he had been offered a place by the course co-ordinator in the belief that these barriers could be overcome. An early opinion was sought from a member of the HE team:

> *'This student has very good technical skills however he cannot be a successful web developer simply because he needs to communicate with the client – explain to them the requirements of a web site and explain his product. He will be able to pass the unit but he will face severe difficulties in the future putting his knowledge into practise.'*
>
> HES1 Feedback - Student Soft Skills. Before the introduction of VW technology: Question 5.

However, it transpired that the most dramatic change was seen in this student. As time progressed, he was not only able to give successful RW presentations, but chose to start the Work-Based Experience unit early and in so doing was able to successfully discuss requirements with a range of external clients (providing a number of Web sites for them, including one specialist high profile commission). Student 2 became a key member of his 'business group' and the successful dynamics of the team led to them actually starting their own business. Once Student 2 began to communicate and consequently interact socially, he was able to reveal a delightful personality to others. He became extremely popular within the institution, with staff from areas other than computing going out of their way to speak well of him.

Student 2's comments about VW were as follows:

> *'I enjoyed the use of browsing the scene for any clues and having a designated time slot to hold an interview with a real user'*
>
> *'Yes, it was refreshing to have this task in the simulation as it can open up new ideas and may result in improved clues being found'*

'It was beneficial yes! I am keen to continue using a virtual world'

In the 'preferred environment' section of Surveys 21 and 22, Student 2 selected the VW in the former and 'both - VW slightly more' in the latter.

While it could be said that a number of influencing factors contributed to the notable personal achievement of these students in overcoming such problems, it was also clear from their comments that the VW experiences had played an important part.

Summary

In this chapter the broad range of data collected from each of the participating groups, as well as the individual case studies, was collated and analysed. Where possible, verification of the interpretation and evaluation of findings was performed through triangulation.

Emergent patterns have allowed a number of conclusions to be drawn from the outcomes and these are discussed in the following chapter with reference to the research aims and objectives. Other themes that have surfaced as part of the process will be highlighted, along with the contribution to existing knowledge and some proposals further research.

6 Conclusions, Suggestions for Professional Practise and Further Research

The purpose of this research was to evaluate the ability of VW technology with its characteristics of immersion, identity and interaction, to foster the soft skills of computing students with LEHS tendencies. The targeted skills were those identified as presenting the most difficulty for these students, the intervention forming part of their technical HE experience.

In order to achieve the research aim, as well as provide a framework for the study, a number of objectives were devised as research questions, relating to each of the skills under inspection. Although these skills were examined separately, in reality they tend to interrelate and any affective influence in one will often be seen in others, communication skills, for example, will inevitably impact upon social relationships.

This chapter discusses the results in relation to each of the research questions. In considering outcomes from the combined main and supporting study groups, those involving LEHS students are highlighted. Conclusions are based on the students' perception of the VW experiences obtained from the survey summaries see Table 5.32, their open comments and the views of others. Further observations relate to scholastic achievement and progression outcomes relating to the VW intervention. The contribution to existing knowledge is explained, along with some additional themes that have surfaced during the course of the investigation. A number of ideas are proposed for implementing the techniques within a wider community, along with suggestions for future research in this area.

6.1 Discussion of Findings

RQ1: Does learning in a VW help to diminish the need for routine in LEHS computing students?

Some initial prejudice was found, in all groups, towards the change in learning routine proposed by the introduction of VW technology. However, the majority of students viewed this in a positive light following the intervention, a high proportion considering it to be memorable, as well as beneficial to their learning. Overall, the majority of students thought that the VW intervention should continue, since it was enjoyable and enhanced their understanding.

LEHS students agreed more strongly than NLEHS students that learning in the VW was memorable, it had improved their understanding and should continue. However, it appeared that they were not as positive about the learning benefits or their enjoyment of the experience, see Table 5.16. This may be explained in part by an examination of the detail, see Section 5.3.1:

- Survey 7, carried out in Year 2 of the course, indicated that the LEHS students in Group B did not consider the change in routine to have been of benefit, with only 38% agreeing that it had been.
- However, a significant improvement in their perception was seen in Survey 8, carried out in Year 3 of the course, with 91% agreeing that the intervention was beneficial.

While the results indicate that LEHS students did eventually embrace the change in learning routine, their acceptance of it appeared to be delayed, although further work is necessary.

RQ2: Are VW learning activities able to influence the verbal and non-verbal communication skills of computing students with LEHS tendencies and if so, in what way?

A high proportion of students indicated that the importance of cues (conveying messages through facial expression, voice, posture and attitude) and the selection of an appropriate venue, for achieving a successful communication, had been highlighted by activities in the VW. The majority of students felt that the VW facilitated the management of critical feedback and over half felt that their VW experiences had raised the profile of presentation techniques in the RW. However, less than half of the group considered the rehearsal of a communication in the VW to have been of value.

The results, shown in Table 5.17, show that LEHS students reported a strong appreciation of the significance of cues in enriching a communication, as well as the influence of a carefully selected venue, following the VW activities. Participants were required to work much harder in the VW at managing the many devices that contribute to a successful communication e.g. expressive body language, running a slide show etc. In their subsequent acknowledgement of the benefits offered by the RW, the reticence of LEHS students for giving presentations appeared to be mitigated. This can be considered an important outcome.

Just over half of the LEHS students considered that responding to critical feedback in the VW was easy for them, although the majority of NLEHS students did not consider the exercise to be a problem. This may suggest that LEHS students were starting to seek the additional feedback of cues that assist in the interpretation of comments, which would indicate some personal development in communication skills, but further work would be necessary.

RQ3: Can the use of play and imagination in the VW be helpful to learning for LEHS computing students?

Through the participation in scenarios that incorporated play and imagination within the VW, a high proportion of all students felt that their confidence in being able to understand a challenging topic was improved. They also felt that the scenarios were enjoyable. The majority of students considered that their subsequent understanding was enhanced by the experience and that learning was made more memorable.

A very high proportion of LEHS students reported that the VW activities involving play and imagination had increased their confidence in being able to understand a challenging topic and as a result their knowledge in that subject area had subsequently improved. However, with respect to the events being enjoyable and making learning more memorable, they were not as positive as the NLEHS students, see Table 5.18.

RQ4: Are VW learning experiences influential in developing the social skills of LEHS computing students and if so, in what way?

A very high proportion of all students reported that the VW scenarios provided some insight into social skills, generated an awareness of their own capacity for fostering relationships and improved their aptitude for eliciting information. A large proportion considered the skills they acquired in the VW to be transferrable to the RW, although just over half thought that rehearsal/role play activities were helpful.

A large proportion of LEHS students agreed that the VW scenarios had improved their ability to acquire information through social interactions, improved their social awareness and enabled them to reflect on their own capabilities in this area. However, in all these respects, they were not quite as enthusiastic as NLEHS students. Just over half the LEHS students considered that the skills developed in the VW would be relevant in the RW and viewed rehearsal/role play as being beneficial, see Table 5.19.

Overall, the student survey analysis indicated that the most positive reactions among LEHS students to VW affordances related to communication skills and dealing with non-routine situations, albeit with some delay in the latter. The views about play and imagination were equally divided between LEHS and NLEHS students, but LEHS students were generally more negative about the affordances their VW experiences offered for managing social relationships than the NLEHS students. An analysis of the student survey open comments showed a bias in favour of the VW intervention for building the targeted soft skills, which was also reflected in the discussion forum, see Figure 5.20 and 5.21 respectively. The strongest negative reactions applied to 'change in routine' in the former and 'play and imagination' in the latter. However, the discussion forum was conducted with Group D, which also included students with some of the highest AQ scores.

Certain situations were revealed as being less comfortable for LEHS than NLEHS students, such as the initial change in learning routine or the enjoyment of play and imagination see Figures 5.16 and 5.18 respectively in Section 5.5.3. Nevertheless, it should also be borne in mind that experiences, sometimes perceived as difficult at the time, can be equally beneficial to learning. Barnett (2011, p.1) mentions 'possibilities that both unsettle students, but which also help them to develop the inner resources to go on learning in a difficult world' and perhaps longer exposure to the VW may have mitigated the earlier reactions in LEHS students, as discussed above. However, even where some negative views were expressed, this does not appear to have adversely effected scholastic attainment. On the contrary, improved outcomes have generally been seen in units that incorporated VW activities. This was particularly the case for the formative/summative assessments that included or were linked to VW elements, where the component grades were considerably higher, see Section 5.5.1, Figures 5.14 and 5.15. The preferred learning environment for all students was a mixture of both the RW and the VW. However, of those who selected the VW only, all were LEHS students, see Section 5.5.4.

In terms of progression outcomes, all groups demonstrated a variety of success, some to an extent that would not have been predicted by the lecturing staff prior to the VW intervention. Within Group B, certain students were made offers of employment even before the completion of their course (Weston College, 2014), the employers being prepared to wait for what they considered to be right person. Student destinations for this group included:

- a research project leading to a PhD '*It was great to get a job before I graduated. My PhD will be based on modelling command teams in various domains from a* *sociotechnical aspect, and analysing how improvements could be made, to better facilitate objectives.*[…]' (Evans, 2014).

- software development positions:

  at a company employing Oxbridge students: '*It's been a great experience and I have learnt so much. I'm working on an app for central control systems* in houses *for things such as lighting, heating and cameras.'*

  at a London-based award-winning supplier of consultancy and software solutions for property companies and accommodation providers (Evans, 2014).

- a consultancy position within an ICT service organisation.

In addition, two of these students won prizes at the institution's Celebration of Success: the Principal's Scholarship and Higher Education Student of the Year (in partnership with HEI1).

The supporting study groups also exceeded expectations:

- for employment (Group A, see Section 5.2.1)
- in achieving the progression requirement for Year 3 (Group C, see Section 5.2.3)
- in attaining an unusually high grade profile for Year 1 of a computing degree course at the institution (Group D, see Section 5.2.4).

The transfer of these skills to the RW has been indicated by a number of internal and external observations, see Section 5.5.3 as well as the achievement of a prestigious award for the students' work on the Tech Genius Help Desk, see Section 4.7.1. But while most observations were positive it was clear that the use of VW technology did present numerous challenges that included not only the design and implementation of scenarios, but also technical, logistical and class management issues.

> *'[…] students who have a shortage of the [targeted] soft skills felt more active in the VW whilst they adopted a passive role in the physical world. However that needed an additional control by the lecturer to maintain the pace of the session delivered.'*
>
> HES1 Feedback - Student Soft Skills. Following the introduction of VW technology: Question 10.

6.1.1 Emergent Themes

Two themes have emerged during the course of the investigation: firstly, VW experiences can be transformative for those experiencing more serious problems with soft skills, and secondly, the scenarios developed for the VW may require some adjustment to better accommodate students with high scores on the AQ spectrum.

Theme 1:

Case studies highlighted the success of the VW experiences for students who presented some severe communication difficulties, which were also inevitably impacting upon their social skills. While this transformation, particularly evident in one of the students, could certainly be attributed to a number of factors, the influence of the VW can be seen in both their objective and subjective personal development, as discussed in Section 5.6.

Group B were an example of a cohort, consisting mainly of internal progression students, who had established a certain modus operandi at FE level and were having some particular issues in making the transition to HE. This was manifested in a problems relating to all of the soft skills involved in this research, meaning that any technical achievement could be compromised by their difficulty in practising the profession within a social context. At the beginning of the course, sustained disruptive classroom behaviour presented a number of challenges for the HE teaching team, as discussed in Appendix D. It was not until Year 3 that a sudden and quite dramatic change was perceived in this group. The noticeable application of this skill set in the RW resulted in a more co-operative and collaborative group ethos, which in turn fostered a determination to succeed in their studies. While this vote-face, appeared very late in their course and may be attributed to a number of factors, there is evidence to suggest that the extra support afforded by the VW intervention helped to develop the personal skills that enabled them to achieve some remarkable success in their studies and lay the foundation for their future careers.

Theme 2

A close examination of the data across all groups suggested a common theme amongst those with AQ scores of ≥ 32, which applied to certain students in three of the four study groups. All were found to have expressed a more negative view of the VW, a selection of comments across the groups being:

> *'I think that it is good, but will not be better than face to face contact.'*
>
> *(Group B, Survey 12).*

'In regards to Q12: I am open to new technology, not so much to [a] virtual environment.'

(Group C, Survey 16).

The following comments also indicate the difficulty these students had with the representation of objects in the VW, some of the reactions mirroring the issues discussed in see Section 2.3, such as 'the requirement to issue clear instructions', 'the directness of their criticism'.

'It doesn't help me personally at all [...] so detached from a RW situation. [...] Do they have medicine bottles at the Doctor's? the prescriptions would be in boxes.'

(Group D, Discussion Forum).

'I would say it wouldn't make any difference whether it was used or not. [...] There could have been more detailed objects.'

(Group D, Survey 26).

Of these students with the higher AQ scores, those in Groups B and D showed a preference for the RW as their learning environment with the Group C student 'fully disagreeing' that the VW activities should continue. This raises some questions about certain VW design aspects, such as the degree to which they should mirror the RW for students with high AQ scores and the type of educational devices employed e.g. metaphor, which may influence their engagement with online learning as suggested by Falconer (2008).

6.1.2 Conclusions

Based on the quantitative and qualitative evidence gathered through scholastic achievements and progression, student surveys and the opinions/observations of others, the following conclusions can be drawn:

- It appears that the VW intervention did help to diminish the need for an established routine in LEHS computing students. They were more in agreement than NLEHS students in four out of six categories depicting the affordances of the VW in relation to 'change in routine, see Figure 5.16. However, the reaction may have been delayed.

- The findings suggests that tailored activities in the VW were able to positively influence the communication skills of computing students with LEHS tendencies by raising their awareness of the key factors involved in a successful interaction. This also helped them to overcome their anxieties when giving presentations in the RW. They were more in agreement than NLEHS students in three out of four categories depicting the affordances of the VW in relation to 'communication', see Figure 5.17.

- The ability of the VW to aid understanding through play and imagination was found to be of valuable to LEHS computing students. They agreed in two out of four categories that depicted the affordances of the VW in relation to 'play and imagination', see Figure 5.18. Although some situations were viewed as not being particularly enjoyable or memorable, they were prepared to carry out activities in the VW that they would not normally have sanctioned in the RW.

- The results indicate that VW learning experiences had some beneficial effect on the social skills of LEHS computing students, by promoting an awareness of their own capabilities and presenting ideas on how to foster productive working relationships through a systemising approach. While they were more in agreement than NLEHS students in only one of the five categories depicting the affordances of the VW in relation to 'social relationships', there was no more than a 22% difference between the groups in three of the other affordances, see Figure 5.19.

As discussed in the previous section, complementary work carried out in a VW could provide considerable support for those experiencing more severe difficulties in the development of these soft skills, see also Section 5.6. However, students with the higher AQ scores of ≥ 32, were more critical of their experiences, which appeared to be largely due to the VW representation.

It is important that vocational computing courses lead by example and clearly demonstrate what they expect of their students, basically the practical application of principles, but ultimately the ability for innovation. The VW activities presented in this research were facilitated in areas of particular difficulty by a systemising approach. Apart from offering a new dimension to their curriculum, recent research has suggested that, contrary to popular belief, empathetic accuracy is derived more from systematic thought than 'gut reaction'

(Ma-Kellams and Lerner, 2016), meaning that this may be an approach that could benefit all students.

While a successful HE can be considered to consist of many contributory factors, the way in which a learning environment is presented tends to be reflective of the insight of the lecturing staff. This relates not only to the subject specialism, but also to the needs of its future practitioners. Students on vocational courses such as Applied Computing need to demonstrate their effectiveness in relating their knowledge and understanding to RW situations. The facilitated learning opportunities in the VW were representative of many RW situations that are likely to confront ICT professionals on day-to-day basis. This environment allowed students to learn from their experience and be free to make the mistakes that may prove disastrous within the RW, giving them greater confidence in their own abilities. The concept of a 'safe-pair of hands' should not be underestimated when an organisation's future is dependent upon its computing infrastructure and supporting staff. Employers have clearly recognised this potential in the graduating participants of this research.

It is not always the case that academic success translates into employability and learning is deepened through practical experience, a vital factor in building a professional reputation and a career path. The research has indicated that, despite a number of challenges needing to be overcome in the introduction and continued use of VW technology, it can provide a positive influence on the development of sought-after soft skills not only for career preparation, but also for personal improvement. As suggested by Dewey (1893) *'the most needed of all reforms in the spirit of education'* is to *'cease conceiving of education as mere preparation for later life, and make of it the full meaning of the present life'*.

6.2 Contributions to Existing Knowledge

The outcome from this research is the creation of bespoke VW scenarios that provide undergraduate computing students with more opportunities to learn and practice soft skills by dealing with technically-related problems. There has long been an acknowledgement of the need for soft skills in the computing industry and attempts have been made to hone them by various means (Hundhausen et al., 2013), see also Sections 1.7 and 2.6. While many studies have been concerned with the needs of the employment, there appears to be less attention paid to the problems some students face in acquiring soft skills, particularly those studying STEM subjects, see Section 1.3 and 2.21. There is much literature to suggest the benefits afforded by VW experiences to autistic spectrum conditions

(Kandalaft et al., 2013; Stendal and Balandin, 2015), but a paucity of advice on how those with LEHS tendencies might best be supported. This study contributes to shaping best practice guidelines by creating an understanding of the way in which the needs of these students may be better accommodated in their HE. The research indicates that a more tailored pedagogical approach was made tangible through the versatility of VWs, specifically SL with its potential for 'collaboration, immersion, aesthetics, creativity and social interaction' (Science Daily, 2007). Such affordances not only assisted and empowered students to overcome their anxieties, contributing to improved student learning and attainment, but also engaged them more profoundly in their studies, see Sections 5.5. This was achieved through the following:

- Scenarios were designed with sensitivity to the needs of LEHS students in order to extend their learning opportunities and increase participation; systemising was used as a strength for teaching empathising, the immediacy of extended support was offered through peer observation and the feedback of other VW participants, role play was conducted via avatars enabling students to acquire valuable tacit knowledge by means of skills, ideas and experiences, see Section 4.5.1.

- The VW environment accentuated the value of many learning devices, such as simile, metaphor, analogy, illustration and visualisation by making them more tangible.

  Ligorio et al., (2016 p. 235) mention the 'expressive power of metaphors to represent people, situations, ideas and feelings circulating within virtual space' providing 'concreteness and familiarity to the immateriality of virtual spaces'.

- The intrinsic importance of particular soft skills for effective professional practice was demonstrated through VW experiences, which in turn increased the receptiveness of participants to ideas that would improve their own capabilities.

- The VW permitted realistic scenarios to be constructed that were representative of RW events, allowing students to benefit from the authentic experiences of others. In this way, a rich repository of memories could be formed as a basis for the development of further strategies for managing situations in the RW.

However, while it appeared that the VW experiences were particularly successful in helping students who manifested more severe problems in the targeted soft skills, those with high scores on the AQ continuum expressed some dissatisfaction, discussed further in Section 6.4.

The research also provided some insight into the following:

- The value of constructive criticism within the context of an educational experience, in the design and development of VW scenarios. This eventual user involvement, applicable to software/systems development, helped to increase their effectiveness as a learning tool.
- The VW as a viable option in supporting both formative and summative assessment, by allowing a broader range of skills to be exercised than traditional paper-based method(s) could offer, see Section 4.7.4.

While these scenarios have been produced with LEHS students in mind, the personal development of all computing students appears to have benefited by this novel targeted approach which, in terms of educational practicality, is important. This raises the possibility of extending such techniques to other areas of STEM, particularly for the soft skills considered in this research, and even to other subject disciplines.

6.2.1 Study Limitations

The outcomes of the study should be considered in the context of a number of limiting factors, some of which were mitigated:

- Participant group limitations; it would have been useful to have continued the study for Groups C and D though to the completion of their courses in order to gather more data. While theoretically possible for Group D, this would have been difficult for Group C, as two different Year 3 courses would have been running in parallel the following year, either of which could have been selected by the group members. This could have meant unacceptably small numbers for a research study.
- Sample size and group culture; small group numbers created some statistical analysis problems, particularly for quantitative data. Also the culture that all groups develop tends to be more powerful when they are smaller, which raised some initial concerns about the impact this might have on student feedback. However, by examining the results from four combined groups and identifying data associations, both aspects were mitigated.

- Resources; the successful implementation of many scenarios required a number of additional/supporting resources including lecturing staff, rooms, volunteer participants along with a suitable network infrastructure and technical staff, all of which may not be available to some educational institutions.

- The HE environment; the research was conducted with HE students studying within a FE institution, where tuition was largely classroom-based with the more personalised approach permitted by smaller cohorts. The flexibility of being able to adopt novel learning and teaching methods may not be as viable at other HEIs with larger student numbers.

6.3 Suggestions for Professional Practice

While the bespoke scenarios devised for this study did represent a significant investment from the researcher, who was highly motivated to overcome the challenges, there is theoretically no reason why similar techniques used should not be adopted within mainstream education as well as for STEM subjects. Therefore, a number of ideas are proposed on how VWs and other methods could be used to incorporate the essence of the activities in this research.

While the evolving nature of VWs presents an opportunity for this technology to realistically form an intrinsic part of the HE experience, there still remains a number of barriers to their adoption, discussed in Section 4.8. However, the design and construction of VW scenarios should not necessarily be a deterrent, a major benefit being that once setup they are reproducible. One option is to invite contract bids for VW development, another is for educators and institutions to share resources. As suggested by a recent study examining identity federation solutions ‘if trust relations between institutions exist, within the use of Virtual Worlds, we are only one step behind the concept of 3D open education - by reusing shared resources and spaces, within institutional copyright policies and accountability terms.’ (Cruz et al., 2015, p. 33). It is also the case that many VWs, SL in particular, have the versatility of being able to be used at a range of levels, from simple to complex. Therefore, scenarios may even be devised and/or constructed by students as part of their studies, either for themselves or for others, with the benefit exercising soft skills in the RW.

It is also possible for the activities to be incorporated by other means, such as the multimedia program Air Gondwana (Butler, 2008) developed to replace traditional lecturing methods to teach integrated negotiating skills that used videos, online modules and machinima movies made using a virtual environment (SL), see Section 2.6. Other 2D environments would provide viable means, such as the following web-based solutions: the virtual classroom used by O'Flaherty and Laws (2014) to simulate the synchronous face-to-face discussions that occur between Bachelor of Nursing students and tutors in a 'flipped class' and the virtual simulation designed by Peddle (2015) to develop non-technical skills in student nurses and midwives

It is also possible to apply similar techniques in the RW, although depending on the nature of the students involved, these may not be as effective as the VW. Classroom activities may be setup, with students and/or invited guests playing different roles. There may be the option of requesting the support of drama students from within an educational institution, which could also benefit them. A RW field trip, such a visit to a park (or a walk in any 'green space') where students are encouraged to look for representations of programming concepts, may be used as an alternative to the 'PrimTime Education' scenario.

Importantly, student expectations do need to be managed, since their perceptions will be influenced by the relevance and authenticity of the activity being conducted to the course objectives. It is therefore crucial that session objectives are carefully prepared and shared with the students. While this is the case for any classroom activity, it is particularly relevant for any innovative educational technique.

6.4 Future Research

It would be possible to progress this research in a number of directions. Firstly, it would be interesting to determine the medium to long-term affective influence of the learning platform, the maintenance of effects and the generalisations to everyday life, by carrying out a longitudinal study. Although this may appear to present a challenge once students have entered employment, a productive working relationship established with staff as part of their HE, usually means that they are happy to remain in contact and provide further feedback. It has also been found that employers, appreciative of quality staff, are amenable to some dialogue with the educational institution that helped develop their skills. Secondly, the research could be extended to HEIs offering a different educational ethos and larger data sets, in order to overcome some of the limitations of this investigation. Thirdly, it would be useful to further explore some of the variable components of this research, such as the time required and/or the amount of exposure to the intervention needed to produce an affective response, as well other methods of implementation.

Finally, it was suggested earlier that students could be involved in the design and development of scenarios. It may be particularly useful for those higher on the AQ continuum, to suggest ways in which their requirements might be honed and integrated into scenarios that could be used by all. It would also be interesting to measure any influence that this extended participation in their education might have on student performance.

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Appendix A

Professional Capability Mix (adapted from SFIA Foundation, 2003-2014)

Professional Skills
SFIA lists more than 100 of these, such as database design.
Behavioural Skills
Being organisation-dependent these will vary, although some organisations use SFIA's generic level of responsibility definitions, such as oral and written communication.
Knowledge
A broad area in which ICT professionals are expected to be conversant, such as technologies and even legislation. Many ways of gaining knowledge are now being mapped to SFIA as a means of confirming professional skill requirements.
Experience and Qualifications
Experience will demonstrate the ability to apply knowledge and achieve practical outcomes. SFIA describes the skills, applicable to the experience expected at different levels. Qualifications demonstrate an understanding of the principles of a subject area, the mapping to SFIA demonstrates their value to the profession. Both experience and qualifications contribute to professional credibility.

Example Skill Set for a Systems Analysis Unit

<table>
<tr><td colspan="4">Systems Analysis Unit
Skills Mapping</td></tr>
<tr><td rowspan="3">Skills</td><td>Practical</td><td>Use of a CASE tool</td><td>Taught, Assessed</td></tr>
<tr><td>Personal</td><td>Time management
Personal organisation
Working with others
Independent research
Problem solving</td><td>Facilitated</td></tr>
<tr><td>Communication</td><td>Interviewing
E-mail
Written reports</td><td>Taught, Assessed</td></tr>
</table>

Example Skill Set for a Developing Professional Skills Unit

<table>
<tr><td colspan="2">Developing Professional Skills Unit
Skills Mapping</td></tr>
<tr><td colspan="2">Intellectual</td></tr>
<tr><td>Improving own learning and performance</td><td>Facilitated, Assessed</td></tr>
<tr><td>Applying theory to practice</td><td>Taught, Facilitated, Assessed</td></tr>
<tr><td>Developing reflective practice in self and others</td><td>Taught, Facilitated, Assessed</td></tr>
<tr><td colspan="2">Professional</td></tr>
<tr><td>Working in an independent and autonomous way</td><td>Facilitated, Assessed</td></tr>
<tr><td>Communicating professionally - including confidentiality</td><td>Taught, Facilitated, Assessed</td></tr>
<tr><td colspan="2">Key/Transferable</td></tr>
<tr><td>Communicating - using different formats (face to face, telephone, e-mail, written report and oral presentation) and with different audiences (peers, work colleagues, managers)</td><td>Taught, Facilitated, Assessed</td></tr>
<tr><td>Solving problems</td><td>Taught, Facilitated</td></tr>
<tr><td>Working effectively as a team and group</td><td>Taught, Facilitated</td></tr>
<tr><td colspan="2">Practical</td></tr>
<tr><td>Assessing strengths and development needs</td><td>Taught, Facilitated, Assessed</td></tr>
</table>

Visual Representation of Thesis Structure

Lead-in Materials	CHAPTER 1 Introduction
	CHAPTER 2 Literature Review
The Core	CHAPTER 3 Research Philosophy Ethics Methodology Methods
	CHAPTER 4 Research Activities
	CHAPTER 5 Analysis and Results
Lead-out Materials	CHAPTER 6 Conclusions Suggestions for Profession Practice Future Research

Appendix B

The Basis of the Empathising-Systemising (E-S) theory

Category	Brain Type	Description	Representation
E	Female	in which empathising is stronger than systemising	(E>S)
S	Male	where systemising is stronger than empathising	(S>E)
B	Balanced Brain	where empathising and systemising are equally developed	(S=B)
Extreme version	Male	individuals with an above average ability to empathise, but who are challenged when it comes to systemising	(E>>S)
Extreme version	Female	individuals with above average systemising ability, but who are challenged when it comes to empathy	S(S>>E)

AQ Results in a Large Population (adapted from Baron-Cohen, 2008)

Most people without a diagnosis fall in the region of 0-25
Most with a diagnosis fall between 26-50
Of those with an autism spectrum condition: 80% scored above 32 with 99% scoring above 26
93% of the general population fell within the average range of the AQ
99% of the autistic population appeared in the high end of the scale
The average threshold of the test in a control group was found to be 16.4 (Baron-Cohen et al., 2001, p. 5).

Example Employers of High Systemisers

Government Communications Head Quarters (GCHQ), the British intelligence and security organisation, have acknowledged the fact that in employees selected for their ‘neuro-diverse’ tendencies certain skills may be below average, but in other areas, such as the ability to analyse complex information, they are well above (Stanford, 2014; Kerbaj, 2015).

Systems, Applications and Products (SAP), a multi-national provider of enterprise software and services, have been recruiting people with autism for ICT related jobs in software development, testing and quality assurance, specifically because of their ability for intense concentration and their tenacity in detecting problems. By seeking people with a different mind-set they were also actively promoting innovation (Vasagar, 2013). Frith (1991) discusses Asperger’s view of parallels between autism, scientific originality and introversion, with the implication that she too would like to claim a ‘dash of autism’ for herself.

> *‘It seems that for success in science or art a dash of autism is essential. For success the necessary ingredients may be an ability to turn away from the everyday world, from the simple practical, an ability to rethink a subject with originality so as to create in new untrodden ways, with all abilities canalised into the one speciality’.*
>
> (Asperger, 1944, cited by James, 2003).

The final example is that of Hao2.eu Ltd, a small social enterprise, who use a variety of 3D VW/cloud technologies, ranging from open-source options like OpenSim to others like Unity3D, AvayaLive Engage and SL to design, program and sell 3-D ‘virtual office’ software. The majority of their staff are on the autistic spectrum. Interestingly, having won the Most Innovative Business category at the Nominet Internet Awards 2012 they built a model of the venue for the awards ceremony, the Saatchi Gallery (Hao2.eu, 2014). This enabled their team to rehearse the event, allowing them to participate with confidence in the RW and appreciate their recognition (O’Mahony, 2013).

These employers have accommodated their staff in the following ways:

GCGQ have a Neurodiverse Support Group, SAP ensure that a colleague is nominated as a single point of contact for each autistic employee and at Hao2.eu Ltd the team conduct their own meetings in the virtual office they have developed, as their staff tend to find face-to-face encounters in the RW uncomfortable.

Appendix C

The Knowledge Hierarchy

- Data: acquired facts, irrespective of context.
- Information: includes facts with some context and perspective, allowing for the identification of relations between the data.
- Knowledge: consists of information, where patterns in those relations start to emerge, from where an understanding of those patterns becomes apparent.
- Wisdom: includes knowledge, when the precise nature of why such patterns are occurring becomes clear and the underlying rules are able to be uncovered.

Many authors agree (Rowley, 2006) that the first appearance of the hierarchy was in T.S. Eliot's poem 'The Rock' in 1934, from the lines:

> *'Where is the wisdom that we have lost in knowledge?*
>
> *Where is the knowledge that we have lost in information?'*

More recent literature tends to cite a paper by Ackoff (1989) as a source, which included 'understanding' as part of the model. This has been criticised as a separate level by Bellinger et al. (2004) who saw 'understanding' as a requirement for the transition between each level.

Examples of how ethical values were instilled in HE computing

Element	Method(s)
Course Induction	IT code of conduct for the educational institution fully explained.
Group Tutorials	Students were informed of the code of conduct specified by professional bodies e.g. the British Computer Society. Career advice e.g. the rights and responsibilities of a Network Administrator.
Personal Tutorials	1:1 reinforcement of honesty, frankness and personal integrity, as and when necessary.
Course Units	Conduct issues embedded in unit outcomes e.g. Cyber Security and Ethics: ‘demonstrate an understanding of professional ethic’s. Also an integral part of the syllabus e.g. Service Support; Tools and Techniques: ‘ITIL concepts’.
Reading Lists	Required reading e.g. *Computer Security: Tavani, H.T. (2011) Ethics and Technology: Controversies, Questions, and Strategies for Ethical Computing.* Third Edition, John Wiley & Sons Inc., USA.
By Illustration	Examples from personal experience were used throughout the course to emphasise particular issues e.g. ensuring transparency in the selection of software contracts.
Setting an Example	The professional conduct of the HE Team members.

Research Material Relating to Ethical Approval

Initial Research Proposal

Why this subject is of interest:

Having worked at Weston College since 2007 as Curriculum Manager in Computing and ICT I have just started a new specialist post as Curriculum Co-ordination in Computing (HE). This is my particular area of interest and I am keen to explore new methods of delivery which would engage all students and allow them to demonstrate their abilities via a broader range of less traditional methods. The effect of this should be not only to improve retention and achievement but also to enhance the overall student experience. The Computing industry is continually evolving and the aim is to capture current tools and techniques to enhance the educational environment of Computing students allowing them to take more ownership of their education.

Background problems or concerns:

Research suggests (Baron-Cohen et al 2001) that some people who develop an interest in mathematics and computing tend to display characteristics that are typical of autism spectrum disorders (i.e. low empathising and high systemising).Traditional classroom methods of delivery and assessment are known to be problematic for some people displaying autistic tendencies – even those who would not be diagnosed as being on the autism spectrum. The requirements of a vocational course such as the FdSc and the BSc(Hons) in Applied Computing (WBL) are not only to ensure that students understand best practise but are able to apply these skills to any situation in a variety of commercial environments. The qualification is also designed to equip all students to be immediately useful in the workplace and the Work-based Learning component of the course ensures that learners have some experience of carrying out IT related work in a commercial setting. The use of a virtual world environment should enhance this aspect of the course by bringing activities into the classroom that are expensive or difficult to reproduce in the physical world.

An important trait for an IT practitioner is the ability to embrace change. The intention is to embed this ethos into the education of students where strategies linked to developing skills can both enhance and expand the overall experience of those who have decided upon a computing career. Therefore the investigation and exploration of virtual worlds would not only be an attractive proposition to students who have an affinity to this type of subject but also personality traits that are similar to some autistic tendencies (to a greater or lesser extent).

Research questions or intellectual puzzle the research is addressing:

The role of an IT employee is to ensure that staff are productive i.e. the job provides a means to an end, although it is often viewed as an end in itself from the perspective of the employee. IT students can be technically very good but in a workplace environment this is often not enough. For example, a common first appointment will be on the Help Desk where customer facing skills are essential to maintain productivity. Such skills have often been assessed by building portfolios of evidence, but actual experience of a difficult situation cannot easily be replicated in real life without causing some disruption to the workplace, and also be a stressful experience for those with social inhibitions or lacking empathy. A virtual classroom discussion following such a virtual world scenario might help to provide the tools and techniques to deal with adverse situations and assessment could be built into pre-determined situations for those who have difficulty presenting this information in a written format. A very common problem for IT students is having the confidence to deliver a successful presentation. Such techniques can be practised in a virtual world where mistakes can be made without embarrassment and then the experience transferred to the real world. The questions I will be addressing are:

Does simulation improve learning for Higher Education IT students who tend to have particular learning needs/personality traits of low empathising and high systemising

Can simulation better assess the ability of those students who may be disadvantaged by traditional assessment methods?

Will simulation enhance and extend IT skills thus improving student confidence as well as experience in order to ensure that the IT industry does not loose potentially valuable employees because of learning difficulties/personality traits?

Baron-Cohen S, Wheelwright S, Skinner S, Martin J and Clubley E (2001). The Autism-Spectrum Quotient (AQ): Evidence from Asperger Syndrome/High-Functioning Autism, Males and Females, Scientists and Mathematicians. *Journal of Autism and Developmental Disorders*, **31**, (1) pp 5 – 17.

Ethical Review Checklist: Original and Processed (Scanned) Documents

University of the West of England BRISTOL

Faculty of Environment & Technology

Research Ethics Committee (FETREC)

ETHICAL REVIEW CHECKLIST

Please provide project details and complete checklist overleaf.

Project Details:

Project title	Developing a more holistic approach to the education of HE Computing students by specifically addressing low empathising and high systemising tendencies through a virtual world experience.
Project funder	Weston College
Proposed project start date	**3 Jan 2012**
Anticipated project end date	3 Jan 2015

Applicant Details:

Name of researcher (applicant)	Janice Castle
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Status (Staff/ PG Student/ UG Student)	PG Student
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Contact telephone number	(01934) 411496
Name of co-researchers (where applicable)	N/A

For student applicants only:	
Name of Supervisor (for student applicants)	Liz Falconer
Supervisor's email address	Liz.Falconer@uwe.ac.uk
Supervisor's telephone number	+44 (0) 117 328
Details of course/degree for which research is being undertaken	The research will be undertaken @ Higher Education level within a Further Education college.

	CHECKLIST QUESTIONS	Y/N	Explanation
1.	Will participants be clearly asked to give consent to take part in the research and informed about how data collected in the research will be used?	Y	As part of the induction to the proposed programme and based on student feedback the course content has been revised to incorporate a number of additional TEL elements designed to benefit the students. The research will be built into the programme of study and students will be asked to critically reflect on the approach.
2.	Can participants withdraw at any time if they choose, and are they told this?	Y	The nature of the research is designed to enhance the student experience and this therefore will not be separate to their learning. But they can withdraw from anything they are asked to do in addition to this.
3.	Are measures in place to provide confidentiality for participants and ensure secure management and disposal of data collected from them?	Y	Security measures will ensure that data is safe and secure.
4.	Does the study involve people who are particularly vulnerable or unable to give informed consent (eg children, or people with learning difficulties)?	N	All participants will be involved in study at Higher Education level. Whilst some may have learning difficulties e.g. dyslexia, they are able to give their consent where necessary.
5.	Might your research cause physical or psychological harm or stress to participants, or to others, or damage to	N	Anonymity of participants will be maintained throughout the research, no names will be published.

	CHECKLIST QUESTIONS	Y/N	Explanation
	the environment?		
6.	Are there any aspects of the research that might lead to unethical behaviour by participants or researchers?	N	This will be monitored throughout.

Explanations should indicate briefly for Qs 1-3 how these requirements will be met, and for Qs 4-6 what the pertinent concerns are.

If Qs 1-3 are answered Y and Qs 4-6 are answered N, no further reference to the Research Ethics Committee will be required, unless the research plan changes significantly. In the case of a student applicant, the supervisor should submit the form on the student's behalf, to confirm their agreement with it.

Signature of applicant Date 12 Sep 12

Signature of supervisor…………………………………….

Date……………………….

Please send the completed form to **fetresc.enquiries@uwe.ac.uk**. For further guidance, please contact: Lynn Goh, Faculty Research Office (3S809), UWE Frenchay Campus, at the above email address or phone 0117 328 4250.

University of the West of England
BRISTOL

Faculty of Environment & Technology
Research Ethics Committee (FETREC)

ETHICAL REVIEW CHECKLIST This form was meant for UG/PGT, not PGR

Please provide project details and complete checklist overleaf. But this not clear on the form

Project Details: ⇒ FREC regards this checklist as a good-faith attempt to submit an application for ethical approval.

Project title	Developing a more holistic approach to the education of HE Computing students by specifically addressing low empathising and high systemising tendencies through a virtual world experience.
Project funder	Weston College
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Applicant Details:

Name of researcher (applicant)	Janice Castle
Faculty and School	FET
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Name of co-researchers (where applicable)	N/A
For student applicants only:	
Name of Supervisor (for student applicants)	Liz Falconer
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Supervisor's telephone number	+44 (0) 117 328
Details of course/degree for	The research will be undertaken @ Higher Education level within

which research is being undertaken	a Further Education college.

	CHECKLIST QUESTIONS	Y/N	Explanation
1.	Will participants be clearly asked to give consent to take part in the research and informed about how data collected in the research will be used?	Y	As part of the induction to the proposed programme and based on student feedback the course content has been revised to incorporate a number of additional TEL elements designed to benefit the students. The research will be built into the programme of study and students will be asked to critically reflect on the approach.
2.	Can participants withdraw at any time if they choose, and are they told this?	Y	The nature of the research is designed to enhance the student experience and this therefore will not be separate to their learning. But they can withdraw from anything they are asked to do in addition to this.
3.	Are measures in place to provide confidentiality for participants and ensure secure management and disposal of data collected from them?	Y	Security measures will ensure that data is safe and secure.
4.	Does the study involve people who are particularly vulnerable or unable to give informed consent (eg children, or people with learning difficulties)?	N	All participants will be involved in study at Higher Education level. Whilst some may have learning difficulties e.g. dyslexia, they are able to give their consent where necessary.
5.	Might your research cause physical or psychological harm or stress to participants, or to others, or damage to the environment?	N	Anonymity of participants will be maintained throughout the research, no names will be published.
6.	Are there any aspects of the research that might lead to unethical behaviour by participants or researchers?	N	This will be monitored throughout.

Explanations should indicate briefly for Qs 1-3 how these requirements will be met, and for Qs 4-6 what the pertinent concerns are.

If Qs 1-3 are answered Y and Qs 4-6 are answered N, no further reference to the Research Ethics Committee will be required, unless the research plan changes significantly. In the case of a student applicant, the supervisor should submit the form on the student's behalf, to confirm their agreement with it.

Signature of applicant

Date 12 Sep 12

Signature of supervisor……Liz Falconer

Date…18/9/2012.

Please send the completed form to **fetresc.enquiries@uwe.ac.uk**.

For further guidance, please contact:
Lynn Goh, Faculty Research Office (3S809), UWE Frenchay Campus, at the above email address or phone 0117 328 4250.

Participant Consent Form

Informed Consent

As part of Weston College's commitment to the introduction to Technology Enhanced Learning into Higher Education Janice Castle and HES1 are carrying out research into the effectiveness of this to help enhance the skills of computing students and to make learning easier.

Therefore permission is being requested to analyse the data collected as part of your normal studies in Higher Education Computing in order to determine the potential benefits to; students, their future employers, the IT industry and the wider community.

- All data, comments and discussions will be kept anonymous.
- No data, comments or discussions will be disclosed to third parties.
- You have the right to remove your data from the project at any time.
- You will receive a digital copy of the research paper on completion of the study.

If you are happy to take part please sign both copies and keep one for yourself:

Signed: ______________________________

Print Name: ______________________________

The ‘Rules of Evidence’ (adapted from Adams et al., 2014, pp. 14-15)

Real	Demonstrative	Documentary	Testimonial
‘Relevant’, ‘material’ and ‘competent’. So qualitative evidence, such as a questionnaire, could be seen as weak since it cannot easily be reproduced.	Submitted to support an argument, such as a quote or a diagram. To be viewed with a degree of caution and preferably accompanied by some additional validation.	Although seemingly authentic should be viewed with a degree of caution, preferably accompanied by some additional validation. A questionnaire would again be an example of evidence that cannot be considered as essentially ‘true’.	Supporting authentication is not generally necessary. However, account needs to be taken of any factors that may influence a response, such as self-interest.

Relevant Continued Professional Development

Further preparation for the research study was carried out through a variety of short courses such as, Excel 2010 – Summarising and Displaying Data (13 February 2013), Microsoft Visio - Module 1 (19 October 2012), The Digital Researcher - Social Media Workshop (12 December 13), and other Continuous Professional Development (CPD) activities involving seminars and/or workshops such as, BCS: Learning with Blended Reality (11 February 2013), BCS: Pervasive Learning Activities: Bringing Reality to Classroom-Based Teaching (22 July 2013), Practise Based Learning and Teaching, UWE Learning and Teaching Conference (29 April 2014). These are a small sample of the activities that were undertaken to help improve relevant knowledge as well as the quality of interpretation and reporting.

A range of skills were provided by the four course modules of the UWE MA in VWs, attended as part of the PhD Programme:

September 2012
- Designing Curricula in VWs

May 2013
- Scripting and Building Learning Environments in the VW

December 2013
- Research Methods in the VW

May 2014
- Artificial Intelligence, Bots and Non-player Characters

Appendix D

Research Considerations

When carrying out any research it is important to bear in mind any factors that may influence the credibility of results and therefore consideration was give to the following issues:

- Statistical calculations have taken account of the existing and new courses by applying the relevant weighted averages to represent the quantitative results as accurately as possible.

- For the period of this study two specialist HE lecturers were assigned to the majority of the Year 1 and Year 2 units and all of the Year 3 units. This provided some consistency and reduced the possibility of variable outcomes due to a wide range of staff with different teaching strategies.

- A further consideration was the steep learning curve that is generally seen on the first year of the HE computing course. The transition from FE to HE required a substantial alteration of the students' perception of study. This was a particular issues for Group A(1) who were taught by a number of staff already familiar to them at Level 3. In addition they were physically based on the same floor as the FE students, albeit in a dedicated HE room. However, by the time Group B had started their course the decision had been made to only include staff in the teaching team that were unknown to the students during their time in FE, in order to help differentiate the HE environment and therefore ease the transition. In the mean time, undergraduate provision at the institution had been moved to a central location within the building in order to strengthen the HE ethos.

- Following some serious concern with Group A(1)'s individual grade profile, a RW intervention was considered necessary. This took the form of introducing teamwork for the classroom activities, which was also extended to assessment work, with a view to improving individual progression opportunities to Year 2. Since this strategy appeared to be working well, it was refined and introduced to other years of the FdSc where some extra support was deemed necessary.

  The teamwork took the following form: students selected their own groups (of 3-4 students) and became a 'business' with their own company name, logo and culture. They were advised that all activities involving teamwork should be viewed from the perspective of their own company. Nevertheless, robust systems were in place to ensure that individual contributions was recognised and rewarded appropriately. However, all Year 3 courses continued to remain individual work only.

- As the effective use of VW in the classroom was very much dependent on the computing infrastructure within the institution, it was important that flexibility of technical support was available, particularly as a poor network response could influence the perceived value of the activities.

Research Assumptions and Terminology

As the VW intervention formed an integral part of the course, all students participated. However, for the purpose of the research study the following assumptions were made:

- Full-time students would only be included in the study to maintain data consistency and also to facilitate analysis.
- Students who, for whatever reason, did not complete the academic year were excluded from the results.
- However, those who retrieved units or had to retake specific units, but continued the course were included as valid participants, since they were sufficiently motivated to continue with their qualification.
- In the description of VW scenarios in Sections 4.4–4.7 the researcher was also the unit lecturer, unless stated otherwise.
- To preserve staff anonymity, members of the HE Applied Computing Team are referred to as HES1, HES2 etc. and support staff as SS1, SS2 etc.

Background and Nature of Participant Groups

The following provides some general observations on the background and nature of the four groups of students involved in the study.

Group A(3) - Pilot Study

In Year 1 a large proportion of students (86%) were internal progression. The group was diverse in terms of background, ethnicity and learning difficulties, but cohesive. However, the transition to HE was seen to be particularly challenging for them. From the start of the course they were extremely quiet, despite techniques that were put in place to encourage participation. By Year 2 they were taught only by specialist HE staff and the teamwork strategy was put into operation, which encouraged a greater degree of contribution while at the same time reinforcing the vocational ethos, as observed by Valenti (2015) 'the nature of work today is inherently team-based and collaborative, [as well as being] often virtual, and geographically distant'. This strategy developed a strong culture of mutual support, resulting in a substantially improved individual performance. By the start of Year 3, there were signs of significant changes in the group dynamic. The inclusion of VW scenarios was designed to give learners a greater degree of autonomy 'likely to increase the all-important motivation to participate' (Salt et al., 2008, p. 20).

Group B (1-3) - Main Study

This group was deemed to be the main interest for the study as their yearly progress though the course could be compared with and without the application of VW activities. However, this was not the sole reason for selecting Group B. In this case, the fact that the majority of the group (92%) were internal progression students, proved to be a distinct disadvantage to making the transition to HE, since a particular dynamic had already been established at Level 3. Early in the course, this group were showing signs of difficulties in areas that the research study was specifically designed to address. This was manifested by some extraordinary classroom behaviour i.e. a lack of concentration, vociferous outbursts, inter-personal conflict and a generally disruptive atmosphere that was far from conducive to learning at the required level. In other words, in terms of behaviour Group B was diametrically the opposite of Group A and this in turn was causing some serious educational challenges for the teaching team. In Year 1 a variety of attempts to engage these students had been made, including the teamwork strategy, which resulted in little improvement to the group's approach to their studies. While it is not unusual for the transition to HE to take some time, usually dramatic changes are observed in students at the start of Year 2, notably a transformation in attitude and commitment to the course. However, this was ominously absent in Group B(2). It was therefore an academic (as well as a research) decision to see if the group would benefit from the novel learning and teaching intervention of the introduction of VW activities in Years 2 and 3 of their studies.

Groups C(1-2) and D(1) - Supporting Studies

Group C was very small group, but diverse in terms of ethnicity and learning difficulties. They had some initial problems focusing on their studies, so it was decided to introduce VW elements in Years 1 and 2 of their course as supporting data for the research.

Group D was the first group of the newly created course, validated by HEI2. Therefore it was seen that this group would add breadth to the study. Again this was a diverse group containing a number of students for whom English was not their first language, including some learning difficulties and other personal issues.

Tech Genius Help Desk - Case Study

'Tech Genius' an IT Help Desk

Learning Technology Support *by* Students *for* Students

Background Information

Weston College has transformed itself in the last nine years and has maintained the position as one of the top performing colleges in the West of England Further Education College tables for the last four years. It continues to offer a wide range of courses to ensure that learners develop the skills that employers and universities are seeking. It offers more than 100 vocational courses, 27 A Levels and an ever increasing range of very popular Apprenticeships.

Over the last three years buildings and facilities have been invested in heavily to ensure that students are offered the best possible resources in the South West. The prestigious state-of-the-art University Campus opened in 2007 and houses Arts, Media, Design, Music and a Sixth Form Centre. It also houses Degree Level education delivered in partnership with Bath Spa University. Weston College's Knightstone Campus includes the latest technologies and modern facilities, including an industry standard fitness suite and gym, world-class training kitchens, a top restaurant, a Higher Education Centre, an Electrical Installation Training Centre and a Learning Resource Centre. The third site, the South West Skills Campus, located in an eight and a half acre site on Locking Road in Weston-super-Mare opened in September 2010. This campus contains the Progress courses, the Construction and Engineering Centre of Excellence and the bespoke Business Enterprise Centre.

The college is very technology oriented across all areas with a high number of computing laboratories. The majority of classrooms will contain interactive whiteboards and projectors. A high emphasis is also placed on e-learning, which allows students to access online resources through a **V**irtual **L**earning **E**nvironment (VLE) off campus over the Internet.

The college has an active IT Help Desk which provides support across all campuses for the college equipment and network. However, the support provided for staff is currently limited and only includes access to the college computer facilities. Students who require help and advice with computer technology are required to seek this via their course tutors.

The Problem

As technology is placed high on the college's agenda, students are actively encouraged to complete assessment work using computers both inside and outside of the college and to make use of the many facilities offered by the VLE. However, the Computing Department is unable to provide this extensive amount of support which may range from simple software installation and configuration problems to more serious hardware malfunctions and failures. In addition students, as well as staff, often require some assistance in the use of new and/or existing applications in order to carry out their work both effectively and efficiently.

A need therefore has been identified to better support end users and enable them to benefit as much as possible from the wide range of technical facilities available to them. This will take the form of a 'Tech Buddies' scheme to ease non-technical support pressures on the college Help Desk staff whilst empowering users to make the most of technology to support education.

The Solution

The proposal, therefore, is that a Help Desk will be setup by 'students for students'. This will be run as a 'Tech Genius Bar' staffed by Higher Education Computing students, who would provide help, support and advice for those who need it. Supervision will be carried out by LibraryPlus staff who will oversee some of the main areas of support such as:

- Quick fix of easily identifiable faults and IT problems with referrals to other departments if necessary.
- Sourcing and/or advising on the purchase of educational software for students' own use.
- Identifying training needs for students and advise LibraryPlus Learning Technology Team.
- Help students access the college online resources using their own and college equipment.

- Advice/guidance on how to make the best of college software.

ComputerGenius TabletGenius PhoneGenius
LaptopGenius SoftwareGenius DesignGenius
MusicGenius WebsiteGenius ResearchGenius
TechGenius.

Used with permission of the author and publisher (Hutson, 2015).

The IT Help Desk within the college is able to provide some limited advice with setting this up. For example, as a first step, the Head of IT has advised that a Service Level Agreement (SLA) should be developed so that the students know what to expect from this new student-led 'Tech Genius' facility.

It is envisaged that the ICT Service Support unit will form the basis of this project and be staffed by students studying the unit.

Other units will also make use of this project-based scenario for assessment tasks giving those studying at different stages of the course the opportunity be act as a customer; a service provider or consultant.

The Current Situation

Following a successful pilot year in 12/13 it has been decided that the Tech Genius service should continue this year. Therefore, FdSc Yr 2 Applied Computing will take on this responsibility from Sep 13. The selection of 'Tech Buddies' will again be subject to interview with current skills and interests being taken into consideration.

The remit is to provide advice and support for the many common enquiries that would normally be requested of Computing Support Staff and the Learning Resource's Help Desk, whilst using initiative to develop an efficient and friendly service that also incorporates a proactive approach.

The following is an example assessment added to the case study from the Managing Information BSc (Hons) course:

Example (Tech Genius-Based) Assessment

Members of the Tech Genius are in need of some advice and guidance for managing the large amount of information that they suddenly realise they are acquiring before it become a large problem. They are very busy themselves so have little time to deal with this administrative problem.

As you have had some experience in this area you are required to assist them as consultants. They do not fully appreciate the importance of data to the success of their service. Therefore you will need to carry out the following tasks and advise them on how to deal with this neglected aspect of their service.

Information Systems: The way in which IS (**I**nformation **S**ystems) are applied can affect both the strategy and competitiveness of an organization. Using, as opposed to wasting, the potential of these systems is one of the many challenges facing a manager and one key management responsibility is to ensure that IS staff produce systems that are relevant for the business.

Decision Making: The performance of an organisation is also influenced by the decisions people make. Therefore, an appreciation of the tasks through which decisions are carried out performed, the types of decisions that exist and models for the decision-making process is an essential management skill.

Communication: Despite the variety of technologies now available it is still common for communication to be ineffective within organizations. Technology can help, but communication is essentially a human activity, based on particular interpersonal skills. It is important for a manager to realise that these skills are exercised within an organizational context and this will affect the choice of communication method, which in turn will determine whether communication leads to mutual understanding.

Write a (2000 word) report to perform the following tasks:

Task 1: Carry out an evaluation of the data sources**,** information and retrieval systems in the LibraryPlus, explaining how they meet legal requirements.

Task 2: Perform an assessment of a decision-making process within LibraryPlus, and the information used to reach the decision(s).

Task 3: Evaluate the range of communication methods available (including electronic communication). Ensure that you analyse the advantages and limitations of each, by examining the context in which they can be used.

Task 4: Plan, run and follow up on a meeting, in the workplace (or as a simulation) to:

- Consider the evaluative work carried out above.
- Recommend ways of improving communication and productive working relationships.

Note:

The main report should also include appendices for knowledge and factual information which should not be counted in the total word count.

Appendix E

Quantitative Results

Progression Tables

Group A:

Progression	Results	No. of Students
Yr 1 (to Yr 2)	Pass	10
	Retrieval/Pass	1
	Unit Retake(s)	2
	Pass/Employment	1
Yr 2 (to Yr 3)	≥55%	7
	≤55%	3
	FdSc Achieved (Progression Declined)	1
Yr 3	Graduation: 1st	2
	Graduation: 2.1	3
	Graduation: 2.2	2

Group B:

Progression	Result	No. of Students
Yr 1 (to Yr 2)	Pass	12
Yr 2 (to Yr 3)	≥55%	11
Yr 3	Graduate: 1st	2
	Graduate: 2.1	3
	Graduate: 3rd	1

Group C:

Progression	Results	No. of Students
Yr 1 (to Yr 2)	Pass	6
	Certificate of HE	1
Yr 2 (to Yr 3)	≥55%	6

Preferred Learning Environment Tables

The following are tables from Surveys 8, 22 and 21. Students have been divided into LEHS and NLEHS categories and although comments were not specifically sought as part of the surveys, many chose to further clarify their selection.

A summary table of the combined groups and surveys is also provided.

Group B (for programming):

Preferred Learning Environment Survey 8	Real World	Virtual World	Both	Comments
AQ >16	1	0	1	*Both*
AQ ≤16	0	0	4	

Group D (for programming):

Preferred Learning Environment Survey 22	Real World	Virtual World	Both	Comments
AQ >16	2	5	6	*Mixture of both, 75% virtual.* *Both, virtual for hard to visualise concepts, real world for learning the concepts.* *Real world before, virtual world after using it.*
AQ ≤16	0	0	2	

Group D (for databases):

Preferred Learning Environment Survey 21	Real World	Virtual World	Both	Comments
AQ >16	5	2	8	*Both, but more of Second Life.* *Both, virtual world slightly more.* *Prefer virtual world a little more (lot more possibilities).*
AQ ≤16	1	0	1	

Preferred Learning Environment Summary

	Preferred Learning Environment	RW	VW	Both	Comments
Group B: Survey 8 Group D: Surveys 21 & 22	AQ >16	8	7	15	*[Both] providing the HCI improved.* *Both, but more of Second Life.* *Both, virtual world slightly more.* *Prefer virtual world a little more (lot more possibilities).* *Mixture of both, 75% virtual.* *Both, virtual for hard to visualise concepts, real world for learning the concepts.* *Real world before, virtual world after using it.*
	AQ ≤16	1	0	7	
	ALL	9	7	22	

Qualitative Results

Survey Open Comments

The following tables show open comments gathered from the student surveys, divided into LEHS and NLEHS components, within targeted soft skills.

CHANGE IN ROUTINE
Group A
Student Comments: Survey 3
AQ>16
'I have read a bit about [the] use of Second Life and have navigated through the software before. I think it is a good idea worth exploring further. I think students will benefit, at least I think I will benefit as I learn better from visualisations/pictures/videos.'
AQ≤16
'At first hearing about Second Life I couldn't see that it would help in education, however after seeing the virtual classroom it does seem good to visualise computing theories.' *'Seems too much work for not enough gain.'*
Student Comments: Survey 4
AQ>16
'I found that learning in Second Life and in the virtual world was beneficial to my studies as it was different to anything I had done in educational environment before. We were able to simulate and learn things that could not be simulated or explained within the classroom. It also showed us a new way of learning which made things more interesting.'
'I think the use of Second Life is beneficial. For me personally, it works because I am a visual learner.'
AQ≤16
'I strongly agree to the use of acting as a manager on Second Life so that students can compare the role of a manager in real life to Second Life. '
'Second Life is inefficient and draws away user interaction which is a vital aspect of presentations.'

CHANGE IN ROUTINE
Group B
Student Comments: Survey 6
AQ >16
'Having not used Second Life before, I am hesitant to embrace it fully until its merits and skills are proven/explored. This I am fully open to.'
AQ ≤16
'Need to get used to it to give reliable review.'
'Let's do this!'
'I feel that second life will give us a opportunity to see a different way to approach new customers from a business point of view as well as expand our knowledge and understanding of new technologies.'
Student Comments: Survey 7
AQ >16
The ability to do student devised activities. Novel Help Desk applications for example.'
'I think Second Life needs to be improved before it can be used in a professional way as it has many let downs such as low fps, graphics terrible, animations terrible. Overall it fails as usable software.'
AQ≤16
'The experience gained in a virtual world isn't as effective as real life experience as the characters can't be portrayed as effective in Second Life.'
'Great potential!!'
'I believe that so far it has been a good insight to Second Life, but it should NOT be taken into the third year.'

CHANGE IN ROUTINE
Group C
Student Comments: Survey 15
AQ>16
'I am fully looking forward to using this software to its advantage.'
'I have heard about it and know a bit about what it is and how it is used but never seen its use or used it myself.'
'I think it will be an interesting experience.'
AQ< =16
'I have never used Second Life and therefore don't know if I like to learn by using it. I also feel at the present time that I would prefer to learn with a real life tutor as opposed to a virtual tutor however this may change after use of the software.'
'I look forward to trying new simulation software.'
Student Comments: Survey 16
AQ>16
In regards to Q12: I am open to new technology, not so much to virtual environment.'
Group D: N/A

COMMUNICATION
Group A: N/A
Group B
Student Comments: Survey 13
AQ>16
'Enormous technical issues grossly delayed the presentations by over an hour.'
AQ≤16
'The virtual world lacked the feedback real life has.'
'Having the presentations in a virtual world gave me more confidence in my presentation so I didn't feel like everyone was watching.'
Group C: N/A
Group D: N/A

PLAY AND IMAGINATION
Group A: N/A
Group B: N/A
Group C
Student Comments: Survey 18
AQ≤16
'Less network lag on Second Life!'
Group D: N/A

SOCIAL RELATIONSHIPS
Group A: N/A
Group B
Student Comments: Survey 12
AQ>16
'Perhaps give students a chance to think of/implement novel support methods.'
'I think that it is good but will not be better than face to face contact.'
AQ< =16
'The exercise would be more effective if the virtual customers really were anonymous and actually had the conditional trait that was acted by the other students.'
'Second life is a great way to learn but this activity, although fun, was badly executed.'
Group C: N/A
Group D: N/A

Discussion Forum

The purpose of the forum was to assess student opinion on the value of VW activities to their education based on their experience. Scenario 18 (part of the TCA) was the focus of the discussion as this was the activity most recently applied. In order to make the sessions manageable and to ensure equal participation four forums were organised each consisting of the students' own 'business groups' referred to as: Teams 1-4.

The following questions formed the framework for the discussion:

Q1: Did the experience of seeking information in a simulated VW environment help you to consider the many ways in which information can be acquired within a RW situation?

Q2: Did the experience of the VW simulation help you to visualise the paper-based material you were given (as part of the time constrained assessment)?

Q3: Did the range of fact-finding activities offered within the VW simulation help you to evaluate their effectiveness for the RW?

Q4: Did you feel part of the VW simulation? If so, did this improve your understanding of the system requirements?

Q5: Were the range of objects within the VW simulation representative of a RW doctor's surgery?

Q6: What are your views on the potential of VWs for your HE; would you like further assessment within a VW (whole or partial) and/or VW activities as part of your studies or would you prefer not to have any more VW activities?

The following is a transcript of the recorded comments:

Team 1:

AQ: 3 >16, 1 ≤16

- The VW simulation provided a good example and there were many ways to find information, however this would clearly be more difficult in the real world.
- More can be discovered through visualisation and therefore it was useful to have the VW assessment component. Also it was fun, like playing a game.
- The range of fact finding activities in the VW represented those of the RW, but in the RW there are likely to be more distractions.

- A good experience, at one point I got lost (as I may have done in the RW in a place that I am not familiar with).
- The objects in the VW effectively modelled the RW.
- I have never tried anything like this – for me this is a new skill that I can use in the RW to discuss potential with employers. This is probably the future. We liked the component format of VW, paper-based [work alone] is boring. Simulations are good as the situation can be experienced prior to performing in the RW.
- VWs are keeping skills up to date which is important for future employment. When we finish this course we only know IT people, but we have to be able to communicate effectively with a variety of different people at work.
- Simulation was a fresh idea and would be intriguing to develop it further.
- It would be useful to extend the simulations to other areas, such as programming.
- Simulation is better than no experience at all.

Team 2:

AQ: 5 >16, 0≤16

- Clues were too obvious, interviews not representative, not a true simulation. In the real world you would have to ask someone.
- Cannot observe someone at work as you would in the RW.
- Will not be given the accuracy of information in the RW.
- The VW simulation was better than having just a paper-based assessment.
- The scenario did not improve understanding of the data requirement for the database system, although it did make finding the information easier.
- The layout of the simulation was representative of a doctor's surgery and provided useful preparation for a similar RW situation.
- The lack of body language in the VW proved a problem with communication and therefore the interview technique was not as representative as it could have been (not able to empathise).
- The scenario improved understanding of database elements e.g. entities, relationships.
- The objects were not representative of a doctor's surgery, [I wasn't] sure, felt uncomfortable about the representation of objects. Found it difficult. Not sure [about the] medicine bottles, medicine would be in a box. Difficulty with metaphor. The two levels in the surgery were not representative.

- Should be used as an aid only. Clunky.
- Each of the clues [could be used to] produce a VW scenario [to aid] communication [with a client]. To visualise the relationship role play [was useful]. Liked the idea of role play from each of those involved.
- Useful for TCA as cannot do it in the RW - more difficult. This enabled me to engage more in the [appraisal of] fact finding which followed the VW activity.
- Does not help me personally at all, not even rehearsal, too detached from RW situation.
- It works, [gives] more of an idea of what the RW equivalent would be.
- I'd prefer the TCA without the VW component.

Team 3:

AQ: 4 >16, 0≤16

- The VW helped with Task 2, got brain working well.
- Felt like an analyst, the immersive element was better than being given a paper-based activity.
- Helpful to experience the doctor's surgery, rather than have a paper-based scenario only.
- Helped thinking about stored data elements.
- I know how a surgery works, something more unusual would be more engaging.
- VW made the nature of the system clearer.
- The scenario was not representative of the RW was rather simplified
- Appreciated the importance of an appointment for interview.
- Would like some assessment in VW, subject to network performance. Performance for the assessment was OK.
- As a vehicle for communication with the end user VW may be a better mechanism.
- A mixture of VW would be good 50%, 50% to avoid technical problems.

Team 4:

AQ: 3 >16, 1≤16

- The interview was useful experience in a VW.
- Apart from the interview I did not see the point of it. I would prefer a paper-based system. VW did not add anything.

- It focused on the clues and was purposeful. But they did not consider the surgery itself.
- The VW component is better than purely paper-based.
- The representation was good enough to prepare for a real world situation, can copy the VW experience. Couldn’t do this in the RW, as an analyst would. Feel more confident in the sorts of things [I would need to do] in a surgery.
- I was just focusing on trying to find the clues. I wasn’t really thinking ‘this is a doctor’s surgery’.
- Assessment in VW as a component is fine, a bit different which is good.
- ‘I don’t really think [the college] is ready for [SL] yet [due to] the fact that our computers aren’t good enough’.
- Good idea splits it up and makes it more interesting, but networking issues.
- Can see the value in communicating with clients as opposed to diagrams.
- The interview did not work for everyone.

Observations

Group-Based: Personal, Others, Student Publicity Comments

Group A

Personal observation

Scenario 1: Conveying a difficult message

The majority of the group found this activity extremely difficult and required some assistance from the unit lecturer. However, one student stood out as being particularly able in this area, considering ways in which the message could be conveyed in order to promote a positive response and reacting appropriately as the conversation progressed. It is worth noting that this student had one of the lower AQ scores. It was clear however, that students did benefit from the safe environment of this scenario. Those playing the role of staff were unknown to them and consequently the potential for embarrassment was minimized. They were able to receive feedback on their member of staff's reaction both during and after the scenario. It also provided them with a self-awareness that may not have been apparent before the activity. In playing the role of a manager they needed to be able to empathise with their staff's reaction on hearing the message and respond appropriately. This was clearly difficult for many of them, judging by the rather direct way in which the information was sometimes conveyed.

Scenario 2: Being served at a buffet

The changing atmosphere was observed in this activity from some initial anxiety, because of the perceived difficulty of the subject, to confidence during the students' presence in the VW. They all took part in the activity without any self-consciousness and appeared to be having fun. The narrative was clearly understood by those present who were able to link the process of queuing to be served at the buffet to the related computing concepts. Thus, an abstract idea was successfully conveyed through a participative analogy that made use of play and imagination.

Other observations/Student publicity comments

The following extracts from Weston College Undergraduate Prospectus, 2015 indicate the employment success of some of the Applied Computing graduates from Group A:

'[Student A] works as a junior programmer for [Company 1] - a leading developer of IT Services. His role involves developing and coding government and defence systems.'

'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 A] cited by Weston College, 2014, p. 30).

'The experience and skills [Student A] gained at Weston College have enabled him to fit into any situation. He's keen to learn and able to adapt his knowledge and skills to many different business areas and roles. The course gave [Student A] the 'real-world' experience of meeting deadlines and completing work to a high standard that has been crucial to his success in this role.

[Company 1] would be more than happy to consider further graduate applicants from Weston College in the future, especially if they are the same high calibre as [Student A].' ([Employer 1] cited by Weston College, 2014, p. 8).

'After completing the degree, [Student B] gained employment at [Company 2] in Keynsham and, within six months had been promoted from a junior position to Software Engineer. His role involves creating bespoke software applications, including software design, coding, testing and client training.'

'I benefited from the variety of teaching methods the course offered and the work placement helped me understand the demands of the industry at an early stage.' ([Student B] cited by Weston College, 2014, p. 32).'

Group B

Personal observation

Scenario 3: Research Methods (with Virtual World Support)

Students appeared to enjoy the VW demonstrations and the extension of practical activities offered by the VW. Linking the research syllabus to the UWE VW Observatory provided a visual structure and process overview, which is often lost in the amount of detail contained in this unit.

Scenarios 4 and 5: Being Served at a Buffet / PrimTime Education - A Walk in a Green Space

Students appeared to be intrigued by both scenarios. There was a very enthusiastic reaction to the former and they appeared to enjoy the range of devises employed in the latter such as the concise information (via notice boards/note cards), the visualisation of abstract concepts, metaphor and VW object examples to illustrate the design and construction of ‘structure’ and ‘class’ programming concepts.

Scenarios 6 and 7: Dealing with Help Desk Customers / Coping with Pressure on the Help Desk

This generated a great deal of fun and laughter, but many student had difficulty with the roles they were given and also coping in a pressured social situation. The post-activity discussion helped resolve some of the issues and proved to be excellent preparation for the RW Tech Genius Help Desk as reflected in its subsequent and ongoing success.

Scenarios 8 and 9: Development Project Presentations / Responding to Critical Feedback

Some technical issues delayed the start of the proposal presentations of the Development Project, which may have influenced the students’ views. This was quite a difficult activity for them as many factors had to be considered in this once-removed situation such as tone of voice, body language, the manipulation of the slide show. This proved to be useful material for the subsequent class discussion. The Multimedia Technologies critical feedback session was very well received by the students who were worked hard on achieving a good rapport with their audience.

Other observations/Student publicity comments

‘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 A] cited by Weston College, 2013).

‘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 B] cited by Weston College, 2013).

‘We’ve made Tech Genius part of a work experience module for higher education computing students and so far it’s working brilliantly.

It was set up for the students but now we’re finding the staff calling in for help.’ (SS1 cited by Evans, 2013).

Group C

Personal observation

Scenario 10: Iteration in Programming

Students were taught how to create a loop in a traditional way, but were thrilled to see the more visual feedback of moving an object in the VW using this programming technique.

Scenarios 11 and 12: PrimTime Education - A Walk in a Green Space / The Rules of Database Normalisation

Network response issues rather marred Scenario 12 and this may have had some bearing on the students' perception of the VW. Scenario 11 appeared to engage the students, who found this a more enjoyable event than the paper-based equivalent. Both activities benefited from student feedback and were amended accordingly.

Scenario 13: Dealing with Help Desk Customers

Although one student flatly refused to participate in this activity, the others found it quite entertaining and appeared to enjoy the benefit of role play in a once-removed situation. A productive classroom discussion followed the event.

Group D

Personal observation

Scenario 14 and 16: The Rules of Database Normalisation / PrimTime Education - A Walk in a Green Space

In both situations the students were interested in the bespoke scenarios and their construction. They were able to participate and see the effects of their actions in real-time.

Scenario 15: Iteration in Programming

The students clearly enjoyed this practical activity, the abstract concepts made more visible to them through the manipulation of objects. However, it was noticeable that one student in particular usually very quiet in class, became overactive in the VW. This behaviour was also confirmed by HES1 *'[Student A] was restricted in the real world and in the VW he was set free, this unfortunately was manifested by some noticeably uncontrolled behaviour which needed harnessing.'*.

Scenario 17: Conducting an Interview

Each of the four ‘business groups’ were tasked with obtaining information on system requirements from a ‘client’. An important component of the task was to carefully plan and organise the process in advance in order to make the most of the limited interview time they had with the client. However, it quickly became apparent that they had underestimated the difficulty of obtaining information via the interview process and had no contingency plans to put into operation. As often happens in real life, they found that the client was not able to clearly express their needs, which may occur for various reasons such as language barriers or feeling concerned about the process. Therefore, patience and encouragement was needed to foster the interview process and thereby facilitate their understanding of requirements. Many students were surprised by this difficulty and found the exercise quite a frustrating experience. The importance of being able to effectively apply social as well as communication skills to elicit information was the topic of the class discussion that followed. The VW activity helped to reinforce the points raised, as students could refer back to the techniques they had selected for the interview process as part of the RW discussion.

Scenario 18: Ashgrove Surgery (TCA)

On the whole the assessment went smoothly, but required a heavy investment in planning and resources (including contingency for any technical issues appearing on the day). The practical activity seemed to inspire the students to complete the remaining paper-based tasks and assisted in the design of the Entity Relationship Diagram for the database.

Other observations/Student publicity comments

The Field External Examiner’s Report 2013-2014 for the Applied Computing Course with HEI2 made the following statement under ‘Observed Distinctive and Good Practise’:

“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.”

Summary of Personal Observations

Personal observations	
Scenario	Comments
1	Students found certain activities more difficult than expected e.g. when they had to conduct an appropriate communication based on the imagination of another's feelings. The support of the lecturer during the session and that of the peer group helped the students to adopt a systemising approach to such situations.
2	Through scenarios that applied play and imagination the level of anxiety associated with difficult topics was visibly reduced. Students became part of the event without any noticeable self-consciousness.
3	The change in learning routine created by introducing (and referring back to) a unit through a VW representation of the content provided students with a visual structure which is often lost in the detail of the syllabus.
4&5	Students appeared to be intrigued by the devices employed with the scenario designed to generate learning through play and imagination.
6&7	Certain scenarios created a great deal of fun and laughter, despite some difficulty with the interpretation of roles. Direct personal experience allowed individuals to reflect on their own professional conduct by explaining and/or justifying their actions, while obtaining the advice of others during the classroom feedback sessions.
8&9	Certain scenarios served to highlight the benefits of the RW, as the specified tasks were more difficult in the VW e.g. the presentation exercise required students to use techniques that would be expected in the RW and the multimedia exercise they had to elicit critical feedback.
10	The change in learning routine appeared to be enjoyed, the immediate visual feedback of the VW element making the session appear more relevant and less prescriptive.
11&12	In certain situations students found the RW scenarios more engaging than the paper-based equivalent.
13	In the RW computing students have rarely agreed to role play for various reasons as part of their learning. In this situation, one did flatly refuse to participate, but the others appeared to enjoy the scenario and its benefits immensely.

Personal observations	
Scenario	Comments
15	The change in routine of learning iteration through the practical application of iteration in the VW, showing the consequences of programming actions, helped the students to assimilate the concept more readily.
17	An uncomfortable and possibly frustrating scenario for the students. However, the process accurately reflected many of the situations that occur in the RW. Students were able to judge the success of their own communication from the amount of information they were able to report that they had elicited at the end of the interview.
18	A great deal of preparation, including contingency planning for the time constrained assessment was necessary to ensure that all went smoothly on the day.

General Observations: Internal/External, Publicity Articles

HES1 Feedback - Student Soft Skills

26 June 2014

Key to soft skills:

A - Social relationships

B - Verbal communication

C - Non-verbal communication

D - The development of play or imagination

E - Change in routine

Before the introduction of VW technology:

Question 1: In which of the units you teach do you consider the above skills are critical. Please give your reasons why.

- Web Design – All
- Multimedia Technologies – All
- Creative Computing – All
- Multitasking Systems – C, D, E
- Advanced Web-based Technologies – All
- Developing Technologies – B, C, D
- Computing Projects – All

With the units dealing with customers all the above are necessary for the communication made to collect the information and present the product.

In other highly technical units certain aspects of communication are less needed.

Question 2: What do you consider to be the impact of a shortfall in these skills?

Students get less information as an input to their project or coursework which will have negative impacts on the final outcome which again will be poorly presented to the client resting in poor evaluation of their products.

In the IT industry particular emphasis is placed on customer satisfaction.

Question 3: Before the use of VW did you assume that computing students would naturally have these skills?

No. We normally have a number of students with a different range of different learning difficulties and there is a strong correlation between their achievement and the strong skills they have in this field.

Question 4: From your observations have you found a tendency for computing students to experience difficulties with any of these? Please state which skills and in what way.

Certainly, yes. The majority of computing students tend to have difficulties in presenting (B) either the information they research or the products they produce. They also have difficulties in writing reports (C), and they are less confident in facing uncertainty in their work (E)

Question 5: How currently do students attain these skills (if they are not already naturally present)?

1:1 tutorial sessions which are for a short time every week. These tend to be helping but not actually very effective. Certain skills such as imagination are difficult to convey using traditional methods.

Question 6: Do you as, a matter of course, integrate the development of these skills into your units?

I provide support whenever possible in terms of drawing on the white board, presenting images on the SMART board and explaining factors of good communication however, it is the students' responsibility to pursue the development of these skills.

Question 7: Do you consider that traditional teaching methods can address the importance and need for these specific skills?

Certainly not, as indicated above.

Question 8: Have you identified any students with particularly severe/unique issues that may impact upon their learning, achievement and possibly future career? If so, please briefly explain the issues if they relate to the above.

Computing students in general are known for having some limitations in all of the above skills to different degrees. Some students with low percentages could manage under certain circumstances however the percentage of these students is quite low.

One student in Yr 1 has a situation that is affecting almost all of the skills indicated above. This student has very good technical skills however he cannot be a successful web developer simply because he needs to communicate with the client – explain to them the requirements of a web site and explain his product. He will be able to pass the unit but he will face severe difficulties in the future putting his knowledge into practise.

Spoken communication is a well-known difficulty amongst computing students who choose this field possibly to concentrate on more practical activities to avoid this problem.

Following the introduction of VW technology:

Question 1: Following the implementation of VW what sort of impact has this made on the success of the units you teach (objective and subjective observations would be useful).

Student felt more confident in their presentation delivery and they become less resistant to carrying out this type of activity for their coursework. Better grades have been achieved in the majority of the modules compared to those of previous assessments before the application of VW.

Question 2: Do you consider that students who appear to have any/all of the above characteristics to have benefited? If so, in what way?

Certainly yes the verbal and non verbal communication in particular has been enhanced with noticeable improvements in the social relationship skills.

Question 3: Did you perceive any change of behaviour to similar situations following the introduction of VW into your units? Please give examples.

See question 1 above.

Question 4: Describe the impact of the introduction of VW as a learning tool on students with the 'particularly severe/unique' issues (item 8) identified above.

The students indicated in question 8 above said they were more engaged in the VW and they said that this environment was very suitable for them to exercise the tasks of their coursework. [Student A] was restricted in the real world and in the VW he was set free, this unfortunately was manifested by some noticeably uncontrolled behaviour which needed harnessing.

Question 5: Give an overview of the introduction of computing student reaction to VW into the curriculum by group:

See questionnaires distributed at the start of the academic year 2012-13 which were designed to investigate students' acceptance of new technologies and the application of the VW technology in their studies. This has been done for 3 years.

BSc(Hons)

Before
During
After

FdSc Yr 2

Before
During
After

FdSc Yr 1

Before
During
After

Question 6: Did you notice a difference in reaction between the stronger and weaker students in the groups? If so please describe briefly.

Strong students resisted more. Weaker students were more inclined to accept it – weaker students are more open to sources of support.

Question 7: Describe the personal characteristics of the students who appear to have enjoyed the VW the most.

Quiet students and students who are less confident in communicating with others.

Question 8: In which situations would you consider VW to be the most effective; as a learning tool, formative or summative assessment? Please state why.

It's a learning tool rather than an assessment tool – because students would benefit more from the element of collaborative learning within that environment rather than working in isolation to achieve assessment work.

Question 9: Based on your experience of the use of VW what percentage of the overall course would you suggest could be used in this way to achieve learning and help computing students to progress?

This is difficult to answer as it depends on the units involved in the computing programme in the year and level of study. Based on the current course an estimation of 30-50% of the course could be delivered within this environment. This is very dependent on having suitable resources that can facilitate delivery.

Question 10: Did you find that any changes in behaviour during the VW experience?

Yes, students who have a shortage of the above skills felt more active in the VW whilst they adopted a passive role in the physical world. However that needed an additional control by the lecturer to maintain the pace of the session delivered.

Question 11: Did that change of behaviour transfer to the real world?

It was noticeable but the period in the VW probably needs to be longer to have a clearer result.

Question 12: Was the change of behaviour positive or negative?

It was positive in certain aspects relating to verbal and non-verbal communication and also the social relationships. Becoming active in the virtual environment distracted their focus from the learning outcomes of the session.

Question 13: How did the change of behaviour impact upon their learning in the unit(s) you deliver?

See above.

Question 14: Which (if any) aspects of experience in the VW do you think has influenced computing students the most?

Collaborative learning. Computing students are used to working in isolation.

Question 15: Are there any (external/mitigating) factors that may influence the impact and perception of the students on the course to this mode of study?

Technical issues e.g. slow network, low specification graphics adapters caused frustration for the students as they felt they are not learning as fast as in the RW.

Question 16: What (in your opinion) has been the most successful exercise of this suite? Please explain why and the influence this has had on your teaching and the learner understanding.

The visualisation of programming instructions e.g. loops and the first 2 normal forms of the database normalisation process as these were very abstract concepts and the visualisation has aided their understanding and learning.

Question 17: Do you think that VW made any difference to the above factors e.g. social skills etc. for the computing students?

Generally the outcomes were positive however as indicated above the technical issues have impacted the results of questionnaires and the behaviour of some students within the environment was not welcomed or accepted by the other students.

Question 18: What impact has the introduction of VW had on you as a lecturer?

New horizons for the delivery of the computing curriculum at this level for students.

The following table provides a visual summary of the above feedback:

Issue	General comments
Soft skills shortfall	*'The majority of computing students tend to have difficulties in presenting … either the information they research or the products they produce. They also have difficulties in writing reports …, and they are less confident in facing uncertainty in their work …'* *'Computing students in general are known for having some limitations in [the identified soft] skills to different degrees. Some students with low percentages [of these skills]could manage under certain circumstances however the percentage of these students is quite low.'*
Academic impact	*'Students get less information as an input to their project or coursework which will have negative impacts on the final outcome which again will be poorly presented to the client resting in poor evaluation of their products.'*
Skills	Comments relating to soft skills
Change in Routine	*'… students who have a shortage of the [identified soft] skills felt more active in the VW whilst they adopted a passive role in the physical world. However that needed an additional control by the lecturer to maintain the pace of the session delivered.'*
Communication	*'Student felt more confident in their presentation delivery and they become less resistant to carrying out this type of activity for their coursework.'*
Play and Imagination	*'[the most successful exercise of this suite has been] the visualisation of programming instructions e.g. loops and the first 2 normal forms of the database normalisation process as these were very abstract concepts and the visualisation has aided their understanding and learning.'*
Social	*'… the verbal and non verbal communication in particular has been enhanced with [a] noticeable improvements in the social relationship skills.'*
Concerns	Comments relating to issues of concern
Technical	*'Technical issues e.g. slow network, low specification graphics*

Issue	General comments
	adapters caused frustration for the students as they felt they are not learning as fast as in the RW.'
VW influence	*'Generally the outcomes were positive however as indicated above the technical issues have impacted the results of questionnaires and the behaviour of some students within the environment was not welcomed or accepted by the other students.'*
Student behaviour	*'[students with particularly severe/unique issues] said they were more engaged in the VW and they said that this environment was very suitable for them to exercise the tasks of their coursework. [Student A] was restricted in the real world and in the VW he was set free, this unfortunately was manifested by some noticeably uncontrolled behaviour which needed harnessing.'*

SS1 Feedback - Tech Genius Help Desk (RW)

Question 1: Have you recognised any development in the performance of the Foundation Degree Applied Computing – Year 2 students on the Tech Genius Helpdesk?

The students have been able to develop their skills set across many areas, including:

- Customer case and fault-finding skills
- Accurate call logging and record keeping
- Managing difficult situations or customers
- Develop their knowledge of support systems and equipment
- Analytical and problem-solving skills
- Assessment and diagnostic skills
- Software/website development
- Team building and organisational skills

Question 2: How do you rate their performance now compared to when they started their duties as helpdesk staff a few months ago?

Their customer service and problem-solving skills have all improved throughout the duration of the project. The expertise and helpfulness of the Tech Genius students has impressed students and teaching staff alike and gained them a loyal customer base.

Question 3: Do you believe that their interpersonal; skills have developed through this period, especially they communicate with their customers?

They have definitely become more confident and outgoing as the project has continued, although if they were a bit shy at the start, they were very careful not to give this impression to their helpdesk 'customers'.

Question 4: Do you believe that their self-confidence in solving computing technical problems has increased compared to when they started a few months ago?

The technical confidence was already there: they are very talented (and well taught ;-) students who have impressed other students and teaching staff alike with their knowledge and helpfulness.

Question 5: At the start of their duties, did you notice that becoming helpdesk staff and facing real customers was a difficult job for all (or some) of them?

From past experience training new staff in my previous bookselling career, I would have expected them to find it more of a challenge than they did. If they were nervous, they certainly didn't show it, and appeared to be enjoying helping our 'customers' with their technical issues and queries from the outset.

Question 6: Did they require a great deal of support or were they using their own imitative? Did this improve over time?

At the start of the project, while they were learning the requirements of the job they needed a bit more support and guidance – but no more than any new members of staff. Overall, I was very impressed by how well they organised themselves and worked on their own initiative.

Difficult to make distinctions between students, as they all worked hard whether they were on the helpdesk or in a behind the scenes role. Overall the performance of all the students was very good, but I have awarded the extra 'stars' to the team leaders and those who worked overtime to cover the helpdesk on other shifts.

Student	Very Good	Good	Average	Poor	Unsatisfactory
1	*				
2	**				
3	**				
4	*				
5	**				
6	**				
7	**				
8	*				
9	*				
10	**				
11	**				
12	*				

Publicity Articles

"**CoLRiC Best Practice Awards 2013: winning projects**

Weston College – Tech Genius

Tech Genius is a student led technology support service available in the LibraryPlus facilities at Weston College. The service helps those users who need support with using technology and also the e-resources provided by the College library.

This approach serves a number of needs – it certainly enables the library to support students needing valuable work experience but also ensures that the library is able to effectively promote its own services and provide for the extra demand technology has created.

The Tech Genius team members had to apply and be interviewed for their posts and successful applicants had to fulfil a number of objectives which included running a support desk, maintaining records, developing a website, conducting surveys, contacting the IT department for serious issues, maintaining IT support virtually through Second Life and working with the library team on other projects.

Tech Genius has been a very successful model which has extended to other areas of the college where the LibraryPlus facilities exist."

(CoLRiC, 2013)

“**Weston College students present their work in virtual world (8 Apr 2013)**

Weston College Computing students have been experiencing a taste of education in the future by presenting projects as avatars in a virtual classroom.

Instead of writing on a whiteboard or presenting via PowerPoint the second year FdSc Applied Computing students have created virtual representations of themselves and presented their work in the ‘Second Life’ platform.

[…]

Janice Castle, Weston College’s Curriculum Coordinator in Computing (HE), said the exercise was extremely popular as well as being innovative

She 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. We thought that a virtual presentation would be an answer to that, plus it gets students to think about practical applications of the technology in the workplace and elsewhere.*

‘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!’

Janice added that she and the other staff didn’t know where their students were operating their avatars from.

‘They could've been in college, or somewhere in Weston, or even at home,” she said. “The point is that working this way saves time, travel and office space, and could easily be applied to the real world.’

[Student A], a FdSc Applied Computing Yr 3 student, 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 B], a FdSc Applied Computing Yr 2 student, added*: ‘It was definitely a different experience carrying out our presentations in a virtual setting. It went surprisingly well and made me feel more confident.’*

(Weston College, 2013)

“**Students step into the future (14 Apr 13)**

WESTON computing students were given the chance to step into the future by presenting projects as avatars in a virtual classroom

Instead of writing on a white board or giving a Power Point presentation the second year Weston College students created virtual representations of themselves and presented their work in the second life platform.

It is hoped the use of avatars will encourage students to think about how presenting virtually might work in other scenarios, including education, seminars and work place training or meetings.

Janice Castle, the college’s curriculum coordinator in computing, said: *‘We have many very able students on our courses but not all of them feel confident about presenting.*

‘We thought a virtual presentation would be an answer to that, plus it gets students to think about practical applications of the technology in the work place and elsewhere.

‘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.’

Janice added that she and the other staff didn’t know where their students were operating their avatars from.

She said*: ‘They could’ve been in college, or somewhere in Weston, or even at home. The point is that working this way saves time, travel and office space, and could easily be applied to the real world.’*”

(Evans, 2013)

“**Students setup IT helpdesk (6 May 13)**

The Tech Genius helpdesk is operating in Weston College’s LibraryPlus facility and although it was set up to provide solutions for fellow students, staff members are now coming forward seeking help.

It aims to solve everything from virus issues to Sims cheats. For the students themselves, it’s as much about learning the techniques of customer service and satisfaction as it is about using their IT knowledge to help others.

[SS1], the college’s learning technologist, was responsible for introducing the concept, with the help of tutors Janice Castle and [HES1].

She said: *‘We’ve made Tech Genius part of a work experience module for higher education computing students and so far it’s working brilliantly*.

‘It was set up for the students but now we’re finding the staff calling in for help.’”

(Evans, 2013)

"**Students secure jobs - before they've even graduated! (13 June 2014)**

Four talented Applied Computing degree students have scooped high-flying jobs even before they have graduated.

Two of the BSc (Hons) students have invented life-changing apps, including one that reminds patients about physiotherapy exercises between treatments and another which translates sign language.

[Student A], 21 of Weston, had already scooped the Principal's Scholarship at the College's Celebration of Success in January, for his hard work […]. Now he's been invited to team up with [University A] staff on a research project that will see the computing specialist work towards a PhD. [Student A] said: *'It was great to get a job before I graduated. My PhD will be based on modelling command teams in various domains from a sociotechnical aspect, and analysing how improvements could be made, to better facilitate objectives.'* […].

[Student B], 21 of Weston, is now working as a developer in London for [Company 1], an award-winning supplier of consultancy and software solutions for property companies and accommodation providers.

[Student C], 21 of Weston, created an innovative and bespoke physiotherapy aid after identifying the need for an app when carrying out work experience at Weston-based Company 2.

Now at software development [Company 3], [Student C] said: *'It's been a great experience and I have learnt so much. I'm working on an app for central control systems in houses for things such as lighting, heating and cameras.'*

Computing Curriculum Co-ordinator Janice Castle, who spent many years working in the IT industry, said*: 'It's fantastic to find good jobs before they finish their degrees.*

'Our courses are vocational with work-based elements providing a range of technical and team-working skills to improve employability. These exceptional students have got jobs several months before graduating and worked part-time until the course finished; their employers were more than happy to wait for them!'"

(Weston College, 2014)

The following table provides a selection of observations that may be related to soft skills in this study:

Skills	Observations	Observed By
Change in Routine	*'The change in routine of learning iteration through the practical application of iteration in the VW, showing the consequences of programming actions, helped the students to assimilate the concept more readily'*	Personal Observation (Scenario 15)
	'(...) students who have a shortage of the [identified soft] skills felt more active in the VW whilst they adopted a passive role in the physical world.'	HES1
	'[their skills were developed in] managing difficult situations or customers.'	SS1
	'He's keen to learn and able to adapt his knowledge and skills to many different business areas and roles.'	Employer 1
	'I benefited from the variety of teaching methods the course offered.'	Student B Group A
	'Presenting our work in a virtual world has brought another dimension to the development project.	Student A Group B
	'Students were able to judge the success of their own communication from the amount of information they were able to report that they had elicited at the end of the interview.'	Personal Observation (Scenario 17)
Communication	*'Student felt more confident in their presentation delivery and they become less resistant to carrying out this type of activity for their coursework.'*	HES1
	'The (...) helpfulness of the Tech Genius students has impressed students and teaching staff alike and gained them a loyal customer base.'	SS1
	'[they] have impressed other students and teaching staff alike with their knowledge and helpfulness.'	SS1
	'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 B Group B

	'Through scenarios that applied play and imagination the level of anxiety associated with difficult topics was visibly reduced. Students became part of the event without any noticeable self-consciousness.'	Personal Observation (Scenario 2)
Play and Imagination	*'[the most successful exercise of this suite has been] the visualisation of programming instructions e.g. loops and the first 2 normal forms of the database normalisation process as these were very abstract concepts and the visualisation has aided their understanding and learning.'*	HES1
	'analytical and problem-solving skills [have developed].'	SS1
	Under 'Observed Distinctive and Good Practise': *"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."*	Field External Examiner's Report 2013-2014
	'Direct personal experience allowed individuals to reflect on their own professional conduct by explaining and/or justifying their actions, while obtaining the advice of others during the classroom feedback sessions .'	Personal Observation (Scenarios 6&7)
Social Relationships	*'... the verbal and non verbal communication in particular has been enhanced with noticeable improvements in the social relationship skills.'*	HES1
	'They have definitely become more confident and outgoing as the project has continued (...).'	SS1
	'The experience and skills [Student A] gained [...] have enabled him to fit into any situation.'	Employer 1

Appendix F

Survey Listing

Group	Survey No.	Scenario No.	Skills	Original Survey Name	Survey Date
A(3)	1	2	P&I	The Use of Second Life to Visualise Difficult Concepts in Computing - Concurrency and Parallelism	18-Oct-12
A(3)	2	2	P&I	The Use of Second Life to Visualise Difficult Concepts in Computing - Concurrency and Parallelism	13-Nov-12
A(3)	3	N/A	CinR	Technology Enhanced Learning in Higher Education	24-Sep-12
A(3)	4	N/A	CinR	Technology Enhanced Learning in Higher Education	17-Apr-13
A(3)	5	1	VC/ NVC	Managing Information	05-Feb-13
B(2)	6	N/A	CinR	Technology Enhanced Learning in Higher Education	27-Sep-12
B(2)	7	N/A	CinR	Technology Enhanced Learning in Higher Education	18-Apr-13
B(3)	8	3	CinR	Research Methods - Principles and Practise within a Virtual Environment	04-Dec-13
B(3)	9	4 (2 Revised)	P&I	Multi-Tasking Systems Unit - Concurrency and	06-Nov-13

Group	Survey No.	Scenario No.	Skills	Original Survey Name	Survey Date
				Parallelism	
B(2)	10	5	P&I	The Use of Second Life to Visualise Difficult Concepts in Computing - Programming	04-Mar-13
B(2)	11	6	SR	The IT Service Support Unit - a 'Virtual Help Desk' within Second Life	06-Dec-12
B(2)	12	7	SR	ICTSS Virtual Help Desk Support	14-Apr-13
B(2)	13	8	VC/ NVC	Presentations in Second Life	07-Mar-13
B(2)	14	9	VC/ NVC	The Use of Second Life to Visualise Difficult Concepts in Computing - Multimedia Technologies	28-Jan-13
C(1)	15	N/A	CinR	Technology Enhanced Learning in Higher Education	24-Sep-12
C(1)	16	N/A	CinR	Technology Enhanced Learning in Higher Education	22-Apr-13
C(1)	17	10	CinR	The Use of Second Llfe to Visualise Difficult Concepts in Computing - Programming	27-Feb-13
C(2)	18	11 (5 Revised)	P&I	Introduction to Programming	07-Mar-13
C(1)	19	12	P&I	The Use of Second Life to Visualise Difficult Concepts in Computing - Database Normalisation	27-Feb-13
C(2)	20	13	SR	ICT Service Support Unit	18-Oct-13

Group	Survey No.	Scenario No.	Skills	Original Survey Name	Survey Date
		(6 Revised)	NVC		
D(1)	21	14 (12 Revised)	P&I	Systems Analysis and Database Unit - Database Normalisation	18-Nov-13
D(1)	22	15 (10 Revised)	CinR	Software Design and Development Unit - Computer Programming	12-Nov-13
D(1)	23	16 (5, 11 Revised)	P&I	What do you think of programming so far?	07-Oct-13
D(1)	24	16 (11 Revised)	P&I	Software Design and Development Unit - Structures and Classes	10-Dec-13
D(1)	25	17	VC/ NVC	Systems Analysis and Databases Unit - Systems Analysis Fact-Finding (Interviews)	12-Nov-13
D(1)	26	18	SR	Systems Analysis and Database Unit	25-Mar-14

Key: Soft Skills	
CinR	Change in Routine
VC/NVC	Verbal/Non-Verbal Communication
P&I	Play and Imagination
SR	Social Relationships

Surveys of Soft Skills

The surveys have been stylised to aid readability.

The set of completed surveys can be seen on the accompanying CD.

Survey 1: Being served at a buffet	
Q1	You have found Second Life friendly and easy to use.
Q2	The (hour and a half) initial visualisation session in Second Life helped you more in understanding the difficult concepts of concurrency and multithreading techniques in the computer RAM, processor, virtual memory and the role of the Operating System.
Q3	Before the actual visualisation in Second Life starts you were surprised to see the whole of the 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).
Q4	The visualisation of concurrency and multithreading techniques in Second Life enhanced your learning compared to the theory sessions delivered in-class earlier.
Q5	Playing the role of computer tasks in RAM and the virtual memory in different case scenarios facilitated the visualisation of this difficult concept.
Q6	Attending this session in Second Life from home (in separation from other students) has enabled more concentration on the demonstration and visualisation activities and encouraged you to think more, interact and answer questions in isolation of the effects, interruption and distraction by other student(s).
Q7	Despite the fact that some students, who attended this first session in Second Life, 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 your learning and encouraged you to attend further sessions in Second Life.

Survey 1: Being served at a buffet	
Q8	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 future for 'Social Computing' activities.

Response				
Fully Agree	Agree	I Don’t Know	Disagree	Fully Disagree

Survey 2: Being served at a buffet	
Q1	The session in Second Life has facilitated your learning and understanding of the difficult concept of parallelism in a duel core/multi-processor computer system.
Q2	Acting the role of the Computer Operating System in Second Life in judging the different parallelism scenarios that have been made to you has corrected one or more wrong concepts that you had following the theory sessions.
Q3	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 Second Life more than the information delivered in the theory sessions.
Q4	Following having three sessions in Second Life for the Multi-Tasking Unit you believe that this is a useful tool to enhance the learning and achievement of students in this unit.
Q5	You will think of the virtual world of Second Life in the future after you complete the unit.

Response				
Fully Agree	Agree	I Don’t Know	Disagree	Fully Disagree

Survey 3: Introduction of VW	
Q1	You have heard of Second Life before.
Q2	You have good background information about Second Life.
Q3	You have good background knowledge about the application of Second Life in Further Education.
Q4	You have good background knowledge about the application of Second Life in Higher Education.
Q5	You have good background knowledge about the application of Second Life in Further Education Computing.
Q6	You have good background knowledge about the application of Second Life in Higher Education Computing.
Q7	You have good background knowledge about the application of Second Life in electronic libraries of universities.
Q8	You have heard and understood the term 'Social Computing'.
Q9	You have heard and understood the term 'Simulation'.
Q10	Applying education (in general) in a virtual world will enhance the students' learning experience.
Q11	Applying Computing education in a virtual world will enhance the students' learning experience.
Q12	As a Computing student, you are open to different Computing technologies.
Q13	As a Computing student, you would like to investigate and exercise the developing technologies in the Computing field.

Response				
Fully Agree	Agree	I Don’t Know	Disagree	Fully Disagree
Any comments you would like to add (optional):				

Survey 4: Introduction of VW	
Q1	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.
Q2	You believe that these activities were generally beneficial and facilitated your learning.
Q3	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.
Q4	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 future.
Q5	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.
Q6	Attending all the activities in Second Life throughout the academic year managed to change your initial idea/option about the use of virtual world in a positive manner.
Q7	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 □)
Q8	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.

Survey 4: Introduction of VW	
Q9	You believe that sometimes people are not open to new technologies and/or they have prejudgements based on one-sided news or another person's experience.
Q10	(Based on Question No. 9) - You believe that the statement in Question no. 9 applied to your initial judgement on Second Life. (If N/A tick here □)
Q11	(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 □)
Q12	(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 □)

Response				
Fully Agree	Agree	I Don't Know	Disagree	Fully Disagree
Any comments you would like to add (optional):				

Survey 5: Conveying a difficult message	
Q1	The delivery of the message would be more successful in the virtual environment than in the real world.
Q2	The message would be better received in the virtual environment than in the real world.
Q3	The environment in which a message is delivered is important.
Q4	Cues can cause a problem in communication.
Q5	Cues can sometimes be confusing.
Q6	A message can be delivered more effectively if some cues are available.
Q7	A virtual space communication scenario can be used as a substitute for a real world situation.
Q8	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.
Q9	A virtual space is an appropriate environment in which to practise dealing with situations which are non routine.
Q10	People I have not met before are easier to communicate with in a virtual space.
Q11	A virtual space rehearsal can be used in preparation for any real world situation.
Q12	A virtual space can help foster a better inter-personal relationship.
Q13	A virtual space gives me more opportunities to participate in communication than the real world.
Q14	The conversation flows better in a virtual world.
Q15	A virtual space offers more flexibility of communication than the real world.
Q16	Could a similar idea to this be used in the workplace to improving communication and productive working relationships?
Q17	Simulation is an effective way to train existing or potential managers.

Response				
Strongly Agree	Agree	Unsure	Disagree	Strongly Disagree

Survey 6: Introduction of VW	
Q1	You have heard of Second Life before.
Q2	You have good background information about Second Life.
Q3	You have good background knowledge about the application of Second Life in Further Education.
Q4	You have good background knowledge about the application of Second Life in Higher Education.
Q5	You have good background knowledge about the application of Second Life in Further Education Computing.
Q6	You have good background knowledge about the application of Second Life in Higher Education Computing.
Q7	You have good background knowledge about the application of Second Life in electronic libraries of universities.
Q8	You have heard and understood the term 'Social Computing'.
Q9	You have heard and understood the term 'Simulation'.
Q10	Applying education (in general) in a virtual world will enhance the students' learning experience.
Q11	Applying Computing education in a virtual world will enhance the students' learning experience.
Q12	As a Computing student, you are open to different Computing technologies.
Q13	As a Computing student, you would like to investigate and exercise the developing technologies in the Computing field.

Response				
Fully Agree	Agree	I Don't Know	Disagree	Fully Disagree
Any comments you would like to add (optional):				

Survey 7: Introduction of VW	
Q1	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.
Q2	You believe that these activities were generally beneficial and facilitated your learning.
Q3	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.
Q4	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 future.
Q5	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.
Q6	Attending all the activities in Second Life throughout the academic year managed to change your initial idea/option about the use of virtual world in a positive manner.
Q7	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 □)
Q8	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.

Survey 7: Introduction of VW	
Q9	You believe that sometimes people are not open to new technologies and/or they have prejudgements based on one-sided news or another person’s experience.
Q10	(Based on Question No. 9) - You believe that the statement in Question no. 9 applied to your initial judgement on Second Life. (If N/A tick here □)
Q11	(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 □)
Q12	(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 □)

Response				
Fully Agree	Agree	I Don’t Know	Disagree	Fully Disagree
Any comments you would like to add (optional):				

Survey 8: Research Methods unit (with virtual world support)	
Q1	Research Methods is a challenging topic
Q2	Methods of investigating the information on computing projects are limited
Q3	The theory concepts of this subject require visualisation in order to be better understood
Q4	You feel that different approaches to studying this subject are needed
Q5	The ability to extend methods of research increases the potential of success to a computing project
Q6	The experience of being able to research within multiple environments has increased my vision of how my computing project should develop
Q7	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
Q8	The use of an observatory methaphor (symbol) for research methods aids the understanding of this subject
Q9	I am able to concentrate and focus clearly on this subject
Q10	I can visualise 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
Q11	Teaching the research methods concept within one environment only e.g. either the real or the virtual world, would be sufficient to achieve a successful computing research project

Survey 8: Research Methods unit (with virtual world support)	
Q12	State the preferred method of teaching the Research Methods (for computing projects) subject: RW, VW or Both.

Response							
Before using the VW				After using the VW			
Slightly Agree	Fully Agree	Slightly Disagree	Fully Disagree	Slightly Agree	Fully Agree	Slightly Disagree	Fully Disagree

Survey 9: Being served at a buffet	
Q1	Concurrency and Parallelism' is a difficult subject.
Q2	The visualised mode of explaining concurrency and parallelism helped my understanding and learning.
Q3	I am confident with the subjects of: concurrency and parallelism.
Q4	Playing the different roles of the CPU, RAM and the Operating System facilitated my understanding and learning of this technical subject.
Q5	An analogy adds interest to the subject, making it more enjoyable and as a result more memorable.
Q6	The traditional method of teaching the 'Concurrency and Parallelism' subject (alone) is suitable for facilitating the understanding and learning of its concepts.
Q7	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).
Q8	The inclusion of technology-enhanced tools has furthered my understanding and learning of the 'Concurrency and Parallelism' subject.
Q9	Because of the subject difficulty, verbal communication of the concepts was not adequate to convey the ideas fully.
Q10	Using visual metaphors (symbols) in an immersive environment improved my understanding and learning of this fundamental area of Multi-Tasking Systems.
Q11	Being able to place myself in the role of a specific computer component helped me to appreciate its job in service provided.

Response							
Before using the VW				After using the VW			
Slightly Agree	Fully Agree	Slightly Disagree	Fully Disagree	Slightly Agree	Fully Agree	Slightly Disagree	Fully Disagree

Survey 10: PrimTime Education – a walk in a green space	
Q1	You consider that the learning programming is a difficult subject.
Q2	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.
Q3	According to your unit lecturer and previous observations to your programming sessions, you face difficulties in learning essential programming concepts and the types of execution expected as a result of applying them in a program.
Q4	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.
Q5	You have enjoyed the scenario designed for you in the virtual world of Second Life to learn programming in a visual manner.
Q6	You believe that programming 3D objects in the multimedia environment of Second Life has facilitated a better imagination of what a computer program do.
Q7	You believe that the scenario in Second Life was useful and appropriate to facilitate your understanding and learning of this difficult subject.
Q8	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.
Q9	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.
Q10	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.
Q11	You felt more encouraged to take a more active role in the virtual world for your own learning of computer programming.

Survey 10: PrimTime Education – a walk in a green space	
Q12	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.
Q13	You have felt less engagement in the programming activities carried out in the physical classroom compared to the virtual world.
Q14	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.
Q15	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.
Q16	You prefer using the 3D multimedia environment of Second Life to visualise other difficult concepts in your Computing degree to facilitate your learning and achievement.

Response				
Fully Agree	Agree	I Don't Know	Disagree	Fully Disagree

	Survey 11: Dealing with help desk customers
Q1	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.
Q2	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.
Q3	Following the first session in Second Life, I realised the advantages of ‘Role-Playing’ in a virtual environment to replicate a physical ‘Call Centre’.
Q4	I believe that students’ attitude in general was better in the virtual environment, which facilitated a successful lesson and maximized learning.
Q5	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.
Q6	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.
Q7	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.
Q8	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.

Q9	I believe that Second Life is a useful platform to enhance learning in Higher Education.
Q10	I believe that the ‘Computing Building’ in Second Life was well designed to suit the needs of Higher Education Computing students.
Q11	Acting as a customer/technical support staff gave me more of an appreciation of another person’s perspective.
Q12	Helping customers in a virtual world helped me to concentrate and focus more on the problem.
Q13	In the virtual environment, having no feedback with respect to body language was less stressful for me.
Q14	In the virtual world, I could readily detect the type of person I was dealing with.
Q15	I was more easily able to deal with the individual’s personality traits in a virtual world.
Q16	I felt more comfortable dealing with a stressful situation as I did not have to concentrate, in the virtual environment, on my body language.
Q17	I learnt some new coping mechanisms when dealing with people in the virtual world.
Q18	The virtual world helped me to prevent a difficult situation from escalating.
Q19	I dealt with the given situation better in a virtual world than I would have in the real world.
Q20	It was useful to be able to try out techniques in a simulated environment before being put into a real life situation.
Q21	Interviewing individuals/eliciting information about the problem was much easier in the virtual world.

Q22	The virtual world helped me to practice my interpersonal skills.
Q23	The virtual world allowed me to deal better with people I do not already know.
Q24	I preferred using the virtual world to 'the Apprentice Style real-world activity' session.
Q25	I feel less self-conscious in the virtual world.
Q26	I felt less likely to give up trying to deal with the problem in the virtual world.
Q27	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.
Q28	I would be happier spending time doing virtual rather than physical support.
Q29	I think it would be sensible to incorporate some virtual support as part of the Tech Genius Helpdesk Project.
Q30	I have to concentrate more on what I was saying in the virtual world.
Q31	I am looking forward to a second session in Second Life to play a different role in the virtual helpdesk to develop your skills.
Q32	The experience of simulated scenarios has increased my confidence in dealing with the unexpected.

Response				
Fully Agree	Agree	I Don't Know	Disagree	Fully Disagree

Survey 12: Coping with pressure on the help desk	
Q1	The virtual environment added flexibility to support.
Q2	The virtual environment resulted in easier support.
Q3	Customer personality traits were easier to identify.
Q4	Dealing with different personality traits was easier.
Q5	The environment meant that personality traits made less impact upon the success of the outcome.
Q6	The facilities offered by the setting e.g. refreshments, enabled me to handle a difficult situation better.
Q7	The environment (a dedicated building) offered more credibility to the Help Desk support.
Q8	The environment (a dedicated building) provided me with more confidence as a help desk technician.
Q9	The situation of a virtual world provided less distraction than the real world allowing me to concentrate more fully on the issue in hand.
Q10	Support facilities e.g. on-line were easier to access in the virtual environment.
Q11	I found non-verbal communication easier in a virtual environment.
Q12	I found verbal communication easier in a virtual environment.
Q13	You believe that performing the duties of a staff member at a physical helpdesk system without actual training on the difficult skills and techniques required for a successful delivery of such a service is difficult to achieve.

Q14	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 practise on a replication of an actual helpdesk system with real customers.
Q15	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.
Q16	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.
Q17	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.
Q18	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.
Q19	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.
Q20	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.
Q21	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.
Q22	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.

Q23	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.
Q24	(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 ☐)

Response				
Fully Agree	Agree	I Don’t Know	Disagree	Fully Disagree
Any comments you would like to add (optional):				

Survey 13: Development project presentations in Second Life	
Q1	Presentations are easier for me to give in a virtual world.
Q2	Presentations given in a virtual world allow me to express myself better.
Q3	I felt less self-conscious giving a presentation in a virtual world than in real life.
Q4	Preparation for the presentation was easier in a virtual world.
Q5	I prefer to give a presentation in the real world as I can use my body language more expressively.
Q6	I prefer to see the audience reaction in the real world.
Q7	I feel more confident giving a presentation in the real world.
Q8	It is easier to deal with critical feedback of my presentation in a virtual world.
Q9	I enjoyed the experience of giving a presentation in a virtual world.
Q10	A virtual world gives me more scope for selecting a setting/environment suitable to my presentation.
Q11	I am able to 'add more value' to my presentation in a virtual world.
Q12	I would like to do further presentations in a virtual world as opposed to a real world setting.
Q13	I am able to prepare myself better for a presentation that is required to be delivered in a virtual world.
Q14	The virtual world can enhance a presentation.
Q15	I am able to think more clearly and concentrate on the message when delivering a presentation in the virtual world.

Response				
Fully Agree	Agree	I Don't Know	Disagree	Fully Disagree
Any comments you would like to add (optional):				

Survey 14: Responding to critical feedback (multimedia project)	
Q1	The activity of obtaining live feedback from a broad audience in Second Life was successful.
Q2	You underestimated the various advantages of this activity when iut was first explained to you by your unit lecturer.
Q3	You found the activity engaging and the atmosphere was user-friendly.
Q4	You obtained a valuable and constructive feedback from the audience on your marketing digital story.
Q5	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.
Q6	You believe that the live feedback was useful to you in improving the quality of your final product before final submission of the product.
Q7	The additional resources that the audience provided via e-mail 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.
Q8	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.
Q9	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.
Q10	The honesty of the feedback has been increased by the anonymity of the audience.
Q11	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.

Response				
Fully Agree	Agree	I Don’t Know	Disagree	Fully Disagree

Survey 15: Introduction of VW	
Q1	You have heard of Second Life before.
Q2	You have good background information about Second Life.
Q3	You have good background knowledge about the application of Second Life in Further Education.
Q4	You have good background knowledge about the application of Second Life in Higher Education.
Q5	You have good background knowledge about the application of Second Life in Further Education Computing.
Q6	You have good background knowledge about the application of Second Life in Higher Education Computing.
Q7	You have good background knowledge about the application of Second Life in electronic libraries of universities.
Q8	You have heard and understood the term 'Social Computing'.
Q9	You have heard and understood the term 'Simulation'.
Q10	Applying education (in general) in a virtual world will enhance the students' learning experience.
Q11	Applying Computing education in a virtual world will enhance the students' learning experience.
Q12	As a Computing student, you are open to different Computing technologies.
Q13	As a Computing student, you would like to investigate and exercise the developing technologies in the Computing field.

Response				
Fully Agree	Agree	I Don’t Know	Disagree	Fully Disagree
Any comments you would like to add (optional):				

Survey 16: Introduction of VW	
Q1	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.
Q2	You believe that these activities were generally beneficial and facilitated your learning.
Q3	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.
Q4	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.
Q5	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.
Q6	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.
Q7	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.
Q8	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.

Survey 16: Introduction of VW	
Q9	You believe that sometimes people are not open to new technologies and/or they have prejudgements based on one-side new or another person's experience.
Q10	(Based on Question No. 9) - You believe that the statement in Question no. 9 applied to your initial judgement on Second Life.
Q11	(based on Question No. 9) - You believe that the experience from attending the different activities in Second Life managed to change the negative opinion that you initially has on the use of virtual world in your higher education.
Q12	(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.

Response				
Fully Agree	Agree	I Don’t Know	Disagree	Fully Disagree
Any comments you would like to add (optional):				

Survey 17: Iteration in programming	
Q1	You consider that the learning programming is a difficult subject.
Q2	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.
Q3	According to your unit lecturer and previous observations to your programming sessions, you face difficulties in learning essential programming concepts and the types of execution expected as a result of applying them in a program.
Q4	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.
Q5	You have enjoyed the scenario designed for you in the virtual world of Second Life to learn programming in a visual manner.
Q6	You believe that programming 3D objects in the multimedia environment of Second Life has facilitated a better imagination of what a computer program do.
Q7	You believe that the scenario in Second Life was useful and appropriate to facilitate your understanding and learning of this difficult subject.
Q8	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.
Q9	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.
Q10	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.
Q11	You felt more encouraged to take a more active role in the virtual world for your own learning of computer programming.

Survey 17: Iteration in programming	
Q12	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.
Q13	You have felt less engagement in the programming activities carried out in the physical classroom compared to the virtual world.
Q14	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.
Q15	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.
Q16	You prefer using the 3D multimedia environment of Second Life to visualise other difficult concepts in your Computing degree to facilitate your learning and achievement.

Response				
Fully Agree	Agree	I Don't Know	Disagree	Fully Disagree

Survey 18: PrimTime Education – a walk in a green space	
Q1	The scenario increased my understanding of the concepts.
Q2	I was able to explain the concepts following the scenario.
Q3	The virtual world helped me to visualise the ideas better than I could have in the real world.
Q4	The scenario was appealing.
Q5	I would like to have similar scenarios to help me understand difficult concepts.
Q6	The scenario helped me to imagine how user defined data types are created.
Q7	The scenario was a good representation of design and creation of structures and classes.
Q8	The links between variables, structures and classes helped me build on my knowledge.
Q9	The situation of a virtual world provided less distractions than the real world allowing me to concentrate more fully on the issue in hand.
Q10	The ability to move around an environment helped me to learn.
Q11	The scenario formed a good basis on which to progress.

Survey 18: PrimTime Education – a walk in a green space	
Q12	The scenario could have been used in a standalone situation.
Q13	The scenario added interest to the Introduction to Programming unit.
Q14	The scenario made the concepts memorable.
Q15	I quickly understood the concept of a class; how to create one and how to create an object.
Q16	You consider that Object Oriented Programming is a difficult concept.
Q17	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.
Q18	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.
Q19	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.
Q20	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.
Q21	Generally, you believe that the 3D visualisation of difficult Computing concepts in the virtual world facilitates their understanding and learning.

Response				
Agree	Somewhat Agree	Unsure	Somewhat Disagree	Disagree
Is there anything that could have been improved in the scenario:				

Survey 19: The rules of database normalisation	
Q1	You consider that database normalisation is a difficult subject in HE Computing.
Q2	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.
Q3	According to your unit lecturer, you were unable to remember the explanations delivered to you on the database normalisation subject (in the physical classroom) a week later.
Q4	You have enjoyed the scenario designed for you in the virtual world of SecondLife to learn database normalisation.
Q5	You believe that the scenario in SecondLife was useful and appropriate to facilitate your understanding and learning of this difficult subject.
Q6	You liked the idea of role-playing and gathering the information yourself for the database in the virtual world.
Q7	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.
Q8	As you have now received tuition on this subject in both the physical and the virtual worlds, you believe that the database normalisation process is better learned in the virtual world.
Q9	You felt more encouraged to take a more active role in the virtual world for your own learning of this subject.
Q10	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.
Q11	You had less engagement in the activities of the database normalisation lesson in the physical classroom.

Survey 19: The rules of database normalisation	
Q12	When you had the lesson for the database normalisation subject in the physical classroom, you realised that this subject requires a method beyond the white/smart board and the presentation/handout approach.
Q13	Having immersed and role played in the virtual scenario to learn database normalisation, you believe that you will be able to better recall the information you learned in the virtual world compared to the physical one.
Q14	You prefer using the 3D multimedia environment of Second Life to visualise other difficult concepts in your Computing degree to facilitate your learning and achievement.

Response				
Fully Agree	Agree	I Don't Know	Disagree	Fully Disagree

Survey 20: Dealing with help desk customers	
Q1	Unexpected situations make me unsettled.
Q2	I find it difficult to imagine what types of problems I could encounter at the helpdesk.
Q3	I find it difficult dealing with a variety of different people with certain personality traits.
Q4	Communication can sometimes be a challenge for me.
Q5	I find the unit requirement easy to achieve.
Q6	I am not comfortable to go on a real helpdesk without experience.
Q7	I find it very difficult to interpret people's non-verbal communication (e.g. body language).
Q8	I find the training on the helpdesk duties helpful.
Q9	Being able to simulate situations improve my self-confidence and helped me to better prepare for a real-life situation.
Q10	Being able to rehearse/experience potentially difficult situation has added my planning to defuse/deal with them in the real world.
Q11	I can recommend ways of extending the range of ICT service support beyond the traditional approach.
Q12	I appreciate the advantages of providing ICT service support in a non-traditional environment.

Response											
Before using VW						After using VW					
Fully Agree	Agree	Slightly Agree	Fully Disagree	Disagree	Slightly Disagree	Fully Agree	Agree	Slightly Agree	Fully Disagree	Disagree	Slightly Disagree

Survey 21: The rules of database normalisation	
Q1	Database Normalisation is a difficult subject
Q2	The visualised mode of explaining the concepts and application of database normalisation helped my understanding and learning of this subject. (i.e. on the SMART/White Board compared to the virtual world scenario).
Q3	I am confident with the main concepts of the database normalisation subject (e.g. UNF, 1NF, 2NF, 3NF).
Q4	Being able to see the real-time effects of database normalisation process (visualised) aided the retention of the information (i.e. the traditional exercises in the classroom and the visualised exercises in the real world).
Q5	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).
Q6	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.
Q7	I find it difficult to imagine the process of carrying out the different normalisation rules and the resulting outcome.
Q8	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.

Q9	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 Microsoft PowerPoint presentations, notes and 3D objects in the immersive environment of the virtual world.
Q10	The learning tools used to explain the difficult concepts of the database normalisation subject were successful in making my learning environment enjoyable.
Q11	I understood the database normalisation concepts quickly because of the learning tools used to explain them.
Q12	One method of teaching the database normalisation concepts would be sufficient. State your preferred method: RW, VW or Both.

Response							
Before using the VW				After using the VW			
Slightly Agree	Fully Agree	Slightly Disagree	Fully Disagree	Slightly Agree	Fully Agree	Slightly Disagree	Fully Disagree

Survey 22: Iteration in programming	
Q1	Computer Programming is a difficult subject.
Q2	The visualised mode of explaining the concepts and application of programming helped my understanding and learning of this subject i.e. on the SMART/White Board compared to the virtual world scenario.
Q3	I am confident with the main concepts of the database normalisation subject (e.g. sequence, selection, iteration).
Q4	Being able to see the real-time effects of programming instructions (visualised) aided the retention of that information i.e. the traditional exercises in the classroom and the visualised exercises in the real world.
Q5	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.
Q6	The traditional method of teaching the programming subject in the physical classroom (alone) is suitable for facilitating the understanding and learning of its concepts.
Q7	I find it difficult to imagine the process of executing the individual programming instructions and their resulting outcome.
Q8	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.
Q9	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 MS PowerPoint presentations, notes and 3D objects in the immersive environment of the virtual world.
Q10	The learning tools used to explain the difficult concepts of the programming subject were successful in making my learning environment enjoyable.
Q11	I understood the programming concepts quickly because of the learning tools used to explain them.

Q12	One method of teaching the programming concepts would be sufficient. State your preferred method: the RW, the VW or Both

Response							
Before using the VW				After using the VW			
Slightly Agree	Fully Agree	Slightly Disagree	Fully Disagree	Slightly Agree	Fully Agree	Slightly Disagree	Fully Disagree

Survey 23: What do you think about programming so far?	
Q1	Before the start of the course, you thought that you would enjoy programming
Q2	Computer programming is a difficult subject
Q3	Programming being a conceptual subject makes the learning more difficult.
Q4	Being able to visualise the programming process would make learning it easier.
Q5	You believe that at this stage you will not be able to master the programming subject
Q6	Programming subjects making Computing degrees difficult to achieve
Q7	You think that the traditional method of teaching programming makes it difficult to imagine the ideas and how the programming instructions actually work
Q8	A visualised scenario and the use of metaphors will improve your understanding of programming.

Response			
Fully Agree	Agree	Disagree	Fully Disagree

Survey 24: PrimTime Education – a walk in a green space	
Q1	The link between variables structures and classes is clear.
Q2	Structure and Classes subject is difficult to understand.
Q3	The abstract concept of a Class and a Structure is readily understood.
Q4	The physical implementation of a Class and a Structure is easily visible.
Q5	The environment used to convey this specific subject facilitated the learning of it.
Q6	The subject was made more memorable by the method used to explain it.
Q7	The theory concepts of the Structure and Classes subject require visualisation to facilitate understanding (i.e. on the white/smart board compared to the virtual world scenario)
Q8	Examples and the use metaphors (symbols) make this subject more imaginable.
Q9	It is clear how to use these facilities successfully in programming.
Q10	The method used to deliver this subject was enjoyable.
Q11	This subject was understood quickly.
Q12	Learning in multiple environments addressed my learning needs/preferences.

Response							
Before using the VW				After using the VW			
Slightly Agree	Fully Agree	Slightly Disagree	Fully Disagree	Slightly Agree	Fully Agree	Slightly Disagree	Fully Disagree

Survey 25: Conducting an interview	
Q1	It is challenging for me to express myself clearly.
Q2	I understand what people say from their verbal expression.
Q3	The fact-finding tools that were available to me in my learning environment were very effective.
Q4	I feel confident in using my interpersonal skills to elicit information.
Q5	The systems analysis techniques available are suitable to provide the quality and quantity of information required for business needs in order to design a software solution.
Q6	Physical restrictions (e.g. travel, place, time) can prevent successful communication.
Q7	A combination of communication techniques could enhance the outcome of an investigation (e.g. merging immediate communication and non-verbal communication).
Q8	Interviewing is convenient for everybody (the interviewer and interviewee).
Q9	I am able to achieve effective fact-finding for my systems analysis.

Response							
Before using the VW				After using the VW			
Slightly Agree	Fully Agree	Slightly Disagree	Fully Disagree	Slightly Agree	Fully Agree	Slightly Disagree	Fully Disagree

Survey 26: Ashgrove Surgery – time constrained assessment	
Q1	Did the experience of looking for information in a simulated environment help you to consider the many ways in which information can be found within a given physical scenario?
Q2	Did this experience in the virtual world help you to visualise the paper-based description of the database system?
Q3	Did you find the virtual world a valuable experience to improve your understanding of the data requirements for the database system under investigation?
Q4	Did the representation of the Ashgrove Surgery in the virtual world help to prepare you for a similar situation in the real world?
Q5	Did the range of fact-finding activities offered in the virtual world help you to evaluate their effectiveness in the real world?
Q6	Did the range of fact-finding activities offered in the virtual world help you to immerse in the scenario given? Did it enable a better understanding of the requirements of the database system under investigation?
Q7	Was the range of objects you found in the virtual world representative of what you would expect to see in the real world scenario?
Q8	Having looked at other means of assessment in the virtual world would you prefer to carry out an entire assessment within this environment in the future (for this and possible other modules)? If yes, state the names of the modules.
Q9	Do you consider there were any benefits to having access to a replication of a doctor's surgery? If so, what were they?
Q10	Do you think the visualisation of the input and output transactions to the database system would have helped you further to understand the design of the database system?
Q11	Do you think that the visualising each of the rules in the virtual world e.g. patients queuing to see a GP but the patients only see one GP per visit, would help you to confirm your understanding with a customer and facilitate the production of an accurate ERD?

Response
Open Questions

VW Scenario/Activity Listing

Group	Scenario No.	Survey No.	Unit	Scenario Name	Scenario Date	Skills
A(3)	1	5	MI	Conveying a Difficult Message	Feb-13	VC/NVC
A(3)	N/A	3	N/A	N/A	Sep-12	CinR
A(3)	N/A	4	N/A	N/A	Apr-13	CinR
A(3)	2	1	MTS	Being Served at a Buffet	Oct-12	P&I
A(3)	2	2	MTS	Being Served at a Buffet	Nov-12	P&I
B(2)	N/A	6	N/A	N/A	Sep-12	CinR
B(2)	N/A	7	N/A	N/A	Apr-13	CinR
B(3)	3	8	RM	Research Methods Unit (with Virtual World support)	Dec-13	CinR
B(3)	4 (2 Revised)	9	MTS	Being Served at a Buffet	Nov-13	P&I
B(2)	5	10	OOSD	PrimTime Education A Walk in a Green Space	Mar-13	P&I
B(2)	6	11	ICTSS	Dealing with Help Desk Customers	Dec-12	SR

Group	Scenario No.	Survey No.	Unit	Scenario Name	Scenario Date	Skills
B(2)	7	12	ICTSS	Coping with Pressure on the Help Desk	Apr-13	SR
B(2)	8	13	PM/DP	Development Project Presentations in Second Life	Mar-13	VC/NVC
B(2)	9	14	MT	Responding to Critical Feedback (Multimedia Product)	Jan-13	VC/NVC
C(1)	N/A	15	N/A	N/A	Sep-12	CinR
C(1)	N/A	16	N/A	N/A	Apr-13	CinR
C(1)	10	17	ItoP	Iteration in Programming	Feb-13	CinR
C(2)	11 (5 Revised)	18	OOSD	PrimTime Education A Walk in a Green Space	Mar-13	P&I
C(1)	12	19	IDD	The Rules of Database Normalisation	Feb-13	P&I
C(2)	13 (6 Revised)	20	ICTSS	Dealing with Help Desk Customer	Oct-13	SR
D(1)	14 (12 Revised)	21	SAD	The Rules of Database Normalisation	Nov-13	P&I
D(1)	15 (10 Revised)	22	SDD	Iteration in Programming	Nov-13	CinR

Group	Scenario No.	Survey No.	Unit	Scenario Name	Scenario Date	Skills
D(1)	16 (5, 11 Revised)	23	SDD	PrimTime Education A Walk in a Green Space	Oct-13	P&I
D(1)	16 (5, 11 Revised)	24	SDD	PrimTime Education A Walk in a Green Space	Dec-13	P&I
D(1)	17	25	SAD	Conducting an Interview	Nov-13	VC/NVC
D(1)	18	26	SR	Ashgrove Surgery - TCA	Mar-14	SR

Key: Soft Skills	
CinR	Change in Routine
VC/NVC	Verbal/Non-Verbal Communication
P&I	Play and Imagination
SR	Social Relationships

Key: Applied Computing Units	
DP	Development Project
ICTSS	ICT Service Support
IDD	Introduction to Database Development
ItoP	Introduction to Programming
MI	Managing Information
MTS	Multi-Tasking Systems
OOSD	Object-Oriented Software Development
PM	Project Management
RM	Research Methods
SAD	Systems Analysis and Databases
SDD	Software Design and Development

Soft Skills Mapping

CinR	VC/ NVC	P&I	SR	Scenario No.	Survey No.	Unit	Group
	X			1	5	MI	A(3)
X				N/A	3	N/A	A(3)
X				N/A	4	N/A	A(3)
		X		2	1	MTS	A(3)
		X		2	2	MTS	A(3)
X				N/A	6	N/A	B(2)
X				N/A	7	N/A	B(2)
X				3	8	RM	B(3)
		X		4 (2 Revised)	9	MTS	B(3)
		X		5	10	OOSD	B(2)
			X	6	11	ICTSS	B(2)
			X	7	12	ICTSS	B(2)
	X			8	13	PM/DP	B(2)
	X			9	14	MT	B(2)
X				N/A	15	N/A	C(1)
X				N/A	16	N/A	C(1)
X				10	17	ItoP	C(1)

CinR	VC/ NVC	P&I	SR	Scenario No.	Survey No.	Unit	Group
		X		11 (5 Revised)	18	OOSD	C(2)
		X		12	19	IDD	C(1)
			X	13 (6 Revised)	20	ICTSS	C(2)
		X		14 (12 Revised)	21	SAD	D(1)
X				15 (10 Revised)	22	SDD	D(1)
		X		16 (5, 11 Revised)	23	SDD	D(1)
		X		16 (11 Revised)	24	SDD	D(1)
	X			17	25	SAD	D(1)
			X	18	26	SAD	D(1)

Key: Soft Skills	
CinR	Change in Routine
VC/NVC	Verbal/Non-Verbal Communication
P&I	Play and Imagination
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Key: Applied Computing Units	
DP	Development Project
ICTSS	ICT Service Support
IDD	Introduction to Database Development
ItoP	Introduction to Programming
MI	Managing Information
MTS	Multi-Tasking Systems
OOSD	Object-Oriented Software Development
PM	Project Management

Key: Applied Computing Units	
RM	Research Methods
SAD	Systems Analysis and Databases
SDD	Software Design and Development