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UNITE: Enhancing Students' Self-efficacy through the Use of a 3D Virtual World

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Abstract: This paper reviews a primarily quantitative empirical study involving 109 computing undergraduate students to assess whether the use of a 3D virtual world environment, implemented as part of their curriculum, could support the concept of self-efficacy. Whilst the role of self-efficacy within education in enhancing student motivation and learning has received increasing coverage over the last twenty years, its role within the context of 3D virtual worlds is still to be more fully explored. This study found that the use of a 3D virtual world for communication and collaboration improved students' self-efficacy beliefs in relation to activities undertaken as part of collaborative team-based projects. The results indicate significant improvements between students' pre-test and post-test self-efficacy ratings.

Keywords: 3D virtual worlds, Open Wonderland, 3D virtual environment, collaborative learning, constructivist learning environments, educational software, game-based learning, human-computer interaction, multi-user virtual environment (MUVE), research methods, simulation, self-efficacy, virtual environment (VE), virtual learning community, virtual worlds (VW).
Categories: L.2.3, L.2.7, L.3.0, L.3.3, L.3.6, L.5.1, L.6.2

1 Introduction

Research has documented the importance of effective team working in relation to the success of organisations [Salas, 08; Todorova, 08; Wuchty, 07]. Specifically in relation to computing, the British Computer Society [McManus, 08] identifies a number of reasons for IT project failures. These include: insufficient communication between project team members and end users; poor delegation and poor decision making. The Confederation of British Industry [Confederation of British Industry, 11], has criticised graduates for their inability to work effectively in a team. [Hollan, 92; Salomon, 10] have suggested that communication and collaboration are optimised when participants are present in the same physical place at the same time. [Kahai, 07; Papamichail, 09] have contended that the features of virtual worlds offer a rich range of possibilities for virtual team collaboration and experiential learning.

In addition to acknowledging that virtual worlds can support the process of communication in virtual environments it has also been acknowledged that they can engender and support the concept of self-efficacy. The theory of self-efficacy is embedded in an individual's belief in their abilities to perform certain tasks though it can also affect cognitive processes, motivation and feelings [deNoyelles, Hornik and Johnson, 2014]. In the context of virtual worlds, three dimensions of self-efficacy designed to assess the impact of the theory in educational scenarios have been proposed, namely: (1) virtual world-environment self-efficacy; (2) learning domain self-efficacy and (3) virtual world-learning domain self-efficacy [deNoyelles, Hornik and Johnson, 2014, pp.258-259]. Virtual world-environment self-efficacy (VWE-SE) is associated with an individual's ability to traverse and interrelate to other people in the virtual world where collaboration with avatars provides greater interaction for communication. Learning domain self-efficacy (LD-SE) relates to an individual's belief on their ability to undertake pivotal tasks in a certain learning environment. In contrast to LD-SE, virtual world-learning domain self-efficacy (VWLD-SE) is where students must be able to demonstrate their ability to use or manipulate learning objects entrenched within the virtual world environment to achieve certain learning domain tasks. The theoretical underpinning that informs the research study presented in this paper is the concept of self-efficacy.

At the time of writing and to the best of the authors' knowledge this theory has not been investigated within the context of virtual worlds and the tertiary education domain of games development to assess whether students' self-efficacy can be enhanced in relation to communication and team work via virtual world use. This paper contributes to the body of knowledge surrounding virtual world use and self-efficacy by providing an empirical study that explores the question of whether the pedagogical use of 3D virtual worlds can enhances students' self-efficacy and communication skills when working in games development project teams.

2 Literature Review

There are several definitions of the term "virtual world" in the academic literature and this phrase is sometimes used by authors to mean different things. There is no broadly agreed definition of the term [Bell, 08]. For example, the terms Massively Multiplayer Online Role-Playing Game (MMORPG), Collaborative Virtual Environment, virtual space, Multi-User Virtual Environment, metaverse and others have been used to describe virtual worlds. There are opposing views in the literature regarding a supposed ontological distinction between "games" and "virtual worlds". One paper [Grassian, 07] describes Second Life explicitly as an MMORPG, while another [Bainbridge, 07] states that *"Second Life is not a game"*. This study uses the Bainbridge [Bainbridge, 07, p.472] definition of virtual world, namely: *"an electronic environment that visually mimics complex physical spaces, where people can interact with each other and with virtual objects, and where people are represented by animated characters."*

Virtual worlds have existed for some time, and researchers have been actively investigating their educational potential. It has been argued that when applied in educational scenarios 3D virtual worlds have to ability to enhance the experience of interactive learning in comparison to more conventional teaching approaches. It has been further stated that virtual worlds can facilitate and support processes of

communication and knowledge construction [Tavares, Formanski and Silva, 2012, p.2]. Furthermore, Zhang, De Pablos and Zhu [Zhang, Ordonez de Pablos and Zhu, 2012, p.1388] state that the design of virtual worlds can enhance explicit and tacit knowledge sharing via *"…embraced voice and chatting"*.

Empirical research is steadily progressing in the area of 3D virtual worlds and their pedagogical application in educational settings. For example, the benefits of adopting the use of 3D virtual worlds has been identified in medical and health education where simulation models can aid trainee performance, improving practitioner quality via training on operations or simulating patient behaviour to enhance the delivery of clinical practice [Christopoulou et al., 2013]. Hew and Cheung [2010] have undertaken a review of the literature surrounding research in 3D virtual worlds in K12 and higher education. They reviewed and categorised several empirical studies and found that in educational contexts, virtual worlds have the potential to be used for: (1) communication spaces where virtual worlds are used to allow users to share information among themselves; (2) simulation of space (spatial) where a spatial aspect or a simulation of a 3D space can immerse users in a 3D environment through the use of an avatar (e.g. a virtual campus) and (3) experiential spaces ('acting' on the world) whereby in the context of Kolb's [1984] experiential learning cycle users engaged in 3D worlds can act on objects in their environment facilitating the concept of learning by doing allowing them to reflect on the outcomes of their actions and understand the environment they are immersed in.

Virtual environments can also afford students with various intrinsic benefits such as self-efficacy where individuals impart their knowledge to others and enhance their own confidence and enjoyment in assisting other individuals [Zhang, Ordonez de Pablos and Xu, 2014, p. 492]. Positive results have been reported relating to learning in 3D virtual environments, particularly for foreign language learning [Wehner, 2011], engineering education [Sancho, 09], information systems, and software engineering teaching [Connolly, 06, 07a]. However, a number of gaps in knowledge have been identified in relation to virtual worlds and their pedagogical and practical potential in higher educational contexts. These include the dearth of empirical evidence to support the claims that have been made in the literature and a need for greater understanding of the contexts and conditions upon which positive outcomes depend [de Freitas, 07; Richter, 11; Sancho, 09; Sancho-Thomas, 09; Wouters, 09]. The empirical work so far has tended to concentrate on the replication of physical world learning transposed to a virtual world. Teaching methods have largely been didactic and transmissive, rather than investigating the potential that virtual worlds offer for in-world student-to-student communication and collaboration.

3 The UNITE Environment

In recognition of these issues, the authors decided that the development of the UNITE environment should be designed as a platform to motivate students and facilitate enhanced self-efficacy with a focus on creating a dynamic, active, social collaborative, contextual, engaging, and challenging learning environment. Self-efficacy is associated with the process of empowerment that has connotations with an individual's personal competence related to the choices they make in terms of completing certain tasks that they feel capable of completing [Dinther, 11]. The creation of the UNITE platform was

designed to assess if students would become empowered to share project information and knowledge in an interactive learning environment.

The overall research project, of which this study forms a part, comprises three distinct empirical phases: an initial large-scale survey of the behaviours of university students in relation to virtual worlds and learning, a small pilot implementation of an experimental virtual world, and a final substantive empirical phase. [Scullion, 11] reports some of the findings of the initial survey. This indicates that most students communicate in-world with others, that informal learning processes are used to increase mastery of new skills and ways of learning, and that more frequent online communication is associated with higher levels of mastery. They suggest that members of virtual world communities use online communication and collaboration as part of an informal learning process. The pilot study [Scullion, 14] built upon these findings by implementing an online 3D virtual space that provided students in a single centre with tools and facilities for remote communication and collaboration during the undertaking of a team-based formal education project.

The following sections of this paper describe the multi-campus implementation and use of a 3D virtual online environment called UNITE for Computing students enrolled on undergraduate degrees at the University of the West of Scotland (UWS). The aim of introducing UNITE was to assess, when employed in a group work scenario, whether it had the potential to support and enhance self-efficacy in terms of motivating the students to learn from one another.

Open Wonderland, an open source toolkit for building 3D virtual worlds [Kaplan, 11], was used to create the UNITE environment. UNITE is hosted on a virtual server provided by UWS. Open Wonderland was selected because it is a flexible, modular and open-source platform for the creation of 3D virtual spaces. The focus of this research project is on facilitating the improvement in self-efficacy via collaboration on team-based projects, and Open Wonderland was considered best suited to that requirement. The pedagogical thinking that underpins the UNITE platform embodied the principles of empowerment and self-efficacy in that the students using the platform would feel more empowered in relation to:

- participating more openly with one another
- collectively working together,
- managing project tasks
- sharing their thoughts
- exchanging ideas with one another
- providing each other with support if they encountered difficulties throughout the duration of their coursework.

For the UNITE pilot, participants were initially directed to a “Starting” location in-world. They could then navigate among eight different locations, pre-populated with 3D and other content to provide visual interest. Participants could add their own 3D or 2D content by dragging and dropping the files in-world. Screenshots of two of these in-world locations are illustrated in Figure 1.

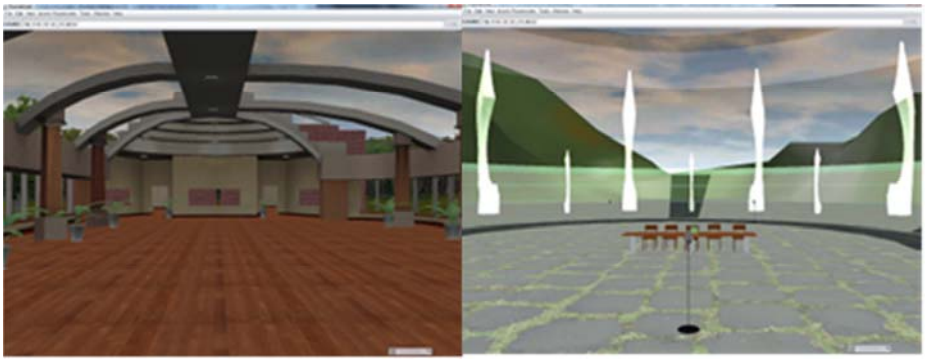

Figure 1: Examples of In-World Locations: Meeting Complex (left) and Auditorium

On initial login, a simple cartoon-like avatar with limited functionality is created. If the graphics hardware on their computer has OpenGL capability, participants are allowed to customise their avatar to give it a more realistic appearance. Examples of avatar appearance are shown in Figure 2.

Figure 2: Examples of Avatar Appearance. Cartoon (left) and Realistic (right)

UNITE provides a range of in-world tools and facilities for communication and collaboration. These include synchronous text chat, voice chat, collaborative creation and editing of text documents, interactive whiteboard, sticky notes, audio and video playback and recording, screen sharing, drag and drop display of image and PDF files, and the conversion of any MS Office Open Office or Libre Office file to PDF format for display in-world. Some examples are shown in Figure 3.

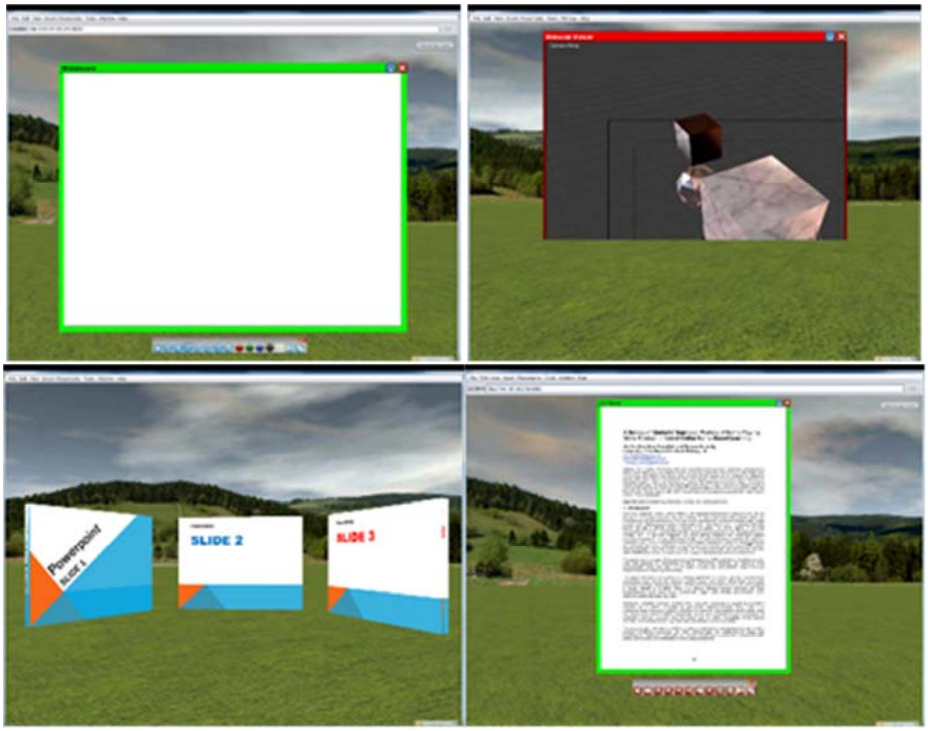

Figure 3: Examples of In-World Tools and Facilities: Interactive whiteboard (top left), screen sharing (top right), presentations (bottom left) and PDF document viewing (bottom right)

Participants were given access to the UNITE environment for a period of 10 weeks. They were provided with video tutorials on how to log in and use the in-world facilities. Their method of use of the facilities was not prescribed: they were allowed to select the facilities and processes that best suited how they wished to work. The facilities were used by participants to support team activities in a variety of ways, including: brainstorming to select a suitable project, then to identify content and processes required to complete it. This enabled participants to develop their own processes in reaching a desired solution. In addition, the facilities provided for team meetings to discuss project planning and management and other task-related issues. The collaborative creation of text documents and other content and rehearsal of a presentation that was to be delivered face-to-face as part of their coursework, enabled participants to experience and appreciate other perspectives.

3.1 Methodology and Research Design

The UNITE project uses a mixed-methods research design that combines qualitative and quantitative approaches at different stages of the research process in order to provide an in-depth account of the research as well as a greater degree of scope to

explore the issues, themes, processes and events that evolved during the study [Glass, 04; Creswell, 09, pp10-11; Creswell, 11].

The first empirical phase of the research [Scullion, 11] was the completion of a questionnaire by 720 university students that was predominantly quantitative, but which also included open-ended questions. It was decided that the addition of open-ended questions in the questionnaire would assist to gather richer qualitative descriptions of student views about their perceptions and experiences of using the UNITE environment. Among the main findings of the survey were: participants' use of virtual worlds often includes a social aspect; that it can be co-operative rather than competitive and that informal learning processes are used to increase mastery. Analysis showed a significant relationship between frequency of online communication and level of mastery. The results suggest that participants use online communication and collaboration as part of an informal learning process that assists them in increasing their knowledge and expertise.

The second phase of the research [Scullion, 14] aimed to build on the findings of the first phase of the research by establishing a pilot study of UNITE that used a qualitative focus group discussion to compare and contrast views of students who had used the platform for collaborative purposes and assess if their opinions differed from some of the issues identified in the interviews. The use of a focus group was based on the small size of the cohort, the need to develop themes and topics for use in the third and final phase, and the desire to provide greater coverage of issues than would be possible in a survey. As suggested by [Cohen, 00, p436], a focus group was an effective mechanism for matching these criteria. The pilot study established the feasibility of using the UNITE environment for a small number of simultaneous participants. Results from the pilot study have provided an interesting insight into the potential of using 3D learning spaces for enhancing communication, collaboration, and teamwork.

3.2 Perceived Self-efficacy

Self-efficacy beliefs are defined as *''people's judgement of their capabilities to organise and execute courses of action required to attain designated types of performances''* [Bandura, 81, p31]. It is a form of self-evaluation that influences decisions individuals make, efforts they exert, and the mastery of behaviour [Eastin, 06]. This theory proposes that a student who believes he or she can successfully perform an activity is likely to exert more effort, spend more time, and master the required skills earlier than one who does not. Self-efficacy beliefs in a specific domain are positively linked with academic achievement in that domain [Pajares, 01]. Findings from several research studies show that self-efficacy plays an important role in the achievements, motivation and learning of students [van Dinther, 11]. According to [Loke, 15, p.117] in the context of virtual worlds the theory of self-efficacy is exhibited when *"…enactive experiences and/or vicarious experiences occur in students' virtual world experience"*. Enactive experiences are associated with the actions undertaken by an individual to complete a particular task whereas vicarious experiences relate to watching an individual successfully accomplish a certain task. The specific elements of self-efficacy that the UNITE platform intends to identify is whether this particular learning environment can assist students to learn, work independently to identify the skills that they require among themselves to work collaboratively in order to share knowledge and information when also working in groups.

4 Participants in the study

UWS students undertaking two modules were invited to participate in this study: Computer Games Design (CGD) and Collaborative Virtual Environments (CVE). Both modules were selected because their pedagogic foundations require collaborative team-based research, planning and creation of both written and practical courseworks. CGD is in the second year of a Scottish four-year Honours degree programme. The module is delivered on three of the University's four geographically dispersed campuses: Ayr, Hamilton and Paisley using a blend of face-to-face and online learning materials. UWS makes extensive use of the Moodle virtual learning environment (VLE). The student cohort for CGD is made up of students from two undergraduate degree programmes: BSc (Hons) Computer Games Technology and BSc (Hons) Computer Games Development. The total number of enrolled students was 102. CVE is in the fourth year of a Scottish four-year Honours degree programme. The module is delivered on the Hamilton and Paisley campuses using a blend of face-to-face and online learning materials. The total number of enrolled students was 31. The students were drawn from a range of computing related courses (BSc (Hons) Computing, 6 students, BSc (Hons) IT, 7 students, and BSc (Hons) Computer Games Development, 18 students).

5 Pre-test Survey

Participants were asked to provide their unique matriculation number, then the following demographic data: University campus (Ayr, Hamilton or Paisley); gender; age and full-time or part-time study.

5.1 Survey Themes

5.1.1 Prior experience of virtual worlds

Respondents were asked to indicate if they had prior experience of Massively Multiplayer Online Games (MMOG) or of social virtual worlds like Second Life. If they responded that they had, they were asked to indicate how many hours per week, on average, they spend in either activity using the following time bands: 0-1; 1-5; 6-10; 11-15; 16-25 and more than 25.

5.1.2 Can a 3D virtual world help student collaboration?

Respondents were asked to indicate on the following scale the extent to which they agree that having access to a 3D virtual world could help them to collaborate with other students working on a team-based University project: Strongly Disagree; Disagree; Agree; Strongly Agree and Don’t Know/No Opinion. They were also given the opportunity to add an optional freeform comment at this point.

5.1.3 Perceived Self-Efficacy: Pre-test

Respondents were asked to rate how certain they were that they could successfully carry out a range of activities by recording a number from 0 to 100 where: 0=Cannot do

at all; 50=Moderately can do and 100=Highly certain can do. The activities listed were: Use a computer; Use an online virtual world or MMOG; Work well in a group; Contribute to discussion in a group; Take an active part in group problem solving; Participate in planning group activities; Contribute ideas for consideration by the group; Comment on ideas from other group me members and Make a presentation to a group.

6 Post-test Survey

Participants were asked to provide their unique matriculation number, which allowed matching with the corresponding pre-test responses for that participant.

6.1 Survey Themes

Use of the UNITE virtual world - Respondents were asked to indicate if they had made use of the 3D virtual world provided as part of this research.

6.1.1 Did the UNITE 3D virtual world help collaboration?

Respondents who answered that they had used the UNITE virtual world were asked to indicate on the following scale the extent to which they agreed that having access to the UNITE 3D virtual world had helped them to collaborate with other students working on their team-based University project: Strongly Disagree; Disagree; Agree; Strongly Agree and Don't Know/No Opinion. They were also given the opportunity to add an optional freeform comment at this point.

6.1.2 Perceived Self-Efficacy: Post-test

Respondents were asked to rate how certain they were that they could successfully carry out a range of activities by recording a number from 0 to 100 where: 0=Cannot do at all; 50=Moderately can do and 100=Highly certain can do. The activities listed were: Use a computer; Use an online virtual world or MMOG; Work well in a group; Contribute to discussion in a group; Take an active part in group problem solving; Participate in planning group activities; Contribute ideas for consideration by the group; Comment on ideas from other group members and Make a presentation to a group.

7 Data Collection and Analysis

Online questionnaires were designed and administered using the online questionnaire tool SurveyMonkey. The design of the questionnaires was based on the principles described by [Bandura, 06]. Access to the questionnaires was restricted by using the student's unique matriculation number to ensure that each respondent completed each survey once only. Pre-test questionnaires were made available during week 1 of the module delivery, and post-test questionnaires were made available during week 11 of the module delivery. The survey results were imported into SPSS for data cleaning and analysis.

8 Results

8.1 Pre-test Results

A total of 109 participants in 2 class group cohorts completed the pre-test survey. An analysis by cohort is shown in table 1.

Cohort	Level Description	Number
1	Second year of a four year undergraduate honours degree	80
2	Fourth year of a four year undergraduate honours degree	29
	Total	109

Table 1: Pre-test participants by cohort

Of the 109 participants who completed the pre-test survey, 89.9% (n=98) were male and 10.1% (n=11) were female. The mean age of respondents was 21.54 (SD=4.07), with a range between 17 and 43. All respondents were full-time students.

77.0% (n=84) agreed or strongly agreed that having access to a 3D virtual world could help them to collaborate with other students working on a team-based University project. 5.5% (n=6) disagreed or strongly disagreed. 17.4% (n=19) did not know or had no opinion. A detailed breakdown of the responses is shown in table 2.

VW Can Help	Number	Percent
strongly agree	20	18.3
agree	64	58.7
don't know/no opinion	19	17.4
disagree	5	4.6
strongly disagree	1	0.9
Total	109	100

Table 2: Extent of agreement on whether access to a 3D virtual world could help collaboration.

The tasks for which respondents indicated they had the highest perceived self-efficacy were “Use a computer” (Mean=87.74 SD=16.492) and “Work well in a group” (Mean=73.48 SD=18.639). The tasks for which respondents indicated they had the lowest perceived self-efficacy were “Make a presentation to a group” (Mean=57.02, SD=25.461) and “Participate in planning group activities” (Mean=68.27 SD=21.46). A detailed breakdown of these responses is shown in table 3.

Task	Minimum	Maximum	Mean	Std. Deviation
Use a computer	20	100	87.74	16.492
Use an online virtual world or MMOG	0	100	70.33	33.136
Work well in a group	20	100	73.48	18.639
Contribute to discussion in a group	16	100	71.13	20.159
Take an active part in group problem solving	20	100	70.54	21.769
Participate in planning group activities	15	100	68.27	21.46
Contribute ideas for consideration by the group	10	100	69.95	22.619
Comment on ideas from other group me members	20	100	72.27	20.131
Make a presentation to a group	2	100	57.02	25.461

Table 3: Breakdown of perceived self-efficacy ratings

8.1.1 Pre-test Qualitative Responses

Cohort 1 comprised 80 participants who completed the pre-test survey. Some of the pre-test qualitative responses from this cohort are illustrated in the following section.

From a self-efficacy perspective certain students stated that the primary motivation and benefit of them using the UNITE environment was that it allowed them to remain focused and motivated in terms of the approach towards how they interacted in their project work however a lot did depend on the willingness of the other students to engage in using the UNITE environment in addition to adapting to functioning as a group when using it for project work.

- "*It would make things easier for people who aren't very good at talking in person to be able to talk through a virtual character and allow them to feel better about it".*
- *"I believe this will make it a lot easier to meet new people".*
- *"I believe it's a good option to have in general. But I prefer meeting in person when possible as when on-line I feel to procrastinate more and work speed isn't as efficient. But on occasion I have found it very helpful when meeting in person isn't an option for whatever reason".*
- *"It would depend on the willingness of the other students to use the 3D virtual world to collaborate".*

Cohort 2 comprised 29 participants who completed the pre-test survey. Pre-test qualitative responses from this cohort were predominately positive with certain

students stating that the UNITE environment provided them with a strong incentive and opportunity to learn within groups and collaborate effectively when they were undertaking their project work. Some students considered that the UNITE environment was a useful tool for meeting with colleagues to discuss and review project related issues and that this was a good incentive for them to engage with the platform. One student formulated the view that using the UNITE environment was beneficial for removing any potential social barriers providing students with the confidence to talk more openly about project related issues online. In comparison, another student stated that the use of virtual worlds can be effective to assist with the student learning process but thought that their pedagogical success would be dictated by the type of project they are applied in. However, a contrasting view was that from another student who did consider that online collaboration was a beneficial approach to assist student learning whereas a different student who used the platform thought that the use of virtual worlds could be viewed as a distraction and is less focused a communication medium such as Facebook.

Some of these aforementioned views are exemplified in the following comments:

- "*Open Wonderland looks very useful and could work just as well as meeting up with people in person".*
- *"Having researched the area previously I think that collaboration via virtual environments can be largely beneficial to the learning process".*
- *"It can help for speed and efficiency, people can be in a meeting with their group in the comfort of their own home, but it can also remove the social informal feeling of meeting face to face".*
- *"I'd like to think so but would need to investigate/hear more on the topic of learning in a virtual world. I agree that online collaboration can aid learning".*
- "*3d worlds can distract the users from the work".*
- *"It would seem to be a distraction. The main functional difference I can see between collaborating over Facebook and collaborating in second life is that second life allows you to run around ignoring what people have to say. The exception to this would be if the project was based on second life or a similar program itself, or if showing actions was an important part of the work (such as film making stunts rehearsing a scene)".*

7.2 Post-test Results

Following data cleaning and matching, 70 participants had fully completed both the pre-test and post-test surveys. Numbers of respondents by cohort are shown in table 4. 92.9% (n=65) were male and 7.1% (n=5) were female. The mean age of respondents was 21.14 (SD=3.08), with a range between 18 and 34. 96.9% (n=156) were full-time students and 3.1% (n=5) were part-time students.

Cohort	Number Pre	Percent	Number Pre and Post	Percent
1	80	73.40	61	87.14
2	29	26.60	9	12.86
Total	109	100.00	70	100.00

Table 4: Breakdown of respondent numbers by cohort

Of the 70 participants who completed both pre-test and post-test surveys, 82.9% (n=58) used the UNITE virtual world and 17.1% (n=12) did not. Considering only those respondents who used the UNITE virtual world, 86.2% (n=50) agreed or strongly agreed that having access to a 3D virtual world helped them to collaborate with other students working on a team-based University project. 5.1% (n=3) disagreed or strongly disagreed. 8.6% (n=5) did not know or had no opinion. A detailed breakdown of the responses is shown in table 5.

VW Did Help	Number	Percent
strongly agree	36	26.3
agree	87	63.5
don't know/no opinion	6	4.4
disagree	6	4.4
strongly disagree	2	1.5
Total	137	100

Table 5: Agreement on whether access to a 3D virtual world helped collaboration

The difference in scores between the pre-test question: "Do you think that having access to a 3D virtual world can help you to collaborate with other students working on a team-based University project?" and the post-test question: "Do you think that having access to a 3D virtual world helped you to collaborate with other students working on a team-based University project?" was examined using a Wilcoxon matched-pairs signed ranks test. There was no statistically significant change between pre-test and post-test responses ($Z= -.571$, $p< .568$).

Differences between pre-test and post-test scores for self-efficacy were examined using a Wilcoxon matched-pairs signed ranks test. The results are shown in table 6.

	Z	Asymp. Sig. (2-tailed)
(a) Used UNITE virtual world		
Use a computer	-2.335	0.020
Use an online virtual world or MMOG	-2.268	0.023
Work well in a group	-3.078	0.002
Contribute to discussion in a group	-3.736	0.000
Take an active part in group problem solving	-2.093	0.036
Participate in planning group activities	-3.985	0.000
Contribute ideas for consideration by the group	-3.146	0.002
Comment on ideas from other group members	-2.813	0.005
Make a presentation to a group	-3.685	0.000
(b) Did not use UNITE virtual world		
Use a computer	-0.424	0.671
Use an online virtual world or MMOG	-0.562	0.574
Work well in a group	-1.266	0.205
Contribute to discussion in a group	-1.482	0.138
Take an active part in group problem solving	-1.204	0.229
Participate in planning group activities	-0.625	0.532
Contribute ideas for consideration by the group	-1.335	0.182
Comment on ideas from other group members	-1.689	0.091
Make a presentation to a group	-1.829	0.067

Table 6: Effect of UNITE virtual world use on self-efficacy (all participants) – Wilcoxon matched-pairs signed ranks test

8.1.1 Post-test Qualitative Responses

Cohort 1 comprised 61 pairs of matched pre-test and post-test responses. The post-test responses towards the UNITE environment were predominately positive with certain students stating that they could acknowledge the learning benefits from having used the platform for the purposes of group work. The environment provided students with the tools that they needed to successfully manage their projects, remain motivated and committed as a group in addition to enhancing their overall learning experience. It was also considered by one student that the success of the learning environment relates to the size of the project being undertaken. However, in contrast to some of these views, one student thought that it was quite difficult to collaborate on the platform in terms of getting project members to be online at the same time though did acknowledge that the UNITE environment had been beneficial for project work.

- "*For the assignment for Learning in CVE the use of a 3D virtual world aided collaboration without the need for us to meet in person easily. For example, I was able to create plans for layout for our project by adding images to the world and placing markers on top for others to see".*

- *"I felt it was pretty hard to collaborate and getting everyone online at the same time was tricky. We have used it for coursework and although it has been useful and relevant it can still cause issues and problems."*

- *"I believe that depending on the nature of the project a 3D CVE would be beneficial: smaller tasks maybe not so much in my opinion".*

Cohort 2 comprised 9 pairs of matched pre-test and post-test responses. The views of some of the students were generally receptive towards the use of the UNITE platform especially for group projects that contain large numbers of students. For example, one student stated that from a coursework perspective they did not see the point in using this type of technology for a group of two project members. In contrast to this view, one student argued that motivation was a factor in terms of the platform being a success or not and that its benefits were dependent on the willingness of students to use it. Another student stated that their project group found it more productive to meet up in person as opposed to using the platform to co-ordinate project activities thereby citing face-to-face communication as a more beneficial communication medium for project work.

- *"I think it has strong potential, more geared for bigger groups (at least 4+ members) my group was a group of 2, so much of the sharing was only two way and because of this we unfortunately found using a virtual world platform became time consuming for only a small group".*

- *"I do think that it helps although it does depend on the members of the group as some are unwilling to use it".*

- *"We found it much better too meet in person and as a result rarely used it".*

Despite some issues with regards to using the virtual environment being identified by a small number of students, the feedback to the UNITE virtual world was predominantly supportive and positive.

9 Discussion

The pre-test survey indicated that 77.0% of respondents considered that a virtual world could help them to collaborate with other students working on a team-based University project. Of the pre-test respondents, 82.9% made use of the UNITE virtual world. Of these, 86.2% considered that the UNITE virtual world had helped them to collaborate with other students working on a team-based University project. Comparison of pre-test to post-test responses in relation to whether a virtual world could or did help team-based collaboration did not yield a statistically significant result. For respondents who did not use the UNITE virtual world almost all tasks showed an increase in self-efficacy ratings between pre-test and post-test. One activity showed a decrease. None of the differences are statistically significant. For respondents who used the UNITE virtual world, all activities showed an increase between pre-test and post-test, all of which are statistically significant.

10 Conclusions

These results suggest that using a 3D virtual world can improve students' self-efficacy beliefs in relation to activities undertaken as part of collaborative team-based projects. This study has assisted in substantiating some of the views articulated in the academic literature indicating that virtual worlds do have practical and pedagogical value in enhancing the theory of self-efficacy among students in a team working collaborative virtual environment. This study is of relevance to educators who are contemplating embedding the use of 3D virtual worlds into their curriculum as it provides a useful case study on how the use of a virtual world can empower students and enhance their levels of self-efficacy in relation to performing group related project tasks. It would be of value if future research were to extend to the investigation of other education sectors, levels and cognate areas. Further research should also seek to address the limitation of gender imbalance that is inherent in the use of the computing cognate area. An additional focus of future research in this research area would be to address another limitation of this study, namely, to compare the use of the UNITE platform against the use of a particular social media tool (e.g. a wiki or the use of Facebook) to assess which is the more effective in supporting communication and facilitating self-efficacy among students working in project teams.

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