Work-in-Progress—Enhancing Cyber Prevention Education: Utilising Virtual Reality Technology for Parents/Carers and Teachers.

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Work-in-Progress – Enhancing Cyber Prevention Education: Utilising Virtual Reality Technology for Parents/Carers and Teachers

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Abstract. Police organisations in the United Kingdom are tasked with promoting cyber prevention activities and awareness, to mitigate the increasing risk of cyber dependent crimes. There is a worrying increase of perpetrators of cyber criminality who are under the age of 18. To help prevent young people from delving into cyber criminality, the police encourage parents/carers and teachers to refer individuals they suspect are at risk of committing cybercrimes, in order to direct the keen interest in technology for positive use. However, parents/carers and teachers may lack knowledge regarding this subject and may be unable to identify indicators of illicit activities. This work-in-progress paper introduces a solution to address this concern through an immersive virtual reality serious game, targeted towards adults of varying technical competencies. Additionally, initial feedback collected from practitioners and the target audience will be presented.

Keywords: Virtual Reality, Serious Games, Interactive Learning, Immersive Education, Cyber Prevention Education, Hand-Gesture Interaction.

1 Introduction.

Cybercrime within the United Kingdom (UK) continues to rise, with the UK Government estimating approximately 2.4 million cybercrimes in 2022/early 2023 across all UK businesses. Government statistics underscore the severity of the issue, revealing over one-third of large businesses fell victim to cybercrime during this time [1]. Alarmingly, the average age of an individual arrested for cybercrime is 17 years old [2]. As a result, the National Crime Agency (NCA) coordinates the National Cyber Prevent Strategy, which aims to direct "gifted and talented" individuals into legitimate cyber security roles [3]. Ten Regional Organised Crime Units also deliver 'Cyber Prevent' education. However, issues arose with traditional education methods, such as presentations and handouts, which fail to hold the audience's attention, harming the effectiveness of the education campaign.

Since introducing the National Prevent Strategy, technology continued to advance, including increased use and accessibility of Virtual Reality (VR). The advent of stand-alone headsets helped facilitate VR use, by decreasing the cost of a fully functional VR set-up. VR applications are leveraged in a variety of domains, from educational settings to enhance students' presentational skills, through to medical settings for rehabilitation training to improve function in chronic stroke patients [4, 5]. Research has demonstrated VR can be adopted as a tool in the classroom to enhance education, learning and training [6, 7]. However, certain considerations need to be taken into account when creating an application for a targeted audience who have wide-spread familiarity with the use of VR technologies. Existing VR applications around improving knowledge in the cybersecurity domain include VRCyberEducation that showcases human error in cybersecurity and CISE-PROS VR that has a purpose to enable computer scientists to prepare as the next-generation of cyber-practitioners [8, 9]. None as of writing have the purpose to teach adults responsible for young persons the indicators of cyber-criminality and associated knowledge of Cyber Prevent.

This work-in-progress paper aims to demonstrate an immersive educational application that will help educate parents, carers, and teachers of young people who are on the cusp of cyber-criminality, focusing on indicators of

potential cyber-criminality and terms and information relating to cybercrime. This is important to reduce the volume of cybercrime, provide early interventions for young people who have not yet committed a crime, prevent further criminal behaviour for those already involved in cybercrime, and raise community awareness of cybercrime.

2 Related Work.

2.1 Educating the Public about Cyber Prevention.

The Yorkshire and Humberside Regional Organised Crime Unit (YHROCU) help to deter and disrupt cyber dependent crime via education and awareness raising programmes [10]. Through these education and awareness campaigns, it is envisioned that the public can help protect themselves from the risk of cyber dependant crime, by ensuring there is a standard level of cyber awareness to protect themselves and the organisations they work for, whilst also providing knowledge to identify those at risk and/or already committing cyber dependent crime. Additionally, the Prevent initiative aims to proactively inhibit individuals from involvement in cyber-criminality through coordinated action and targeted interventions, such as directing skillsets to legitimate purposes [11].

Beyond the UK, other applications are being considered in relation to education. For example, the European Union's Horizon 2020 funded INDEED project aims to develop frontline practitioners' knowledge in relation to de-radicalisation initiatives [12]. As radicalisation can often take place online [13], findings from this project could feed into cyber education and awareness campaigns for the public.

2.2 Immersive Educational Applications.

There has long been an interest in using VR as a tool for immersive education, from leveraging the technology to train astronauts [14], through to helping students understand abstract scientific concepts [15]. The use of VR by police organisations is becoming more common, with approximately one third of UK police forces leveraging VR for training purposes [16]. Additionally, there are examples of collaborations between police forces and academia to produce immersive applications for awareness raising, such as a smartphone VR application to educate users about points on farms susceptible to organised crime [17].

This paper aims to add to the immersive educational applications available, by introducing CyberSpotlightVR, a VR experience that educates teachers, parents, and carers on signs young people are at risk, or involved in, cyber criminality, whilst ensuring a realistic context, thus enhancing ecological validity.

3 Development of the CyberSpotlightVR Application.

CyberSpotlightVR immerses the user in a teenager's bedroom (Fig. 1.), where they explore the virtual environment and complete interactive activities to learn about indicators of potential cyber-criminality. The following section describes the iterative development of the application, while explaining design considerations.

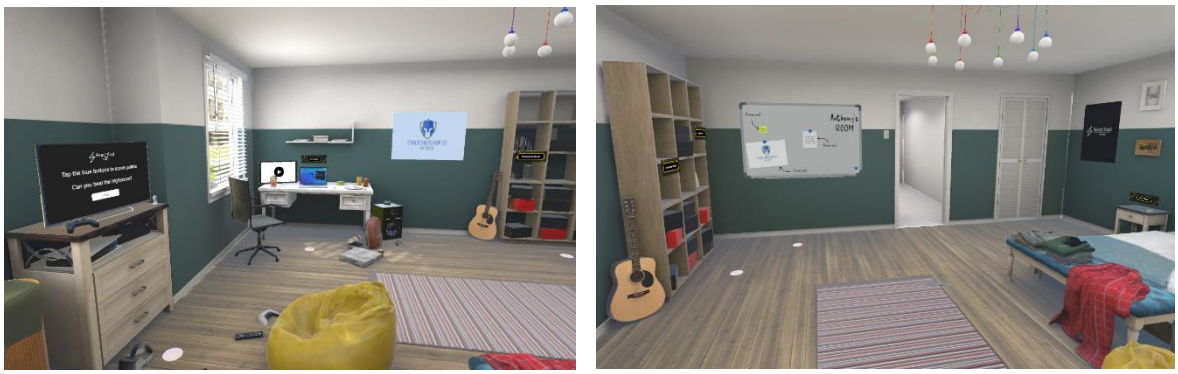

Fig. 1. The virtual environment of CyberSpotlightVR; depicting a teenager's bedroom.

3.1 Design and Conceptualisation.

From the outset, it was identified the game needed to increase engagement and motivate the target audience in learning Prevent strategies. VR was utilised as a novel technology to help draw attention and interest to the awareness campaign. The design process started by defining the learning outcomes of the game. These were largely centred around the Computer Misuse Act 1990 (CMA 1990) and example scenarios developed by the NCA [18]. Additionally, risks and indicators were identified based on the professional expertise of YHROCU. Examples of these risks include unexplained wealth, interests in cryptocurrency, and interests in Computer Bots. The best method for achieving the learning outcomes, whilst utilising VR, was to draw on exploratory learning methods, as this helps users to develop meaningful connections to lessons through active learning and simulated experiences [19]. It is particularly suitable for conceptual understanding, which is useful for learning about the CMA 1990. The concept of the game was for users to search a teenager's bedroom for risks or indicators of cyber-criminality. This allows users to easily relate the lessons to real-world contexts. While privacy concerns could be raised in relation to this scenario, there is a moral and legal justification to positively intervene in a young person's private life for the prevention of crime and to protect/safeguard a young person who is considered 'at risk' in terms of the Children's Acts (1989, 2004).

The virtual environment was developed using a combination of downloaded 3D models from the Unity Asset store and the Unreal Engine Marketplace. These models where adapted in some instances and new models were created using Autodesk's 3DS Max. Additional textures were downloaded from textures.com, where necessary these textures were edited, and new textures were created using Adobe's Photoshop. It was decided the room should be gender neutral to avoid gender stereotyping. The Graphical User Interface was designed using Adobe illustrator.

Located around the environment are information points. These are buttons which, when pressed, supply the user with information about specific risks/indicators. There is also different technology in the environment the user can interact with (tablet, mobile, laptop and console). By interacting with these technologies, the user learns about potential breaches of the CMA 1990. These breaches include: (1) unauthorised access to computer material (users find a password and use it to access a tablet), (2) unauthorised access with intent to commit or facilitate commission of further offences (once the tablet is unlocked, the user sees a website for an online shop where there is a pending transaction using someone else's credit card), and (3) unauthorised acts with intent to impair, or with recklessness as to impairing, operation of a computer (users access a mini game within the environment). Whilst playing the game, the internet connection is interrupted, and the user is informed they have been disconnected. A news broadcast then appears on the television screen, reporting the use of a booter tool to disconnect users from the game. In addition, the environment includes a video developed by the NCA that illustrates risky behaviours, indicators, and attitudes towards cybercrime.

There are three interfaces within the application, which are colour coded to differentiate between them. Additionally, question and breach interfaces include icons to help distinguish them. The interfaces are as follows, with examples provided in Fig. 2.:

- Information - Yellow interfaces provide users with information, such as context for the scenario, knowledge about assets in the environment (e.g., details of crypto wallets and unexplained wealth).
- Questions - Occasionally in the scenario the user will be asked questions. These questions are presented with a blue interface. The answers provided by the user could potentially lead to a breach of the CMA 1990.
- Breaches - When a breach occurs, the interface will be coloured red. This is a bold colour that often connotes danger and will draw the user's attention to the breach. If the user avoids a breach, the interface will be green.

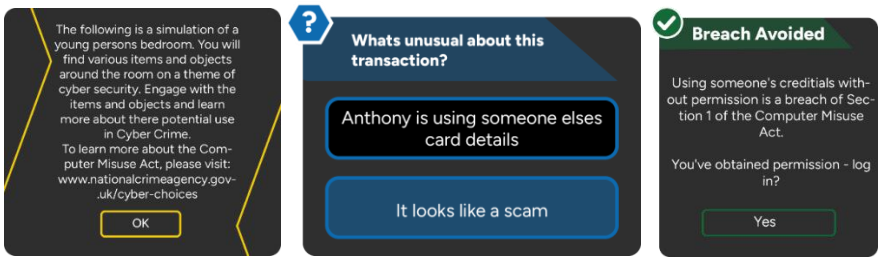

Fig. 2. Examples of different CyberSpotlightVR user interfaces.

Finally, a corridor is present outside of the door of the virtual bedroom, of which leads to a podium with a red button atop. Upon pressing the red button with their hand, the user is greeted with a dialogue box of which concludes the experience. Furthermore, the dialogue box includes guidance for parents or carers who may have concerns about their young person. Additional information is included, such as how they can refer their young person to specialists with a link to a website containing this information.

3.2 Development and Iteration.

CyberSpotlightVR was developed through an iterative process using the Unity game engine and is targeted for use on the Meta Quest 2 Mixed Reality headset. CyberSpotlightVR leverages a stand-alone headset, as opposed to a tethered alternative, due to the cheaper cost, not needing a PC with capable hardware, and the good performance and hand-tracking capabilities of the Meta Quest 2. As the application will be demonstrated at public events and showcased to relevant audiences at their place of work, portability was an additional requirement. Nevertheless, CyberSpotlightVR could easily be adapted for a broader range of VR headsets, particularly if the framework used in development changed from Meta's XR Interaction SDK to Unity's XR Interaction Toolkit, which facilitates cross-platform development (including OpenXR).

With the challenge of users' ranging experience of VR, in-depth consideration was given to which modality of interaction would best suit the target audience; traditional controller input or hand gesture recognition, as recently introduced in the Meta Quest 2's SDK. The latter option was chosen (Fig. 3.) to explore how users with a range of technical backgrounds would find hand-gesture recognition for interacting with an immersive application.

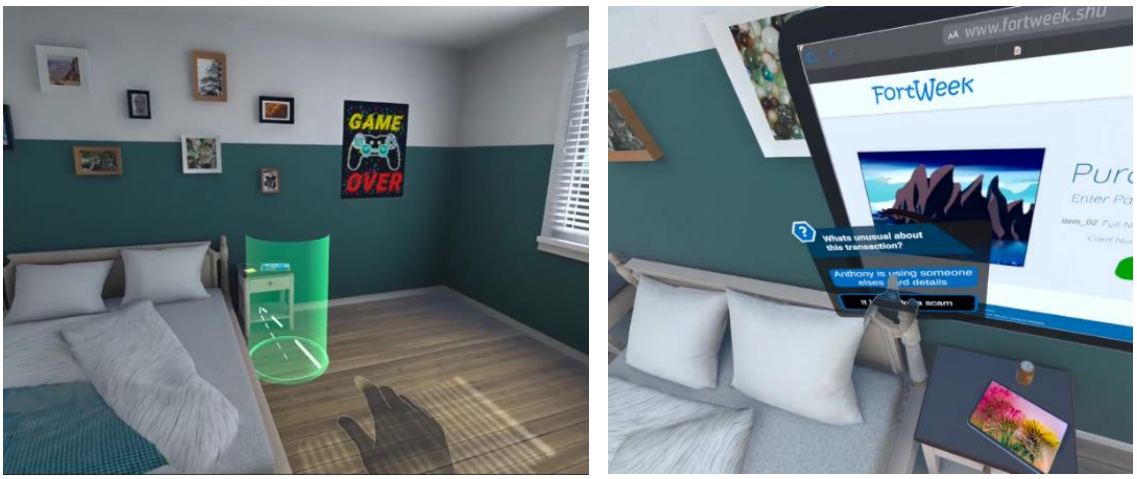

Fig. 3. Screenshots demonstrating the locomotion and user interface modalities.

4 Initial Feedback and Observations of CyberSpotlightVR.

CyberSpotlightVR was inaugurally showcased at Cyber Switch Up 2023 (Switch Up), which took place in August 2023 in Harrogate, North Yorkshire, UK. Switch Up facilitated a digital and cyber skills competition aimed at young people, and had cyber professionals, parents/carers and teachers present [20]. CyberSpotlightVR was demonstrated to adults only, where they were given a Meta Quest 2 and the opportunity to interact with the application. The researchers provided a quick tutorial before immersion, where aspects such as locomotion and how the information points are represented by teleport circles (see Fig. 3.) and their function were explained. The demonstration took around fifteen minutes to complete. This allowed participants sufficient time to actively engage with the various interactive elements within the virtual environment, helping to enhance their understanding of the content presented. Once the demonstration was over, users were asked to complete a feedback survey, which was provided to gather initial feedback of the CyberSpotlightVR application from the participants. This section discusses the findings from the survey, of which are visualised in Fig.4.

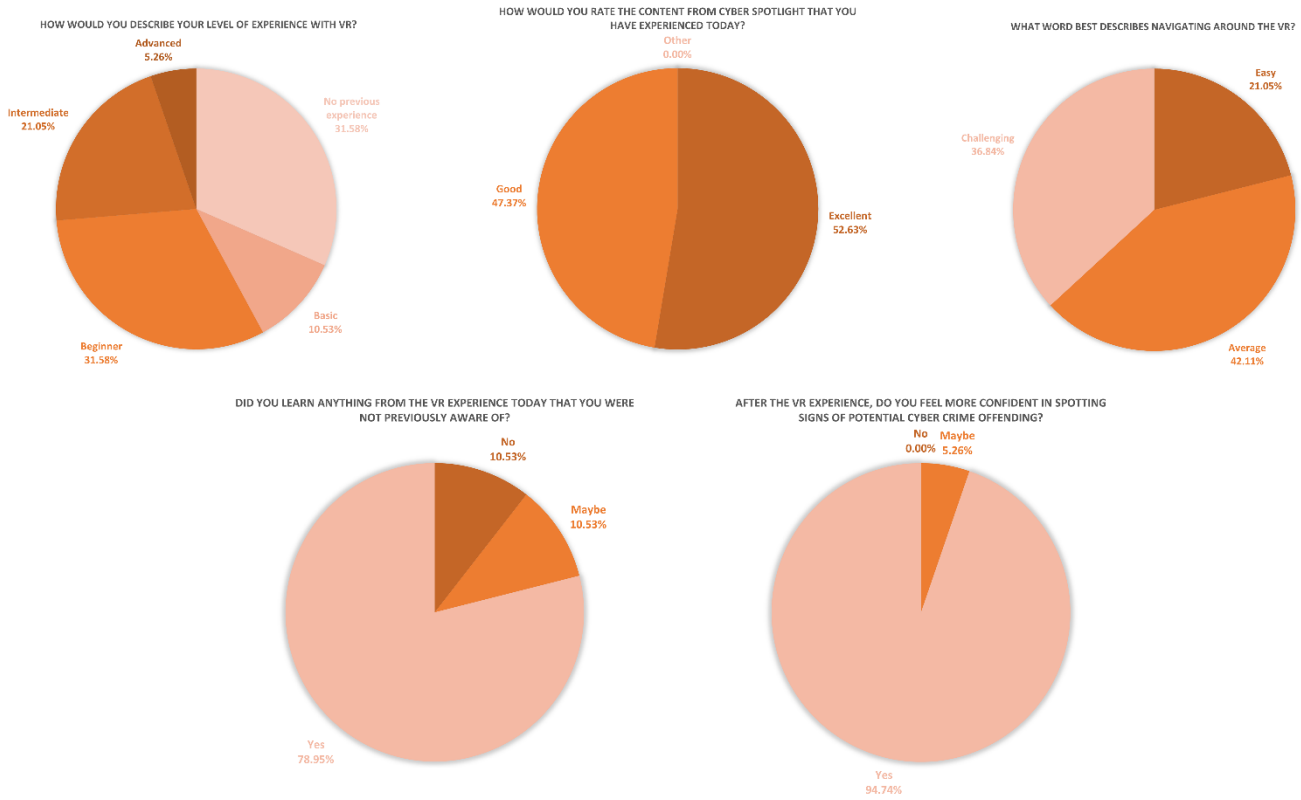

Fig. 4. Results from the survey visualised as pie charts.

4.1 Overview of Survey Results.

Of the 19 participants who completed the survey, six (31.58%) stated they had no previous experience of using VR. A further eight (42.11%) participants rated their familiarity of VR as basic or beginner. Just one participant rated their familiarity of VR as advanced. All participants considered the content of CyberSpotlightVR as either good or excellent. Additionally, 15 (78.96%) participants felt they learned something from using the application.

4.2 Usability.

Seven (36.84%) participants described the method of moving around in the virtual environment as challenging, suggesting that the hand-gesture method to determine movement is not as easy to operate as initially thought. Only four (21.05%) participants thought the method to move was easy. Additionally, some usability issues were observed in relation to using a stationary boundary, which was leveraged due to the limited space available at the event. The boundary indicates to the user, who is immersed in the virtual environment, if they are close to leaving their playing area. The stationary boundary, as opposed to the room-scale boundary, creates a boundary area of one metre by one metre [21]. This was, in certain circumstances, too small for effective interactions with the user interface. On several occasions, a particular user interface was situated outside the boundary area and thus, assumedly through the Oculus software, the user could not interact with that interface.

4.3 Learning Outcomes.

The survey explored whether the learning outcomes of the game had been met. The findings suggest users were overwhelmingly confident in the application's ability to educate users on cybercrime offending, as 15 (78.95%) participants expressed that they learned something new, whilst 18 (94.74%) felt they were more confident in spotting the signs of potential cybercrime offending.

4.4 Additional Comments.

The survey also presented an opportunity for users to provide additional feedback. A range of comments were offered, including feedback on the virtual environment (e.g., the bedroom could be messier to represent more accurately a teenager's bedroom), and educators stating they would like to see the application distributed and presented to parents/carers.

5 Next Steps.

CyberSpotlightVR is currently close to completion in terms of development, and there is ongoing discussion regarding the next phase of development. This would focus on what is known as Cyber Protect, which aims to enhance the education of cyber awareness to protect businesses and charities from cyber threats [22]. With the success of the first development, any further iterations will provide opportunities to enhance the work already completed. Additionally, the second phase of CyberSpotlightVR would provide the further opportunity to thoroughly investigate and measure the success of the application's capability to impart Prevent and Protect knowledge onto its users. For example, insights can be gained regarding the hand-gesture modality for interaction, as well as whether it is preferable to implement the hand-gesture method over traditional controller-based interactions, particularly in terms of enhancing education regarding indicators of cyber-criminality. Through the conducting of further studies with an increased sample size, additional findings such as how demographics affects the enhancement of knowledge of these domains could be uncovered.

Future developments could involve the creation of more specific scenarios relating to particular types of cybercrime. For example, based on the findings of the INDEED project [10], a tailored scenario relating to identifying the signs of radicalisation could be developed. This would help contribute to de-radicalisation initiatives and could be used for training practitioners as well as raising awareness for parents/carers. Any further developments also provide the opportunity to expand on the user testing, allowing for studies that use validated measures to determine how successful CyberSpotlightVR is as an education tool.

6 Discussion and Conclusion.

This paper seeks to provide insight into the development of CyberSpotlightVR, a VR learning application, which was created for parents, carers, and teachers to raise awareness of potential risks or indicators of cyber criminality. The design, development, and initial feedback results have been shared, providing an understanding of what CyberSpotlightVR offers and early insights regarding its success at educating individuals on the potential risks or indicators of cyber-criminality.

CyberSpotlightVR has been demonstrated at numerous events and has shown positive results for improving knowledge on the subject. Whilst there are concerns with usability, these do not seem to impact the overall impression of the application. As hand-gesture controls increase in popularity, it is expected that the useability will improve with more research conducted in this area. Additionally, now that the application is part of the arsenal of methods to educate individuals on Prevent principles, this provides further opportunities to gather results regarding its performance as an immersive educational tool, which can be used for future development of the application. The information gathered from the survey provides useful design and developmental insights on potential further development of the application, particularly as discussion is ongoing for the next stage of development; the production of a tool that aims to raise awareness of Cyber Protect principles.

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