Can immersive technology over traditional photography greater influence the number of hazards identified in a healthcare sector residential facility, and as a result influence the perception of risk.

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Declaration

I, Peter Devlin declare that this thesis is entirely my own work and was not previously submitted to this or any other third level institute

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Signed: 

Date: 30/03/2020

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Abstract

The aim of this study was to explore whether Virtual Reality (VR) can support hazard identification training in a healthcare residential facility and whether VR evokes a sense of presence and as a result increase perceived risk. This was done by comparing the same scene in a residential facility in two different formats, a 360 photograph through a VR headset and regular photographs. A comparative experiment was conducted with thirty Social Care Workers and Nurses the results of which show that VR can create a sense of realism in an alternate environment and can significantly support healthcare workers in identifying hazards, however, it does not increase the perception of risk. This experiment instigates literature in an area, where healthcare workers support people to take risks and live more fulfilling and independent lives.

Introduction

According to Barnabei (2008), the biggest non-event of the millennium, where the world perceived a risk that didn't happen which cost billions of dollars was Y2K. In this case the perception of risk changed how people thought and acted. Flying is another example where perceived risk can change behaviours and while air travel is one of the safest modes of transport it is perceived as the least safe (Barnabei, 2008). Perceived risk shapes attitudes and influences decisions and nowhere is it more critical to get the balance of risk right than in working environments where adults can spend one third of their lives (World Health Organisation,1995). The responsibility of safety in workplaces lies on the shoulders of the Health and Safety Authority (HSA) who have overall responsibility for the administration and enforcement of health and safety at work in Ireland (HSA, 2019).

The impact of HSA inspections and safety promotion is changing attitudes to risk taking in the construction sector, Meekel & Hrymak (2012) highlight how 66% of site workers noticed a reduction in high risk activity in a five-year period and 83% of workers expected to have HSA inspections. This workplace promotion has not transferred equally to the healthcare sector, specifically in the Social Care environment where the inspection process is driven by the Health Information and Quality Authority (HIQA) whose role is to instil high-quality and safe care for people using health and Social Care services in Ireland (HIQA, 2019). With HIQA focusing on the people who use the service, there appears to be a reduced focus on HSA inspections in the healthcare sector, indeed, this disparity is evident in the health and safety literature in Social Care environments.

As part of training promotion and to influence the reduction of workplace accidents in the Social Care sector this research considers the early identification of workplace hazards and associated risks. It highlights how the different industry sectors are governed by different legislation and considers the uniqueness of voluntary healthcare where customers are people with disabilities (Service Users) who live in residential homes and employees are healthcare workers who work in the same homes.

The research recognises a shortfall in sector specific literature and considers the influence that behaviour-based safety, risk perception and VR technology may have on the assessment of risk as a precursor to healthcare sector employment.

The research looks at the methods required to bring the research to a conclusion and ethical requirements needed to complete the study. It discusses the information to be obtained, the cost of running the program in a scheduled timeframe and the results of the findings. Adding to the work of Sacks, Perlman & Barak (2013), Construction Safety Training Using Immersive VR and Pereira, Gheisari & Esmaeili (2018), Using Panoramic Augmented Reality to Develop a Virtual Safety Training Environment In Construction, this research aims to start filling the gap in the healthcare and Social Care sector by comparing whether immersive technology over traditional photography can greater influence the number of hazards identified in a healthcare sector residential facility, and whether technology influences the perception of risk.

Literature Review

Rational for study

According to the 2019 census; 81,502 people in Dublin have at least one disability, with 7,037 of those having intellectual disability (Disability Federation of Ireland, 2019). Statistics show the challenges faced by people with disabilities with 41% not exceeding primary education, 24% in employment and 44% not having access to a car (Disability Federation of Ireland, 2019). Behind the disability support services is a team of Nursing and Social Care professionals who promote people with disabilities to have independence, make real choices and build natural community supports (Saint Michaels House, 2019). Ireland has approximately 8000 Social Care Workers (Lyons & Howard, 2014) who manage the complexities of daily support in the community and in residential settings. This workforce constantly asses the risks posed by hazards in the residential environment, it is for this reason that there is a requirement at training stage to support Nursing and Social Care staff with identifying workplace hazards.

Statistics

In 2017, Ireland had an estimated 884,400 days lost to work related injury (Health as Safety Authority, 2019) yet has the second lowest rate of work-related injuries of 4 plus days in the EU15. A total of 9199 non-fatal injuries were reported to the HSA in 2018 (Health as Safety Authority, 2019) with the Health and Social Work economic sector accounting for 1726 injuries (Health and Safety Authority, 2019).

Behind each statistic is a person and cost factor. Direct costs attributed to injury are productivity and replacement productivity while indirect costs are healthcare, quality of life, administration and insurance (Weerd, Tierney, Duuren-Stuurman & Bertranou, 2014). Workplace injuries have resulted in the creation of an industry in training that meets health and safety legislation. In construction, minimum requirements are for manual handling, safepass and induction, with teams of health and safety officers to regulate adherence. The same minimum level of training does not transfer to the Social Care sector. In this sector there is no safepass equivalent and much of the training focuses on service user wellbeing such as Safeguarding, Medication Management and Positive Behaviour Supports. The Gap which will be filled by this research is the focus on health and safety training at induction stage of Social Care where hazards are specific to Service Users within each residence.

Danger identification

An important step in risk management is hazard and risk assessment. A hazard is defined as a potential source of harm or can have adverse health effect on a person or persons (Health and Safety Authority, 2019) and a risk is the likelihood that a person may be harmed or suffers adverse health effects if exposed to a hazard (HSA, 2019). Identifying hazards and quantifying risk of the hazards is a subjective call based on informed findings (Health Services Executive, 2008) where judgements are made by competent persons (Safety, Health and Welfare at Work Act, 2005) on the basis of perceived risk. With competency deemed as a person with suitable training, knowledge and experience appropriate to the nature of the work (Safety, Health and Welfare at Work Act, 2005), there may be a training deficit in social care competence relative to the hazard's identification and perceived risk. This perception of risk is as an acknowledgment of a hazard's capacity to harm as an estimation of the probability of incurring harm (Cox & Tait, 1991) and employee acceptance of the assessment, is critically important in work settings because of the potential, risk perception has in influencing accident rates (Mearns & Flin, 1995).

Considering different environments

The identifying risks should be carried out in a balanced approach by looking at what are and what are not acceptable risks (HSA, 2014), and in the healthcare sector consideration should be afforded to Service Users to promote experience and independence while considering consequences. An example of risk which has to be acutely monitored in residential homes is fire. With 500 fire callouts in Ireland in 2016 stemming from cooking, heating and electrical equipment (Department of Housing, 2016) and 7 deaths in 2017 where fires started in the kitchen, it is imperative that kitchens are assessed for fire hazards (Department of Housing, 2017). It is the consideration of individualism and capacity to truly understand the risks of hazards which contextually differentiates the disability sector from other sectors. Indeed, employers in the construction sector have a legal obligation to ensure employees attend safepass training to educate employees, prevent accidents and avoid health hazards (Citizens information, 2019). This obligatory safety training promotes behaviour-based safety which assists with the decline in accident and incident rates (Sulzer-Azaroff & Austin, 2002). There is no safepass equivalent for the healthcare sector.

Current training in healthcare

Healthcare service provision has complex requirements for care and support of residents in designated centres and is carried out through care plans and multidisciplinary team support (Health Act, 2007-2013). These complexities mean there is no basepoint risk assessment training program and with the sector having the highest non-fatal injuries reported to the Health and Safety Authority (2018) there is a need to satisfy legal obligation of completing risk assessments for the workplace, and applying control measures based on those risks (Safety, Health and Welfare at Work Act, 2005). Risk Assessment training is carried out three-yearly to people in charge, with little competency assessment at the end of the sessions.

Considering change

An approach by Geller (2005) to risk management is in the modification of behaviours by using behaviour-based safety checklists, while Gershon et al. (2012) see the use of Household Safety Checklists in identifying hazards as the way forward.

These ways to rethink the current systems on safety training are met with words of caution by Jun, Ward & Clarkson (2010), where they highlight the necessity for a clear system understanding as a prerequisite to having effective risk analysis of hazards, they go further to say that systems such as Failure Mode and Effects Analysis and Hazard and Operability Studies were designed to meet the demands of specific industries, one of which was not healthcare.

VR / 360 Panoramic Augmented Reality

One system which may offer a viable alternative to current training is Virtual Reality. VR safety training creates a more effective learning experience (Sacks et al., 2013) and was promoted by Kizil and Joy (2001) as being the next big thing in safety training. However, computer graphics based virtual environments can be very expensive to create (Sirkkunen, Väätäjä, Uskali & Rezaei, 2016) and viewing images with a Head Mounted Display (HDM) can cause cybersickness, pain and discomfort (Park, et al., 2017). An alternative to the expense of VR which uses the latest video technology in conjunction with HMD's, is a 360-degree camera option. This panoramic option offers risk assessors the opportunity to experience the reality of a natural image video in the exact environment where they may work (Lo et al., 2017) prior to entering that environment.

Immersion

Immersion is defined by Witmer, Jerome & Singer (2005) as a psychological state characterised by perceiving oneself to be enveloped by, included in, and interacting with an environment that provides a continuous stream of stimuli and experience. In simplified terms immersion has been positively associated to activities such as playing board games, reading books or having conversations (Alexander, Brunyé, Sidman & Weil, 2005). Taylor (2002) describes immersion as a reader getting lost in the text of a book or during gaming where a player's attention is simply focused on other things. Taylor (2002) further describes a deeper level of situated immersion where video game players become fully engrossed in the game through character and embodiment.

Nakamura & Csikszentmihalyi (2014) describe this sense of immersion as a state of flow where the experience can be intrinsically rewarding with a loss of reflective self-consciousness. Lindberg & Østergaard (2015) discuss how immersive states blur the sense of time and erased self-consciousness, while Olmos-Raya et al. (2018) see high immersion supports as improving memory retention. Hagiwara et al. (2016) agree positively with the use of immersive technology in applying different perspectives, enabling situated learning and supporting the movement of the knowledge from a virtual environment to the outside world. This immersion is enhanced by the sense of being present elsewhere.

Presence

The sense of presence is a pivotal part of this research, where technology may make the task of hazard identification more interesting and VR make the experience more enjoyable (Tussyadiah, Wang, Jung & Dieck, 2018). Presence at its basic form is a response to a certain level of immersion (Slater, 2003) which Witmer & Singer (1998) define as the subjective experience of being in one place or environment, even when one, is physically situated in another. This contradiction in location of the body versus location of mind, causes a subjective paradox, where an increase in the sense of virtual presence leads to a decrease in the sense of physical presence (North & North, 2018) and shifts the process, from playing a computer game to being in the computer game. Presence in VR is seen positively in supporting people with mental health issues (Freeman et al., 2017) and is known to help reduce chronic pain in children (Won et al., 2017). Being in a state of flow offers an experience which unfolds from moment to moment (Nakamura & Csikszentmihalyi, 2014) and the more virtual the environment the more presence a person feels.

360 Panoramic Augmented Reality and Presence

It is not only a fully immersed VR environment that evokes presence, Won et al. (2017) explain that a 360 video viewed through a simple viewer can evoke a sense presence. It is the simplicity of using 360 technology, where a cheap HMD and 360 image can project a user's virtual presence into an alternative environment which makes this research worth investigating.

By comparing 360-degree photography and regular photography of a healthcare residential facility; this research asks the question, can 360-degree photography over traditional photography support greater hazard identification and evoke a sense of presence and as a result increase the perception of risk? With the hypotheses that, 360-degree augmented reality photography over traditional photography, will support greater hazard identification, evoke a sense of presence and as a result increase the perception of risk, in one of the most popular and most dangerous rooms in the house 'the kitchen'.

Context of hazards

The healthcare sector follows other employment sectors, where risks are identified assessed and treated see (Figure 1).

Figure 1 – The Risk Management Cycle

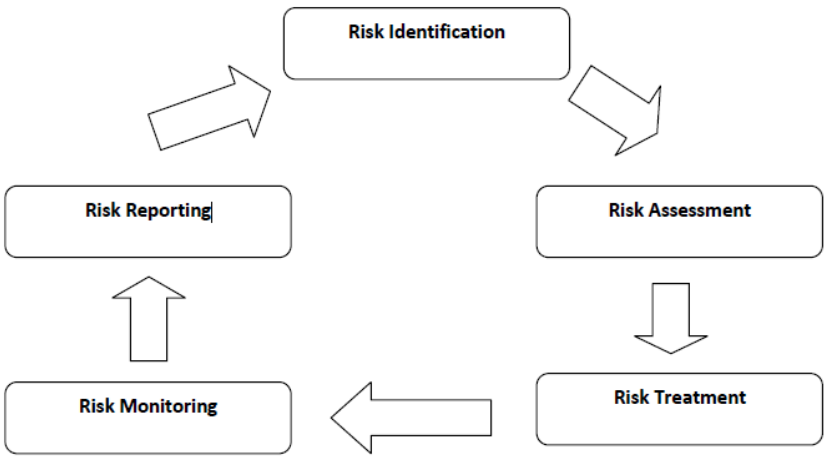


Figure 1 – The Risk Management Cycle, (Health, Information and Quality Authority, 2014)

However, in Social Care, risk management promotes social inclusion and independence for people with disabilities and highlights both negative and positive aspects of given situations (Health, Information and Quality Authority, 2014) and must consider the aspirations and the abilities of people who are completing social activities or using residential facilities (Health, Information and Quality Authority, 2014).

A person-centred approach to hazard identification should ensure that Judgments made should not be influenced by an overly paternalistic approach as it may restrict freedom and dignity (Health, Information and Quality Authority, 2014). These parameters coupled with busy environments and individualism make hazard identification a key part of safety in residential settings, especially kitchen environments.

Hypothesis

First Aim: All participants will have received Risk Assessment training, delivered by the same manager in the same year. The first part of the risk assessment process is to identify those things, situations, processes, etc. that may cause harm, particularly to people (Canadian Centre for Occupational Health and Safety, 2019), not doing so according to OSHA (2019) is one of the root causes of workplace injuries (as cited in Gan, 2019). The first aim of this study is to see whether participants will identify more hazards using VR than they will when looking at the same image with standard photographs.

Hypothesis 1: Staff using VR will identify more hazards in a healthcare kitchen than staff using traditional photography.

Second Aim: To see whether VR increases the sense of virtual presence and a decrease the sense of physical presence (North & North, 2018).

Hypothesis 2: Participants using VR will have a significant sense of presence.

Third Aim: 360 imaging can evoke a sense of presence Won et al. (2017). This sense presence should increase the perception of risk and as a result the risk rating and risk perception values should be higher than the ratings and values by the participants using standard photography.

Hypothesis 3: Participants using VR will perceive risk as being greater than participants using traditional photography.

Method

Overview

Before considering the design, the cautionary advice of Robson and McCartan (2016) resounds, where real-world research is often an 'away fixture' taking place on someone else's territory and false moves can impact the current research and future studies.

Design

To test the effect of VR and traditional photography (IV) in identifying hazards (DV), this study employed two separates independent- samples t-tests. These t-tests compared the mean scores of two different groups of people (Pallant, 2013), one group used VR to identify hazards and one used photography. The fixed design enabled the researcher to remain detached from the experiment and to guard against researcher influence (Robson, 2002). A within-subjects questionnaire design was employed to evaluate sense of presence for participants using VR. Two design methods were used to test for risk perception

- DOSPERT questionnaire was used to established risk perception scale (Appendix L)
- HSE decision matrix was used to gather the perceived risk through quantitative risk ratings (Appendix N).

Participants

The research was conducted in a healthcare environment. Details of the study are in the information sheet (Appendix F). All participants had HSE risk assessment training in the previous year. An advertisement was placed on the Saint Michaels House (SMH) intranet to attract 34 voluntary participants (Appendix D). Participants were provided with an information sheet for the study (Appendices E, F). The final sample consisted of 34 volunteers (N=34, 20% of which were male in line with the SMH working populous)

- 4 for the pilot study,
- 15 Social Care Workers / Nurses for VR hazard identification, presence questionnaire, risk rating and risk perception (Appendices K, L, M, N).
- 15 Social Care Workers / Nurses for hazard identification, risk rating and risk perception (Appendices K, L, N)

As per Physical Readiness questionnaire (Appendix J) exclusion criteria was applied to participants who had epilepsy or who suffer from motion sickness.

The format for participation was pilot study, VR hazard Identification, then hazard identification through photographs.

Materials

Materials required for creating the VR image

The materials used to create the 360 images were SMH kitchen facility, (*Figure 4*) Insta Pro 360 camera (*Figure 2*), fifty household hazard, stitching software, Intempo HMD, antiseptic wipes, VR Media Player App (*Figure 2*), and Samsung A5 Smartphone. There were 25x 360 images taken from the centre of the room with differing quantities of hazards. The pilot study determined the optimum camera angle and hazard quantities for the allocated timeframe.

Figure 2 (Materials used for 360 VR image creation and application)

Pilot Study

Prior to experiment a pilot study was conducted with participants (n=4), with the aim of testing the feasibility of the study to get things right before embarking on data collection (Robson & McCartan, 2016). The participants were afforded the same introduction, GDPR, ethics, consent and summary (Appendices D, E, F, G, H,) as the full experiment. The VR interaction in the pilot study worked well. The initial 360 image from the centre of the room left the hazard images too difficult to see.

A second set of 360 photographs were taken closer to the kitchen. An optimum of 50 hazards were staged to satisfy a 3-minute experiment.

Participants walked towards objects in the pilot study, the decision was made to keep participants sitting on a swivel chair.

Question 15 of the Domain-Specific Risk Perception Scale (DOSPERT) was changed from 'Engaging in unprotected sex' to 'Engaging in drug use' it was felt that the question was inappropriate for the environment. The DOSPERT questions were very Americanised, 'White water rafting' – '$200' and 'camping in the wilderness'. To reduce the ambiguity in, or misunderstanding of the survey question (Robson, 2002) an explanation of the scale was given to participants prior to scoring.

Procedure for VR experimented

Once ethical approval was received from the Department of Technology and Psychology Ethics Committee (DTPEC) and the SMH Ethics Committee an augmented 360 kitchen image was taken where hazards were placed simulating dangers in the kitchen (*Figure 3*). Using stitching software, separate images were stitched together to form a panoramic 360 image, it was then uploaded onto a Samsung Galaxy A5 phone. Using a 360 viewer App and HMD the image could be viewed in real time (*Figure 4*). The VR study was conducted during working hours in a time and place of the participant convenience. The Clinical Nurse Specialist in epilepsy was contacted and her schedule aligned to the VR experiment. Contact was made through the organisation's secure email with the correspondence saved on an SMH encrypted drive.

VR – Procedure The procedure for the participating in the VR experiment was explained to the participants (Appendix F). Covering topics such as task summary, GDPR, ethics, right to withdraw and consent (Appendices D, E, F, G, H, I). The VR participation was conducted first and participants who failed the physical readiness questionnaire (Appendix J) participated in the non-VR experiment, they were then debriefed (Appendix O).

VR– Application Participants sat on a swivel chair, with HMD and 360 VR image of the kitchen (*Figure 4*). When participants adjusted to the virtual environment, they were asked, in a 3-minute timeframe to call out hazards. The researcher wrote the hazards on a spreadsheet (Appendix K) and answered no other questions.

Headsets were wiped after use. (*Figure 2*). When the participants completed the VR application, they complete the Blais & Weber (2006) DOSPERT Risk Perception Questionnaire (Appendix L) and the Witmer & Singer (1998) Presence questionnaire (Appendix M). The final task was to use the HSE decision matrix (Appendix N) to rate the risks of the identified hazards

Procedure for the non-VR experiment

Non-VR Procedure Participants volunteered to complete the experiment; initial contact was made through the intranet then convenience sampling was applied. Contact was made through the SMH secure email with the correspondence saved on SMH encrypted drive. For consistency, screen-shots were taken of the 360 images of the kitchen (*Figure 7*). Six photographs were printed on A4 sheets which covered the full panorama of the kitchen. The non-VR study was conducted in accordance with the ethics application which covered task summary, GDPR, ethics, right to withdraw and consent (Appendices D, E, F, G, H). The procedure was explained to the participants and the experiment was undertaken. Participants were debriefed upon completion (Appendix O).

Non-VR Application - Participants viewed six screen-shot kitchen and called out the hazards in a 3 min timeframe. The researcher wrote the identified hazards on a spreadsheet (Appendix K), the researcher answered no questions. Once the participants identified hazards, they completed Blais & Weber (2006) DOSPERT Risk Perception Questionnaire (Appendix L) and used the HSE decision matrix (Appendix N) to rate the hazard risks

Figure 3 Kitchen used in the experiment with six unstitched images.

Figure 4 Split image used with HMD. As participants rotate, they received full view of the room.

Figure 5 Using HMD to identify hazards

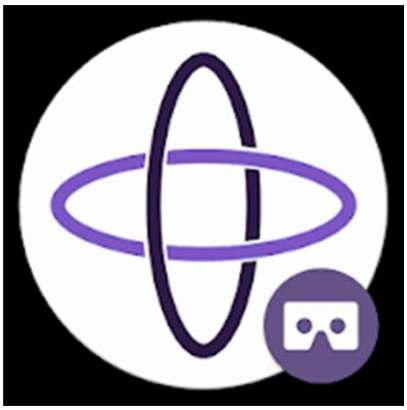


Figure 6 VR Media Player App

Figure 7 Screenshot of VR image. Images numbered from 1-6 covering full kitchen & dining room

Ethics

The assignment was approved by the Saint Michaels House Ethics Committee and the (DTPEC). Robson (2002) sees ethics committees as having a key part to play in removing deception from experiments. Participation was voluntary with no rewards offered. Participants were informed that they could opt out at any stage with their information destroyed and no repercussions. Information was confidential with communication and data stored on an encrypted, password protected and secure platform. Participants were informed that information would be destroyed in one year or 5 years if the thesis was published.

Prior to commencing the research, participants received the full suite of information about the research. They were given a brief of the process, consent forms, physical readiness questionnaire and on completion a debrief (Appendices S D, E, F, G, H. O). Participants were given researcher and supervisor contact details and Employee Assistance Program number.

Workplace seniority was not directly applicable to the researcher's department. There was no deception in this study. Information sheets (Appendix E, F) were supplied to participants outlining experiment details, data collection procedures and potential physical and psychological risks.

Quantitative results and descriptive statistics

Hypothesis 1

Group using photographs to identify hazards (*n* =15), identified *M* = 13.6 (*SD* = 2.38) see Table 1. By comparison, group using VR to identify hazards (*n* = 15) identified a numerically larger amount of hazards *M* = 17.2 (*SD* = 3.55) see Table 1. To test the hypothesis that staff using VR will identify more hazards than staff using traditional photography an independent samples t-test was performed using SPSS (Version 25: IBMCorp., 2017). The assumptions of homogeneity of variances was tested and satisfied Levene's *F* test, *F* (24.48) = 2.45, p=.129. The independent samples *t*-test was associated with statistically significant effect, *t* (24.48) = -3.26, p = .003 (two-tailed) with a 95% confidence level ranging from -5.88 to -1.32. Thus, hypothesis 1 was supported with the hazards identified by the group using VR being statistically significant.

Table 1

Mean scores for photo and VR identification

Hazard ID	n	M	SD
Photo Hazard ID	15	13.60	2.384
VR Hazard ID	15	17.20	3.550

Hypothesis 2

Using a presence questionnaire, the group using VR (*n* =15) while identifying hazards through a HMD were tested for a sense of presence. Augmented VR according to Milgram and Kishino's (1994) sits midpoint between the real environment and the virtual environment which removes some of the presence questions. Realism was tested using questions 3 + 4 + 5 + 6 + 7 + 10 + 13, with *M* = 88.29 (*SD* = 21.6) see Table 2.

Table 2

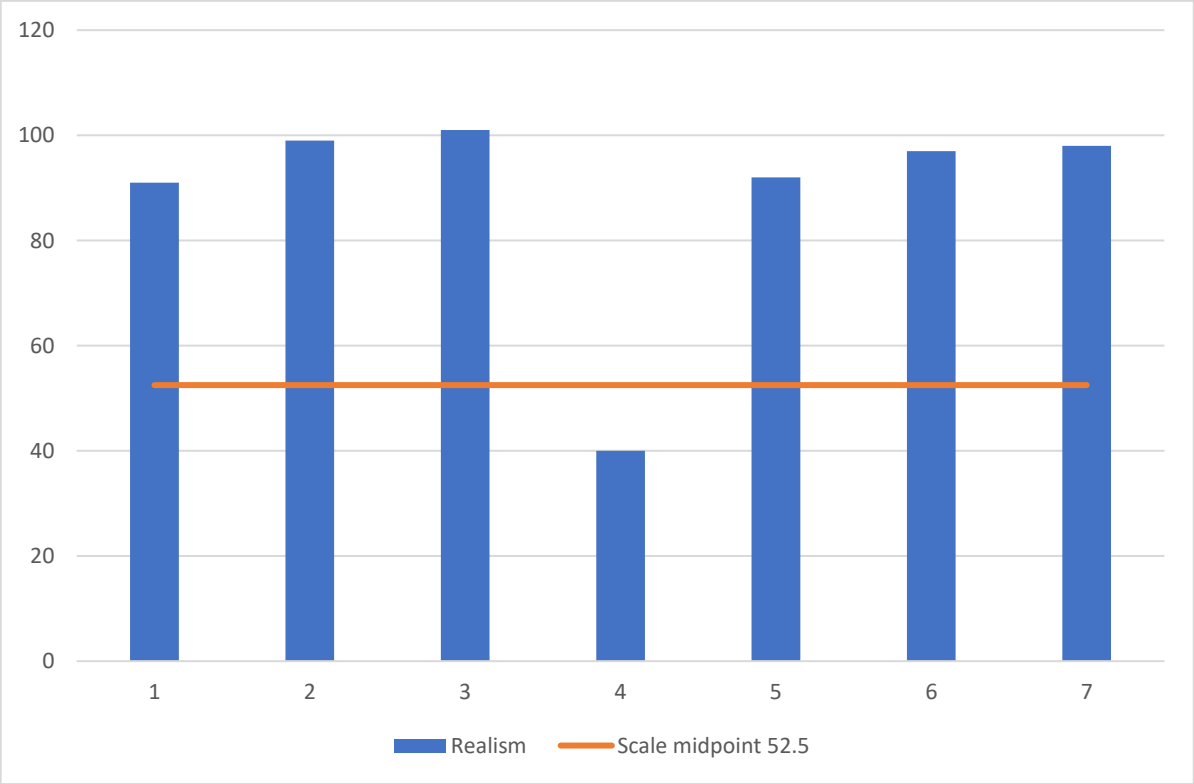
Mean score and standard deviation for presence in VR - realism is a construct of presence

Hazard ID	n	M	SD
VR Hazard ID	15	88.29	21.6

Using the midpoint of the sense of realism scores and based on the 7 questions pertaining to realism the results *Figure 8* appears to show that participants felt the VR environment to have a considerably real experience. Thus, the sense of presence in an alternative location while using VR technology was significant. Therefore, hypothesis 2 is supported, however, Q4 'How much did the visual aspects of the environment involve you', was possibly scored low due to the level of involvement of the participants in the virtual environment.

Figure 8

Sense of realism while using VR



Hypothesis 3

The group using photographs to identify hazards and completed the HSE risk rating (n =15) rated risk as M = 8.12 (SD = 2.45) see Table 3. By comparison, the group using VR to identify hazards and complete the HSE risk rating (n = 15), perceived risk as a numerically larger amount M = 9.14 (SD = 1.33) see Table 3. To test the hypothesis that staff using VR will perceive risk using the HSE risk rating method as greater than staff using traditional photography and rate the risks higher, an independent samples t-test was performed using SPSS (Version 25: IBMCorp., 2017).

The assumptions of homogeneity of variances was tested and satisfied Levene's *F* test, *F* (28) = 6.51, p=.016. The independent samples *t*-test was associated with a statistically non-significant effect, *t* (28) = 1.316, p = .199 (two-tailed) with a 95% confidence level ranging from -2.42 to .528. Thus, the risk perceived by the group using VR was not statically significant. Therefore hypothesis 3 is not supported using the HSE risk rating method.

Table 3

Mean scores and standard deviation for risk perception using the Health Services Executive risk rating method.

Hazard ID	n	M	SD
Photo Hazard ID	15	8.12	2.45
VR Hazard ID	15	9.14	1.33

The group who used photographs to identify hazards and completed the DOSPERT risk perception scale (*n* =15) perceived risk as *M* = 5.91 (*SD* = .65) see Table 4. By comparison, the group using VR to identify hazards and complete the DOSPERT risk perception scale (*n* = 15) perceived risk as a numerically smaller amount *M* = 5.81 (*SD* = .89) see Table 4. To test the hypothesis that staff using VR will perceive risk as greater than staff using traditional photography an independent samples t-test was performed Using SPSS (Version 25: IBMCorp., 2017). The assumptions of homogeneity of variances was tested and satisfied Levene's *F* test, *F* (28) = .92, p=.345. The independent samples *t*-test was associated with a statistically non-significant effect, *t* (28) = .327, p = .746 (two-tailed) with a 95% confidence level ranging from -.490 to .677. Thus, the risk perceived by the group using VR was not statically significant. Therefore hypothesis 3 as not supported using the DOSPERT risk perception scale.

Table 4

Mean scores and Standard deviation for risk perception using the DOSPERT Risk taking (risk perception) scale.

Hazard ID	n	M	SD
Photo Hazard ID	15	5.91	.654
VR Hazard ID	15	5.81	.890

Discussion

Original aims and findings

This research has shown the possibility of creating a VR environment to mirror real-life workplaces with bespoke hazards that consider Service Users. Hypothesis 1 stated that staff using VR will identify more hazards than staff using traditional photography. This hypothesis was significantly supported, the use of VR appeared to enhance participant identification of hazards.

Identifying hazards with photographs was influenced by eyesight of the participants, different environments, room lighting and image resolution. Using VR environmental parameters remained consistent. Insta360 Pro offered 7680 x 7680 8K resolution (Insta360, 2020) while the monitor screenshots were 1280 x 1024 (Amazon, 2020). This difference may have influenced the results, however, the increased hazards identified in VR were consistent with the research findings by Sacks et al. (2013) where VR over slide presentations and discussions had a significant advantage in facilitating hazard identification. Hazard identification according to Pereira et al. (2018) is essential for workplace accident prevention and obligates the employer to recognise the risks of the hazards and apply control measures to reduce employee exposure to those risks (HSA, 2010).

Hypothesis 2 predicted that participants using VR would feel a sense of presence. This hypothesis was tested using the Witmer & Singer (1998) presence questionnaire. The scoring of realism was posed through six questions which appeared to indicate that the virtual experience was significantly authentic.

This lifelike experience aligns with the work of Sacks et al. (2013) who expressed how ‘subjects rated VR scenarios highly in terms of the realism’. The real experiences are supported through the statistics where VR users saw more hazards that were not realised by participants viewing photographs. For example, VR users indicated that clutter in the room was hazardous, this sense of clutter may have been enhanced by the sense of presence which was not experienced by participants using the photos. Likewise, an open sports bag was seen as hazardous by the VR group and not by the photos group.

Similarly, to the research by Sacks et al. (2013) the VR experience was limited in its degree of sophistication and enhancement. However, participants pointed towards objects and moved in the VR environment without realising their physical location. This sense of presence aligns with the definition of presence as the subjective experience of being in one place or environment, even when one, is physically situated in another Witmer & Singer (1998). In terms of training in the healthcare sector these real experiences in VR are seen a catalyst for change (Higgins, 2017).

Hypothesis 3 stated that participants using VR will perceive risk as being greater than participants using traditional photography and as a result will rate the risks higher. Participants using the VR did perceive the risk as greater when scoring using the HSE risk rating method, but this was not significant. There was minimal difference in risk perception with participants using the DOSPERT risk perception questionnaire.
Disproving hypothesis 3 could signify consistency in the quality of risk assessment training, the result implies sameness in the approach to evaluating the risks of the hazards. This consistency strengthens the SMH risk management plan which HIQA (2014) explain needs to be clear if it is to protect Service Users and HSA (2020) see as helping to reduce the risk of injury and illness associated with work. With 451 hazards identified in total and risk perception being constant it may show that the application of the HSE risk assessment tool is applied uniformly to all process where risk assessments are required (HSE, 2008).

The DOSPERT risk perception Health and Safety questions also showed consistency with participant answers. The Irish Law may have contributed to bias in the answers on perceived risk. Questions such as 'driving a car without wearing a seatbelt' or 'riding a motorcycle without a helmet', are in breach of the Road Traffic (Construction, Equipment and Use of Vehicles) (Amendment) Regulations, 1971, and the Road Traffic (Construction, Equipment and Use of Vehicles) (Amendment) (No. 2) Regulations, 1978, and as a result, participant may have seen the risk as greater.

Theoretical implications

Slovic and Peters (2006), explain that the perception of risk is not as straightforward as logical analysis, they see risk analysis as bringing logic, reason, and scientific deliberation to the risk assessment process.

This application of the assessment of risk is endorsed by the logical sequential approach to risk assessments by the HSA (2020) where hazards are identified, assessed and control measures applied. However, Solvic and Peters (2006) consider the more instinctive reactions to danger as the 'the affect heuristic', where perceived risk is a feeling. Risk as a feeling of natural judgement may have a significant role to play when risk assessing environments in the disability sector, and where hazard identification must consider the audience and the actions of the specific Service Users. It is between the logic of the HSA risk assessments process and the Service User driven HIQA risk assessments process that the HSE risk assessment tool lies.

Hazards – cause and effect

The obligation on employers to consider risk is established under The Safety, Health and Welfare at Work Act 2005 where the first two Principles of Prevention are the avoidance of risk and the evaluation of unavoidable risk. Section 19 of the Safety, Health and Welfare at Work Act 2005 requires employers to identify the hazards and assess the risk of the hazards (Government of Ireland, 2005). The importance of hazard identification cannot be underestimated, one of the root causes in workplace injuries, illnesses and incidents is the failure by employers to identify and manage workplace hazards (Occupation Safety and Health Administration, 2020). These hazards and associated risks can be avoided, however, with the Health and Social Work sector having the greatest rate of illness in 2016 per economic sector it would appear that the sector remains volatile (Health and Safety Authority, 2018). With the HSA, the HSE and HIQA considering the method of assessing hazards using the decision matrix (Marhavilas & Koulouriotis, 2008) as the key driver for mitigating accidents, it would seem plausible that focusing on hazard identification could support safer environments.

Augmentation and the sense of reality

The immersive augmented reality aspect of the of the research supports the theories of Witmer et al. (2005) and Nakamura & Csikszentmihalyi (2014), where presence and emersion has a key part to play in offering an engaging experience. According to Pereira et al. (2018) augmented virtual reality offers a high-engaging method of training where 360 imagery can offer immersive visualisation of real-life environments and where hazardous conditions can be introduced outside the workplace setting.

This high-engagement according to Zuluaga Namian & Albert (2016) offers an opportunity to increase hazard identification and the perception of risk, which they directly correlate to improved safety performance. It is the high engagement of virtual training that stimulates the sense of reality where the feelings of being in another situation may induce a more instinctive approach to hazard identification and risk perception and in line with studies by Westerfield, Mitrovic & Billinghurst (2015) and Ma, Jain & Anderson (2014) the immersive effect offers a fun way to learn. The introduction of virtual training as a means of improving safety, changes the approach to risk assessment training, by introducing a fun way to learn through highly engaging immersive technology where there is an increase in hazard identification.

Practical Implications

Milgram and Kishino's (1994) Virtual Continuum explain where Augmented Virtuality sits on the scale between the real world and the virtual world (*Figure 9*) which according to McCall, Wetzel, Löschner & Braun (2011), provides a clear starting point for understanding where presence sits on the continuum.

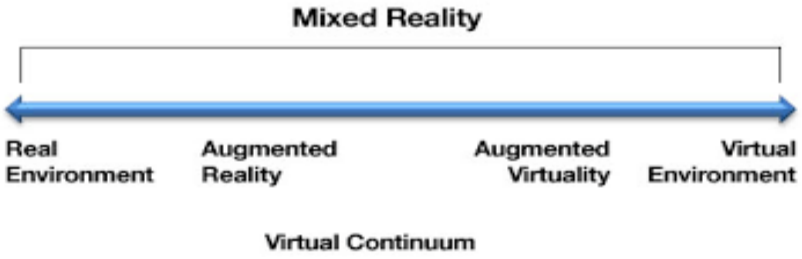


Figure 9 Virtual Continuum (Milgram and Kishino, 1994)

Keeping this in mind the present study gave insight into the practicalities of using an affordable virtual environment for safety training. As a stimulus, the VR application over a three-minute period had a resounding effect on participant sense of presence, where participants felt they were in an alternate environment. By understanding where augmented virtuality sits on the Virtual Continuum scale (*Figure 9*) and the effect that it had on participant engagement, it would infer that, by humans moving further into the virtual environment the more immersive the world and sense of presence may be. However, Cummings, Bailenson & Fidler (2012), pose the question 'How immersive is enough'.

They ask, how much benefit do greater immersive environments add to sense of being physically present and do the actual benefits of the VR experience warrant the additional cost. The present research predicted that a greater sense of presence would evoke a greater sense of perceived risk and as a result influence behavioural and attitudinal change. This was unsubstantiated.

The present research considered the implications of the physical-readiness questionnaire and cybersickness, and whether cybersickness is a consequence of using the technology. In line with the views of Park et al. (2017) the application of VR had implications on the study. 10% of participants refused to participate in the VR experience due to not meeting the physical readiness questionnaire criteria and of the participants who used the HDM for a three-minute period, 7.5% had a feeling of dizziness after use. This feeling of dizziness may be a thing of the past, with Li, Yi, Chi, Wang & Chan, (2018) suggesting that a pixel persistence lower than 3 milliseconds may be an option to prevent users feeling sick when moving their head around

With the aim of keeping staff safer in their workplace this research considered the role that hazard identification and prevention plays in achieving a safer working environment. It specifically directs towards the Social Care environment where managing needs can present unique and complex situations with potentially serious consequences if not managed correctly (Health Services Executive, 2020). When looking at occupational safety and health, Straub (2018) argues that the identification of hazards before they occur and applying preventive actions before a hazard manifests as an incident is a leading proactive safety performance indicator. This is supported by the HSA (2020) who see the identification of hazards as the first step to safety and health. Utilising the significance of this research for hazard identification at high-engagement level where Tussyadiah et al. (2018) consider the virtual aspect of hazard identification in the VR terms as giving participants a greater and more enjoyable experience. By coupling sensible risk assessments, balancing risk and proportionate risk management (Health Services Executive, 2020) with an application which is enjoyable and statistically effective in hazard identification then preparation for trainee students in Social Care could be significant.

Limitations

This study is not without limitations and the results should be interpreted cautiously. The VR simulation was visually clear, however, the central location of the tripod resulted in hazards further away being difficult to identify. This same issue was more prevalent in the photograph images where the screen-shot DPI lessened the quality of the vision of the hazards. A total of 52 hazards were identified 14 were not identified by the participants using the photographs and two were not identified by participants using the VR, a total of 36 were identified by both groups. Examples of hazards not identified by participants viewing through photographs were a 'sign over the cooker', 'paper shredder', 'large bowl' and a 'gear bag'. Where necessary the participants were entitled to ask for clarification of images to support hazard identification. No other clarification was offered

- Within two weeks, the application for voluntary participation in the VR research had disappeared from the SMH intranet front page. Convenience sampling was then applied where, from a pool of 200 potential participants 34 people agreed to participate. The 200 participants were not a representation of the Social Care population in SMH instead they were Social Care leaders or Nurses in charge of residence, and according to Simundic (2013) this could be seen as selection bias.
- The application of a novel way of learning may initially bear positive results which in turn may reduce over time. Edwards & Gangadharbatla (2001) explain that newly encountered stimuli generate a "short-lived novelty effect", Grubert, Langlotz & Grasset (2011) further suggest that the novelty effect was likely to have influenced scores in their study which questions long term use of their VR browsing application. This novel effect may have influenced the study and a further longitudinal study may be required to establish the true effect of VR in hazard identification.
- Evoked cybersickness and epilepsy limits all students from participating in VR training.
- A consideration must be given to the recognition of hazards based on Social Care Worker experience. Many Social Care Workers remain in the residence for years, the mix of residence during those years may influence the perception of hazards.

Strengths.

The present study highlighted some noteworthy strengths.

- There is a gap in knowledge in the Social Care environment particularly with hazard identification. The recognition that Social Care students may understand hazards pertaining to their working environment particularly the Service Users could be a pivotal training application.
- By considering two scales of perceived risk the researcher was able to validate that the decision matrix technique (Marhavilas & Koulouriotis, 2008) adopted by the HSE and the Domain-Specific Risk-Taking – Risk Perception scale (Blais & Weber, 2006) had consistent results.
- There is a consistency in the way Social Care Workers perceive and record risk relating to hazards. The use of the decision matrix technique (Marhavilas & Koulouriotis, 2008) in rating hazards, highlighted that a risk has a systematic approach to being evaluated and that training is consistent.
- Apart from an increase in hazard identification VR simulation, through presence and immersion appeared engaging, and supports the feeling of being in an environment. The feeling of presence appeared to provide a clear distinction between the different types of hazard identification.

Future research

According to Blais & Weber (2006), risk-perception responses evaluate the respondents' gut level assessment of how risky each activity/behavior is. This gut level assessment is a pivotal part of working with people with disabilities. There was an insignificant conclusion as to whether identifying hazards through VR increased the perception of risk. A larger sample size should be used to replicate this study to see whether VR increases the perception of risk.

VR war games are popular because no physical energy is expelled and people can become soldiers without training. The sense of realism in the healthcare facility would increase the perception of risk by introducing the sense of touch where motor resistance applies weight to virtual environments, this could be done through the introduction of Haptography.

Haptic feedback allows greater engagement and is a mode of communication which allows machines and humans to communicate to each other.

As the creation of 3D modelling gets cheaper there is an opportunity to introduce sound, and touch which enhance the sense of immersion and as a result enhance the experience.

Conclusion

The aim of the research was to build on the work of Sacks et al. (2013) and see if VR could be used as a viable platform for training Social Care Workers in a healthcare facility. The research used the identification of hazards which facilitates the assessment of risk (HSA, 2020) and perceived risk, as barometers for evaluating workplace danger. The research used the construct of presence and immersion to evaluated how real the VR experience was.

To achieve this, an experiment was conducted in a healthcare facility with 30 Social Care Workers. Using the same scene in two different formats one group identified hazards in a 360-photograph, viewed through a VR headset and the other group used regular photographs. The experiment employed a DOSPERT questionnaire and HSE risk rating mechanism to establish the perception of risk, and a presence questionnaire to determine the experience of realism.

The results show that significantly more hazards were identified by the group using a 360-photograph viewed through a VR headset and that the sense of presence did alter the viewing pattern. There was no noticeable difference in the perception of risk between the two groups and in line with the Witmer & Singer's (1998) definition of presence, the VR technology did induce an experience of being in one environment while physically situated in another.

Previous studies support the importance of safety training in reducing cost through preventing accidents (Palka, 2017: Ravikumar & Varadharaj, 2018: von Thiele Schwarz, Hasson, & Tafvelin, 2016). The prevention of accidents is the ultimate goal of any safety and health management system (HSA, 2006). Notwithstanding limitations the creation of the 360-image at the click of a button was deceptively uncomplicated and the output enhanced an experience of realism.

By embracing the technology the results of this experiment highlight the usability and capability of an inexpensive system in offering an alternative for risk and accident reduction where employees often have to make a gut level assessment of how risky each activity/behavior is (Blais & Weber, 2006). VR promotes competency and aligns with the training expectations of Safety, Health and Welfare at Work.

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Appendices

Appendix A Research approval SMH

9th October 2019

Mr. Peter Devlin,
11, Blackthorn Grove,
Sandyford,
Dublin 16.

Research Title:

Hazard Identification: Can Virtual Reality enhance the ability to identify hazards and influence the perception of risk in the healthcare sector.

Dear Peter,

Thank you for submitting your Research Proposal to the Research Ethics Committee in St. Michael's House.

The Committee has considered and approved your application, and you now have the permission of the Committee to proceed with your research.

I would like to take this opportunity to wish you well with your research.

Yours sincerely,

Eilín de Paor,
On Behalf of the
Research Ethics Committee

Appendix B Research approval IADT

From: "Sinead Meade" <Sinead.Meade@iadt.ie>

To: "peterdevlin71@yahoo.com" <peterdevlin71@yahoo.com>, "peterdevlin71@gmail.com" <peterdevlin71@gmail.com>**Cc:** "Robert Griffin" <Robert.Griffin@iadt.ie>**Sent:** Wed, 5 Jun z19 at 12:31

Subject: DTPEC Ethics Application

Dear Peter,

Your application to the DTPEC for your MSc Cyberpsychology thesis has been approved pending the following changes which must be approved by your Supervisor before the research commences.

* Adhere to the templates for ethics documentation supplied by the DTPEC.

* On the physical health screening form, insert a note which clarifies the purpose of this form in the context of the study (i.e.) participant exclusion criteria for studies using VR.

We wish you the very best with your research.

Sinéad

Appendix C Ethics B application

DEPARTMENT OF TECHNOLOGY AND PSYCHOLOGY ETHICAL APPROVAL FORM B*

Three printed copies of this form should be submitted to the chair of the ethics committee

Title of project Research Proposal Name of researcher: Peter Devlin

Email contact N00182524@student.iadt.ie Name of supervisor: Robert Griffin

			Yes	No	N/A
1	Will you describe the main research procedures to participants in advance, so that they are informed about what to expect?		X		
2	Will you tell participants that their participation is voluntary?		X		
3	Will you obtain written consent for participation (through a signed or 'ticked' consent form)?		X		
4	If the research is observational, will you ask participants for their consent to being observed?				X
5	Will you tell participants that they may withdraw from the research at any time and for any reason?		X		
6	With questionnaires, will you give participants the option of omitting questions they do not want to answer?		X		
7	Will you tell participants that their data will be treated with full confidentiality and that, if published, it will not be identifiable as theirs?		X		
8	Will you debrief participants at the end of their participation (i.e., give them a brief explanation of the study)?		X		
9	If your study involves people between 16 and 18 years, will you ensure that passive consent is obtained from parents/guardians, with active consent obtained from both the child and their school/organisation?				X
10	If your study involves people under 16 years, will you ensure that active consent is obtained from parents/guardians and that a parent/guardian or their nominee (such as a teacher) will be present throughout the data collection period?				X
11	Will your project involve deliberately misleading participants in any way?			X	
12	Is there any realistic risk of any participants experiencing either physical or psychological distress or discomfort?		X		
13	Does your project involve work with animals?			X	
14	Do you plan to give individual feedback to participants regarding their scores on any task or scale?			X	
15	Does your study examine any sensitive topics (such as, but not limited to, religion, sexuality, alcohol, crime, drugs, mental health, physical health)			X	
16	Is your study designed to change the mental state of participants in any negative way (such as inducing aggression, frustration, etc.)			X	
17	Does your study involve an external agency (e.g. for recruitment)?			X	
18	Do participants fall into any of the following special groups?	People with learning or communication difficulties		X	
		Patients (either inpatient or outpatient)		X	
		People in custody		X	

If you have ticked **No** to any of questions 1 to 10, or **Yes** to any of questions 11 to 18 you should refer to the PSI Code of Professional Ethics and BPS Guidelines. There is an obligation on the lead researcher to bring to the attention of the Department of Technology and Psychology Ethics Committee (DTPEC) any issues with ethical implications not clearly covered by the above checklist.

* This Ethics B form should be completed by researchers whose studies involve any ethically questionable practices.

1. Ethical Considerations

SMH and IADT have given Ethical approval for this research project

This project will support training of hazard identification in the healthcare sector, and will enhance future training and prevent accidents. Informed consent will be received from all participants (Appendix G, H, I). The consent forms will inform the participants of their voluntary right to withdraw at any time with their results destroyed. The consent form considers that the information sheet (Appendix E, F) has been read and approved and it will give opportunity for questions to be asked, if the participants are unsure of any part of the experiment. Participant names will be coded and data will remain anonymous. Emails will be accounted for and deleted. The identity of SMH staff and Service Users will remain anonymous. There will be an invitation (Appendix D) and physical readiness questionnaire (Appendix J) at the start of the study and a debriefing (Appendix O) at the end of the study and time will be afforded to VR users to ensure they have no Cybersickness or seizures. A counselling option will be provided and a Nurse Manager on Call will be available. The Clinical Nurse Specialist in epilepsy will be on call. Participants will be thanked for their cooperation.

2. Ethical Considerations main concerns

VR can cause cybersickness and induce epileptic fits, there will be a Nurse Manager on call who will be organized by the researcher. This Nurse Manager will be the go-to person if there is a reaction to the VR, CNS in epilepsy will be available if required. Participants will complete the physical readiness questionnaire (Appendix J) prior to volunteering; this will give them an option not to participate. Antiseptic wipes will be used to clean the VR headset after each use. All participants will be asked to give informed consent (Appendix G, H, I). and will have a voluntary right to withdraw. No names or associations will be made during the experiment and General Data Protection Regulations and company anonymity will be paramount during the experiment. An extra person will be required for VR user assistance.

I consider that this project **may** have ethical implications that should be brought before the DTPEC.
Please provide all the further information listed below

3. The purpose of this project is to gain an understanding of the relationship between VR and Photographs in trying to identify workplace hazards in the healthcare sector. Many studies have focused on the construction and manufacturing sectors for workplace safety, but the reality is that there are many situations in the healthcare environment which can result in long term serious illness. The gap in knowledge in this sector can be partially closed in this study by enabling students who are training to be Social Care Workers (SCW) to identify hazards in the healthcare sector, prior to them starting to work on the front line. The factors taken into consideration when identifying hazards will be as much about the relationship between the Service Users and their environment as it will be about the hazards in the environment.

4. Proposed methodology

Participants and Recruiting Methods

(a) Participants and recruiting methods
(b) Brief description of Methods and Measurements

(a) To recruit participants Saint Michael's House (SMH) has requested that a notice for participation be placed on the SMH intranet and participants will volunteer of their own free will. As requested by SMH participants will have read the research information invite (Appendix D) and the physical readiness questionnaire (Appendix J) prior to applying to participate. The participant ages range from twenty to fifty-five and there will be a total of thirty-four participants used altogether. The breakdown will be 4 participants for pilot study and thirty for the experiment.
(b) As requested by SMH an invitation will be placed on the SMH intranet with a request for Social Care Workers and Nurses to contact Peter Devlin if they are interested in participating in the research. The participants will have read the research invitation and the Physical Readiness questionnaire Information sheet prior to applying to participate. The Participants will send an email to Peter Devlin to join in the research. Prior to commencing the research participants will be required to read the information sheet (Appendix E, F) and complete informed consent forms (Appendix G,H,I) and physical readiness questionnaire (Appendix J). All elements of the experiment will take place during work time. Data collection will take place during work. The VR part of the study will take no more than five minutes per person and considerably less in many cases. The participants will be given the hardcopy images or the VR equipment and they will be asked to call out hazards, they will have time to ask questions beforehand. The participants will either complete a pilot study or the full study. The participants will be asked to complete appropriate questionnaires (Appendix L, M). Once the participation is finished the participants will be debriefed (Appendix O). The participants will be thanked for their participation and provided with details for where to go if they feel upset. Details of a counselling service will be provided in the debrief.

See below the two-step process for the study.

(1) Pilot study with 4 x SCW's

The purpose of the pilot study is to establish the validity of the mechanism of identifying hazards through VR and Photo's and to establish the method of recording the identified hazards using VR and images. This part will also consider the validity of using the HSE Risk Assessment tool (Appendix M) and recording the risk ratings. The study will require the DOSPERT risk perception questionnaire (Appendix L) and presence questionnaire (Appendix M) to strengthen the research

(2) Study with 50 x SCW's

The information gathered here will determine the weight of the experiment. There will be a simple comparison between groups for hazard identification and risk perception. Using the DOSPERT risk perception questionnaire (Appendix L) and the HSE decision matrix (Appendix N) to perceive risk, there will be a presence questionnaire (Appendix M) for VR users.

Three copies of this form, along with all materials to be used in your study, should be submitted to the DTPEC for consideration.
If any of the above information is missing, your application will not be considered at the DTPEC meeting, and your research may be significantly delayed.

I am familiar with the PSI Code of Professional Ethics and BPS Guidelines (and have discussed them with the other researchers involved in the project). I have read and understood the specific guidelines for completion of Ethics Application Forms.

Signed  Print Name ***Peter Devlin*** Date ***06/04/2020***
Applicant

Signed _____ Print Name _____ Date _____
Supervisor

Appendix D Notice for participant invitation

Notice for Internet Invitation: Participate in Health and Safety research project, as part of an IADT Masters in Cyber Psychology in 2019-2020.

Dear Colleagues

I will be completing a Masters in Cyber Psychology in 2019-2020. To enable me to do this I would like to invite staff who have completed the Risk Assessment training, to participate in an experiment. I will also require assistance to carry out the stages of the experiment, the stages are as follows:

Pilot Study - 2 people to carry out VR element of study and 2 people to carry out photograph element of study.

Experiment - 15 people to carry out VR element of study and 15 people to carry out photograph element of study.

The main experiment will consist of two groups; one group looking at photographs and one group looking at a VR/360 image. The timeframe will be approximately 3 minutes and the experiment will try to establish preordained criteria. If you are interested in the experiment, and would like to participate in the research, I would appreciate if you could read the attached physical readiness questionnaire. If you have read the physical readiness questionnaire and are happy to proceed with the experiment then please complete the attached consent forms and return them to me with the subject ' Research P.Devlin'.

Your data will be coded onto an excel database and will remain anonymous. You do not have to participate in this experiment; you can opt out at any stage, with no questions asked and with all your information destroyed, you can choose to refuse to answer any question on the questionnaires . This experiment has been approved by the SMH research ethics committee and the IADT Department of Technology and Psychology Ethics Committee. It is with thanks to St Michaels House and its staff members that this experiment is able to proceed and if you have questions about this study or you wish to have your data removed from the study please contact me by 27/12/2019 at the following e-mail: N00182524@student.iadt.ie or Ph: 0877946758. Alternatively, you may contact my supervisor, Robert Griffin at IADT, email: Robert.Griffin@iadt.ie Ph: 01 234000

We assure you that your data is confidential and anonymous; the data will not be identifiable as yours. If you have been affected by the content of this study, you are welcome to contact the SMH VHI Employee Assistance Program

Kind Regards,

Peter Devlin

Information Sheet for Experimental group

Study Title: Can VR over traditional photography greater influence the number of hazards identified in a healthcare sector residential kitchen and as a result influence the perceived rating of the risks of the hazards.

Purpose of the Research

The aim of the experiment is to evaluate VR over traditional photography as a superior method of hazards identification in a residential kitchen, and as a result influence the perceived rating of risk. The pilot study will be carried out through observations of photographs and VR. It will take approximately 3 minutes for the experiment and a further 5 minutes for feedback. The Hypothesis is: If VR is used for hazard ID then more hazards will be identified and the perception of risk will be greater

Invitation

You are being invited to consider taking part in a pilot study to compare whether VR can influence hazard identification and influence the perceived risk and the sense of presence. The project is being undertaken by Peter Devlin as part of an MSc Cyberpsychology at IADT.

Before you decide whether or not you wish to take part, it is important for you to understand why this research is being done and what it will involve. Please take time to read this information carefully and discuss it with friends and relatives if you wish. Ask us if there is anything that is unclear or if you would like more information.

Do I have to take part?

You are free to decide whether you wish to take part or not. If you do decide to take part you will be asked to sign consent forms (Appendix, G, H), and you will be given a copy of the consent forms to take away. You are free to withdraw from this study at any time and without giving reasons and you do not have to answer any question on the questionnaires if you do not wish to.

If I take part, what do I have to do?

This pilot study will consist of two groups of two participants. Depending on the group you are in you may be asked to complete either task (1) or task (2). All ethics forms, information forms and physical readiness questionnaire (Appendices G, H, I, J) will be completed prior to participation as per research ethics best practice.

(1) Based on your experience as you will be asked to identify hazards in photograph images of a residential kitchen.

In a three-minute timeframe you will be asked to call out hazards you see in the kitchen images and they will be written onto an excel table (Appendix K). With the hazards identified you will be asked to rate the risk of the hazards using the HSE decision matrix (Appendix N) and complete the DOSPERT Risk perception questionnaire (Appendix L).

You will then be informally asked to evaluate your user experience in participating in the study and whether you feel improvements could be applied to the project.

(2) Based on your experience you will be asked to don a VR headset. You will be asked to identify hazards in the 360 degree image of a residential kitchen. In a three-minute timeframe, will be asked to call out hazards you see in the kitchen image and they will be written onto an excel table (Appendix K). With the hazards identified you will be asked to rate the risk of the hazards using the HSE decision matrix (Appendix N) and complete the DOSPERT Risk perception questionnaire (Appendix L). You will be asked to complete a presence questionnaire (Appendix M). You will then be informally asked to evaluate your user experience in participating in the study and whether you feel improvements could be applied to the project. Upon completion of the experiment, you will be debriefed (Appendix O),asked how you feel and will be given a seat for 10 minutes to ensure there are no side effects of the VR usage. The Nurse Manager on call will be available if you have any side effects of the VR usage and will be contacted immediately by a designated VR assistant or myself. You will be supported throughout this task by another staff member or myself.

What are the benefits (if any) of taking part?

There are benefits to Saint Michaels House for future training in hazard identification and risk perception. There are no benefits in taking part but it may be interesting for you to see how the new technology is applied to your environment and your input may influence change for the project.

What are the disadvantages and risks (if any) of taking part?

When using the VR headset, the risks are for cybersickness and potentially induced seizures. A screening will take place to limit the chances of either of these conditions happening and support will be on hand if required. If you have ever had a seizure or motion sickness you will not be allowed participate in the VR part of this experiment

How will information about me be used?

Suggestions by you will be written in a notebook and brought to the IADT project supervisor to evaluate and to influence changes to the project. The completed tables and hardcopy notes will be retained by the researcher for 1 year. If the paper is published then the data will be retained for 5 years. After 1-5 years the hardcopy data will be shredded and the softcopy information deleted.

All information will be confidential and names will be coded during the pilot study. There will not be a recording of the pilot study but hardcopy data will be stored in a locked filing cabinet in a locked office, softcopy data will be stored on a password encrypted computer, phone and hard drive. All devices have virus protection software. There will be no association between participant names and hazard identification information, there will be no requirement to retain the data for future research.

Who will have access to information about me?

Access to information will be through the secure Saint Michael's House IT system. Peter Devlin and the IT manager will be the only people with access to the information. Drives are only accessible through the SMH logon process. Confidentiality will be safeguarded through the deletion of the emails and reduced association between participants and the information supplied.

Participant initials will be coded. No initials will appear on any documentation. The final report will have no name associations.

What will happen to the results of the study?

The results will be used in my thesis for the MSc in Cyberpsychology with the Dun Laoghaire Institute of Art, Design & Technology. The paper may be published, if so, it will be available in public libraries.

Who has reviewed the study?

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

What if there is a problem?

If you have a concern about any aspect of this study, you may wish to speak to the researcher(s) who will do their best to answer your questions. You should contact Peter Devlin - N00182524@student.iadt.ie, Ph: 0877946758 or his supervisor Robert Griffin - Robert.Griffin@iadt.ie - Ph: 01 2394000.

Contact for further information

Peter Devlin Email: N00182524@student.iadt.ie Ph No: 0877946758

Robert Griffin - Robert.Griffin@iadt.ie - Ph: 01 2394000.

Thank you

Thank you for talking the time to read the information sheet, and if you have any questions don't hesitate to ask.

Information Sheet for VR Study

Study Title: Can VR over traditional photography greater influence the number of hazards identified in a healthcare sector residential kitchen and as a result influence the perceived rating of the risks of those hazards.

Purpose of the Research

The aim of the experiment is to evaluate VR over traditional photography as a superior method of hazards identification in a residential kitchen, and as a result influence the perceived rating of risk. The experiment will be carried out through observations of photographs and VR, through a set time period. The Hypothesis: If VR is used for hazard ID then more hazards will be identified and the perception of risk will be greater.

Invitation

You are being invited to consider taking part in the research study which will compare whether VR can influence hazard identification and influence the perceived risk and the sense of presence. This project is being undertaken by Peter Devlin as part of an MSc Cyberpsychology at IADT.

Before you decide whether or not you wish to take part, it is important for you to understand why this research is being done and what it will involve. Please take time to read this information carefully and discuss it with friends and relatives if you wish. Ask us if there is anything that is unclear or if you would like more information.

Do I have to take part?

You are free to decide whether you wish to take part or not. If you do decide to take part you will be asked to sign two consent forms and you will be given a copy of the consent forms to take away. You are free to withdraw from this study at any time and without giving reasons and you do not have to answer any question on the questionnaires if you do not wish to.

If I take part, what do I have to do?

Depending on the group you are in you may be asked to complete either task (1) or task (2). All ethics forms, information forms and physical questionnaire will be completed prior to participation as per research ethics best practice.

- Based on your experience as a Social Care Worker / Nurse you will be asked to identify hazards in photograph images of a residential kitchen. In a three-minute timeframe you will be asked to call out hazards you see in the kitchen images, and they will be written onto an excel table (Appendix K).

- With the hazards identified you will be asked to rate the risk of the hazards using the HSE decision matrix (Appendix N) and complete the DOSPERT Risk perception questionnaire (Appendix L).
- Based on your experience as a Social Care Worker you will be asked to don a VR headset. Using a Head Mounted Display you will be asked to identify hazards in the 360 image of a residential kitchen. In a three-minute timeframe, will be asked to call out hazards you see in the kitchen image and they will be written onto an excel table (Appendix K). With the hazards identified you will be asked to rate the risk of the hazards using the HSE decision matrix (Appendix N) and complete the DOSPERT Risk perception questionnaire (Appendix L). You will be asked to complete a presence questionnaire (Appendix M). Upon completion of the experiment, you will be debriefed (Appendix O), asked how you feel and will be given a seat for 10 minutes to ensure there are no side effects of the VR usage. The Nurse Manager on call will be available if you have any side effects of the VR usage and will be contacted immediately by a designated VR assistant or myself. You will be supported throughout this task by another staff member or myself.

What are the benefits (if any) of taking part?

There are benefits to Saint Michaels House are for future training in hazard identification and risk perception. There are no benefits in taking part in the experiment but it may be interesting for you to see the new technology is applied to your environment.

What are the disadvantages and risks (if any) of taking part?

The risks are for cybersickness and potentially induced seizures. A screening will take place to limit the chances of either of these conditions happening. You will not be allowed do the research if you have ever had motion sickness or seizures.

How will information about me be used?

You will be invited to participate through the SMH Intranet (Appendix D). Once chosen, an email will be sent to you to accept your participation. Emails will be replied to by me, and information will be put into an excel sheet with participant initials coded and used for association. All emails will be accounted for by me and then deleted. Data will be retained by the researcher for 1 year. If the paper is published, then the data will be retained for 5 years. After 1-5 years the hardcopy data will be shredded and the softcopy information deleted. Hard copy data will be stored in a locked filing cabinet in a locked office, softcopy data will be stored on and password encrypted computer, phone and hard drive. All devices have virus protection software. There will be no association between participant names and hazard identification information, there will be no need to retain the data for future research.

Who will have access to information about me?

Access to information will be through the secure Saint Michael's House IT system. Peter Devlin and the IT manager will be the only people with access to the information. Drives are only accessible through the SMH logon process.

Confidentiality will be safeguarded through the deletion of the emails and no association between participants and the information supplied. Participant initials will be coded. No initials will appear on any documentation. The final report will have no name associations.

What will happen to the results of the study?

The results will be used in my thesis for the MSc in Cyberpsychology in the Dun Laoghaire Institute of Art, Design & Technology. The paper may be published, if so, it will be available in public libraries.

Who has reviewed the study?

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

What if there is a problem?

If you have a concern about any aspect of this study, you may wish to speak to the researcher(s) who will do their best to answer your questions. You should contact Peter Devlin or their supervisor Robert.Griffin@iadt.ie 01 2394000.

Contact for further information

Peter Devlin - N00182524@student.iadt.ie - Ph No: 0877946758

Robert.Griffin@iadt.ie Ph No: 01 2394000

Thank you
Thank you for talking the time to read the information sheet, and if you have any questions don't hesitate to ask.

Date 26/11/2019

Appendix G Project consent form

Consent Form

Title of Project: Can VR over traditional photography greater influence the number of hazards identified in a healthcare sector residential kitchen and as a result influence the perceived rating of the risks of the hazards.

Name of Researcher: Peter Devlin

Please tick box

1	I confirm that I have read and understand the information sheets for the Pilot Study / Experiment and have had the opportunity to ask questions.	☐
2	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 question I choose	☐
3	I agree to take part in this study.	☐
4	I understand that data collected about me during this study is anonymous	☐
5	I am over 18	☐

All recordings used are completely anonymous, with no associations made to either the participant or SMH, and final conclusion of this study will be available to all participants

_____	_____	_____
Name of participant	Date	Signature
_____	_____	_____
Researcher	Date	Signature

Appendix H Use of quotes consent form

CONSENT FORM

(for use of quotes)

Title of Project: Can VR over traditional photography greater influence the number of hazards identified in a healthcare sector residential kitchen and as a result influence the perceived rating of the risks of the hazards

Name of Researcher: *Peter Devlin*

Please tick box

1	I agree for any quotes to be used	☐
2	I don't want any quotes to be used	☐
3	I want to see any proposed quotes before making a decision	☐
4	I am over 18	☐

All recordings used are completely anonymous, with no associations made to either the participant or SMH, and final conclusion of this study will be available to all participants

_____	_____	_____
Name of participant	Date	Signature
_____	_____	_____
Researcher	Date	Signature

Appendix I VR Consent form

Consent Form (for use of VR)

Title of Project: Can VR over traditional photography greater influence the number of hazards identified in a healthcare sector residential kitchen and as a result influence the perceived rating of the risks of the hazards.

Name of Researcher: Peter Devlin

Please tick box

1	I confirm that I have read and understand the information sheets for the Pilot Study & VR Experiment and have had the opportunity to ask questions.	☐
2	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 question I choose	☐
3	I agree to take part in this study.	☐
4	I understand that data collected about me during this study is anonymous	☐
5	I agree to the focus* group being audio/video recorded*	☐
6	I have read the physical readiness information sheet and I understand the effects that VR may have on a person and I would like to proceed with the experiment	☐
7	I am over 18	☐

All recordings used are completely anonymous, with no associations made to either the participant or SMH, and final conclusion of this study will be available to all participants

_____	_____	_____
Name of participant	Date	Signature
_____	_____	_____
Researcher	Date	Signature

Appendix J Physical readiness questionnaire

Physical screening form for adult participants.

ID Number _____

If you have any of the following conditions, please tick either Yes or No:

	YES	NO
Sensitive to motion sickness?		
Prone to eye-strain / serious sight problems?		
Difficulties with balance?		
Difficulties with hearing?		
Prone to dizziness and/or nausea?		
Prone to headaches?		
Prone to seizures?		
Has epilepsy?		
Has a heart condition?		
Do you have any psychological / neurological disorders?		
Other conditions (please describe):		

Note: The purpose of this form is to exclude participants who have suffered from seizures or have a propensity for motion sickness from taking part in the Virtual Reality part of the experiment. Participants who are excluded from the VR participation can partake in the photograph hazard identification.

Participant signature: _____

Date: _____

Appendix K Hazard excel table

ID Number

No	Hazard Description	Associated Risk	Risk Rating
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Appendix L DOSPERT risk perception scale

Domain-Specific Risk-Taking (Adult) Scale – Risk Perceptions

The DOSPERT Scale (from Blais & Weber, 2006)

The *risk-perception* responses evaluate the respondents' gut level assessment of how risky each activity/behavior is, using a 7-point rating scale ranging from 1 (*Not at all*) to 7 (*Extremely Risky*). Item ratings are added across all items of a given subscale to obtain subscale scores, with higher scores suggesting perceptions of greater risk in the domain of the subscale.

The internal consistency reliability estimates associated with the original 48-item English risk-taking scores ranged from .70 to .84 (mean α = .78), and those associated with the risk-perception scores, from .70 to .81 (mean α = .77), as reported by Weber, et al. (2002). The authors also found moderate test-retest reliability estimates (albeit for an earlier version of the instrument) and provided evidence for the factorial and convergent/discriminant validity of the scores with respect to constructs such as sensation seeking, dispositional risk taking, intolerance for ambiguity, and social desirability. Construct validity was also assessed via correlations with the results of a risky gambling task as well as with tests of gender differences.

Domain-Specific Risk-Taking (Adult) Scale – Risk Perceptions

People often see some risk in situations that contain uncertainty about what the outcome or consequences will be and for which there is the possibility of negative consequences. However, riskiness is a very personal and intuitive notion, and we are interested in **your gut level assessment of how risky** each situation or behavior is.

For each of the following statements, please indicate **how risky you perceive** each situation. Provide a rating from *Not at all Risky* to *Extremely Risky*, using the following scale:

Domain-Specific Risk-Taking (Adult) Scale – Risk Taking

For each of the following statements, please indicate **how risky you perceive** each situation. Provide a rating from *Not at all Risky* to *Extremely Risky*, using the following scale:

1	2	3	4	5	6	7
Not at all Risky	Slightly Risky	Somewhat Risky	Moderately Risky	Risky	Very Risky	Extremely Risky

1. Admitting that your tastes are different from those of a friend.
2. Going camping in the wilderness.
3. Betting a day's income at the horse races.
4. Investing 10% of your annual income in a moderate growth mutual fund.
5. Drinking heavily at a social function.
6. Taking some questionable deductions on your income tax return.
7. Disagreeing with an authority figure on a major issue.
8. Betting a day's income at a high-stake poker game.
9. Having an affair with a married man/woman.
10. Passing off somebody else's work as your own.
11. Going down a ski run that is beyond your ability.
12. Investing 5% of your annual income in a very speculative stock.
13. Going whitewater rafting at high water in the spring.
14. Betting a day's income on the outcome of a sporting event
15. Engaging in drug use.
16. Revealing a friend's secret to someone else.
17. Driving a car without wearing a seat belt.
18. Investing 10% of your annual income in a new business venture.
19. Taking a skydiving class.
20. Riding a motorcycle without a helmet.
21. Choosing a career that you truly enjoy over a more prestigious one.
22. Speaking your mind about an unpopular issue in a meeting at work.
23. Sunbathing without sunscreen.
24. Bungee jumping off a tall bridge.
25. Piloting a small plane.
26. Walking home alone at night in an unsafe area of town.
27. Moving to a city far away from your extended family.
28. Starting a new career in your mid-thirties.
29. Leaving your young children alone at home while running an errand.
30. Not returning a wallet you found that contains $200.

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Appendix M Presence questionnaire

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 MODERATELY COMPLETELY
RESPONSIVE RESPONSIVE RESPONSIVE

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

|_____|_____|_____|_____|_____|_____|_____|
EXTREMELY BORDERLINE COMPLETELY
ARTIFICIAL 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 BORDERLINE COMPLETELY
ARTIFICIAL NATURAL

6. How compelling was your sense of objects moving through space?
|_____|_____|_____|_____|_____|_____|_____|
NOT AT ALL MODERATELY VERY
COMPELLING COMPELLING

7. How much did your experiences in the virtual environment seem consistent with your real world experiences?
|_____|_____|_____|_____|_____|_____|_____|
NOT MODERATELY VERY
CONSISTENT CONSISTENT 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 CLOSELY 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 LONG DELAYS 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 PREVENTED
SOMEWHAT TASK PERFORMANCE

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

|_____|_____|_____|_____|_____|_____|_____|

NOT AT ALL INTERFERED INTERFERED
SOMEWHAT 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

Appendix N HSE decision matrix and risk rating tool

HSE RISK ASSESSMENT TOOL

1. IMPACT TABLE

	Negligible	Minor	Moderate	Major	Extreme
Injury	Adverse event leading to minor injury not requiring first aid. No impaired Psychosocial functioning	Minor injury or illness, first aid treatment required <3 days absence < 3 days extended hospital stay Impaired psychosocial functioning greater than 3 days less than one month	Significant injury requiring medical treatment e.g. Fracture and/or counselling. Agency reportable, e.g. HSA, Gardaí (violent and aggressive acts). >3 Days absence 3-8 Days extended hospital Stay Impaired psychosocial functioning greater than one month less than six months	Major injuries/long term incapacity or disability (loss of limb) requiring medical treatment and/or counselling Impaired psychosocial functioning greater than six months	Incident leading to death or major permanent incapacity. Event which impacts on large number of patients or member of the public Permanent psychosocial functioning incapacity.
Service User Experience	Reduced quality of service user experience related to inadequate provision of information	Unsatisfactory service user experience related to less than optimal treatment and/or inadequate information, not being to talked to & treated as an equal; or not being treated with honesty, dignity & respect - readily resolvable	Unsatisfactory service user experience related to less than optimal treatment resulting in short term effects (less than 1 week)	Unsatisfactory service user experience related to poor treatment resulting in long term effects	Totally unsatisfactory service user outcome resulting in long term effects, or extremely poor experience of care provision
Compliance with Standards (Statutory, Clinical, Professional & Management)	Minor non compliance with internal standards. Small number of minor issues requiring improvement	Single failure to meet internal standards or follow protocol. Minor recommendations which can be easily addressed by local management	Repeated failure to meet internal standards or follow protocols. Important recommendations that can be addressed with an appropriate management action plan.	Repeated failure to meet external standards. Failure to meet national norms and standards / Regulations (e.g. Mental Health, Child Care Act etc). Critical report or substantial number of significant findings and/or lack of adherence to regulations.	Gross failure to meet external standards Repeated failure to meet national norms and standards / regulations. Severely critical report with possible major reputational or financial implications.
Objectives/Projects	Barely noticeable reduction in scope, quality or schedule.	Minor reduction in scope, quality or schedule.	Reduction in scope or quality of project; project objectives or schedule.	Significant project over – run.	Inability to meet project objectives. Reputation of the organisation seriously damaged.
Business Continuity	Interruption in a service which does not impact on the delivery of service user care or the ability to continue to provide service.	Short term disruption to service with minor impact on service user care.	Some disruption in service with unacceptable impact on service user care. Temporary loss of ability to provide service	Sustained loss of service which has serious impact on delivery of service user care or service resulting in major contingency plans being involved	Permanent loss of core service or facility. Disruption to facility leading to significant 'knock on' effect
Adverse publicity/ Reputation	Rumours, no media coverage. No public concerns voiced. Little effect on staff morale. No review/investigation necessary.	Local media coverage – short term. Some public concern. Minor effect on staff morale / public attitudes. Internal review necessary.	Local media – adverse publicity. Significant effect on staff morale & public perception of the organisation. Public calls (at local level) for specific remedial actions. Comprehensive review/investigation necessary.	National media/ adverse publicity, less than 3 days. News stories & features in national papers. Local media – long term adverse publicity. Public confidence in the organisation undermined. HSE use of resources questioned. Minister may make comment. Possible questions in the Dáil. Public calls (at national level) for specific remedial actions to be taken possible HSE review/investigation	National/International media/ adverse publicity, > than 3 days. Editorial follows days of news stories & features in National papers. Public confidence in the organisation undermined. HSE use of resources questioned. CEO's performance questioned. Calls for individual HSE officials to be sanctioned. Taoiseach/Minister forced to comment or intervene. Questions in the Dail. Public calls (at national level) for specific remedial actions to be taken. Court action. Public (independent) Inquiry.
Financial Loss (per local Contact)	<€1k	€1k – €10k	€10k – €100k	€100k – €1m	>€1m
Environment	Nuisance Release.	On site release contained by organisation.	On site release contained by organisation.	Release affecting minimal off-site area requiring external assistance (fire brigade, radiation, protection service etc.)	Toxic release affecting off-site with detrimental effect requiring outside assistance.

2. LIKELIHOOD SCORING

Rare/Remote (1)		Unlikely (2)		Possible (3)		Likely (4)		Almost Certain (5)	
Actual Frequency	Probability	Actual Frequency	Probability	Actual Frequency	Probability	Actual Frequency	Probability	Actual Frequency	Probability
Occurs every 5 years or more	1%	Occurs every 2-5 years	10%	Occurs every 1-2 years	50%	Bimonthly	75%	At least monthly	99%

3. RISK MATRIX

	Negligible (1)	Minor (2)	Moderate (3)	Major (4)	Extreme (5)
Almost Certain (5)	5	10	15	20	25
Likely (4)	4	8	12	16	20
Possible (3)	3	6	9	12	15
Unlikely (2)	2	4	6	8	10
Rare/Remote (1)	1	2	3	4	5

Appendix O Debrief

Debrief

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

The study in which you just participated was designed to investigate whether VR technology can more greatly influence hazard identification and perceived risk over traditional images.

If you have questions about this study or you wish to have your data removed from the study please contact me by 08/01/2019 at the following e-mail: N00182524@student.iadt.ie or Ph . 0877946758. Alternatively, you may contact my supervisor, Robert Griffin at IADT, email: Robertgriffin@iadt.ie Ph No. 01 234000

We thank you sincerely for contributing, and assure you that your data is confidential and anonymous, and if published the data will not be in any way identifiable as yours.

If you have been affected by the content of this study in any way, the organisation below may be of assistance:

VHI Employee Assistance Program 01-7994120

Elaine Teague - The Director of Quality Improvement and Safety Development at Saint Michael's House. 01 – 8840200

Kind Regards,

Peter Devlin

Table 5 - SPSS output data for photos and VR, mean scores hazard identification

Independent Samples t-test

Independent Samples Test										
		Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Photo Hazard ID	Equal variances assumed	2.448	0.129	-3.261	28	0.003	-3.600	1.104	-5.862	-1.338
	Equal variances not assumed			-3.261	24.497	0.003	-3.600	1.104	-5.876	-1.324

Table 6 - SPSS output data for photos and VR, mean scores hazard identification

Group Statistics

Group Statistics					
Hazard ID		n	Mean	Std. Deviation	Std. Error Mean
Photo Hazard ID	.00	15	13.60	2.384	0.616
	1.00	15	17.20	3.550	0.917

Table 7 - SPSS output data for photos and VR, mean scores hazard identification

Descriptive Statistics

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
Hazard ID	30	0.00	1.00	0.5000	0.50855
Photo Hazard ID	30	9	24	15.40	3.490
Valid N (listwise)	30				

Table 8 - SPSS output data for photos and VR, mean scores DOSPERT risk perception independent samples t-test

Independent Samples Test										
		Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Risk Perception	Equal variances assumed	0.921	0.345	0.327	28	0.746	0.0933	0.2851	-0.4906	0.6773
	Equal variances not assumed			0.327	25.715	0.746	0.0933	0.2851	-0.4930	0.6796

Table 9 - SPSS output data for photos and VR, mean scores DOSPERT risk perception Group Statistics

Group Statistics					
Dospert RPS		N	Mean	Std. Deviation	Std. Error Mean
Risk Perception	.00	15	5.907	0.6541	0.1689
	1.00	15	5.813	0.8895	0.2297

Table 10 - SPSS output data for photos and VR, mean scores DOSPERT Descriptive Statistics

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
Dospert RPS	30	0.00	1.00	0.5000	0.50855
Risk Perception	30	3.6	7.0	5.860	0.7686
Valid N (listwise)	30				

Table 11 - SPSS output data Cronbach's Alpha DOSPERT Likert scale Reliability Statistics

Reliability Statistics		
Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0.859	0.856	31

Table 12 - SPSS output data for photos and VR, mean scores HSE risk rating

Independent Samples t-test

Independent Samples Test										
		Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
HSE Risk Perception Ave	Equal variances assumed	6.509	0.016	-1.316	28	0.199	-0.948396957359801	0.720874928074562	-2.425042308368730	0.528248393649129
	Equal variances not assumed			-1.316	21.573	0.202	-0.948396957359801	0.720874928074562	-2.445118781952590	0.548324867232987

Table 13 - SPSS output data for photos and VR, mean scores HSE risk rating

Group Statistics

Group Statistics					
Groups		N	Mean	Std. Deviation	Std. Error Mean
HSE Risk Perception Ave	.00	15	8.189451039156920	2.454551629316340	0.633762505516563
	1.00	15	9.137847996516720	1.330445875606400	0.343519647950263

Table 14 - SPSS output data for photos and VR, mean scores HSE risk rating

Descriptive Statistics

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
Groups	30	0.00	1.00	0.5000	0.50855
HSE Risk Perception Ave	30	4.090909090909090	12.800000000000000	8.663649517836830	1.998919233158480
Valid N (listwise)	30				

Table 15 - SPSS output data Cronbach's Alpha Presence Likert Scale

Reliability Statistics

Reliability Statistics		
Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0.261	0.709	19