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Presence and Engagement in Online Learning:

Comparing Desktop-based and Virtual Reality Environments

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I, Andrea Farrelly, declare that this submission is my own work. Where I have read, consulted, and used the work of others I have acknowledged this in the text.

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Contents

Abstract

The aim of this study was to explore whether Virtual Reality (VR) environments can be used to improve the experience of students learning remotely. Schools and universities had to pivot to virtual learning environments (VE) during the Covid-19 pandemic, and it is expected they will be more commonly used in the future. Due to this, it is vital to assess the benefits and limitations of these environments. VR offers a more immersive experience than synchronous and asynchronous video-based platforms. A review of the relevant literature identified presence and engagement as two of the key factors for successful online learning.

To take a closer look at this, an experiment was conducted which compared the differences in learning experiences through a head-mounted display (HMD) against an online (desktop-based) class (OE). A comparative experiment was conducted employing a 'between-subjects' design, with 53 participants.

The results of this study indicate a higher degree of presence and engagement in VEs, in comparison to OEs. This experiment also examined the relevant literature that explored the capabilities VR has to offer in order to enhance the overall learner experience. This study has opportunities for teachers, students and researchers to increase their awareness of the benefits of alternative technology-based methods of learning.

Introduction

Due to the Covid-19 Pandemic, an ever-increasing number of universities shifted entirely to OEs to preserve the academic growth of students. A spotlight has been placed on alternative learning environments, providing researchers with an opportunity to assess the limitations of these spaces (Selzer et al., 2019). Applications such as Blackboard, Microsoft Teams and Zoom have satisfied scholastic advancements (Sobaih et al., 2021), and while there are many benefits of OEs, it is necessary to explore the weaknesses that accompany it. As the literature review below indicates, the employment of OEs in replace of face-to-face teaching is a temporary solution for learners, as it fails to be an effective substitute for in-person classes.

Two key factors for an effective learner experience are presence and engagement (Halverson & Graham, 2019). The concept of 'presence' has been brought to the surface more recently due to the rise in popularity of technology-mediated environments (Owusu-Agyeman & Larbi-Siaw, 2018). According to previous research, presence is a personal, psychological response to immersive situations (Fromberger et al., 2015). Cummings and Bailenson (2016) define it as the sense of "being there" within a particular domain.

Engagement, however, is distinguished by Martin and Bolliger (2018) as an opportunity to collaborate with others by means of sharing ideas and emotions. It is an effortful commitment to learning that helps elicit this sense of presence (Lee, 2014). Maintaining equal involvement across all individuals is a challenging and integral aspect of self-improvement and learning (Ashby-King et al., 2020). Nonetheless, previous research does suggest that a higher sense of presence results in a higher sense of engagement (Cummings & Bailenson, 2016).

Past studies have also explored the relationship between emotion and engagement (Ijsselsteijn et al., 2000; Riva et al., 2007; Baños et al., 2008). Emotional engagement (Molinillo et al., 2018) is determined by feelings and approaches towards academic improvement. Previous literature (Kariippanon et al., 2019) also investigated behavioural engagement, which consists of self-involvement and completion of assignments, as well as attendance record. Despite this, past findings indicate that presence does not stem from an emotional or behavioural engagement with learning (Henrie et al., 2015; Kucuk & Richardson, 2019). This gap in

knowledge fails to identify a reason for the lack of presence and engagement within OEs, and therefore must be addressed. The interactive and immersive characteristics of VR are currently being investigated as a desirable method of teaching within the education sector (Radianti et al., 2020). Biocca and Delaney (1995) dissect the concept of VR as the accumulation of hard and software devices that aim to fulfil an effortless, sensory experience of being present in another dimension. The following research will address gaps in the literature that point towards unexplored regions of VR for academia, which could encourage the transformation of educational spaces into VE.

Literature Review

Engagement in Technology-Mediated Spaces

In the eyes of the pandemic, desktop-based lectures and meetings have become the norm of society. The following review of literature (Henrie et al., 2015) investigates the current techniques for measuring engagement, outlining the benefits and the downfalls to OEs. A rapid, ongoing increase in the number of students choosing an online mode of learning persists (Henrie et al., 2015). Despite the current attraction to working ‘from home’, a barrier exists in OEs that restricts engagement, which in turn has resulted in a rise in withdrawals from online modules. Measuring engagement within these academic spaces is hard to scale and has been prohibited as of late, due to each student participating independently and within their own separate locations. Henrie et al. (2015) suggests that willing ambition and self-motivation allows oneself to reap the rewards of effective student engagement; this being high academic accomplishments and a sense of belonging. Henrie et al. (2015) reported that quantitative surveys were the most common method of identifying the elements of cognitive engagement that promote academic success. According to Henrie et al. (2015), in order to decipher the impact technology has on learning outcomes, an adequate assessment of engagement between OEs and VEs must be set in place.

Wijekumar et al. (2006) investigated student-teacher interactions in OEs, stating that specific activities must be reshaped to ensure all learning requirements are met; the repeated use of methods like standardised testing (e.g. MCQs) can lead to a spike in isolated learning (Wijekumar et al., 2006). However, researchers have suggested that the individual's preference for traditional or desktop-based learning also plays an active role in engagement, as well as academic accomplishment (Campbell et al. 2008; Hurlbut, 2018).

Advantages and Disadvantages of Desktop Learning

Dumford and Miller (2018) examined the demanding challenge faced by lecturers to modify certain tasks (e.g. proctored examinations) for OEs, whilst maintaining connection and content gain. The recurrent issue of isolation and lack of feedback between the learner and the lecturer is an obstacle that requires addressing in order to conserve efficient teaching in OEs. Dumford and Miller (2018) suggested that poorly-designed online platforms, particularly in the absence of in-person teaching, has resulted in a decline in knowledge gain. Improperly designed OE systems can hinder engagement levels (Dumford & Miller, 2018). The literature explored the optimum delivery of course content through OE by utilising data from the National Survey of Student Engagement. Findings suggested that students taking online classes were less likely to engage in extracurricular activities, such as attending student-teacher functions, or interacting in collaborative group discussions, than the students who engaged in traditional, face-to-face learning (Dumford & Miller, 2018).

Although OEs can be engaging for certain individuals, the results indicate they are more detrimental to overall student success. Colleges and other educational facilities must examine this gap in the literature when considering alternative methods of delivering classes to reinforce student engagement and heighten overall academic success.

Implementing VR into Education

For decades, VR has been the 'hot topic' for revolutionising the education sector. There is a considerable amount of older research (Youngblut, 1998; Burdea & Coiffet, 2003) exploring VR and education, however these studies were conducted using low-quality, high-cost HMDs. Yet as they gain popularity, HMDs become cheaper to produce and better quality, making them more accessible to the wider population. The latest headsets such as the HTC Vive or the Oculus Quest 2 are examples of this, as they provide a sophisticated illusion for the user of being present in a metaphysical environment (Junfithrana et al., 2020). Past research has also focused more on implementing VR technologies into aircraft and pilot training (Vince, 1993), medicinal schemes (Riener & Harders, 2012), and military practices (Rizzo et al., 2011; Pallavicini et al., 2016), rather than employing it in the education sector itself. There is a gap in the literature regarding VR and education as they have been largely based on speculation. Johnson et al. (2016) outlined in the New Media Consortium that VR would be embedded into the academic sector within 2-3 years. In 2022, educators are still attempting to introduce VR as a method of conducting classes.

Jensen and Konradsen (2018) further explored how VR environments can contribute to the development of skills for the learner, outlining that the first-person perspective allows the user to exhibit similar behaviour and reactions as they would in a real-world setting. Slater (2003) describes this unconscious, simultaneous response by the brain and nervous system, as an experience of presence. Despite the obvious learning affordances that accompany VR, the advanced technology also provides individuals with a unique opportunity to (usually) inaccessible real-world events. Freina and Ott (2015) reiterate the need for VR in the classroom as a rare moment that students will experience unlikely (due to time and space) or unethical (due to risk and danger) real-life occurrences. Jensen and Konradsen (2018) reported that participants experienced vivid engagement with the VR, paired with an increased sense of presence and improved academic outcomes, while utilising an environment that empowers safe failure.

More recently, Radianti et al. (2020) investigated the substantial body of research regarding the immersive characteristics of VR applications by comparing

low-budget and high-end HMDs within educational boundaries. Radianti et al. (2020) also suggests that VR must be applied consistently and systematically to the educational process in order to positively influence students' learning outcomes. The study outlines that students retain a higher volume of information after taking part in VEs (Radianti et al., 2020), and with the steady growth in VR technologies and rise in interest from the gaming and education sectors, it is predicted the VR market will rise to $25 billion by this year, and again to $120.5 billion by 2026 (Wohlgenannt et al., 2020). Although Radianti et al. (2020) examined in-depth the capabilities of VR enhancing a classroom, the studies mentioned above fail to explore how VR compares to OEs, for the students' sense of presence and engagement. It is also important to recognise the maturity levels of each individual when considering the use ofVR in a teaching environment (Radianti et al., 2020), and to be cautious of distractory elements. Few studies have thoroughly investigated how to adapt the teaching curriculum to insert VR into academic spaces, which is another gap in literature to be conscious of.

The final review of literature by Fromm et al. (2021) corresponds to the research carried out by Radianti et al. (2020),and similarly, it analysed the need for VR in learning environments, and supported the theory that VR-based studies lack an element of learning theories by focusing too heavily on the application design aspect. However, Fromm et al. (2021) had an added examination of the learning modes, styles and preferences of VR users. Past studies (Winn, 1993; Kolb et al., 2001) have been consistent with the distinction that students' learning preferences indicate a desire for tactile experience, speculative observation, theoretical conceptualisation and methodological experimentation (Fromm et al., 2021). Therefore, with primary focus being placed on the technology behind VR devices, if educators' main aim is to achieve a greater experience for learners, then it is necessary to adjust these applications with learning outcomes at the forefront of the design (Fromm et al., 2021). In total, Fromm et al. (2021) identified 17 positive outcomes for VEs and education, including greater student attentiveness and motivation towards class activities. To finalise, the limited number of studies in this review addresses the need for more rigorous research that inspects the full potential VR has in developing an authentic, experiential environment (Buttussi & Chittaro, 2017).

Research Questions and Hypotheses

RQ1: Will there be a difference in Presence and Engagement in VEs when compared to OEs?

RQ2: Does the Application used affect Presence and Engagement?

H1: There will be a significant difference in Presence for the VE, in comparison to OEs.

H2: There will be a significant difference in Engagement for the VE, in comparison to OEs.

H3: There will be a significant difference between Presence and Engagement based on the Application used.

The following study conducted an analysis on (a) Presence and Engagement between VR and Desktop-based (OE) environments, while also investigating (b) the potential affect the Application used (Blackboard, Microsoft Teams, Zoom, Engage, Other) had on Presence and Engagement.

Method

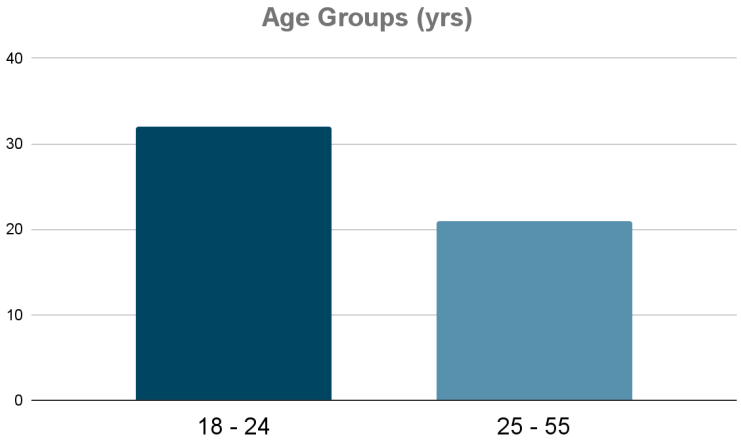
Design

This study used numerical data from an online questionnaire, as opposed to using qualitative statistics through an interview process, in order to test the effect of the Environment (IV with 2 levels: OE and VE) on Presence (DV 1) and Engagement (DV 2).This study employed a 'between-subjects' design to conduct Hotelling's T^2 on the participants' overall Presence and Engagement between the two environments. Group 1 (desktop-based) was asked to reflect on an online (desktop/video-based) environment they had recently taken part in (i.e. Blackboard, Zoom, Microsoft Teams, etc.), while Group 2 (VR) attended a class using a HMD. After reflecting or participating in either environments, two questionnaires were used to analyse the sense of Presence and Engagement in both:

- Presence Questionnaire (Witmer & Singer, 1998; UQO Cyberpsychology Lab, 2004)
- User Engagement Scale (Jacques, 1998; O'Brien et al., 2018)

Participants

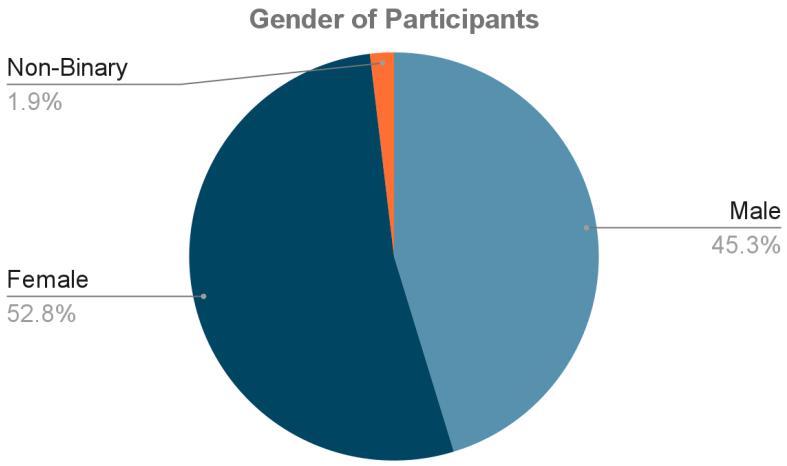
This research was conducted across an academic setting. Details of the study can be found in the information sheet (Appendix B) that was supplied to all participants. 30 posters were displayed around the IADT campus to attract participants for Group 1 (Appendix H). Participants for Group 2 were gathered using convenience sampling, the majority of these being undergraduate/postgraduate IADT students, and faculty members. The final sample consisted of 53 participants (N = 53; 45% male, 53% female, 2% non-binary; with an age range of 18-55 years). The treatment of all participants was under the ethical guidelines of the Psychological Society of Ireland and the Department of Technology and Psychology Ethics Committee (DTPEC). The study was conducted in the order of: Pilot study, Desktop-based Environment (Group 1), VE (Group 2).



· 5 participants used for the pilot study.

· 38 undergraduate/postgraduate students/faculty members for the desktop-based Environment (Group 1).

· 15 volunteers (convenience sampling using fellow students/friends/relatives) for the VE (Group 2).



Materials

Information Sheet (Appendix B)

The information sheet was embedded at the start of the Microsoft Forms survey link, visible to all participants. It included the title of this study, the name of the researcher and project supervisor, a short summary detailing the purpose behind the research being carried out, a participant invitation, answers to FAQs (e.g. *"Do I have to take part?"* or *"What are the benefits/risks in taking part?"* etc.), contact details, information on ethical approval and confidentiality/anonymity information.

Consent Form (Appendix C)

In order to satisfy the DTPEC guidelines, a consent form was attached to the Microsoft Form link. It included five 'Tick the Box' statements, ensuring each participant was above 18 years of age, as well as confirmation that each individual had read the information sheet above. A unique identification code had to be created, in order to identify data, should it need to be removed. The consent form was followed by a number of demographic questions requesting age and gender information.

Presence Questionnaire

Witmer and Singer's (1998) 24-item questionnaire employs a 7-point likert scale to each question to gauge the sense of presence within a particular environment. The 24-item questionnaire is split across 7 subscales, each measuring a different aspect of presence. The questions being asked with regard to the experienced environment include: *"How natural did your interactions with the environment seem?"* or *"How well could you examine objects from multiple viewpoints?"* or *"How quickly did you adjust to the environment you experienced?"*. The Cronbach's alpha of this questionnaire indicates a strong reliability, $\alpha = 0.917$. Further details on how to accurately score this questionnaire can be found in the Appendices (Appendix E).

User Engagement Scale

Jacques' (1998) User Engagement Scale employs a 5-point likert scale ('Strongly Disagree' to 'Strongly Agree') to each statement to examine the sense of engagement within an environment. The 30-item questionnaire is divided into 4 subscales, each measuring a different element of engagement. The statements being made with regard to the experienced environment include: *"The time I spent using the VR environment just slipped away"*, or *"I liked the graphics and images within the environment"*, or *"I continued to use the environment out of curiosity."* The Cronbach's alpha of this scale indicates a strong reliability, $\alpha = 0.963$. Further details on how to accurately score this scale can be found in the Appendices (Appendix F).

Debrief

Upon completing the two questionnaires, participants were required to be debriefed, a short summary of information on how their data would be used for the study was included here. See Appendix G for the Debrief.

Oculus Quest 2 Headsets

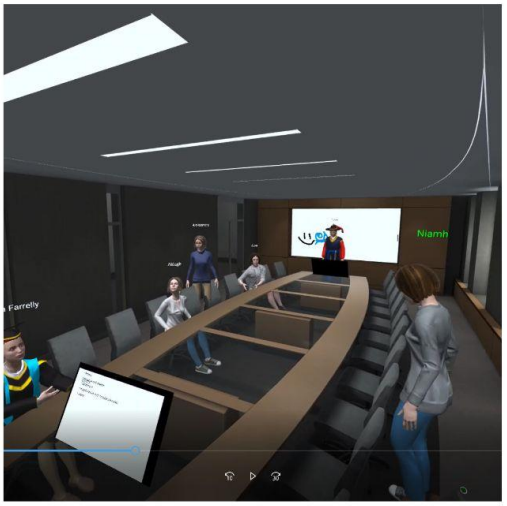
The Oculus Quest 2, also known as the Meta Quest 2, is a VR headset developed in 2020 by Facebook Tech., now known as Meta Platforms. It is usable as an autonomous headset, as well as with Oculus application software downloaded and running on a PC/desktop, when connected via Wi-Fi or a USB cable. Volunteers for Group 2 were all required to use a headset in order to participate in the VR aspect of the study.

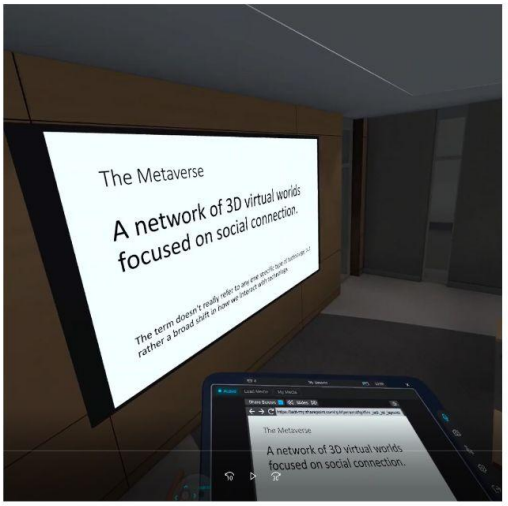
Pilot Study

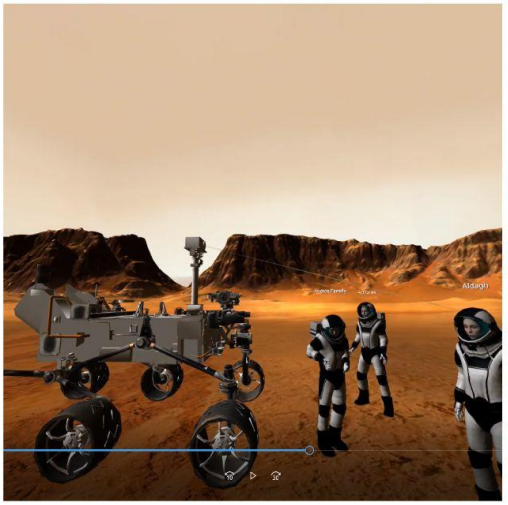
Prior to the experiment, a pilot study was conducted using IADT M.Sc. Cyberpsychology students (N = 5), with the aim of testing the practicality factor of the study before commencing the data collection process. The participants were afforded the same information sheets, consent forms, ethics documents, and debrief (Appendices B, C, D, E, K) as the final experimental participants. The five volunteers took part in a desktop-based class using Microsoft Teams, followed by a class carried

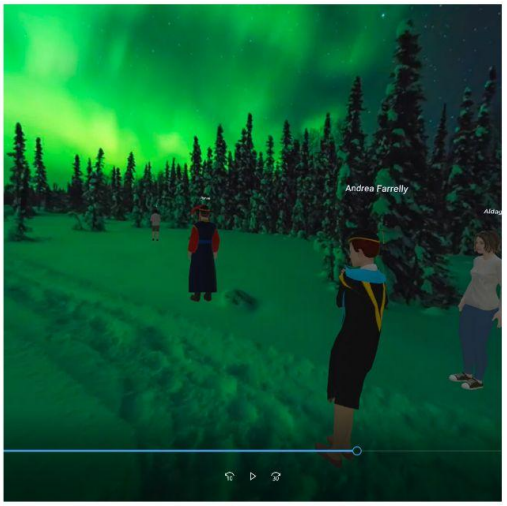
out in VR. The PC-based aspect worked effectively, with no issues to report, however conducting a class through the VR environment was deemed a challenge, as it took place remotely and not every student owned a headset, and were therefore viewing the VR class through the Engage application on a PC/desktop (see images below for the various environments used within the pilot test; Appendix J). It was noted that a change in procedure would have to be adjusted for the VR class to be feasible (i.e. every participant must use a headset to take part) and to convey the predicted results. Two Oculus Quest 2 headsets were obtained from IADT's Department of Technology for the duration of the VR procedures.

Engage Application - Screenshots from the VR Environment









Ethics

Before commencing the data collection process, the study was approved by the DTPEC, who conveyed that it was of a high ethical standard and was in accordance with the guidelines and standards held by the Psychological Society of Ireland (See Appendix A and I). All participation in this study was entirely voluntary with no rewards being offered. Each participant was informed of their choice to withdraw their information should they wish to do so. All data received and any data published has remained anonymous and confidential. Prior to collecting data, each participant was notified of the background information surrounding this research, with all participants receiving an information sheet, a consent form, two questionnaires, and a debrief document (Appendices B, C, E, F, G). Participants were also provided with the contact details of the researcher and project supervisor. There was no deception within this study, with all necessary information being included in the information sheet (Appendix B).

Procedure to test Desktop-based Environments

To test Presence and Engagement within Online (desktop-based) environments, convenience sampling was utilised via posters, word-of-mouth and social media. Participants (N = 38) were required to fill out the Presence questionnaire followed by the User Engagement scale in relation to a recent OE they had experienced. Each individual was urged to reflect on their overall experience with a desktop-based environment (e.g. Microsoft Teams, Blackboard, Zoom, etc.), as well as considering the entirety of each scale when doing so.

Procedure to test VR Environments

To test Presence and Engagement within VR environments, each participant (N = 15) was also acquired through convenience sampling. The application ‘Engage’ was installed on the two Oculus Quest headsets, with each individual attending a pre-recorded class on the topic of Venus; the experience lasted 17-18 minutes. Post-environment, participants were required to fill out the Presence questionnaire followed by the User Engagement scale in relation to the VR environment. Participants were encouraged to reflect on their overall experience with the VR, as well as considering the entirety of each scale when doing so.

Results

Qualitative Data - Feedback from Participants

Desktop-based Environments	VR Environments
“The laptop/desktop experience was invaluable during the past few years but it is dependent on a good broadband connection. An unstable connection can greatly alter the experience.”	“Some of the value may be lost due to the novelty value of using the platform for the first time and using controls, maybe a survey after 2/3 uses would be more beneficial for comparison.”
“Online learning results in poor quality of education.”	“Virtual environment was aesthetically pleasing but lacked resolution. It was an interactive and immersive experience.”
“I hate online learning, I can't sit and focus like I do in traditional, in-person learning environments.”	“Headset was a bit too heavy. I ended up with a bit of a headache and had to take it off.”
“My online learning experience was poor.”	“VR headset was heavy but preferred this experience to normal online class.”
“Online learning was durable but would much rather in person classes continue, whether it meant the classes had to be smaller or smaller class times.”	“I felt the only thing that took away from the experience was my poor eyesight. The heavy headset meant I couldn't wear my glasses and so the strain on my eyes took away slightly from the experience.”
“Some questions were a bit difficult to interpret in terms of their exact meaning. E.g. Does ‘involve’ mean immersion or participation? Overall, a great and very interesting questionnaire. I felt very immersed in the experience.”	“Headset was a bit difficult to use and get comfortable on my head, but overall a really fun experience and someone that I can definitely see being developed even more into the future as it is an extremely immersive piece of technology. Graphics could do with improving slightly, a bit blurry at parts.”
“School online is literally the worst thing to ever exist - I have never gone to class so little and have cared so little.”	“I really enjoyed the experience and hope it becomes more of a norm in the future.”

“I enjoy the online lectures, I study late in the evening as a university student, since I don't have to travel back home late at night. But in general, I feel the experience of online lectures is more demanding than in person lectures.”	“Maybe it is the novelty of a new experience but I loved being able to control my movements in the VR space. It was fun looking around with my gaze and being able to see and use my hands to interact with the environment. It captured my curiosity and I had fun during the experience. However, whether or not that translates into a productive learning environment is debatable.”
“I have used computers since the 1980s and MS Teams is the worst piece of technology I ever encountered.”	X

Quantitative Results and Descriptive Statistics

Laerd Statistics' (2017) indicated that a Hotelling's T^2 should be conducted to determine the effect of environment (desktop-based or VR) on presence and engagement. For descriptive statistics see Table 1 and Table 4. Hotelling's T^2 was then employed a second time to determine if the application used affected presence and engagement. Preliminary assumption checking was conducted across all tests to reveal the normal distribution of data, as satisfied by the Shapiro-Wilk test ($p > .05$), see Table 2. The assumption of homogeneity of variance-covariance matrices was violated, as assessed by Box's M test ($p < .001$), see Table 1 below (Table 3). A Bonferroni adjusted α level of .025 with a simultaneous 95% confidence level was used. There were no univariate or multivariate outliers across the Desktop-based or the VR environment, as tested by boxplot and Mahalanobis distance ($p > .001$), see Figure 1 and Figure 2 below. Additionally, linear relationships were identified through a scatter plot, see Figure 3 below.

Table 1

Confirmation of the violation of homogeneity of variance-covariance matrices, (p<.001).

Box's M	***F***	***df1***	***df2***	***Sig.***
61.448	19.312	3	12846.177	<.001

Figure 1

The distribution of participant's Presence scores filtered by environment (OE and VE) as displayed in a Box Plot graph

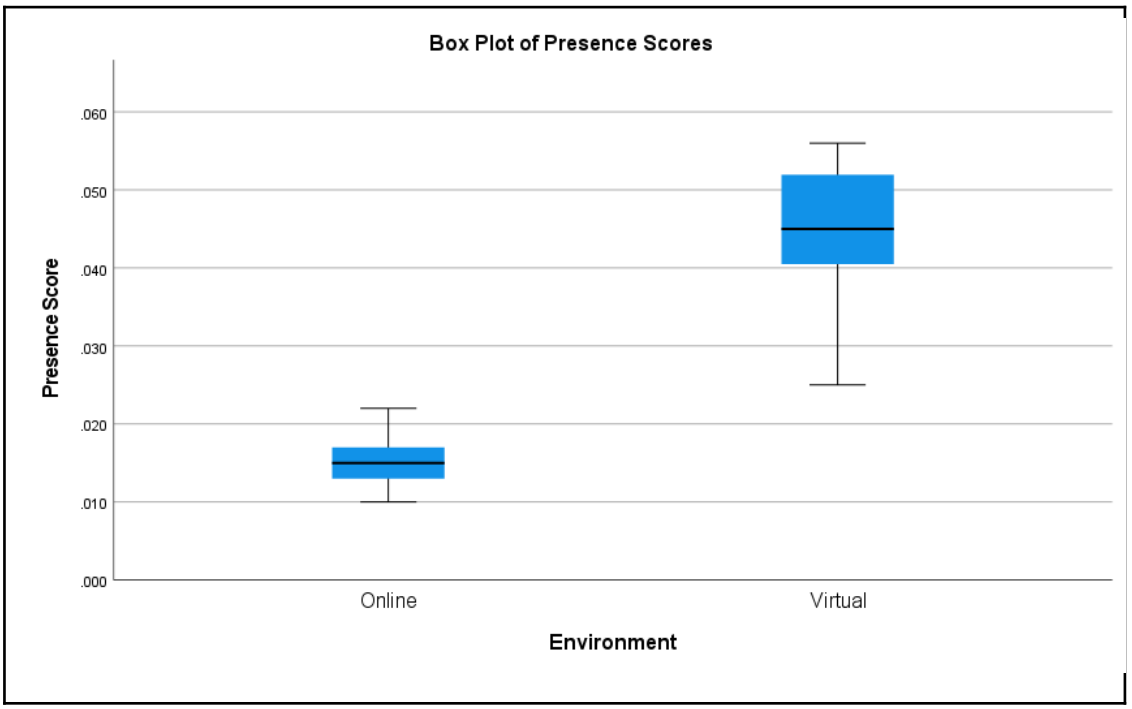


Figure 2

The distribution of participant's Engagement scores filtered by environment (OE and VE) as displayed in a Box Plot graph

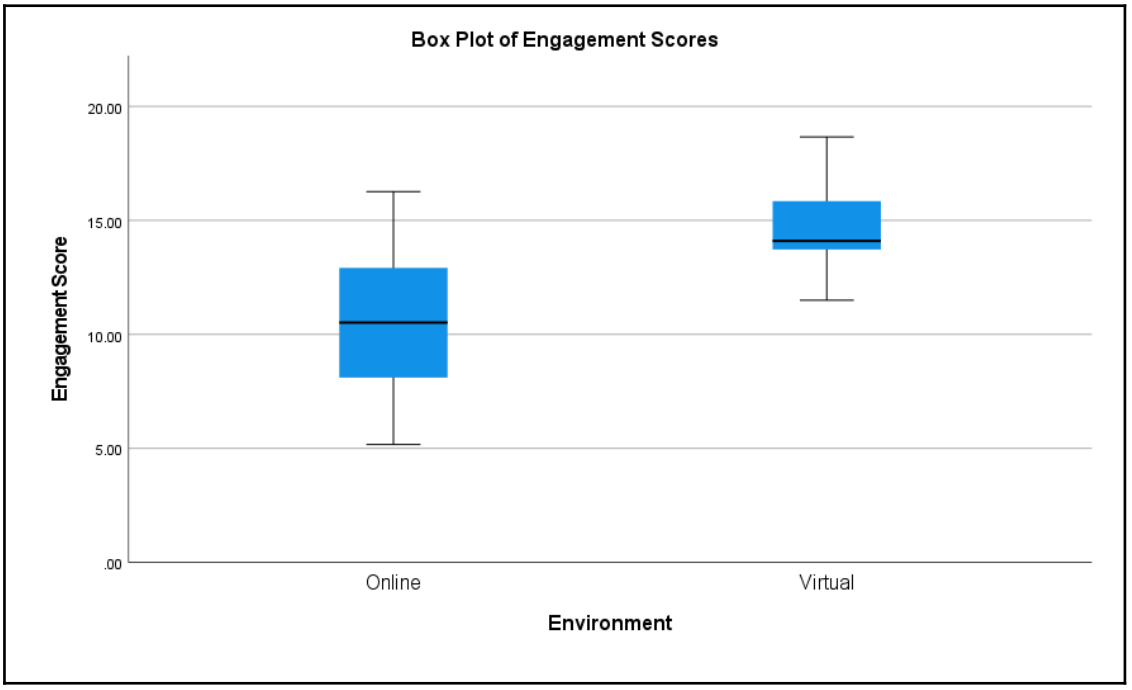
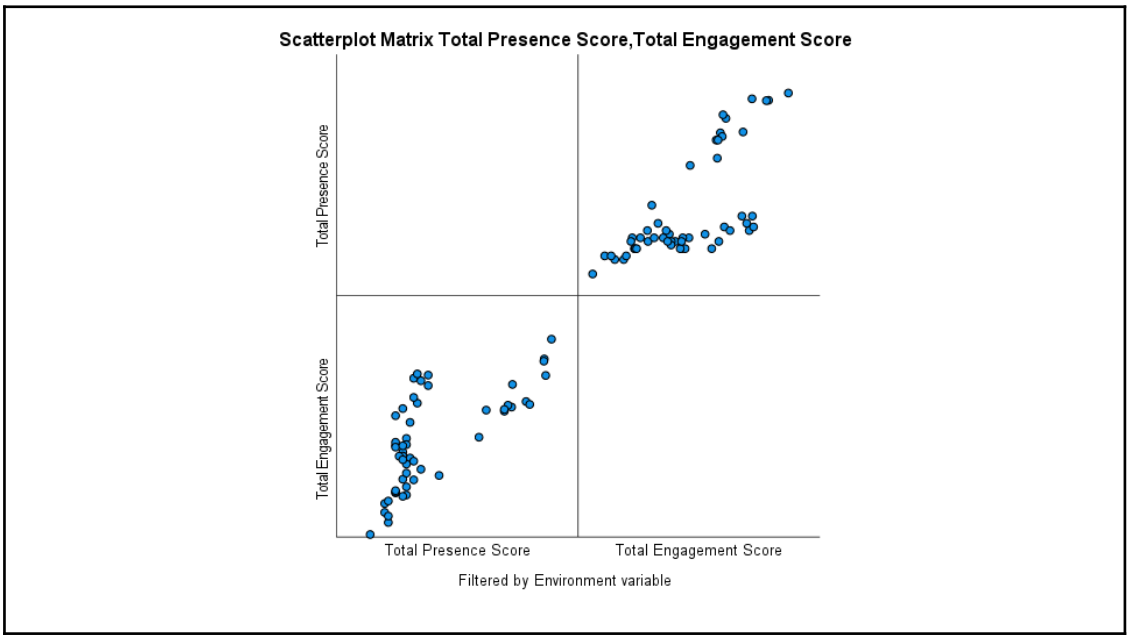


Figure 3

The linearity of Presence and Engagement scores filtered by the Environment.



Hypothesis 1 and 2

The mean presence score for the VE was .029 marks, 95% CI [.024 to .033] higher than mean presence score for the OEs, see Table 7. Therefore, we reject the null hypothesis and accept Hypothesis 1 of a significant difference in presence between desktop-based and VR environments.

The participants for the desktop-based and VR environments scored higher in engagement (M = 10.7, SD = 3.1 and M = 14.2, SD = 2.6, respectively) than in presence (M = .015, SD = .003 and M = .044, SD = .011, respectively), see Table 1. The mean engagement score for the VE was 3.565 marks, 95% CI [1.487 to 5.643] higher than mean engagement score for the desktop-based environment. Therefore, we can accept Hypothesis 2 of a significant difference in engagement between OEs and VEs, see Table 7.

Additionally, the overall difference in presence and engagement across the two environments was statistically significant, $F(2, 50) = 155.808$, $p < .001$; Wilks' $\Lambda = .138$; partial $\eta 2 = .862$.

Hypothesis 3

Homogeneity of variance-covariance matrices was violated, as measured by Box's M test ($p < .001$). There was homogeneity of variances for engagement [.284 to .496], yet the assumption met a lower statistical significance for presence [.005 to .016] across all applications, as assessed by Levene's Test of Homogeneity of Variance ($p > .05$), see Table 8.

Blackboard users (N = 16) scored higher in engagement (M = 9.9, SD = .729) over presence (M = .015, SD = .002). Engage users (N = 15) scored higher in engagement (M = 14.2, SD = .753) over presence (M = .044, SD = .002). Correspondingly, Microsoft Teams (N = 13, M = 11.2, SD = .808) and Zoom (N = 5, M = 12.5, SD = 1.3) users also displayed higher engagement over presence.

There was a statistically significant difference in engagement based on the application used (Table 5), $F(8, 96) = 11.170$, $p < .001$; Pillai's V = .964; partial $\eta 2 = .482$, see Table 3 below.

Table 3

Multivariate Tests determining the differences between Application used and the combined Presence and Engagement variables, deeming Hotelling's T^2 to be statistically significant; $p < .001$.

	Value	*F*	*Hypothesis df*	*Error df*	*Sig.*	*Partial Eta Squared*
Pillai's Trace	.964	11.170	8.000	96.000	<.001	.482

Pillai's Trace was used in replace of Wilk's Lambda due to the unequal sample sizes (Pallant, 2020). The mean engagement score for the Engage application was 4 marks, 95% CI [0.9 to 7.7] higher than the mean presence score. Hotelling's T^2 outlined a statistically significant difference in engagement scores between the Engage application users, $p < .001$, in comparison to any other applications used, $p \geq 1.000$ (see Table 4 and Table 5). Therefore, we reject the null and accept Hypothesis 3 due to the significant difference between engagement and the application used.

Discussion

Original Aims and Findings

This research study examined the differences in presence and engagement between desktop-based and VR learning environments. The goal of this study was to add to the existing body of research (Jensen & Konradsen, 2018; Radianti et al., 2020) on the inclusion of VR as a new, dimensional layer of education. Previous literature mentioned above, detailing the use of VR in education was limited (Vince, 1993; Winn, 1993) and strongly relied on the early models of HMDs (Biocca & Delaney, 1995; Baños et al., 2008). Past studies (IJsselsteijn et al., 2000; Henrie et al., 2015; Jensen & Konradsen, 2018; Radianti et al., 2020) did not highlight the true prospects VR has to offer for learning outcomes, as well as overall academic success.

Although the evidence points towards a gap in the literature regarding comparisons drawn between OE and VR environments, the scope of this body of research was not limited in this study, but instead focused on two (often co-dependent) factors that enhance the success of students: presence and engagement (Henrie et al., 2015). The results of this research convey the possibility of a greater sense of both presence and engagement in VEs, in comparison to OEs, reiterating the need for implementation of VR technology within educational settings (Freina & Ott, 2015; Cummings & Bailenson, 2016). This study also hypothesised that the application used for either environments would have an impact on participants' presence and engagement, and again, the results depict a potential influence the 'application used' has on overall presence and engagement.

Based on the feedback provided by participants, there were a number of trends in the opinions of both learning environments. A large volume of individuals who partook in the VE complained about a discomfort regarding the heaviness of the HMD. The straps on the back of the device were difficult to adjust, which in turn hindered the experience of the environment for the user. Participants who commented on the straps of the HMD being too loose on their head also described a low resolution in the images displayed within the headset. In contrast to this, participants who remarked on the tightness of the straps also mentioned its heaviness, which seemed to result in a slight headache for some users.

For the OE, a variety of students referred to the change in face-to-face classes towards online platforms, describing this transition of education as “poor”, due to a “lack of focus”. The majority of those who completed the presence questionnaire and engagement scale for OEs, also mentioned their preference for in-person classes. This recapitulates the idea that educational spaces, such as VEs (Dumford & Miller, 2018), could be the ‘happy-medium’ of ensuring individuals feel equally present and engaged during distance learning.

Limitations

The VR aspect of the study was severely time-intensive. In order to conduct the VR class, each individual required separate attention to put on their headset (i.e. adjusting the straps and ensuring they had clear resolution of the images displayed in the Oculus), as well as allocation of time for setting up each participant’s play area and Guardian (i.e. scaling the boundaries of the room to construct a play area zone for participants). This was a very tedious and time-consuming process which cost an average of 20-40 minutes. Due to the amount of time this entailed, the number of participants who experienced the VE was low (N = 15), which in turn led to an unequal sample size between the two groups. It was also important to address the substantial barriers in regards to cyber/motion sickness, and because of this a small percentage of individuals requested that they experience the VR in stationary mode (i.e. sitting down) as opposed to standing. Thus, creating a difference in the VE experienced by each participant. This study identified a similar weakness from previous literature reviewed (Jensen & Konradsen, 2018) that reported hardware difficulties as a result of the HMDs being too heavy for some participants. Another limitation to mention regarding the VE was the novelty factor (acting as a distractor) experienced by some of the participants using the VR technology, which could have impacted presence and engagement.

Strengths

The strengths of this study point towards the fact that it is a novel and innovative experiment that has not yet been explored in the field of VR and education research. The aim of this study was to compare levels of presence and engagement in OEs versus VEs, and in doing so, it bridged the gap in research that had not yet touched this side of knowledge. Other strengths to note are in relation to the reliability of the Presence Questionnaire, as well as the User Engagement Scale. The two scales had strong reliability (both had a Cronbach's alpha above 0.9), in comparison to previous studies where the UES had a Cronbach's alpha of 0.58 (O'Brien et al., 2018), and the PQ had an alpha value of 0.7 (Witmer & Singer, 1998).

Future Research

In accordance with previous literature (Radianti et al., 2020; Fromm et al., 2021), researchers must address this gap in the knowledge by taking it a step further and correcting small elements of the experiment, should it be replicated. The sample size should be taken into account, and altered, with equal participants being allocated to the desktop-based and the VR environments. An adjustment could be made to use a larger pool of participants (100+) to gather a sense of variety in the results. It is also crucial to recognise that in order to compare a certain set of students' presence and engagement levels, that it may be necessary to employ a 'within-subjects' design, using the same participants for both environments. In relation to the OE, to accurately compare presence and engagement, a desktop-based class should be physically carried out, using a similar method to the VE, rather than only getting participants to "reflect" on an OE. Likewise, for the VE, a genuine, live class should be conducted in place of a pre-recorded talk.

For future research, the choice given to participants whether they wanted to experience the VR in standing or seated mode must also be considered, as it may have impacted an individual's sense of presence within the environment. Additionally, when using the PQ and the UES, a further examination into the different subscales they had to offer could be an interesting angle to address in future studies. For

example, the PQ consisted of seven different subscales, including Realism, Quality of the Interface, and Sounds/Haptics. As for the UES, it also took into account four different categories: Focused Attention, Perceived Usability, Aesthetic Appeal and Reward Factor.

Conclusion

The aim of this research was to expand on previous studies (Wijekumar et al., 2006; Campbell et al., 2008) in regards to adjusting OEs, and implementing VR within the educational sector. Additionally, this research study employed the constructs of presence (measured using the PQ) and engagement (measured using the UES) differences in OEs and VEs, as a means of building on past research that regard the advancement of the overall academic experience (Henrie et al., 2015; Hurlbut, 2018). It also investigated the difference in presence and engagement based on the application used e.g. Microsoft Teams, Blackboard, Zoom, etc. The results of this experiment convey a significant increase in presence and engagement levels within VEs. There was no notable difference in presence levels across all the applications tested. However, the engagement levels were significantly higher in regards to the VR application ‘Engage’, as opposed to all other learning platforms.

Past research (Rizzo et al., 2011; Pallavicini et al., 2016) supported the importance of enhancing student performance by exploring the powerful abilities of VR in the classroom. Heightened presence and engagement in an educational setting (Buttussi & Chittaro, 2017) is the ultimate goal of achieving maximum academic accomplishments.

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Appendices

Appendix A - DTPEC Ethics Application

IADT Department of Technology and Psychology Ethics Committee (DTPEC)

Application Form 2021-2022

Instructions:

1. Please read all sections carefully, include all of the information relevant to your project, and include all necessary appendices.
2. All students must complete Sections 1, 2, 3, and 4. You will also need to complete at least one other section, depending on the type of research that you plan to do.
3. Email the completed form to your supervisor for approval. They will then complete Section 0 below.
4. Your supervisor will then forward the application to the ethics committee.
5. If your application is under the Red Route, then you may also be required to submit four printed copies of your application (including all appendices). You will be advised closer to the deadline if this is necessary or not.
6. If your study changes from how you have described it in this form then you will need to reapply for approval from the DTPEC. The DTPEC does not guarantee that a revised project will be approved, even if the original project was approved.
7. All communication between students and the DTPEC will occur via the student's project supervisor.
8. The DTPEC will consider all of the information provided in the form when making their decision. Incomplete forms (including forms which do not include all of the necessary Appendices) will be rejected.
9. If the DTPEC's decision is that a revised application must be made then they will provide a list of required changes which are necessary to ensure participant wellbeing. Even if all of these are followed, the DTPEC makes no commitment to approve a revised application.
10. It is highly recommended that 'Red Route' students continue to formulate ideas for projects which fit the criteria for 'Green Route' and 'Amber Route' submissions until they are advised that their application has been approved. This is to ensure that the student can still complete the module, even if their 'Red Route' project does not receive approval from the DTPEC.
11. There is an obligation on the researcher to bring to the attention of the DTPEC any issues with ethical implications not clearly covered by the checklist in Section 6 of this form.
12. 'Signatures' may be typed, scanned in, or digitally signed.

Section 0: For Completion by the Supervisor

I confirm that this application to the DTPEC by ______________________ (student name) accurately reflects all of the ethical implications in the project.

Application type (tick all that apply for mixed methods): Green Route ____

Amber Route ____

Red Route ____

Signed ____________________________ **Date:** ______________________

Section 1: Project Information

Student Name: Andrea Farrelly

Student Email Address: N00180547@iadt.ie

Supervisor Name: Rob Griffin

Working Project Title: Comparing Online vs Virtual Learning: A case study of a Cyberpsychology MSc class.

Main Variables Being Investigated: Effects of Virtual Reality, Sense of Presence, Levels of Engagement

Section 2: External Agencies

Does your project involve recruitment from any external agency (e.g. a school, sports club, medical centre, voluntary organisation, or any other organisation outside of the IADT)?	Yes*	No
		✖
* You must include a letter from a senior manager of each organisation stating that you have approval to collect data within that organisation. Include copies each of these letters in the Appendices to your application. If the organisation has its own ethical review board (which is very common in some settings, such as hospitals), then you are also required to get ethical approval from that board prior to starting data collection, and to submit notice of this approval to your supervisor so that it can be forwarded on to the ethics committee. Some online forums also require permission to post requests for participants – make sure to check the relevant forum/organisation's code of conduct or terms and conditions. You do not need to include approval letters if you are conducting recruitment using mainstream social media routes (e.g., Twitter, Instagram, Facebook, Snapchat, TikTok) to your own followers, and/or snowball sampling/word of mouth recruitment.		

Section 3: Project Methodology – Please tick which type of project you are seeking approval from the DTPEC for. If your project involves mixed methods, then tick all which apply.

Route Type	Methodology	Tick here
Green Route (no direct contact with participants required, and no data is collected/recorded which could identify participants)	Theoretical paper / systematic literature review	
	Novel analysis of an existing dataset gathered by another researcher or group which you are certain has abided by appropriate ethical procedures for the relevant discipline	
	Observation of participants in a public place in which they could reasonably be expected to be observed by strangers or in an online space which does not require users to log in to access.	
	Content analysis of material which is publicly available and does not require users to log in to access content.	
	Other method without direct contact with participants **	

Amber Route (direct contact with participants, but no additional ethical considerations beyond the minimum requirements)	Requirements gathering for and/or user testing of a prototype which is highly unlikely to cause any harm or distress to participants and which does not aim to collect data from a potentially vulnerable group	
	An experiment which is highly unlikely to cause any harm or distress to participants and which does not aim to collect data from a potentially vulnerable group	✖
	A survey/questionnaire design which is highly unlikely to cause any harm or distress to participants and which does not aim to collect data from a potentially vulnerable group	✖
	An observational study which is highly unlikely to cause any harm or distress to participants and which does not aim to collect data from a potentially vulnerable group	✖
	Content analysis research which is highly unlikely to cause any harm or distress to participants and which does not aim to collect data from a potentially vulnerable group	✖
	Interviews and/or focus groups which are highly unlikely to cause any harm or distress to participants and which do not aim to collect data from a potentially vulnerable group	
	Other method which is highly unlikely to cause any harm or distress to participants and which does not aim to collect data from a potentially vulnerable group **	
Red Route (direct contact with participants, including one or more project aspects which require special ethical consideration)	Requirements gathering for and/or user testing of a prototype which may cause harm or distress to participants and/or which involves collecting data from any potentially vulnerable group	
	An experiment which may cause harm or distress to participants and/or which involves collecting data from any potentially vulnerable group	
	A survey/questionnaire design which may cause harm or distress to participants and/or which involves collecting data from any potentially vulnerable group	
	An observational study which may cause harm or distress to participants and/or which involves collecting data from any potentially vulnerable group	
	Content analysis research which may cause harm or distress to participants and/or which involves collecting data from any potentially vulnerable group	
	Interviews and/or focus groups which may cause harm or distress to participants and/or which involves collecting data from any potentially vulnerable group	
	Other method which may cause harm or distress to participants and/or which involves collecting data from any potentially vulnerable group **	
** If you are using a methodology not listed above then provide a short description (fewer than 100 words) here:		

Section 4: Checklist of Attached Appendices and Other Completed Sections

Applicable Project Ethics Route Colour Guide		Section / Item	I have attached this item/completed this section	I have checked with my supervisor and we have agreed that this item/section is not relevant to my project
	1	Section 1		
	2	Section 2		
	3	Section 3		
	4	Section 4		
	5	Letters of permission from any external agencies to be used for data collection		
	6	Statement of approval from ethical review boards in external agencies	✖	
	7	Section 5 (Green Route Projects only)		
	8	Section 6 (Amber and Red Route Projects only)	✖	
	9	Section 7 (Amber Route Projects only)	✖	
	10	Section 8 (Red Route Projects only)		
	11	Section 9 (Red Route Projects only)		
	12	Evidence of why you need to complete a Red Route Project (see note in Section 8)		
	13	Project Information Sheet (Red Route Projects only)		
	14	Project Consent Form (Red Route Projects only)		
	15	Project Demographic Questionnaire (Red Route Projects only)		
	16	All Other Questionnaires and Data Collection Materials (Red Route Projects only)		
	17	Project Debrief (Red Route Projects only)		

Section 5: Declaration of a Green Route project

I hereby declare that [all of / this aspect of (delete as appropriate)] my project involves no direct interaction between me and any research participants, and that having checked with my supervisor, that I do not need to seek informed consent from those whose data I use in my research. In addition,

I will ensure that all data which I do gather is held in a manner which is compliant with GDPR, and will be deleted once it is no longer required (and definitely within 6 years of collection). At all times my study will be conducted in adherence to the ethical policies of the Psychological Society of Ireland and the British Psychological Society.

Student Signature: _____ Date: _____

Section 6: Confirmation of Adherence to Basic Ethical Principles for Amber and Red Route Projects

Complete the Table below with guidance from your supervisor. If you need to tick any of the 'red' boxes, then your project must be submitted under the 'Red Route'.

		Yes	No	N/A
6.1	I will describe the main research procedures to participants in advance so that they know what to expect. I will use the sample Information Sheet provided by DTPEC to do this.	✖		
6.2	I will tell participants that their participation is voluntary.	✖		
6.3	I will obtain written consent from participants using a 'tick' consent form which follows the current template provided by DTPEC prior to starting data collection.	✖		
6.4	I will verify that participants still wish to include their data in online studies by including a final indicator of consent at the end of the questions.	✖		
6.5	If my research involves content analysis or observation in any private or partially private setting then I will ensure to obtain informed consent prior to collecting data.	✖		
6.6	I will explain to participants that they can withdraw from the study at any time and for any reason.	✖		
6.7	I will ensure that participants know that they can refrain from answering any question that they don't want to, even if this is part of a psychometric scale.	✖		
6.8	If using an online data collection method I will ensure that the only questions which require answers in order to proceed are the questions relating to providing informed consent, and I will ensure that participants are provided with an option which indicates that they do not give their consent.	✖		
6.9	I will inform participants that their data will be treated with full confidentiality, and that, if published, it will not be identifiable as theirs.	✖		
6.10	I will debrief participants at the end of their participation (i.e. give them a brief explanation of the study, whether or not deception was involved) following the current template provided by DTPEC	✖		
6.11	I will obtain passive consent from parents/guardians for studies involving people aged between 16 and 18 years, as well as active consent from the participant and their school/organisation			✖
6.12	I will obtain active consent from parents/guardians for studies involving people aged under 16 years. Where feasible I will also obtain active consent from the participant themselves. I will ensure that the parent/guardian or their nominee (e.g. a teacher) will be present throughout the data collection period.			
6.13	I will ensure that my project supervisor has full access to the data that I collect and will only use data collection software which permits this.	✖		
6.14	I will ensure that my project supervisor retains full rights to the data collected, including the ability to delete all data at any time, and that third-parties (e.g., software companies) will not 'own' the data collected.	✖		
6.15	I will ensure that participants in studies involving Virtual Reality (VR) are not susceptible to extreme motion sickness or other physical conditions which may result in harm to the participants. I will ensure that a chaperone is present during VR sessions, and that the participant has the option of also having a nominee of their choosing present as well.	✖		
6.16	I will ensure that any equipment used in this study is cleaned and disinfected after each participant, and that appropriate hygienic barriers (e.g. masks) are used by all participants	✖		
6.17	Is there any realistic risk of any participant experiencing either physical or psychological distress or discomfort?		✖	
6.18	I plan to use animals as part of my research study		✖	
6.19	I plan to tell participants their results on a task or scale which I am using in my research.		✖	
6.20	I am researching a sensitive topic which may cause some participants distress (such as, but not limited to, religion, sexuality, alcohol, crime, drugs, mental health, physical health, parenting, family relationships)		✖	
6.21	One or more aspects of my study is designed to change the mental state of participants in a negative way (such as inducing aggression, frustration, sadness, etc.)		✖	
6.22	My study involves deception or deliberately misleading participants in some way.		✖	
6.23	My target population includes people who have learning or communication difficulties		✖	
6.24	My target population includes patients (either inpatient or outpatient)		✖	
6.25	My target population includes people in custody		✖	
6.26	My target population includes people who may feel under personal or professional pressure to take part in my research (for example, close friends; family; employees or staff of managers or school principals who may support the research).		✖	

Section 7: Declaration of an Amber Route project

I hereby declare that [all of / this aspect of (delete as appropriate)] my project involves no risk of physical, emotional, social or cognitive harm to participants; that I will obtain full informed consent from all participants and provide a full debrief afterwards (using the templates provided); that I will provide full anonymity and/or confidentiality to participants; and that my participants are not a potentially vulnerable population. In addition, I will ensure that all data which I gather is held in a manner which is compliant with GDPR, and will be deleted once it is no longer required (and definitely within 6 years of collection). At all times my study will be conducted in adherence to the ethical policies of the Psychological Society of Ireland and the British Psychological Society.

Student Signature: Andrea Farrelly Date: November 14th 2021

Section 8: Additional Information For Red Route Projects

8.1 What are the aims of your research? Include your research question and hypotheses for all studies which are not exploratory in nature (Max. 100 words)
8.2 What is the specific reason(s) why this is a Red Route project? (Max. 100 words)
8.3 How will you ensure that participants are not harmed as a result of participation in your research, given your answer to 8.2 above (Max. 100 words)
8.4 Why do you need to do this project at this stage in your career? For example, is there a specific postgraduate programme which you wish to apply for which requires you to have completed research in this area? Do you have specific additional qualifications or experience which equip you to manage the additional ethical implications in this project? Bear in mind that if your main reason for wishing to do this research is because the area of study is important then your application is likely to be refused – in general it is better for research with important societal implications to be conducted at a time when you have more research experience. (Max. 100 words)
8.5 Provide a rationale as to why another methodology related to your chosen topic (such as a systematic review, theoretical paper, content analysis, or analysis of an existing dataset) cannot be done in your case (Max. 100 words)
8.6 List supporting documentation which you have included in an Appendix to this application to justify the need for you to do a Red Route project (this might be: the list of entry requirements for a specific postgraduate programme which you are planning on applying for, along with the link to the website where you found this information; a transcript or certificate for a training course related to the area; a letter from your manager or supervisor where you are engaged in voluntary work related to the area, etc.). 1. 2. 3.

Appendix B - Information Sheet (Microsoft Forms)

Information Sheet

Study title: The Difference in Presence and Engagement between Online and Virtual Environments.

Name of Researcher: Andrea Farrelly

Purpose of Research
Due to the current climate of the Covid-19 pandemic, an ever-increasing number of schools and universities shifted entirely to online methods of education to preserve the academic growth of their students. While traditional face-to-face learning has been put on hold, it is necessary to investigate the pros and cons of a variety of methods of teaching. The following study aims to determine the effect of student engagement on levels of presence in online versus virtual learning environments. The study intends to compare an online class with a class that takes place in virtual reality.

Invitation
You are being invited to consider taking part in a study that is researching the effect of student engagement on levels of presence in online versus virtual learning environments. The project is being undertaken by Andrea Farrelly, a final year undergraduate student of Applied Psychology at IADT.

Before you decide whether or not you wish to take part, please take the time to read this information sheet carefully, and do not hesitate to ask us if anything is unclear or if you wish for more information.

Do I have to take part?
You are free to decide whether you wish to take part or not. If you decide to take part, you will be asked to complete the following consent forms. You are free to withdraw from this study at any given time (without reason). You do not have to complete the following questionnaire if you do not wish to do so.

If I do take part, what is involved?
If you choose to take part, you must first complete the following consent form, you will then be asked a variety of demographic questions relating to your age and gender. After completing these, you may begin the online questionnaire. Depending on the group you are in, you will be asked to take part in Task 1 or Task 2 (or potentially both). The study will consist of two groups: (a) those who take part in the online class, and (b) those who take part in the VR class. All information and consent forms must be completed prior to participation in this study as per research ethics best practice.

What are the benefits (if any) in taking part?
We cannot promise this study will have any psychological benefit on the participant, but the information gathered will be added to the existing body of research regarding online and virtual learning. The collection of information will effectively be used to represent the comparisons that exist between online and virtual learning environments, and further the understanding of a need for future research into the potential improvements virtual learning spaces may have on the effects of student engagement and levels of presence within the education sector.

What are the disadvantages and risks (if any) in taking part?
You do not have to complete any of the questions below, should they make you uncomfortable. For the VR group, when using the headset, there is a risk of motion sickness and/or potentially induced seizures. A screening will take place to limit the chances of these conditions occurring. If you are prone to motion sickness and/or seizures, please refrain from participating in the VR elements of this experiment.

How will my information be used?
Your identity will remain anonymous throughout the process of the experiment. Your demographic information and responses to the questionnaire will be combined with the data from every other participant, and will be statistically analysed by the researcher. Your data will remain unidentifiable in the final report of the results that will be published in the thesis for the BSc in Applied Psychology (DL825) in the Dun Laoghaire Institute of Art, Design & Technology. Should you wish to access these results, they can be requested through an email to the IADT library at infolib@iadt.ie. The final results can also be acquired from the researcher, Andrea Farrelly (N00180547@iadt.ie), or the supervisor of this project, Robert Griffin (robertgriffin@iadt.ie). This study may also be published as an academic journal article, or it may be referenced in blog posts or media articles. Should this occur, they can also be requested from the researcher and/or project supervisor.

Who will have access to my information?
Andrea Farrelly (researcher), Robert Griffin (project supervisor), and the assigned statistics support lecturer will be the only people with access to the data from this study. Anonymity and confidentiality will be safeguarded through reduced association between participants and the information supplied.

Will my data be protected?
Under the EU General Data Protection Regulation (GDPR) the legal basis for collecting data for scholarly research is that of public interest. The regulations regarding the protection of your data will be followed. Only data which is needed for analysis will be collected. By giving your consent to take part in the study you are consenting to the use of your data as detailed in this information sheet.

The data will be retained by the researcher for at least one year, and may be retained for up to 7 years if the results of the study are published in certain capacities (e.g. in a journal article). There is also a possibility that the fully anonymised dataset may be submitted to a journal and made available to other researchers and academics worldwide for verification purposes, but if this occurs it will be ensured that you are not identifiable from the data.

As the supervisor on this project, I, Robert Griffin, am responsible for ensuring that all datasets will be stored in accordance with GDPR regulations and those which are not submitted to a journal will be fully deleted on or before date 7 years from data collection.

Only the researcher, supervisor and statistics support lecturer will have access to the data during the course of the study. All data will be stored securely on a password-protected computer. Should a data breach occur, the data protection officer in IADT will be informed immediately. The data will remain anonymous throughout and will only be identifiable through the identification code created by the participant. Data will be fully deleted after 7 years.

You will find contact information for IADT's Data Protection Officer, Mr Bernard Mullarkey, and more information on your rights concerning your data at https://iadt.ie/about/your-rights-entitlements/gdpr/.

Who has reviewed the study?
This study has been approved by the Department of Technology and Psychology Ethics Committee (DTPEC).

Contact Details
If you have any concerns, or wish to withdraw your data from the experiment please contact us via the details below.
Andrea Farrelly (researcher) - Mobile: 0857630855, or Email: N00180547@iadt.ie.
Robert Griffin (project supervisor) - Email: robertgriffin@iadt.ie.

Appendix C - Consent Form (Microsoft Forms)

Consent Form

Study title: The difference in Presence and Engagement between Online and Virtual Environments.

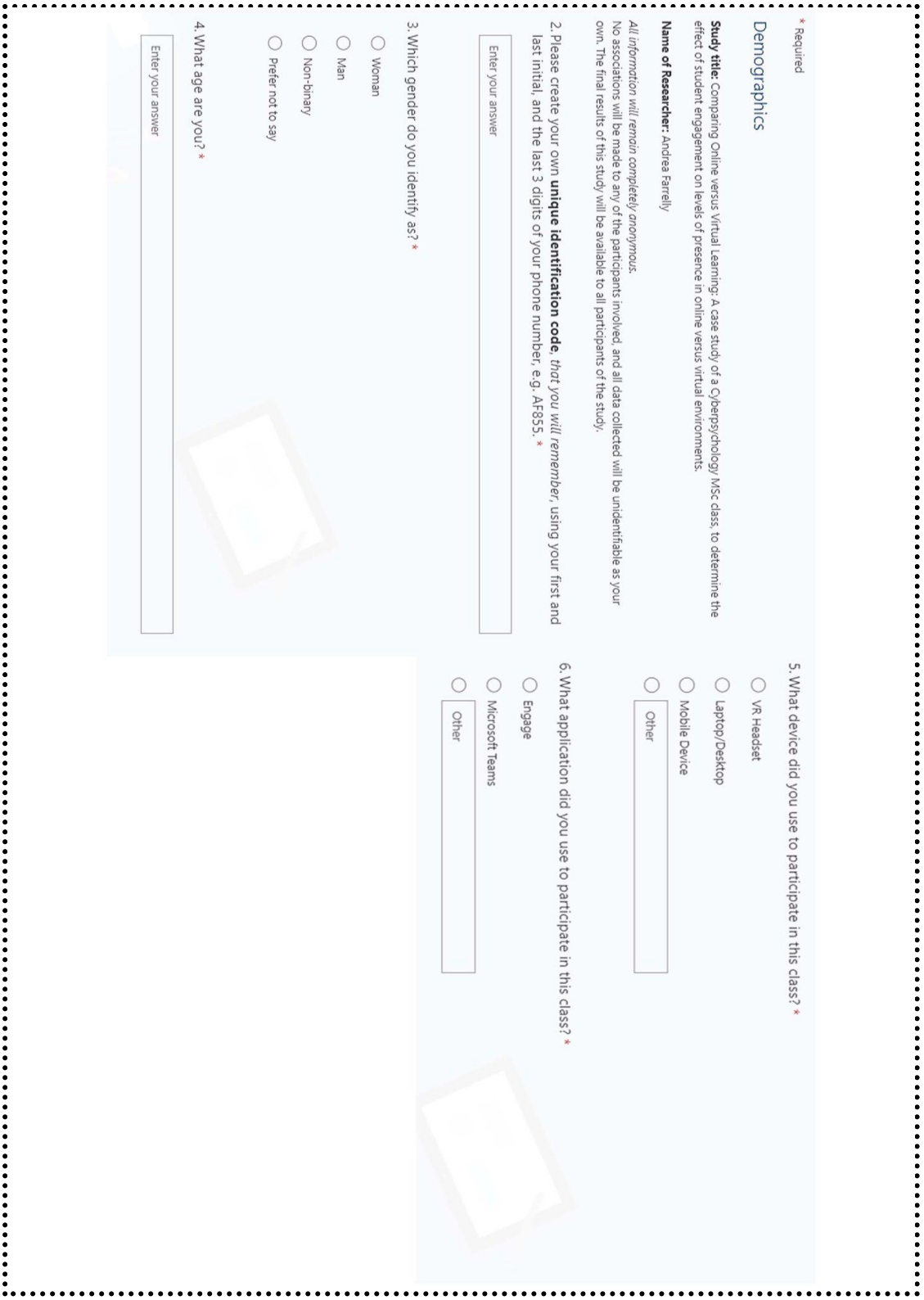
Name of Researcher: Andrea Farrelly

All information will remain completely anonymous.
No associations will be made to any of the participants involved, and all data collected will be unidentifiable as your own. The final conclusion of this study will be available to all participants of this study.

1. Please tick all the boxes *

- [ ] I can confirm that I have read and understand the information sheets for the experiment and have had the opportunity to ask questions.
- [ ] I understand that my participation is voluntary and that I am free to withdraw at any time with my results destroyed. I can refuse to answer any questions I choose to.
- [ ] I agree to take part in this experiment.
- [ ] I understand that data collected about me during this experiment will remain anonymous.
- [ ] I am over 18 (eighteen) years of age.

Appendix D - Demographic Questions (Microsoft Forms)



* Required

Demographics

Study title: Comparing Online versus Virtual Learning: A case study of a Cyberpsychology MSc class, to determine the effect of student engagement on levels of presence in online versus virtual environments.

Name of Researcher: Andrea Farrelly

All information will remain completely anonymous.
No associations will be made to any of the participants involved, and all data collected will be unidentifiable as your own. The final results of this study will be available to all participants of the study.

2. Please create your own **unique identification code**, *that you will remember*, using your first and last initial, and the last 3 digits of your phone number, e.g. AF855. *

Enter your answer

3. Which gender do you identify as? *

- Woman
- Man
- Non-binary
- Prefer not to say

4. What age are you? *

Enter your answer

5. What device did you use to participate in this class? *

- VR Headset
- Laptop/Desktop
- Mobile Device
- Other

6. What application did you use to participate in this class? *

- Engage
- Microsoft Teams
- Other

PRESENCE QUESTIONNAIRE
(Witmer & Singer, Vs. 3.0, Nov. 1994)*
Revised by the UQO Cyberpsychology Lab (2004)

Characterize your experience in the environment, by marking an "X" in the appropriate box of the 7-point scale, in accordance with the question content and descriptive labels. Please consider the entire scale when making your responses, as the intermediate levels may apply. Answer the questions independently in the order that they appear. Do not skip questions or return to a previous question to change your answer.

WITH REGARD TO THE EXPERIENCED ENVIRONMENT

1. How much were you able to control events?

NOT AT ALL			SOMEWHAT			COMPLETELY

2. How responsive was the environment to actions that you initiated (or performed)?

NOT RESPONSIVE			MODERATELY RESPONSIVE			COMPLETELY RESPONSIVE

3. How natural did your interactions with the environment seem?

EXTREMELY ARTIFICIAL			BORDERLINE			COMPLETELY NATURAL

4. How much did the visual aspects of the environment involve you?

NOT AT ALL			SOMEWHAT			COMPLETELY

5. How natural was the mechanism which controlled movement through the environment?

EXTREMELY ARTIFICIAL			BORDERLINE			COMPLETELY NATURAL

6. How compelling was your sense of objects moving through space?

NOT AT ALL			MODERATELY COMPELLING			VERY COMPELLING

7. How much did your experiences in the virtual environment seem consistent with your real world experiences?

NOT CONSISTENT			MODERATELY CONSISTENT			VERY CONSISTENT

8. Were you able to anticipate what would happen next in response to the actions that you performed?

NOT AT ALL			SOMEWHAT			COMPLETELY

9. How completely were you able to actively survey or search the environment using vision?

NOT AT ALL			SOMEWHAT			COMPLETELY

10. How compelling was your sense of moving around inside the virtual environment?

NOT COMPELLING			MODERATELY COMPELLING			VERY COMPELLING

11. How closely were you able to examine objects?

NOT AT ALL			PRETTY CLOSELY			VERY CLOSELY

12. How well could you examine objects from multiple viewpoints?

NOT AT ALL			SOMEWHAT			EXTENSIVELY

13. How involved were you in the virtual environment experience?

NOT INVOLVED			MILDLY INVOLVED			COMPLETELY ENGROSSED

14. How much delay did you experience between your actions and expected outcomes?

NO DELAYS		MODERATE DELAYS		LONG DELAYS

15. How quickly did you adjust to the virtual environment experience?

NOT AT ALL		SLOWLY		LESS THAN ONE MINUTE

16. How proficient in moving and interacting with the virtual environment did you feel at the end of the experience?

NOT PROFICIENT		REASONABLY PROFICIENT		VERY PROFICIENT

17. How much did the visual display quality interfere or distract you from performing assigned tasks or required activities?

NOT AT ALL		INTERFERED SOMEWHAT		PREVENTED TASK PERFORMANCE

18. How much did the control devices interfere with the performance of assigned tasks or with other activities?

NOT AT ALL		INTERFERED SOMEWHAT		INTERFERED GREATLY

19. How well could you concentrate on the assigned tasks or required activities rather than on the mechanisms used to perform those tasks or activities?

NOT AT ALL		SOMEWHAT		COMPLETELY

IF THE VIRTUAL ENVIRONMENT INCLUDED SOUNDS:

20. How much did the auditory aspects of the environment involve you?

NOT AT ALL		SOMEWHAT		COMPLETELY

21. How well could you identify sounds?

NOT AT ALL		SOMEWHAT		COMPLETELY

22. How well could you localize sounds?

NOT AT ALL		SOMEWHAT		COMPLETELY

IF THE VIRTUAL ENVIRONMENT INCLUDED HAPTIC (SENSE OF TOUCH):

23. How well could you actively survey or search the virtual environment using touch?

NOT AT ALL		SOMEWHAT		COMPLETELY

24. How well could you move or manipulate objects in the virtual environment?

NOT AT ALL	SOMEWHAT	EXTENSIVELY

Last version : March 2013

*Original version : Witmer, B.G. & Singer. M.J. (1998). Measuring presence in virtual environments: A presence questionnaire. *Presence : Teleoperators and Virtual Environments*, *7*(3), 225-240. Revised factor structure: Witmer, B.J., Jerome, C.J., & Singer, M.J. (2005). The factor structure of the Presence Questionnaire. *Presence, 14*(3) 298-312.

Questionnaire sur l'État de Présence (QÉP)
Laboratoire de Cyberpsychologie de l'UQO

Validation of the French-Canadian version developed by the UQO Cyberpsychology Lab:

- 101 participants completed the questionnaire following an immersion in a virtual environment;
- Cronbach's Alpha = .84
- Now 19 items (for VEs without sound/touch) et 24 items (for VEs with sounds/touch)

Scoring :

Total : Items 1 to 19 (reverse items 14, 17, 18)

- « Realism » : Items 3 + 4 + 5 + 6 + 7 + 10 + 13
- « Possibility to act » : Items 1 + 2 + 8 + 9
- « Quality of interface » : Items (all reversed) 14 + 17 + 18
- « Possibility to examine » : Items 11 + 12 + 19
- « Self-evaluation of performance » : Items 15 + 16
- « Sounds* » : Items 20 + 21 + 22
- « Haptic* » : Items 23 + 24

* NOTE : Scoring of « *sounds* » and « *haptic* » are not part of the factor analysis of the French version.

Norms (French version) :

	Moyenne	**Écart type**
Total	104.39	18.99
« Realism »	29.45	12.04
« Possibility to act »	20.76	6.01
« Quality of interface »	15.37	5.15
« Possibility to examine»	15.38	4.90
« Auto-évaluation de la performance »	11.00	2.87

Last version : March 2013

*Original version : Witmer, B.G. & Singer. M.J. (1998). Measuring presence in virtual environments: A presence questionnaire. *Presence : Teleoperators and Virtual Environments*, *7*(3), 225-240. The factor structure of the Presence Questionnaire. *Presence, 14*(3) 298-312. Revised factor structure: Witmer, B.J., Jerome, C.J., & Singer, M.J. (2005). The factor structure of the Presence Questionnaire. *Presence, 14*(3) 298-312.

Appendix F - User Engagement Scale

User Engagement Scale Long Form:
Questionnaire items and instructions for scoring

Instructions for administrators: When administering the UES and UESSF, all items should be randomised and dimension identifiers (e.g., "Focused Attention or FA") should not be visible to participants. Below we provide general instructions to participants that can be modified to suit the study context; the five-point rating scale should be used to allow for comparisons across studies/sampled populations. The wording of the questions may be modified to your context of use. For example, item PU.1 "I felt frustrated while using this Application X" may be reworded to "I felt frustrated while using this search engine."

Instructions for respondents: The following statements ask you to reflect on your experience of engaging with Application X or "this study". For each statement, please use the following scale to indicate what is most true for you.

Strongly Disagree - 1
Disagree - 2
Neither Agree nor Disagree - 3
Agree - 4
Strongly Agree - 5

User Engagement Scale Long Form (UES-LF):

FA.1 I lost myself in this experience.
FA.2 I was so involved in this experience that I lost track of time.
FA.3 I blocked out things around me when I was using Application X.
FA.4 When I was using Application X, I lost track of the world around me.
FA.5 The time I spent using Application X just slipped away.
FA.6 I was absorbed in this experience.
FA.7 During this experience I let myself go.
PU.1 I felt frustrated while using this Application X.
PU.2 I found this Application X confusing to use.
PU.3 I felt annoyed while using Application X.
PU.4 I felt discouraged while using this Application X.
PU.5 Using this Application X was taxing
PU.6 This experience was demanding.
PU.7 I felt in control while using this Application X.
PU.8 I could not do some of the things I needed to do while using Application X.
AE.1 This Application X was attractive
AE.2 This Application X was aesthetically appealing
AE.3 I liked the graphics and images of Application X.
AE.4 Application X appealed to visual senses.
AE.5 The screen layout of Application X was visually pleasing.

RW.1 Using Application X was worthwhile
RW.2 I consider my experience a success.
RW.3 This experience did not work out the way I had planned.
RW.4 My experience was rewarding.
RW.5 I would recommend Application X to my family and friends
RW.6 I continued to use Application X out of curiosity.
RW.7 The content of Application X incited my curiosity.
RW.8 I was really drawn into this experience.
RW.9 I felt involved in this experience.
RW.10 This experience was fun.

A1. Scoring the UES-LF

Instructions for administrators: When administering the UES and UESSF, all items should be randomised and dimension identifiers (e.g., "Focused Attention or FA") should not be visible to participants. Below we provide general instructions to participants than can be modified to suit the study context; the five-point rating scale should be used to allow for comparisons across studies/sampled populations. The wording of the questions may be modified for one's context of use. For example, item PU.1 "I felt frustrated while using this Application X" may be reworded to "I felt frustrated while using this search engine."

Instructions for respondents: The following statements ask you to reflect on your experience of engaging with Application X or "this study". For each statement, please use the following scale to indicate what is most true for you.

1. Reverse code the following items: PU-1, PU-2, PU-3, PU-4, PU-5, PU6, PU-8, and RW-3.

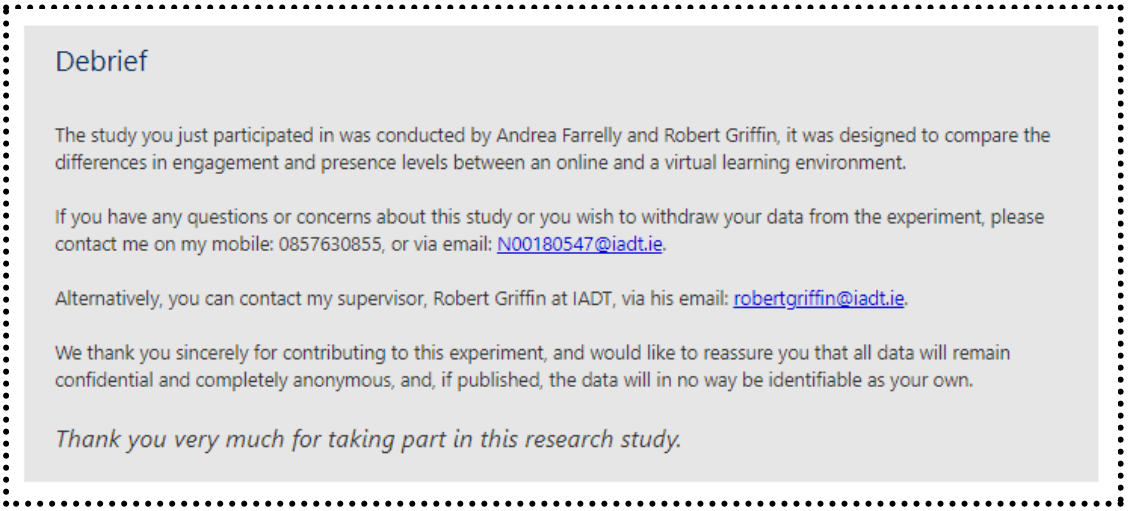
2. Scale scores are calculated for each participant by summing scores for the items in each of the four subscales and dividing by the number of items:

• Sum FA-1, FA2, ... FA7 and divide by seven.
• Sum PU-1, PU-2, ... PU-8 and divide by eight.
• Sum AE-1, AE-2, AE-3, AE-4, and AE-5 and divide by five.
• Sum RW-1, RW-2, ... RW-10 and divide by ten.

3. If participants have completed the UES more than once as part of the same experiment, calculate separate scores for each iteration. This will enable the researcher to compare engagement within participants and between tasks/iterations.

4. An overall engagement score can be calculated by adding the average of each subscale as per #2.

Appendix G - Debrief (Microsoft Forms)



Debrief

The study you just participated in was conducted by Andrea Farrelly and Robert Griffin, it was designed to compare the differences in engagement and presence levels between an online and a virtual learning environment.

If you have any questions or concerns about this study or you wish to withdraw your data from the experiment, please contact me on my mobile: 0857630855, or via email: N00180547@iadt.ie.

Alternatively, you can contact my supervisor, Robert Griffin at IADT, via his email: robertgriffin@iadt.ie.

We thank you sincerely for contributing to this experiment, and would like to reassure you that all data will remain confidential and completely anonymous, and, if published, the data will in no way be identifiable as your own.

Thank you very much for taking part in this research study.

Appendix H - Participants Needed Poster for Online (desktop/video-based environment)

Appendix I - Ethics Approval

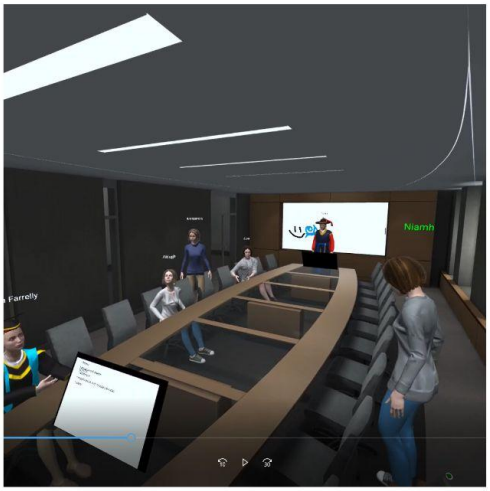
DL825 Year 4 MRP Green and Amber Ethics Applications December 2021

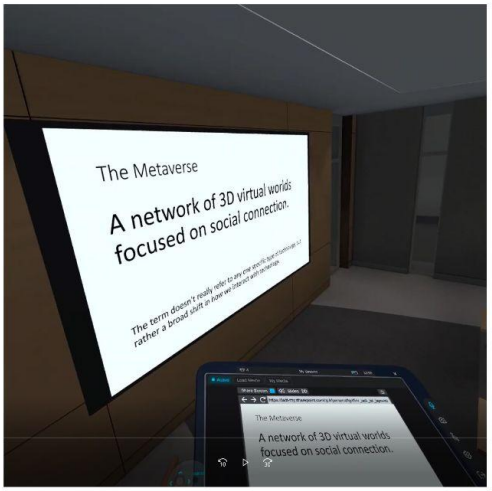
The following Ethics Applications have been approved:

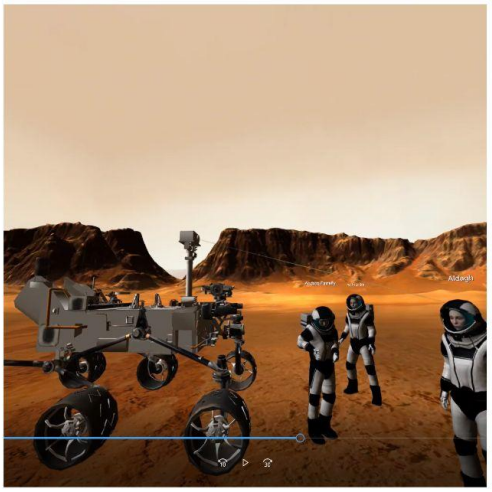
Alessia Merkes	Jake Richardson
Alison Deegan	Jason Chatham
Amy Benton Byrne	Jordan McDonnell
Ana Neres Borges	Kate Lifely Stafford
Andrea Farrelly	Katie Jenkinson
Angela Hegarty	Killian Schonfeld
Anita Hovarth	Lukas Dillon
Armandas Bendaravicius	Lynda Brady
Chloe O'Connor	Mark Byrne
Ciara Little	Matthew Delaney
Ciaran Nally	Megan Doherty
Cliona Gaffney Moran	Molly Kavanagh
Clodagh McCarthy	Niamh Dennehy
Danny Corbin	Nicholas Rooney
David O'Hagan	Nora Noone
Dora Krstulovic	Owen Cooney
Eamonn Cooke	Peter Conlon
Eden Bryan	Samual Edomwonyi
Emilja Gostautaite	Sarah Flavin
Gemma Clabby	Stuart Kavanagh
Jack Condron	Yvonne McNulty
Jacob Green	Sabina Bacinschi

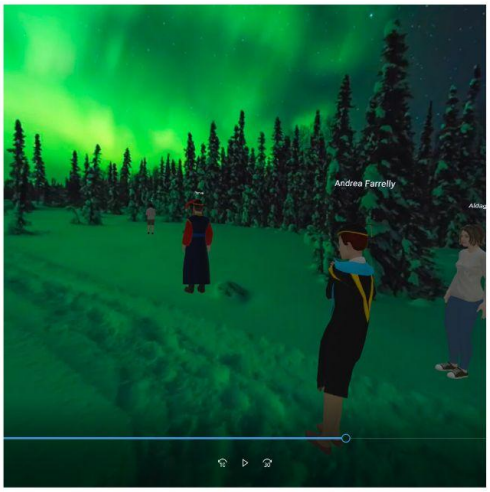
If your name is not on this list and you have not yet received Feedback on your Ethics Application please contact your supervisor.

Appendix J - Engage Application - VR Environment (JPEGs)









SPSS Output Data (Tables & Figures)

Table 1 - Descriptive Statistics for Participants' Mean and Standard Deviation Scores for Overall Presence & Engagement

Between-Subjects Factors

		Value Label	N
Environment	1	Online	38
	2	Virtual	15

Descriptive Statistics

	Environment	Mean	Std. Deviation	N
Total Presence Score	Online	.01508	.003340	38
	Virtual	.04377	.010529	15
	Total	.02320	.014423	53
Total Engagement Score	Online	10.6680	3.07249	38
	Virtual	14.2326	2.60198	15
	Total	11.6769	3.34182	53

Table 2 - Normal Distribution of Data

Tests of Normality[a]

		Kolmogorov-Smirnov[b]			Shapiro-Wilk	
	Environment	Statistic	df	Sig.	Statistic	df
Total Presence Score	Online	.123	38	.154	.965	38
Total Engagement Score	Online	.098	38	.200*	.958	38

Tests of Normality[a]

		Shapiro-...
	Environment	Sig.
Total Presence Score	Online	.280
Total Engagement Score	Online	.162

*. This is a lower bound of the true significance.

a. Environment = Online

b. Lilliefors Significance Correction

Table 3- Violation of Homogeneity of Variance-Covariance Matrices for Overall Presence & Engagement

Box's Test of Equality of Covariance Matrices[a]

Box's M	61.448
F	19.312
df1	3
df2	12846.177
Sig.	.000

Table 4 - Descriptive Statistics for Participants' Mean and Standard Deviation Scores for Application used

Between-Subjects Factors

		Value Label	N
Application used most often for Online Environments	1	Blackboard	16
	2	Microsoft Teams	13
	3	Zoom	5
	4	Other	4
	5	Engage	15

Descriptive Statistics

	Application used most often for Online Environments	Mean	Std. Deviation	N
Total Presence Score	Blackboard	.01456	.003540	16
	Microsoft Teams	.01515	.003716	13
	Zoom	.01660	.002881	5
	Other	.01500	.001826	4
	Engage	.04377	.010529	15
	Total	.02320	.014423	53
Total Engagement Score	Blackboard	9.9429	3.34005	16
	Microsoft Teams	11.2359	2.83261	13
	Zoom	12.5257	3.32853	5
	Other	9.4009	1.29909	4
	Engage	14.2326	2.60198	15
	Total	11.6769	3.34182	53

Table 5 - Estimates of Application used for Overall Presence & Engagement

Estimates

Dependent Variable	Application used	Mean	Std. Error	97.5% Confidence Interval	
				Lower Bound	Upper Bound
Total Presence Score	Blackboard	.015	.002	.011	.018
	Microsoft Teams	.015	.002	.011	.019
	Zoom	.017	.003	.010	.023
	Other	.015	.003	.008	.022
	Engage	.044	.002	.040	.048
Total Engagement Score	Blackboard	9.943	.729	8.257	11.629
	Microsoft Teams	11.236	.808	9.365	13.106
	Zoom	12.526	1.304	9.510	15.542
	Other	9.401	1.457	6.029	12.773
	Engage	14.233	.753	12.491	15.974

Table 6 - Multivariate Tests between Application used and Presence & Engagement

Multivariate Tests

	Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
Pillai's trace	.964	11.170	8.000	96.000	.000	.482

Table 7 - Pairwise Comparisons

Pairwise Comparisons

Dependent Variable	(I) Environment	(J) Environment	Mean Difference (I-J)	Std. Error	Sig.[b]	97.5% Confidence Interval for Difference[b]	
						Lower Bound	Upper Bound
Total Presence Score	Online	Virtual	-.029*	.002	<.001	-.033	-.024
	Virtual	Online	.029*	.002	<.001	.024	.033
Total Engagement Score	Online	Virtual	-3.565*	.900	<.001	-5.643	-1.487
	Virtual	Online	3.565*	.900	<.001	1.487	5.643

Based on estimated marginal means

*. The mean difference is significant at the .025 level.

b. Adjustment for multiple comparisons: Bonferroni.

Table 8 - Levene's Test displaying Homogeneity of Variance

Levene's Test of Equality of Error Variances[a]

		Levene Statistic	df1	df2	Sig.
Total Presence Score	Based on Mean	4.310	4	48	.005
	Based on Median	3.895	4	48	.008
	Based on Median and with adjusted df	3.895	4	20.601	.016
	Based on trimmed mean	4.069	4	48	.006
Total Engagement Score	Based on Mean	1.299	4	48	.284
	Based on Median	.859	4	48	.495
	Based on Median and with adjusted df	.859	4	43.931	.496
	Based on trimmed mean	1.256	4	48	.300

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Design: Intercept + Application

Figure 1 - Box Plot of Presence in Online and Virtual Environments

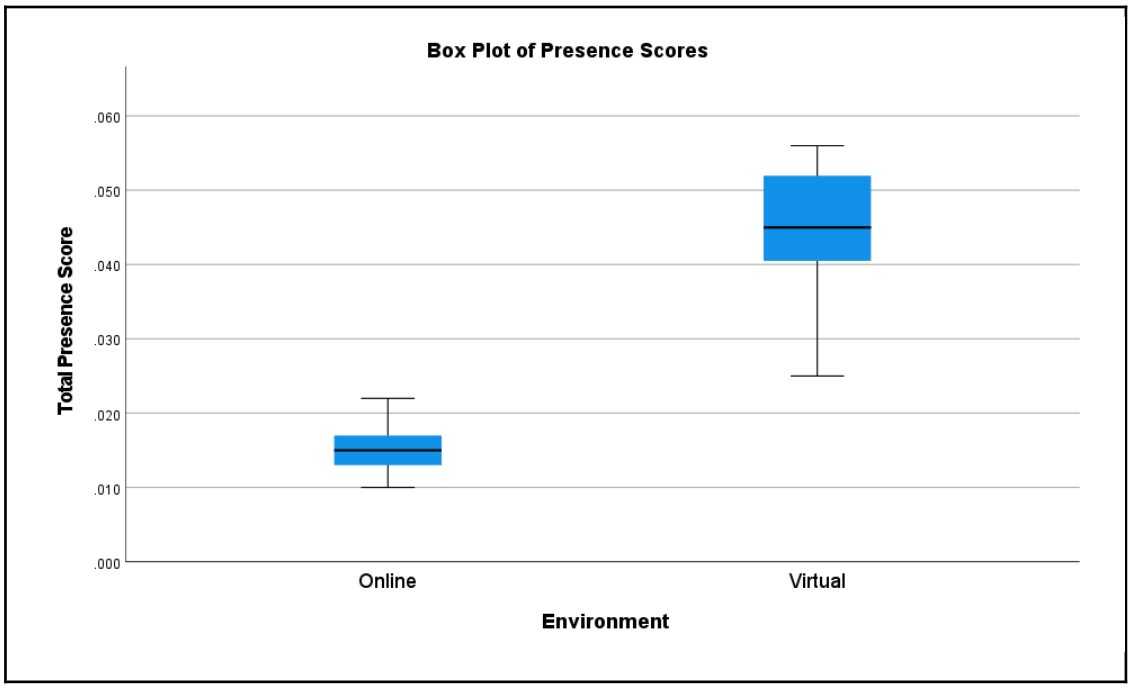


Figure 2 - Box Plot of Engagement in Online and Virtual Environments

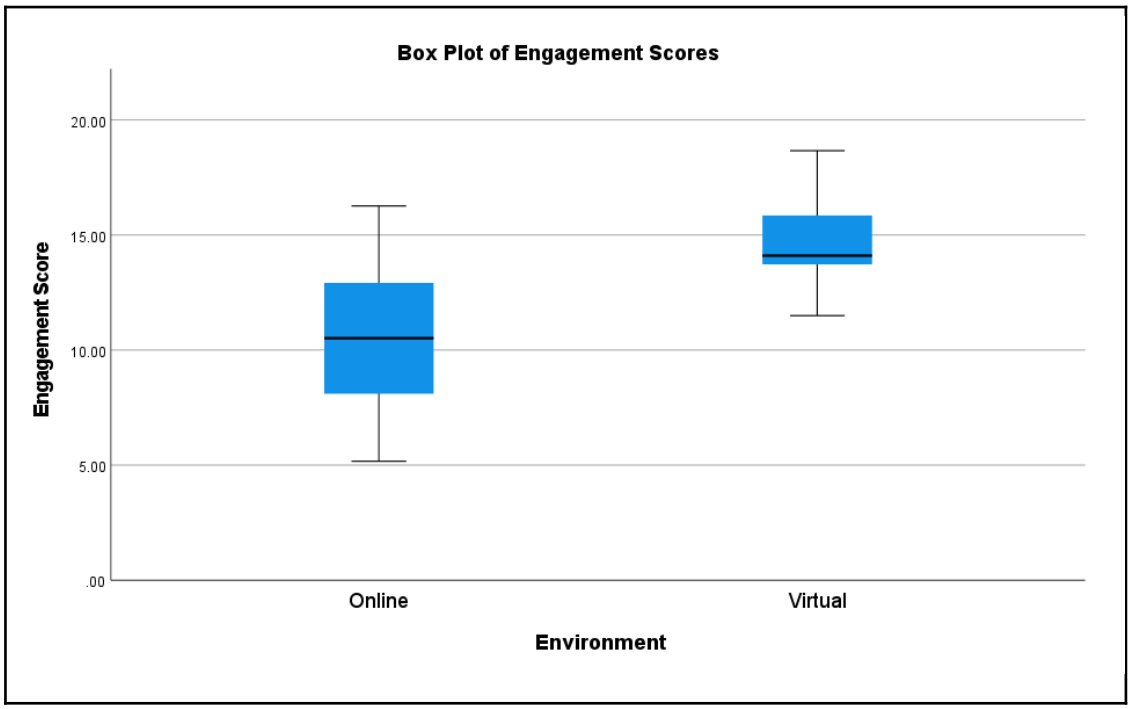


Figure 3 - Linearity of Overall Presence & Engagement