Low Empathising and High Systemising Tendencies in Higher Education 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 tendencies may present a barrier to future professional success. It is therefore important that the needs of such students are considered as part of their higher education experience, in order to ensure that the development of essential soft skills can be addressed 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 recognised as presenting the most difficulty for those with a low empathising, high systemising disposition.

Method. A variety of bespoke scenarios were developed for a VW and introduced to an undergraduate Applied Computing programme. These were based on technical activities but with a focus on managing non-routine situations, improving communication, embracing play and imagination as well as developing social relationships. Associations were made between the students’ cognitive style and their scholastic performance, including their own perception of the intervention. Consideration was also given to the observations of others, such as higher education unit lecturers, support staff, volunteer VW scenario participants and employers.
Result. Achievement for all students was generally found to be better in areas of the course incorporating VW activities. Those with low empathising, high systemising traits considered their communication to have improved the most, followed by their ability to tackle non-routine situations, albeit with some delay in their reaction to the latter. A positive, but less significant, impact was reported for the other skills. However, the contribution of VW activities appeared to be transformational in some students experiencing more severe difficulties in these areas.

Discussion. The research provided evidence of the VW as an engaging environment for developing non-technical skills through technical experiences, but raised a number of adoption concerns. While these techniques, applicable to other Science, Technology, Engineering and Mathematics (STEM) areas or indeed any subject discipline that requires an emphasis on sought-after soft skills, could still be implemented by other methods in the real world, the activities may not be as effective as they are in avatar-based VWs.

Keywords: Low Empathising High Systemising, Soft Skills, Virtual Worlds, Higher Education, STEM

1.0 Introduction

The principle 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 operate has turned out to be anything but simple. The computing industry continues to offer an extensive range of career opportunities. However, the exponential evolution of technology and the requirement for specialists who are able to appreciate, supply and/or effectively support the diverse and often sophisticated needs of an organisation including its workforce, means that the demands on those who are drawn to this competitive profession are becoming ever more challenging. Hence, the importance of closing any perceived gap in soft skills between graduate ability and employer expectations [19]. Previous research indicates that those working in the science and engineering professions are more likely to have low empathising, high systemising tendencies than those in less technical occupations [5]. But little work has since been done into how students might be helped to overcome these tendencies, particularly with respect to their interactions with others. It is therefore important that those working in higher education are aware of these learning requirements in order to ensure that students are equipped with the range of skills necessary to excel in an increasingly complex workplace. The specific soft skills identified for this study, illustrated in Table 1, have been informed by prior research [3]. They relate to a below average ability to empathise and an average or above average, ability to systemise, the intention being to use the latter as a strength though which to raise the profile of the former.
‘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.’

Table 1: Targeted soft skills for the VW intervention

<table>
<thead>
<tr>
<th>Trait</th>
<th>Skill</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Empathising</td>
<td>• Communication difficulties</td>
</tr>
<tr>
<td></td>
<td>• Social difficulties</td>
</tr>
<tr>
<td></td>
<td>• Problems with play and imagination</td>
</tr>
<tr>
<td>High Systemising</td>
<td>• Resistance to change / Need for sameness</td>
</tr>
</tbody>
</table>

The relevance of such skills to proficient practice is promoted by professional bodies, including the British Computer Society (SFIA™) and the Association for Computing Machinery [1].

‘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.’

The rationale for this study, therefore, was to assess any impact the educational affordances of VW technology might have on the learning needs of higher education computing students by identifying, describing and analysing the findings with a view to developing associated theory and making recommendations for a more personalised learning environment.

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

RQ1: Does learning in a VW help to diminish the need for routine in low empathising, high systemising computing students?

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

RQ3: Is the use of play and imagination in the VW helpful to learning for low empathising, high systemising 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 low empathising, high systemising computing students and if so, in what way?
1.1 Low Empathising, High Systemising Traits Explained

Although the term ‘empathy’, a subject of broad and current interest to neuroscience, is now in common use its origins are relatively recent, the psychologist Edward Bradford Titchener of Cornell University having been widely credited for its first appearance in English in 1909. Translated from the German ‘einfühlung’ meaning ‘feeling into’ it was initially understood as being a sort of projection of imagined bodily movements and related feelings into an object or another person, a vehicle that artists might use. However, the exact nature of the feeling continues to be debated. A more modern definition considers both the emotional and cognitive features 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’ [9]. Others suggest that the affective response does not have to be similar, simply adjusted in a suitable manner by the person feeling it [4], which is the view taken in this research. Systemising is described as the desire to understand, analyse and possibly construct any predictable rule-based system, such as mechanical or numerical systems. It has been theorised that those with an average or superior ability in this area ‘hyper-systemise’ [3].

Low empathising, high systemising characteristics can be described as the representation of a different cognitive style appearing as a continuum across the general population, with autism seen as an extreme manifestation of such traits. This study was therefore guided by an Autism-Spectrum Quotient (AQ), a self-reporting test, both brief and simple to administer, designed to assess the degree to which adults with normal intelligence exhibit the traits associated with the autistic spectrum [3]. Although not deemed suitable for a diagnosis, it has been confirmed as an effective tool in a number of studies for the detection of patterns [16]. The average threshold of the test in a control group was measured at 16.4 [5].

1.1 Why Virtual Worlds?

A number of approaches have been devised to add value to the development of soft skills in both the real world [22] and the VW, revealing some of the latter’s limitations [14]. However, many of the educational opportunities in VWs are presented by their inherent characteristics, which are both varied and supportive. This study was designed to make use of the ‘3Is’ [7], the unique and inextricably linked features of VWs:

- **Immersion** - this can simply be described as what the technology delivers from an objective standpoint. Immersion can lead to a feeling of ‘presence’, a more subjective human reaction, and a perceived level of body ‘ownership’ [20].
- **Identity** - being able to project an individual’s own or a chosen identity via the personification of an avatar can be an extremely engaging learning device. The affective influence of virtual embodiment is strengthened by contemporary research into mirror neurones [18]. These are the specialised brain cells that allow individuals to learn and also to empathise by performing an action or ‘mirroring’ the same action performed by another.
- **Interaction** - the persistent nature of VWs means that they are always available
for a wide range of interactions such as playing, socialising, collaborating and transacting [7].

Since the central focus of a higher education computing curriculum is seen to be the development of technical competencies, the challenge for the tutor 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 of course can only be achieved by means of the very skills that are inherently difficult for them and here is where the VW offers the most value. The ‘once removed’ [2] activities involving avatars enable students to experiment with roles and acquire valuable tacit knowledge through skills, ideas and experiences in a less self-conscious way than may be achievable within the real world. There is also the benefit of being able to demonstrate the intrinsic importance of particular soft skills for effective professional practice through direct personal experience, which in turn has the potential for increasing the receptiveness of participants to ideas that would improve their own capability in these areas.

The intention of this investigation therefore was to assess the value of this fresh approach that would not necessarily replace, but possibly enhance current methods to foster soft skills. The novelty resides in focusing on areas of perceived difficulty in a way that would be naturally appealing to students who are drawn to technology and expect it to form part of their educational experience.

Although there are many free open-source platforms for VWs such as OpenSim (ulator)™ and Open (formerly Project) Wonderland™, Second Life™ (SL) was selected for this study as it offered a mature and popular platform for learning as well as research, while continuing to incorporate innovation. In particular, the building and scripting functions available within SL made it a perfect platform for teaching the practicalities of computer science and interactive multimedia.

However, a view that particularly resonates with this research is that of Steils et al. [21] who argue that any technology having the potential to improve student learning should be considered. They discuss ways in which the use of VWs in higher education may facilitate the adoption of a ‘liquid curricula’, simply explained by placing an emphasis on the stances and experiences of both students and staff in order to increase educational versatility. Hence the starting point for the scenarios devised as part of this investigation [6] was to enable vocational students in higher education to benefit from the authentic experiences of others.

2.0 Materials and Methods

The initial strategy was to operate within the broad scope of an Action Research methodology, yet to remain open to other possibilities as the work progressed. Although not usually considered to be a methodology as such, a case study approach was also used to highlight certain aspects of the research. Two students experiencing particular communication difficulties (with the potential for some impact upon their social relationships) formed the focus of this part of the investigation. An initial pilot study was carried out with a BSc (Hons) Applied Computing group, in order to test the chosen evaluation framework which was
based on the de Freitas and Oliver four-dimensional model [8]. This pays due attention to the learner, pedagogy, representation (of the learning experience) and context. A group of FdSc Applied Computing students 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 Applied Computing groups, at different stages of their course, to establish whether or not the findings from the main study group were confirmed. The data gathered from all groups were subsequently combined and analysed.

Associations were made between the students’ cognitive style (based on their AQ score) and scholastic performance, as well as their own perception of the intervention. The observations of others were also taken into account. A mixture of quantitative and qualitative analysis was carried out for each group of participants on the data captured by the following methods:

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.

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. In order to gain a broader perspective, observations were collected from other higher education lecturers, support staff, volunteer VW scenario participants and employers.

Interrogation – a significant amount of data was gathered through various methods of interrogation, either individually or as a group, such as surveys (containing both open and closed questions) and discussion forums.

1.1 Scenario Design Considerations and Example Activity

The component elements of VW scenarios were organised in a way that enabled students to obtain experience of the desired soft skills. Wherever possible, activities were designed and constructed with high-systemisers in mind, for example ‘rule-based’ activities were used to help facilitate social situations, as illustrated in the following ‘program-like’ guidance:

```plaintext
IF two customers arrive at the help desk needing ‘urgent’ support THEN
    Establish a priority for each problem
    Direct customer with the lower priority problem to ‘help guides’
    Deal with the higher priority customer problem
ENDIF
```

The use of realism [13] was also intended to help high systemisers by providing behaviour ‘clues’, such as the use of a bookcase to suggest ways in which pressure might be reduced on the Help Desk by directing customer(s) to appropriate reference material. Saleeb and Dafoulas [17] indicate that a student’s pleasure and satisfaction from an educational space is largely dependent and reliant on its architectural design characteristics, so care was taken to make VW spaces aesthetically appealing. In order to encourage participation, spaces were also
designed to capture the imagination, stimulate creative and critical thinking, independence and experiential collaborative learning. Students were required to contribute to their learning as individuals and/or group members, whether they were participating in scenarios or observers of scenarios, providing feedback. Since learning tends to be deeper when students are more emotionally engaged constructive criticism was actively encouraged and scenarios modified accordingly. The value of this feedback, within the context of an educational experience, helped to increase the intervention’s effectiveness as a learning tool.

1.2 Example Activity: A Walk in a Green Space

PrimTime Education - A Walk in a Green Space (Figure 1) was designed to act as a bridge between two programming units by managing the transition from ‘structures’ to ‘classes’, the subject being sufficiently troublesome to be considered a possible threshold concept [12]. Since the aim was to reduce the stress often associated with this topic and facilitate learning through play and imagination, the scenario inspiration was drawn from the observations of Roe and Aspinall [15] that taking a walk in a green space, or simply sitting and viewing green spaces from a window, is likely to have a restorative effect and help with attention fatigue. Students entered the scenario in the small ‘business groups’ they were allocated in the real world and explored the space, learning from their experience. The design made extensive use of real world metaphors to illustrate the underlying concepts. A transfer of behaviour to the real world was also suggested by demonstrating how solutions to end user problems may be better explained to them by means of an imaginative approach and using non-technical language.

4.0 Results

Quantitative and qualitative data analysis indicated that achievement was generally better in areas of the course incorporating VW activities (detailed in Table 2,
summarised in Figure 2) and that VW elements enriched both formative and summative assessment (Figure 3) as well as learning activities.

Table 2: Unit grades involving VW vs no VW activities

<table>
<thead>
<tr>
<th>Group Name (Year)</th>
<th>A(3)</th>
<th>B(2)</th>
<th>B(3)</th>
<th>C(1)</th>
<th>C(2)</th>
<th>D(1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AQ&gt;16</td>
<td>10</td>
<td>5</td>
<td>2</td>
<td>-3</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>AQ≤16</td>
<td>15</td>
<td>6</td>
<td>2</td>
<td>-4</td>
<td>4</td>
<td>0</td>
</tr>
</tbody>
</table>

The analysis of qualitative data indicated that low empathising, high systemising students considered their communication to have improved the most, followed by their ability to deal with non-routine situations, albeit with some delay in this reaction. Overall, a positive, but less significant, impact was seen in the development of play and imagination, as well as improved social interactions.

While the notable personal development of the case study students could be attributed to a number of influencing factors, it was clear from their attainment and feedback that the VW experiences had played an important part. The case of Student 2 was the most dramatic, the unit lecturer’s initial assessment being: ‘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’. Following the intervention, Student 2 even chose to seek out/interact with external clients for work-based projects a year earlier than the course programme required. The following are examples of his feedback: ‘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’, ‘It was beneficial yes! I am keen to continue using a virtual world’.
Two additional themes emerged from the study. Firstly, in situations of more severe difficulty with certain soft skills the contribution of VW activities appeared to be transformative, as seen in the case studies and also in the main study group. Secondly, some dissatisfaction with the VW representation was expressed by students with high AQ scores (≥32): ‘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), thereby confirming aspects of previous research, particularly the use of metaphor [10].
Students were asked to consider the advantages and disadvantages of developing the targeted soft skills within the real world and the VW as they were presented during the course of their studies and to state their preferred learning environment: the real world, the VW or both. The results, summarised in Figure 4, showed a tendency to select ‘both’, with some low empathising, high systemising students selecting the VW only. While comments were not specifically sought in the survey, certain students took the opportunity to clarify their selection and this feedback demonstrated a bias in favour of the VW when ‘both’ was selected. None of these comments related to the technical issues and regardless of the amount of disruption and accompanying frustration they caused, students only occasionally reported poor technology as a reason for impeding participation. The preferred learning environment generally reflected the positive reaction to the VW in the open survey comments. However, a close examination of the data tellingly showed that all students with an AQ score $\geq 32$ selected the real world only as their preferred learning environment.

5.0 Discussion

The outcome from this research was the creation of a variety of bespoke VW scenarios that provide undergraduate computing students with more opportunities to learn and practice soft skills through technical experiences [6]. 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 [11]. While many studies have been concerned with the needs of employment, less attention appears to have been paid to the problems some students face in acquiring soft skills, particularly those studying STEM subjects.

This investigation 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 higher education. 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. Such affordances not only made it possible for students to confront their anxieties, contributing to improved learning and attainment, but also helped them to engage more profoundly in their studies. Nevertheless, a number of barriers to VW adoption were also uncovered, such as the challenges involved in the creation and implementation of scenarios as well as the need for additional resources. A number of persistent technical issues required some extensive contingency planning, particularly when any form of assessment was involved. In this respect the VW brought as many problems as it did opportunities, hence the need to also find solutions in the real world. It would be possible to implement the ‘essence’ of these scenarios by other means, such as using classroom-based role-play activities or real world field trips, for example a visit to a park or any ‘green space’ could be a substitute for the ‘PrimTime Education’ scenario. However, the outcomes may not be quite as effective as in avatar-based VWs.

There are a number of directions in which this research could be progressed. A longitudinal study on the affective influence of the learning platform could
establish whether the effects were maintained and if there were any generalisations to daily life. It would also be interesting to involve students in the design and development of scenarios to assess any influence this extended participation in their education might have on subsequent achievement. It may be particularly useful for those with AQ scores $\geq 32$ to suggest ways in which their requirements might be honed and integrated into scenarios that could be used by all.

6.0 Acknowledgements

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7.0 References

6 Castle J L (2016). Low empathizing and high systemizing tendencies in Higher Education computing students: The affordances of virtual worlds in their education (Doctoral dissertation, University of the West of England).