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Enhancing Information Security Education for Children: A Game-Based Approach Using Immersive Technologies

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Abstract
This paper presents an Information Security training course using immersive technologies to amplify the learning experience. We aim to identify immersive technologies for effective training materials and offer a guide for creating cybersecurity content. Recognizing existing methods, we emphasize online gaming dangers like cyberbullying, privacy threats, and security concerns, including malware and online predators. Using virtual reality and gamification, our approach suggests enhanced engagement and retention. Upcoming evaluations will assess material effectiveness, promoting profound learning in information security.

Keywords: Information Security, Training Course, Immersive Technologies, Virtual Reality, Gamification

Introduction
Online gaming's rise in the digital era has introduced new risks like cyberbullying, security concerns, malware threats, webcam vulnerabilities, and online predators. Children, especially vulnerable, increasingly engage in unsupervised online activities (Hartikainen et al., 2019), underscoring the urgency for cybersecurity education.

Traditional methods like lectures and readings often fall short in engaging young learners. Immersive technologies, including virtual reality (VR) and augmented reality (AR), can elevate learning experiences, promoting better engagement and retention (Kamińska et al., 2019). These technologies immerse children in virtual settings where they interact directly with cybersecurity concepts, intensifying their learning engagement (Lee, 2004).

We present a game-based training course leveraging immersive technologies for children's online safety. Aimed at children aged 10 and above, this course, accessible across devices, merges VR, gamification, and interactivity for an impactful learning journey. The course offers a profound understanding of online gaming risks, promoting safe gaming practices.

Additionally, our VR platform choice was informed by metrics from Mado et al. (2022) for accessibility and Wang et al. (2021) for user experience. This holistic approach aspires to deliver an inclusive, captivating, and efficient learning experience.

Review of related literature
The literature review aims to grasp the dangers of online games and pinpoint the most apt immersive technology. A thorough analysis of articles addressing online game dangers

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revealed these risks to be different from general internet usage. Specifically, online games provide a plethora of information, tools, and interactions with unfamiliar individuals.

Ktoridou et al. (2012) dived deep into the awareness levels of parents and children regarding internet threats and safety. Their findings indicated significant gaps in understanding among children. Willett (2017), on the other hand, investigated how online games can be integrated safely into family life for preteens, suggesting that parental supervision plays a vital role. Nansen et al. (2012) emphasized the need for digital well-being in Australian children, proposing regulations and protocols for safer internet usage. Meanwhile, Makarova and Makarova (2019) uncovered a direct relationship between aggressive behaviors in online games and cybervictimization among teens. On the front of immersive environments for education, Häfner (2020) offered a comprehensive overview, highlighting the merits such as interactive learning and potential challenges like high costs.

The subsequent section of the literature review delved into the potential and constraints of various immersive technologies, aiming to select the optimal technology for our course. While Zhang et al. (2021) validated that immersive technologies boost student motivation and adaptability, it is crucial to understand that not every technology fits every content or audience.

An apparent disparity was noticed in the number of articles discussing VR and AR educational applications compared to MR. Reasons for this could be the technical intricacies linked with MR, such as the need for high-quality display technology (Liberatore & Wagner, 2021). Furthermore, privacy issues related to capturing real-world surroundings might hinder MR's universal adoption in educational settings. Contrarily, VR and AR have made a mark in education due to their simplistic implementation. For instance, Ming Tang et al. (2022) showcased a VR educational environment that demonstrated its capabilities, suggesting that detailed exploration of such studies could fill existing gaps in our review.

A study by Kamińska et al. (2019) has championed the potential of VR in education, mainly due to affordable options like cardboard VR. Thus, our study underscores VR as the most suited immersive technology for our training, given its affordability, ease of use, and complete immersive nature.

Design considerations and specifications

This section highlights the design considerations and specifications steering our training course development, aimed at fulfilling its educational objectives. We rooted our methodology in Bloom's taxonomy, blending its principles with other educational theories despite its critiques (Velázquez-Iturbide, 2021).

Using the Bloom's Taxonomy framework, students-players should:

Remember: Recall core online safety facts, e.g., importance of strong passwords, non-sharing of personal information, and recognizing scams.

Understand: Grasp online safety concepts like different cyber threats, digital privacy significance, and immersive online game dangers.

Apply: Use knowledge in real-life contexts like spotting and reporting online scams, evading phishing, and employing robust passwords.

Analyze: Assess risks from immersive online games and recognize risk mitigation strategies.

Evaluate: Discriminate online information, deciding on what to share.

Create: Formulate and enact their own online safety tactics.

For a suitable VR platform choice, we considered factors from expert views, user feedback, and VR education literature. These covered accessibility, user experience, and interaction capabilities.

Accessibility: Emphasizing inclusive learning, we focused on a VR platform suitable for diverse student needs. The chosen technology should cater to varying physical, sensory, and cognitive abilities, making training material universally usable (Mado et al., 2022).

User Experience: Based on prior studies and our initial user tests, we accentuated user experience in our immersive technology choice. We appraised usability, enjoyment, and end-user satisfaction components like intuitive design, real-time feedback, engagement, immersion, and adaptability (Wang et al., 2021).

Interactive Features: Drawing from VR research in education, we prioritized interactive tech features, analyzing engagement and immersive potential. Enhanced interaction augments player engagement (Wang et al., 2021).

To boost learner engagement, we incorporated proven gamification techniques, including interactive quizzes (Kiryakova et al., 2014; Rabah et al., 2018). This makes our content engaging and instructive for our audience.

Regarding our material's efficacy, while confident in our design, empirical validation remains essential. Future endeavors will involve real-world evaluations with students and educators to determine our VR application's real impact.

Additionally, our literature review assessed current VR learning environments to critique and compare our tool against existing VR educational resources, offering a holistic view of our position in the VR educational field.

Implementation of the training course

The implementation utilized the FrameVR platform, known for its user-friendly creation of interactive VR experiences without coding. FrameVR offers tools like a visual scripting interface, 3D asset libraries, and integration with platforms like YouTube and Soundcloud. It supports various VR headsets, ensuring broad accessibility. Through FrameVR, we craft experiences aligning with Bloom's taxonomy levels, making it apt for our project. Using FrameVR, we aim to educate students-players, aged 10 and up, about online gaming dangers. It's noteworthy that other platforms, including Artsteps, Spatial.io, and Engage VR, were explored. Artsteps lacked sufficient interactivity, and Spatial.io and Engage VR proved challenging for younger students and had technical issues. Thus, FrameVR was the chosen platform.

To supplement FrameVR, tools like Voki for avatars, online quiz makers, YouTube, and 3D models from Sketchfab were used to boost realism and engagement. Materials for the six Cybersecurity topics (Cyberbullying, Online Predators, Social Engineering, Webcam dangers, Malware, and Privacy) were carefully selected, favoring kid-friendly sources. The topic of life-threatening games was omitted to ensure safety. Each topic-station provides a link or a PDF with key topic information and a following quiz for knowledge assessment.

Application description and features

The designed training course in a gamelike form can be accessed in this link: https://framevr.io/safetyinonlinegames.

Figure 1. The Lobby of the VR world

Upon entering the frame, players-students are immediately prompted to click on the first image they see, which serves as an introduction to their mission (see Fig 1.). The course centers around the story of two children who have faced the consequences of playing online games without being aware of the dangers. The main objective of the students is to gain an understanding of the various risks associated with online games and learn how to protect themselves and their friends.

Figure 2. The external view of the VR world

As players wander in the virtual world (see Fig 2.), they encounter a surprise element: a short treasure hunt. During this treasure hunt, the students must explore the virtual environment to locate and collect five hidden items. Each item contains a word that is crucial for completing the challenge. The students need to carefully note down the words associated with each item and arrange them in the correct order to create a slogan that encapsulates the importance of online safety.

The training module introduces several salient features intended to amplify the educational experience and boost students' engagement.

The key attributes comprise:

- Interactive exploration: Students navigate and interact within the virtual environment, immersing themselves in a realistic and engaging setting. They have the opportunity to explore different scenarios and make choices that impact the outcome of the game.
- Story-driven learning: The course is designed as a narrative-driven experience, using the story of the two children to convey the importance of online safety. This approach helps students connect emotionally to the content and understand the potential consequences of their actions.
- Gameful Components: The infusion of gamification components, such as the treasure hunt, instills thrill and spurs motivation in the learning trajectory. It promotes active involvement and acknowledges students for their advancements.
- Evaluation of Acquired Knowledge: The module incorporates quizzes and interactive sessions that enable pupils to gauge their grasp on online safety tenets. These evaluations

are intended to offer instantaneous feedback, accentuating the learning curve and pinpointing zones for refinement.

We acknowledge that the claims about the effectiveness of these features are based on design intentions and pedagogical principles, and we aim to validate these claims with empirical studies in the near future.

Benefits of the training course

In this section, we reflect on the effectiveness of the proposed training course and highlight its strengths while also addressing potential limitations. Our aim is to emphasize the significant potential of immersive technologies in creating engaging and effective cybersecurity training programs, yet keeping in mind the iterative nature of design and its reception in real-world settings.

The literature, inclusive of Rabah et al's (2018) and Kiryakova et al's (2014) research on educational gamification, suggests that our course offers multiple benefits:

- Enhanced cybersecurity awareness: The game-based training course, informed by existing research and design principles, offers an engaging and interactive way for students to learn about the dangers of online games and develop a better understanding of information security.
- Practical learning: By utilizing FrameVR, students have the opportunity to engage in a virtual reality experience that not only builds on the potentials of immersive technologies but also critically considers their limitations. The treasure hunt style of the game promotes active participation, allowing students to apply their knowledge in a fun and immersive manner.
- Refined critical thinking: The course incorporates puzzles and quizzes that stimulate critical thinking and problem-solving skills, with content meticulously tailored for the cognitive abilities and developmental stage of the targeted age group.
- Augmented student motivation: The fun and engaging nature of the training course motivates students to actively participate and retain the information they learn. Drawing upon the tenets of gamification, this approach is particularly beneficial for students who may be less engaged in traditional classroom-based methods, promoting a higher level of knowledge retention.

Limitations of the project

Technical limitations: The use of FrameVR may have certain technical limitations, such as software compatibility, hardware requirements, and internet connectivity. These factors can affect the functionality and accessibility of the game.

Lack of familiarity with the VR platform: Given that VR technology is still relatively new, it's important for children to become familiar with it. Therefore, we recommend introducing them to the FrameVR platform before they participate in the 'game.' This preparation will ensure a smooth experience without interruptions

Limited impact: Recognizing the vast landscape of online gaming dangers, it is acknowledged that the training course may not cover all possible risks comprehensively. The primary focus is on raising awareness and providing foundational knowledge to students. The impact on behavior change may vary, and it is essential to reinforce the teachings through continued education and support.

While these limitations are important to consider, they do not detract from the overall value and effectiveness of the training course. Efforts have been made to address these

concerns and maximize the learning experience for the students, promoting a safer online environment. Continuous evaluation and refinement will further enhance the course's impact and address any identified limitations.

Conclusions

This paper sought to explore immersive technologies to identify the best medium for a training program aimed at educating children above 10 on online gaming dangers. Virtual reality (VR) emerged as a preferred choice due to its strengths in enhancing engagement, motivation, and content retention.

Factors like usability, cost-efficiency, and target audience fit were pivotal in determining the apt VR tool for the training content. The insights garnered serve as a resourceful guide for those venturing into VR-powered cybersecurity education.

The research underscores VR's capability in amplifying awareness of online gaming threats among children. While further studies are advocated, these findings establish a solid foundation for subsequent research and shaping akin educational initiatives.

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