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Exploring Students' Experiences in Using Virtual Simulation and Gamification Principles for Authentic Learning and Assessment in Criminal Psychology

F. J. Gerard^a , K. Ammerer^a, M. Mentzelopoulos^b  and D. Economou^b 

^aCriminology, University of Westminster, London, UK; ^bComputer Science and Engineering, University of Westminster, London, UK

ABSTRACT

This pilot study delves into the use of virtual simulation and immersive experiences coupled with game-based principles in higher education, focusing on the teaching of criminal/investigative psychology. The study showcases how virtual simulation, and specifically "CrimOPS" (Criminology Offender Profiling Simulation), enhances knowledge transfer, engagement, and learning outcomes. This interdisciplinary tool allows students to practically apply theoretical knowledge in offender profiling by investigating simulated murders in a realistic environment. Three focus groups, totaling nine participants, were conducted to assess the students' experiences and perceptions of this learning and assessment tool. Through thematic analysis, three primary themes were constructed: experiential learning and skill development, innovative experience, and technical and immersive challenges. Participants expressed positive views on the simulation for the practical application of knowledge, skill development, and engagement. They highlighted its value in understanding profiling and practical field aspects. The study's recommendations will guide the future development of CrimOPS.

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Introduction

Bonasio (2019) emphasizes the growing significance of mixed reality and immersive experiences in contemporary education, highlighting their potential to facilitate knowledge transfer and foster identity formation, thereby impacting learning outcomes. Furthermore, Mayne and Green (2020) demonstrate the cost-effectiveness and practical benefits of using virtual reality (VR) crime scenes to impart practical skills to students while enhancing their overall learning experience. Mentzelopoulos et al. (2016) demonstrated an applied example of combining immersive learning and gamification to effectively support law students in higher education (HE)

investigating a crime case, applying law principles and making legal conclusions. The current project has been created to support the student experience and learning and teaching in a particular optional module/course entitled “Forensic and Criminal Psychology” which is offered in the Department of Criminology at the University of Westminster. As such, an inter-disciplinary collaboration was created between students and staff from the Department of Criminology and the Department of Computer Science and Engineering. The “CrimOPS” - Criminology Offender Profiling Simulation, was developed to allow students to investigate a series of murders in a gamified virtual simulation (GVS), and link the crime-scene actions/behaviors to the characteristics that the offender may possess (a process also known as offender profiling). CrimOPS was devised to enable students to apply their theoretical understanding of offenders and geographic profiling to a scenario closely resembling real-world contexts. Indeed, students must complete a template report, summarizing and analyzing the key features, as well as inferring offender characteristics, using academic and empirical evidence. The objective of this task lies in developing students’ observation and problem-solving skills, fostering critical thinking abilities, and facilitating the understanding of a case study. CrimOPS aims to function as an educational tool that authentically evaluates students’ abilities in an engaging, gamified immersive environment by simulating real-world criminal scenarios. The literature review will give an overview of pedagogical techniques, such as case studies, and the rise of technological tools in teaching and assessment.

Literature review

Case studies

Case studies are widely used as an instructional technique in disciplines such as Forensic Psychology and Criminology at our university. Razzouk and Johnson (2013) define case studies as “well-structured, authentic problems (i.e. real-world problems) that require learners to work collaboratively and apply their knowledge and skills to develop a viable solution to the presented problem” (p.752). The primary objectives of using case studies are to encourage the application of theoretical concepts to practical issues and foster productive thinking, thus facilitating the development of critical thinking skills (Dowd & Davidhizar, 1999). A review conducted by Popil (2011) highlighted that case studies promote active learning, clinical problem-solving, and the development of critical thinking abilities. Additionally, Dowd and Davidhizar (1999) found that case studies enable emotional preparedness, enhance the capacity to learn from past experiences, and encourage the exploration of alternative problem-solving approaches.

Currently, within the discipline of psychology, course material is commonly supplemented with case studies which assist in the illustration of the etiologic and diagnostic patterns, symptoms and treatments for different psychological disorders (Sheen et al., 2019). Furthermore, research indicates that case studies produce enhanced learning outcomes, resulting in improved student mastery and retention of the learning material, along with a heightened capacity to extrapolate the learned principles to broader contexts (Herreid, 2007; Chaplin, 2009). However, according to Sheen et al.

(2019), with the emergence of the Internet, new innovative teaching methods have been developed to capture students' interest, such as weblogs, interviews, YouTube videos, movie clips, and online discussion boards. Students have reported a heightened understanding of the material, potentially attributed to the accessible jargon-free first-hand information, as opposed to the formal language and limited scope typically associated with single case studies (Sheen et al., 2019). Popil (2011) highlighted that case study limitations include author biases, focusing on a single person or group, time-consuming for the instructors (i.e. development), the necessity for students to be prepared ahead, and the impossibility to generalize findings to a population. Technology can provide an alternative and improvement to case studies, and CrimOPS introduces the innovation of presenting a case study in a digital and immersive format rather than its usual paper-based form.

Serious games and VR in education

Serious games or computer-based learning games are designed to educate participants and have been found increasingly in a variety of disciplines, such as medicine or forensic sciences to train and develop students' knowledge of particular topics. An example is Adventure Legal Medicine (Anders et al., 2023), created to train students to understand the fundamentals of forensic casework, such as time of death, or DNA analysis, using five cases with specific tasks to complete in the game. Users had access to textbooks on methods and background, and received feedback at the end of a case from a virtual senior physician. Another example is an educational platform called "Unravel the Mysterious Murder" (Drakou & Lanitis, 2016), where players are police officers investigating a murder case in a three-dimensional environment. Players have to follow the procedures and rules, use the correct equipment and examine the evidence scattered throughout an eight-room house. Drakou and Lanitis (2016) found that users acquired and/or increased their knowledge of forensic investigation procedures after the game. They suggested that this game could be used as an educational tool to train forensic investigators, with some amendments recommended by Cypriot forensic specialists consulted on this project.

In recent years, with the increasing knowledge and decreasing costs of VR technologies, VR settings and serious games have paved their way into the educational setting and offer new opportunities for educators and students (Philippe et al., 2020). VR is described as a simulated environment that users (students) can explore, while the technology provides feedback to one or more senses after perceiving the user's position and actions (Makransky & Lilleholt, 2018; Sherman & Craig, 2019). It is argued that the VR environment might enable students to be active learners, capable of reflection, critical analysis and novel meaning-making, likely leading to a conceptual change (Sherman & Craig, 2019). Highlighting the notion of "learning by doing," Ticknor (2018) argues that VR has a longstanding history of utilization in professions like aviation and surgery, providing training for diverse scenarios in varied environments. This use effectively simulates real-world experiences for learning. For example, Baceviciute et al. (2021) conducted a study involving 51 University students divided into two groups, with one group reading a text about sarcoma cancer on a physical pamphlet in the real world, and the other group reading the exact same text on a

virtual pamphlet embedded in an immersive VR environment resembling a hospital room. It was found that students were able to memorize material on sarcoma cancer more effectively when in a virtual hospital room. In addition, most studies evaluating the usefulness of VR learning focus on medical education, teaching surgical interventions and anatomy learning, and these showed that VR simulators reduce errors and increase performance in surgical tasks (Haque & Srinivasan, 2006). Regarding the efficacy of VR technologies in education, Kyaw et al. (2019) found that they improve knowledge and skills compared to traditional teaching methods. Building on this, Avcı et al. (2019) conducted a meta-analysis study considering experimental studies and analyzing the effects of experimental and control groups on learning achievement. They found that three-dimensional VR learning environments were more effective than face-to-face teaching in terms of learning achievement. However, other studies suggest that there is no significant difference between education provided within a VR environment and other educational environments in terms of learning (Kaplan et al., 2020).

The entertainment value and enjoyment in VR-based learning

It is important, nevertheless, to point out the entertaining aspect gained through learning in a VR environment compared to learning in the classroom. Lucardie (2014) conducted a study on the role fun and enjoyment play in adult learning programs and their impact on adult learning, and suggested that fun and enjoyment are perceived by both adult learners and teachers as a motivator to attend classes and gain knowledge and skills. Furthermore, fun and enjoyment were found to encourage learners' concentration and thereby help them absorb the learned material. Entertainment in lessons is often achieved *via* games. The study conducted by Smetana and Bell (2012) highlights the effectiveness of computer simulations in science teaching, with computer games being just as effective, if not more, than traditional games in promoting knowledge, developing procedural skills, and facilitating conceptual changes. Building on this, Plass et al. (2015) present four main arguments for using game-based learning: motivation, engagement, adaptivity and graceful failures. Game-based learning motivates learners to remain engaged on a series of tasks, whilst their engagement is tailored according to learning goals, their characteristics, or the settings of the game. This type of learning is adaptable to all players with possibilities of self-customization, personalization of the game or features according to each player's specific situation. Finally, "graceful failures" are seen as part of the design and an integral and useful part of the learning process in which one learns from their mistakes (Plass et al., 2015).

Limitations of VR-based learning

Limitations were identified in a study by Merchant et al. (2014) investigating the impact of instructional design principles in VR-based instruction in HE. Individually playing games was found to enhance students' performance more than collaborative play. This limitation has been echoed in other studies, highlighting the

potential drawback of limited peer interaction and communication with instructors in VR game-based learning environments (Bolliger et al., 2015). Additionally, individual differences should be considered, as some students may derive greater enjoyment and learning benefits from computer-based games. Gender disparities in gaming enthusiasm were observed, with male students exhibiting higher levels of interest compared to female students (Hailey et al., 2011). Inclusive considerations are also crucial, as VR programs often rely on stable internet connections and computer proficiency, potentially excluding students with disabilities or those who struggle with online learning (Pringle et al., 2022). Moreover, appropriate resources and support must be provided to ensure equitable access and avoid potential pitfalls.

Enhancing student experience in crime-scene analysis and innovations with VR Technology

Casanova et al. (2011) suggest that VR could be used as a tool to enhance crime-scene investigation. They used the capabilities offered by VR and synthetic images to allow the manipulation of virtual exhibits in a crime-scene while seeing the actual surroundings, which can be a powerful tool for visual hypothesis formulation and verification (Casanova et al., 2011). More recently, Mayne and Green (2020) conducted an experimental study comparing undergraduate students and staff/postgraduate students to evaluate the effectiveness of a bespoke VR crime-scene app in teaching practical crime scene processing skills. The majority of participants found the VR app suitable for its intended purpose, achieving the desired learning outcomes such as identifying relevant evidence and generating appropriate hypotheses. The participants also expressed high satisfaction with the VR app, indicating its potential as a valuable teaching and learning tool. As explained earlier, Drakou and Lanitis (2016) developed a serious game "Unravel the Mysterious Murder," aimed at training crime scene investigators in forensic examinations. Building on this, Pringle et al. (2022) advocated using VR in teaching forensic science, reporting increased awareness and understanding of equipment usage and best practices among forensic geoscience students through an educational forensic geoscience eGame. Additionally, VR was used in a legal context to analyze murder and manslaughter scenarios, enabling law students to apply theoretical knowledge to actual cases (Mentzelopoulos et al., 2016). However, specific studies focusing on criminal/investigative psychology in VR have not been identified in the available literature.

With the pedagogical shift from traditional lectures towards a more student-centered environment in HE, it is predicted that the use of serious games as an innovative learning technology will increase, with games and simulations being expected to play a significant part in the learning process (Vlachopoulos & Makri, 2017). However, ethical considerations are crucial for the future development of educational games. The design of these games inevitably reflects the values, attitudes, and beliefs of their creators, raising concerns about who is responsible for their design (Alshammari, 2021). Additionally, emphasis should be placed on player independence, allowing learners to actively engage in the learning process, make their own choices, and observe the consequences of their actions (Alshammari, 2021). Furthermore, Bonasio

(2019) suggests that virtual environments should not be limited to brief engagement but should provide immersive experiences within rich contexts, incorporating strong narratives and authentic practices that connect to real-world outcomes.

The literature review showed the numerous benefits of immersive learning, and gamification in addressing authentic teaching and assessment, and there has been some development of its uses in a variety of disciplines. There is, however, a lack of studies looking at its benefit in the context of criminal psychology, and the development of CrimOPS is an effort to remediate this gap and create an educational tool for this topic area.

CrimOPS was piloted by students and this study aimed to explore the student experience of using CrimOPS in relation to student engagement, motivation, and learning through the use of a virtual simulation. This is a qualitative study that sought to explore the research question: "What were students' experiences of CrimOPS; what worked, their preferences, dislikes, and what would they recommend to improve the experience?".

Method

Design and implementation of CrimOPS

CrimOPS was designed as an educational tool, a first-person game in a three-dimensional environment in which students are behavioral investigative advisers working with the police to understand a serial murder case. The scenario, designed by the lecturer who has received training in forensic medicine and investigative psychology, was created to be as authentic as possible and usable for students' purposes. The players are being called to the crime-scene after a witness found a body in a park. The game takes place in two main scenes and players can investigate the crime-scene at the park (scene 1) (see [Figure 1](#)), collect evidence ([Figure 1\(b, c\)](#)), and speak to characters at the crime scene ([Figure 1\(a\)](#)), mimicking reality as close as possible. Participants are then directed to a police station (scene 2) (see [Figure 2](#)), where they can assist in a series of interviews with people who knew the victim and could help to reconstruct what happened. The game was developed using the Unity 3D game engine.

Consequently, CrimOPS was designed as a platform for students to immerse themselves in a case study involving serial murders (Gerard et al., 2022). As part of their module/course, students have taught sessions on offender and geographic profiling, and understanding serial killers, which cover the history, development and a critical evaluation of the field. The assessment required students to synthesize information, demonstrate their understanding of the case, and apply academic literature to make inferences about the characteristics of the offenders. Additionally, students analyzed salient case features and utilized summary skills, problem-solving abilities, communication skills, and decision-making processes.

Sample

This data collection was conducted at the University of Westminster, between December 2021 and January 2022. Participants' experiences of CrimOPS as a learning and

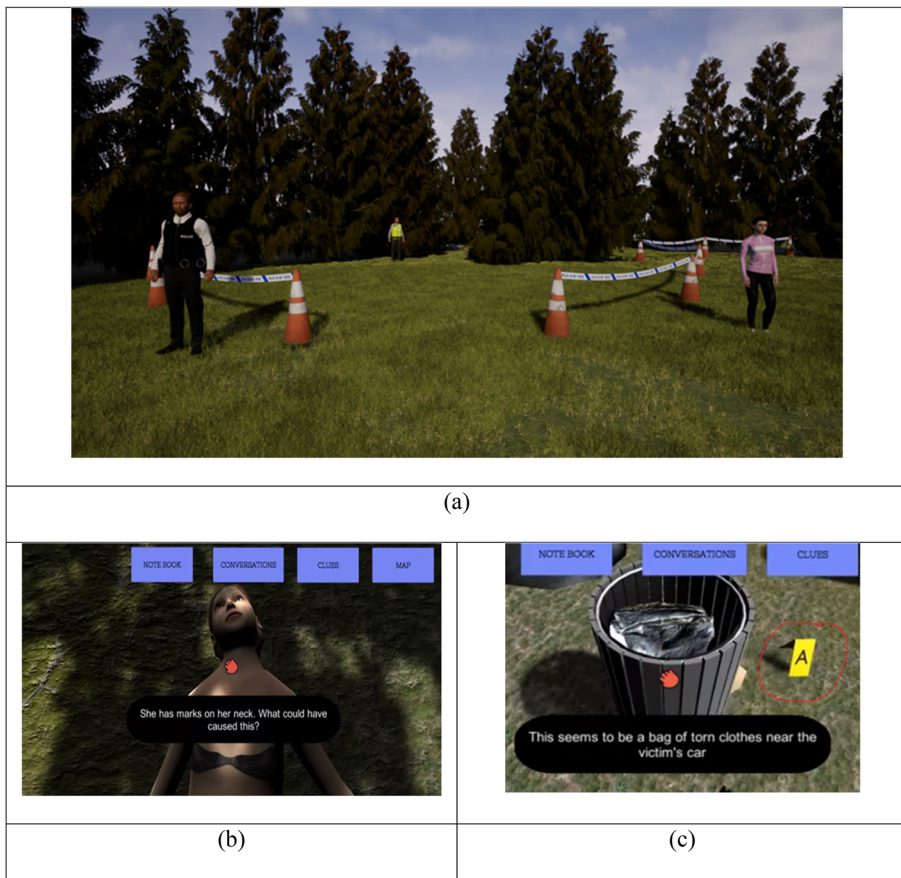


Figure 1. CrimOPS crime scene at the park.



Figure 2. CrimOPS scene at the police station.

assessment tool were gathered from focus groups. A convenience sample was recruited after advertising the research in class to all students ($N=100$), and an announcement on the virtual learning environment was released to gather volunteers to participate in this study. The overall sample consisted of students in BA criminology and BA

sociology and criminology, registered in second year module on Forensic and Criminal Psychology, during which they were taught the topic of offender profiling and used CrimOPS. Nine female students, aged between 19 and 29 years old ($X: 22.4$; $SD:3.5$) took part in three focus groups (three students per groups). In the context of usability testing, where the primary focus is on studying user performance and preferences, employing nine participants proves to be sufficient, enabling the identification of a substantial number of interface issues (Hwang & Salvendy, 2010).

Focus groups

The focus group sessions followed the guidelines as described by Krueger and Casey (2000). All focus groups took place online *via* MS Teams and were audio recorded with students' permission and lasted for around 45 min. It was explained that there were no definitive right or wrong responses, emphasizing on the exploration of participants' experiences, perceptions and feedback. These focus groups occurred after the module had ended and the semester finished. Participants were asked about their experiences of CrimOPS, what they liked or not, but also about it as part of their assessment, and any recommendations that they might have had (see questions of semi-structured interview schedule in [Appendix 1](#)). The interest in conducting focus groups was to learn about each individual's experiences but also their interactions with their peers and their shared experiences as one of the benefits of focus groups is the joint construction of meaning (Bryman, 2016). The sessions were facilitated by the first (FJG) and second (KA) authors.

Data analysis

The recorded focus groups were transcribed verbatim, and imported into NVivo 12 (i.e. software allowing the classification/coding of data, to support the iterative process of thematic analysis). Reflexive thematic analysis, which was developed by Braun and Clarke (2022), was used, to provide theoretical independence and flexibility. An inductive approach was used, in which codes and themes were constructed from the data. Their six-phase analytical process was followed, which means that each transcript was read in-depth and several times, initial and recursive coding were conducted. The next phases were to group codes and refine themes, to finally define the themes and write the final analysis (Braun & Clarke, 2006). The transcripts were coded by the lead author and the second author, who discussed codes and the development of themes in an iterative process. As such, a quantitative approach to inter-rater reliability (measuring inter-coder agreement) was incoherent with the reflexive approach that is being used (Braun & Clarke, 2022).

Ethical approval was granted from the University of Westminster. Participants provided informed consent by signing a form and were explicitly informed of the voluntary nature of their participation and were assured the right to withdraw from the study at any point if they felt uncomfortable. Participants were offered each a £10 voucher for participating in the focus group. The following section will introduce the results of the analysis.

Results

Three themes were created that reflected the student experience:

- experiential learning and skill development,
- innovative experience,
- technical and immersive challenges.

All the participants related their own experience of CrimOPS. They expressed what they liked or disliked, what worked or didn't work for them, and how they engaged with it as a learning/teaching tool, but also as an assessment tool. A video recording of the game being played slowly ("a playthrough") was provided to address accessibility and inclusion for the students who were not able to interact with the simulation or chose not to do so. This allowed them to explore the simulation as if they were personally engaged in the gameplay. All participants attempted to play CrimOPS and the majority also used the playthrough to ensure they hadn't missed any parts of the case. The following subsections present the three themes that have been created to reflect students' experiences.

Experiential learning and skill development

This theme highlights the positive experience and perception of participants in skill development, innovative and practical learning and engaging experience. Each participant expressed their unanimous perception that the virtual simulation provided them with a platform to effectively apply the knowledge acquired through classroom lectures and seminars, as well as their own research endeavors. Rather than perceiving the simulation as an avenue for acquiring novel information, participants primarily viewed it as a valuable tool for practical application of their existing knowledge base, as exemplified by participant 9:

I think it was a helpful tool. It wasn't like the, the most important thing which could help you with understanding offender profiling because you need to have the base with the theories and everything. But for the person who already read all of the materials, it was really helpful tool because when you have this base of the theories and all of the academic stuff. I could say it's really nice to go and just use it in practice [P9 FG3¹].

This experiential learning is also translated into skills development. One participant explained how the assessment helped them with their critical thinking, necessitating a meticulous consideration of each constituent element within the simulation. Most participants also said that it helped them gain a clearer understanding of profiling, and they seemed to enjoy the practical element of using this as a tool. They thought that it was very interesting to explore the crime-scene, attend police interviews, consult autopsy reports, and have the different aspects of what would constitute a real murder case: "so it's cool that we could put it in an actual real-life scenario where there is an actual murder happening, it was just nice, yeah" [P2 FG1].

¹Participant names are made of the number they were allocated to as well as which focus group they were part of. As an example here: P3 FG1, this was participant 3 from the focus group1.

Participants in two of the focus groups also mentioned the benefit of doing this assessment at their own pace and going back to it if they missed anything. They also felt that they had a bit more freedom and control:

It just... it was a nice break from..., it didn't feel as heavily academic as you know, a lot of what the other things that we do and that a lot of the other assessment styles obviously it is still academic. But I think with the simulation and just the fact that you're sort of making your own report, you kind of you feel that you've got a bit more control over it as well [P5 FG2].

This can also reflect the development of authentic skills and independence that can be provided by feeling more involved with the situation and simulated environment in which students needed to reflect and provide a useful report for the investigation.

Innovative experience

This theme highlights the novel aspect of this learning experience. Every participant perceived the GVS as noticeably different from their customary experiences at the university, with many expressing excitement and enjoyment throughout the process. However, for students unaccustomed to playing video games, this novel approach provoked apprehension and proved to be challenging for some. Nevertheless, the majority of participants expressed gratitude for venturing outside their comfort zones and ultimately expressed satisfaction with their decision to participate in the simulation. Passed the initial shock, one of the participants said they were swayed:

At the beginning I was like oh [name of the lecturer] why you can't just give us a question? Why are you stressing out us this long? but I think, if I'm asked what would I want to be changed, I don't think I would anything to be changed. I think it was a really good experience and we weren't spoon fed [P8 FG3]

There is comfort in traditional assessments, that they know and have been regularly practicing for, but this might be at the expense of developing a new range of skills. Participants could also all see that this was an innovative approach, set to provide them with a more authentic experience, very far from the usual university coursework:

I thought it was so, I thought it was refreshing to have something that was just different. You know it just wasn't the same assessment style that we've done 100 times [P5 FG2].

Participants said they felt quite excited at the prospect of investigating a case. They also felt quite engaged with the task, in comparison to traditional case studies on paper (P5 FG2), but also taking a very proactive role:

I really felt like I'm involved in the process of collecting this evidence, and even later, when we've been writing the offender profiling and I had everything in my notes, I felt like I collected this myself, so it was really engaging [P9 FG3].

Here the participant felt really engaged with the tasks and we asked whether they might have preferred a paper-based version instead of CrimOPS, participants were uncertain, acknowledging that playing and experiencing a scenario might be more enjoyable than reading about it. The unanticipated tepid response to CrimOPS might

have been due to the technical issues they experienced, but this might also be apprehension or the perception that a paper-based would be “easier” than playing a game.

Most participants said that they found this learning/assessing experience interesting and enjoyable. Participants who either actively engaged in gameplay, or derived enjoyment from watching the game video playthrough, expressed a positive and entertaining experience while exploring CrimOPS. Several participants acknowledged that, despite being aware of its academic nature and association with an assignment, they appreciated the change from the usual literature searches to address essay questions. They also explained how the GVS made them engaged with the content of the lecture and seminars on the topic:

I think it made me engage with the stuff that we were taught, so like the part that I understood most was the geographic blank and by being given that... that photo of the map, it was really helpful to me to actually engage with what we have been taught in the lectures and seminars [P6 G2].

The student reflected back on how the theories could be put into practice and applied in the real world, providing a deeper understanding. Conversely, for some participants, the connection between CrimOPS and the assessment dampened their enjoyment, limiting the overall sense of immersion and entertaining value. One of the participants also mentioned that some of her classmates were resistant to the idea and did not want to engage with the simulation. Indeed, the many technical and practical issues with the game impacted their experience. Many relied on the playthrough to overcome these issues.

Technical and immersive challenges

This theme illustrates some of the negative aspects encountered by participants when playing CrimOPS and has two subthemes: technical challenges and immersive challenges.

Technical challenges

This subtheme explored how participants engaged with the practical and technical aspects of the simulation. Several technical challenges manifested early in the process, as evidenced by MacBook users encountering incompatibility issues and subsequently being directed to use university computers. Moreover, participants faced disruptions such as lags and glitches during gameplay, resulting in instances of being trapped within certain areas of the simulation. Participants further brought attention to practical impediments and difficulties in communicating or interacting with specific characters, as well as grappling with maneuvering their own characters within the game, thereby affecting its overall playability. The game also kept crashing with a participant saying: I literally spent basically the whole day trying to finish the game even just once [P3 FG1].

Another crucial issue was the fact that the game did not save students’ progress and they had to restart everything from the beginning if the game crashed, or if they were trapped and exited the game. Most participants were frustrated with all the issues mentioned and felt like they were wasting precious time as illustrated here:

It was the fact that you couldn't like, save the game, I think that was one of the most, not like, not the least favorite but the most, like frustrating thing about the game [P2 FG1].

The participants explained how they, and other classmates, stopped trying to play the game and instead opted for the alternative provision that was arranged by watching a playthrough of the game. This alternative method granted students unrestricted access to the comprehensive information required for comprehending and analyzing the given case.

that was stressful. So yeah, the videos you made were perfect for me. That was what got me through the whole assignment. So yeah, it was great. [P8 FG3]

As a result of these technical issues, several participants felt that the simulation was not ready to be used as an assessment tool. Students were also given an extension once it was realized that they needed a little more time to analyze the videos.

I think it was bugging out so much and then that it was actually linked with an assignment it was like – because some of us were saying it was a good idea, because its different but we would have preferred it more as like a test or small kind of assignment and then a big one because at least then there won't be as much I guess pressure in terms of trying to get this thing to work and it's not working. [P3 FG1]

It seems that the numerous issues around playing this pilot game led to a stressful situation for the participants.

Immersive challenges

The game was produced by an undergraduate student of the computer science and engineering school, and as a result, its realism in graphics and interactivity cannot be compared with the professional video games that students are used to and expect, as illustrated here: "The quality of the game itself. It wasn't the best. It felt like you were playing a really old game" [P7 FG3].

Additionally, as explained previously, the response to the provision of a playthrough video of CrimOPS was provided to students as an alternative means of experiencing the content of the virtual simulation to complete their assessment. However, this influenced immersion and some participants failed to feel immersed, as can be seen in this quote:

I think, yeah, the design of the game didn't allow me to be fully immersed in it, it was sort of like watching a TV show if you know what I mean. Like watching it and seeing what happens with the interviews and stuff but not really. I had my own thoughts about it, but I didn't think I was in the game if that makes sense? [P1 FG1].

However, participants also talked about how they liked the interactive nature of CrimOPS, and enjoyed playing or watching the paythrough. They could explore the crime-scene and the surroundings, the police station in which they could be involved in some of the dialogue with witnesses/family/friends of the victim. Several lecturers recorded the voice over of some of the characters in the game, which added a fun aspect to trying and recognize the voices:

I liked having the voiceovers from the lecturers because I think that just made it more interactive having something like that rather than just reading it off the screen, so I think that was a good thing just to have – yeah I think that was really my favorite just because it was so interactive in that sense [P1 FG1].

This was also done to try to give them a feeling of familiarity when immersed in the GVS and was received positively by all participants.

Finally, participants made several recommendations based on their experience to try and improve the existing simulation, some of which are trivial to be implemented:

- Creating automatic saving points throughout the game
- Fixing technical issues (glitches, lags) and making it compatible and accessible to most computers (including MacBooks)
- Improving graphic and authenticity of the experience
- Ensuring that any additional features, such as a notepad or list of pieces of evidence collected could be saved and usable.

Additionally, participants also commented on access to more resources to help them to make evidenced based inferences, keeping an example and template for the structure of the report, and other elements that could improve assessment content. Finally, they also commented on what could be done in the seminar session to support students with the use of the simulation and the assessment.

Discussion

Despite being a pilot project aimed at using an innovative GVS approach to foster authentic learning and assessment, numerous valuable insights were gathered from this endeavor. Findings from this study indicated three main themes in the experience of all participants: experiential and practical learning, innovations, but also technical and immersive challenges.

In the experiential learning and skill development theme, participants had an overall positive perception of CrimOPS as a useful tool to apply what they had learnt. VR enables participants to learn and train within a safe, secure, and controlled environment, and has been used to train practitioners in medicine, psychology and law enforcement for decades (Ticknor, 2018). It has also been used to recreate crime-scenes for trainees to interact with and examine, to apply theoretical knowledge but also to enhance understanding of forensic practices (Drakou & Lanitis, 2016; Mentzelopoulos et al., 2016; Pringle et al., 2022). Kyaw et al. (2019) found that VR technologies enhance knowledge and skills in comparison to conventional teaching methods, and it would have been interesting to see whether this approach is better than paper-based case studies, and future studies could consider this. “Learning by doing” and using VR to do so has showed very positive results and a better recall of information than simply reading about something (Baceviciute et al., 2021; Kyaw et al., 2019). Although essay writing skills are important, CrimOPS provided a framework in which students have to understand a case scenario and write a report on their meticulous examination of all the constituent elements necessitating interaction within the scenario. They also

needed to consult relevant existing academic literature to build an argument on making evidenced based inferences whilst remaining critical. Studies have shown that developing critical thinking skills is very important in numerous disciplines (Popil, 2011; Pringle et al., 2022). This task was seen as an opportunity for the development of new skills, as well as resilience and perseverance with a difficult task. Participants also perceived this task to be akin to a practice-oriented approach, as opposed to a predominantly theoretical one, affording them a measure of autonomy and control to construct their own case report. Encouraging the development of problem-solving skills is essential as this is often a sought-after soft skill by potential employers, and the use of case studies was found to facilitate this (Dowd & Davidhizar, 1999).

In the theme “innovative experience,” the uniqueness and novelty of this experience sparked both excitement and apprehension among participants. The apprehension was clearly linked to the assessment side, and the consequences of not engaging with CrimOPS and completing a report on this case for the assessment. CrimOPS was designed to improve students’ learning experience, and Plass et al (2015) argued that game-based learning would increase students’ motivation and engagement. Participants felt engaged with completing the task and expressed that playing or watching the recorded playthrough was an amusing part of the learning activity. As such, Lucardie (2014) found that having fun and enjoying playing activities in an adult learning environment motivated participants to attend classes and acquire knowledge and skills, fostered concentration, and facilitated the creation of a socially connected learning environment. HE increasingly values authentic assessments, which necessitate the application of real-world professional competencies and foster the development of skills such as problem-solving, and strategic thinking and working under pressure (Gulikers et al., 2004; Villarroel et al., 2018). The use of CrimOPS as a learning and assessment tool has, therefore, much potential in developing the knowledge of students but also numerous soft skills that will be useful in everyday life.

In the technical and immersive experience theme, participants reported some negative experiences and frustration and the need to improve the virtual simulation, in terms of playability, graphics, design and game features (e.g. saving the progress). As this was co-created, the student who designed the original version of CrimOPS had to learn several new programming skills in Unity, as well as design a series of assets to enhance the experience of students. Although many improvements were made thanks to piloting the first version before releasing it to students, nonetheless, there were still several issues when expanding it to a larger sample. At the time of writing, a new version of CrimOPS has been created in Unreal Engine 5 for a more authentic feel and better user interaction. The “playthrough” video seemed a worthy addition that will ensure inclusivity for anyone struggling with the game (Pringle et al., 2022).

Limitations and further developments

This pilot study would have greatly benefited from employing a mixed-methods approach, as originally planned. Moreover, larger focus groups would have provided a more comprehensive understanding of the participants’ experiences. Additionally, the lack of gender diversity is another limitation (and considering Hainey et al. (2011)

findings on gaming enthusiasm), although the gender ratio in class is 1:10 of male students for that class. It is worth noting that two of the focus groups were conducted by the first author, who also served as the module leader. This introduces the potential for biases and potential limitations in the range of perspectives that were explored. The presence of the module leader as the moderator may have influenced participants' willingness to express negative experiences or opinions, leading to potential self-censorship. Additionally, the provision of incentives to participants may have influenced their overall perception, potentially resulting in a more favorable view of the simulation. However, participants did not seem to shy away from the challenges they encountered. The generalizability and internal validity may threaten the results, and further study on larger and more diverse samples is needed.

All recommendations gathered from the focus groups were implemented, and changes were made to the original CrimOPS. It is hoped that refinements will continue to occur and that this tool can be co-created between students using it in criminology and students in computer-sciences to build it. Additional scenarios are also hoped to be developed as well as a version that could be used with 3D headsets.

In conclusion, the use of a gamified virtual simulation tool to allow students to experience a criminal case study has shown that it can be a very useful support to develop students' knowledge and skills. Students also felt that this was a fun and innovative approach that was interesting and practical. Modifications need to be made to ensure that the gaming experience is smooth and free of technical issues but shows great potential. Notes

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Notes on contributors

Dr F. J. Gerard, PhD, is a senior lecturer in Criminology at the University of Westminster and course leader for the BSc Psychology and Criminology. Her academic background is in Psychology and Investigative Psychology, and she is a Chartered Psychologist. She has been involved in a number of research projects and worked on large international studies, such as the interdisciplinary, multi-agency, EU-funded project: "Examination of Firearms and Forensics in Europe and across Territories" (EFFECT). She has published her work in a number of high-quality international journals on juvenile homicide, school shooting, cyber-related homicides. Her research interests include criminal behavior, violent crime and homicide, gun crime, police investigations and offender profiling.

K. Ammerer is a Master's graduate in Criminology from the University of Westminster (United Kingdom). She is set to start a PhD in Criminology, and her research interests include female imprisonment, prisoners' families and prison education.

M. Mentzelopoulos, MSc, is a senior lecturer and Course Leader for BSc Computer Games Development at the University of Westminster. His research interests encompass a range of areas, including the analysis and retrieval of sports videos based on content, the detection of semantic events, the application of statistical methods and pattern recognition techniques for classification and modeling, as well as tracking and recognition. He has also been exploring man-machine interfaces and specializes in the design of serious games. Markos has a substantial publication record in both conferences and journals and has actively contributed to program committees at various international conferences within the fields of multimedia and neural networks, such as IJCNN, ACM, and ACVR. Furthermore, he brings valuable industry experience as a Program Analyst and Developer, having previously worked with Glaxo Smith Kline (G.S.K) in 2006.

Dr D. Economou, PhD, is a senior lecturer at the Department of Computer Science, Faculty of Science and Technology at the University of Westminster. She is also the leader of Serious Games at Westminster Research Group. She is a dedicated and innovative educator who employs imaginative teaching methods to actively involve and inspire her students in their educational pursuits. Her research, well-documented in widely referenced publications, revolves around enhancing pedagogy in higher education, with a focus on game-based and technology-enhanced learning designed to enhance the student learning experience. She is a Senior Executive Board Member of the IEEE Technical Committee on Immersive Learning (IEEE TC-ILE), and she volunteers as an Executive Board Member of The Immersive Learning Research Network (iLRN), a non-profit that promotes immersive technologies for education and innovation. Besides this, she served as Associate Editor for various Journals related to Computer Science, Digital Health, Immersive Technologies, Virtual Environments, and Advanced Interfaces. Her other professional contributions include invited talks, peer-reviewed publications, and editorial work, including chairing and co-organizing multiple academic conferences and events.

ORCID

F. J. Gerard  <http://orcid.org/0000-0003-1246-5879>

M. Mentzelopoulos  <http://orcid.org/0000-0002-0799-8673>

D. Economou  <http://orcid.org/0000-0003-0885-4011>

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Appendix 1: Questions for semi-structured interview

1. Tell us about what you thought of the virtual simulation?
2. What did you like the most about the virtual simulation?
3. What didn't you like at all about the virtual simulation?
4. We'll now talk about some of functionality to see if you have any recommendations to make in terms of: a) the design of the game; b) interactions with characters in the game; c) immersion (did you feel like it held your attention)?
5. Do you think it was helpful for your understanding of the module?
6. Do you think it was more practical to do an assessment like this rather than just a written assessment (essay)?
7. Did you have any technical issues? (explore)
8. What do you think could be improved?
9. Would you like to use this method again in future assessments?
10. What you think you have learned from the virtual simulation?
11. Would you like to tell us about your experience with the game?