

**WestminsterResearch**

<http://www.westminster.ac.uk/westminsterresearch>

**Work-In-Progress—CrimOPS-Gamified Virtual Simulations for  
Authentic Assessment in Criminology**

**Gerard, F. Jeane, Mentzelopoulos, Markos, Economou, Daphne,  
Khalish, Zeeshan, Ingram, Jack and Ashley, Edwards**

This is a copy of the author's accepted version of a paper subsequently published in the proceedings of the 8th International Conference of the Immersive Learning Research Network (iLRN 2022)), Vienna, Austria, 30 May - 04 Jun 2022, IEEE.

The final published version is available online at:

<https://doi.org/10.23919/ilrn55037.2022.9815942>

© 2022 IEEE . Personal use of this material is permitted. Permission from IEEE must be obtained for all other uses, in any current or future media, including reprinting/republishing this material for advertising or promotional purposes, creating new collective works, for resale or redistribution to servers or lists, or reuse of any copyrighted component of this work in other works.

The WestminsterResearch online digital archive at the University of Westminster aims to make the research output of the University available to a wider audience. Copyright and Moral Rights remain with the authors and/or copyright owners.

# Work-In-Progress Paper – CrimOPS – Gamified Virtual Simulations for authentic assessment in Criminology

F. Jeane Gerard  
*School of Social Sciences-Criminology*  
*University of Westminster*  
London, UK  
gerardj@westminster.ac.uk

Zeeshan Khalish  
*School of Computer Science and Engineering*  
*University of Westminster*  
London, UK

Markos Mentzelopoulos  
*School of Computer Science and Engineering*  
*University of Westminster*  
London, UK  
mentzem@westminster.ac.uk

Jack Ingram  
*School of Computer Science and Engineering*  
*University of Westminster*  
London, UK  
j.ingram@westminster.ac.uk

Daphne Economou  
*School of Computer Science and Engineering*  
*University of Westminster*  
London, UK  
D.Economou@westminster.ac.uk

Edwards Ashley  
*School of Computer Science and Engineering*  
*University of Westminster*  
London, UK

**Abstract**— Authentic assessment is the concept of using creative learning experiences to assess students' skills and knowledge in conditions that simulate reality. The importance of authentic assessment in higher education is recognized as it helps measure student performance and attainment of skills related to the expected learning outcomes of the degree program they study that map the skills required in their profession in the related industry. There is also growing evidence that authentic assessment can enhance student engagement, and improve the student experience and learning outcomes. VR coupled with gamification offers the authentic context for students to apply their knowledge and skills while solving real-world problems. This paper presents a work-in-progress study that focuses on the creation of an educational resource that effectively supports teaching and learning crime-scene analysis and evidenced-based inferences in Criminology through simulated crime scenes. The paper describes a participatory design process involving students and academics as co-creators of a VR game, the CrimOPS, it presents the initial prototype derived from this collaboration and preliminary study results.

**Index terms** — *Virtual Reality; Authentic Assessment; Serious Games; Game-Based Learning; Criminology.*

## I. INTRODUCTION AND PROBLEM STATEMENT

Currently, case studies have been used to teach how to analyze salient features in a homicide committed by serial killers in our class. According to Sheen, Yekani, and Jordan [1] case studies have been used in several disciplines as a strategy for active learning and found to encourage student engagement and critical thinking.

However, Bonasio found that mixed reality and immersive experiences will play an increasingly critical role in modern education, and immersive learning is “a powerful vehicle for identity and knowledge transfer, both of which are crucial factors affecting learning outcomes” [2]. Akhgar, et.al. present how serious games can enrich and complement other training approaches, especially in the sense that they provide a link between the classroom, scenario-based training, and real-life operations [3].

This project has been created to support learning and teaching and improve students' experience of criminal psychology for criminology students at the University of Westminster. As such, an inter-disciplinary collaboration was created between Social Sciences and Computer Science. A Participatory Design approach has been adopted, involving students and academics as co-creators of a gamified virtual simulation (GVS), namely the “*Criminology Offender Profiling Simulation*”: CrimOPS. CrimOPS combines VR technology and is designed to support the criminology students to apply their theoretical knowledge of offender and geographic profiling to a scenario that would be close to physical reality. The GVS would support the learners develop observation and problem-solving skills and critical thinking to understand what happened in a scenario. Additionally, students would learn to make inferences supported through the use of empirical academic studies in an assessed report.

The rest of this paper presents the research questions driving this study, the methodology we followed, the research instruments we designed to support the study, and the preliminary results. The paper closes with a discussion and future directions.

## II. RESEARCH QUESTIONS

The ultimate goal of this work-in-progress project is to study the effect of GVSs for authentic assessment. We unpack student experience as elements of student engagement, motivation, and learning compared to the use of case studies in supporting HE students in achieving deeper learning [4]. The research questions this project attempts to answer are the following:

- RQ1 GVSs support authentic assessment;
- RQ2 GVSs can help learners achieve deeper knowledge and critical thinking;
- RQ3 Criminology students perform better in terms of achieving learning outcomes with GVSs compare to conventional paper-based material;
- RQ4 GVSs compared to conventional paper-based material improves student engagement;

RQ5 *GVSs compared to conventional paper-based material improves student motivation and experience;*

### III. RESEARCHRESEARCH METHODOLOGY

To study the research questions and address the project aims the study ensues the following systematic approach:

- uses a Participatory Design process involving all the stakeholders (students and academics) for the design of an educational resource for authentic assessment;
- uses criminology students who were taught offender profiling, as insiders to create the scenarios that can assess the knowledge of their peers;
- it combines VR technology and gamification for the creation of an educational resource for authentic assessment, the CrimOPS, which will be used as a research instrument for the study;
- it plans a comparative study to evaluate the achievement of expected learning outcomes in offender profiling, as well as the student experience comparing paper-based versus authentic assessment using a GVS, the CrimOPS;
- uses analytics integrated into CrimOPS to evaluate the learner's journey and learning behavior, like collecting evidence, completing tasks, and time-related to achieving those tasks;
- user satisfaction is evaluated using the User Experience Questionnaire (UEQ) [7] and immersion based on the Immersive Experience Questionnaire (IEQ) [8].

The following sections elaborate on the creation of the research instruments to support the study.

### IV. PROTOTYPE DESCRIPTION – VR INTERACTIVE GAME

To support the study two research instruments have been created: (a) a paper-based and (b) a GVS, both covering learning outcomes demonstrating recognizing salient features of a criminal case, such as:

- Modus Operandi (MO), actions necessary to commit a crime successfully [5];
- Signature, behavior going beyond what is necessary to commit the crime, almost as a ritualistic action, related to cognitive process and relatively consistent [5];
- Staging, intentional alteration of the scene before the arrival of the police [5];
- Trophy, item taken from the crime scene or the victim (something personal) by the offender to symbolize the offender's triumph over the victim [6];
- Souvenir is, a meaningful item taken by the offender to remember the incident and the pleasure gained from the crime [6]

Both research instruments covered the same learning outcomes to support the students to discover salient characteristics of the crime scene but simulated two different crime scenes so that the student performance could be compared. The GVS application consists of the following levels.

#### A. Level 1 – Crime Scene

The learners take the role of the criminal investigator who visits and explores a crime scene to collect evidence and recognize the salient features of the crime scene. The learners meet police and forensics investigators on site who also provide the information they collected at the crime scene (see Fig.1). The learners collect evidence (see Fig. 2.) and note down information in a notebook. There is no time limit to explore the scene and no system assistance about the clues to be found from a hint for the number of clues to be found, simulating as closely as possible a real-life crime scene investigation. Learners can take as long as they need to collect information and they can return to the scene if they needed to. The game provides also a map that shows the crime scene location.

#### B. Level 2 – Forensics examination

The learners visit the crime lab and talk to a forensic medical examiner to gather the information derived from the forensics examination of the victim's body (see Fig. 3).

#### C. Level 3 – Interviews

The learners return to the police station and support the police interviews with witnesses and people related to the case to gather the information that could help the crime investigation (see Fig. 4).

At the end of the investigation, the learners analyze the clues they have collected and the notes they have taken to conclude the case. They will then complete a report that combines their understanding of the case with the evidence-based inferences that they made with the support of academic studies.



Fig. 1 Crime scene of a park that the learners have to explore in level 1 of the game



Fig. 2 Clue related to the crime scene in level 1

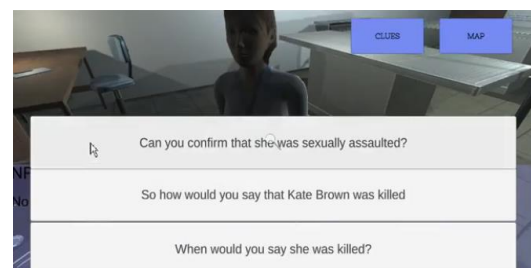


Fig. 3 Conversation with the forensic medical examiner



Fig. 4 Conversation between the police investigator and a friend of the victim

## V. THE STUDY

In this paper, we present a preliminary study involving a small number of second-year students in criminology/soc/crim, registered in a Forensic and Criminal Psychology module. The purpose of this preliminary study was to test the research instruments and the study plan. Participants have been presented with a paper-based scenario of a serial murder case and they have been asked to provide a 250 words summary of their understanding of the case and an analysis of the salient characteristics (e.g., MO, signature, staging, etc) (see Section IV). In the second part of the study couple of weeks later the students have been presented with a virtual simulation/game based on a different scenario to get accustomed to. To evaluate if the use of the different learning instruments supported students to achieve better learning outcomes, we compared the summaries and the salient features they presented for both scenarios.

To evaluate the design of the simulation, as well as the learners' experience, motivation, and understanding participants received an online 5 Likert Scale questionnaire (Negative 1 2 3 4 5 Positive). That was organized into four parts collecting: demographics; feedback about game features; User Experience Questionnaire (UEQ) [7]; and immersion based on the Immersive Experience Questionnaire (IEQ) [8]. All collected data has been aggregated, allowing for all participants' anonymity.

Only 7 students completed the survey and we found that students mostly disagree (somewhat disagreed/strongly disagreed) that the paper-based case was more engaging (n=4)/interesting (n=4) than the gamified VR application. Most students found that the paper-based case was more real (n=6) and more stimulating (n=4) than the gamified VR application. Students had a shared feeling on whether the paper-based was more fun than the gamified VR application (3 agreed, 2 disagreed and 2 had no opinions). Students felt more frustrated (n=5) and anxious (n=4) with the simulation than with the paper-based.

The student had mixed feeling about whether they felt less scared or put off by the description of the crime or the autopsy reports of the paper-based case compared to the virtual simulation. They got the same results with the feeling of whether the paper-based case can help them in developing their observation skills better than the virtual simulation.

On the other hand, most students agreed that the paper-based helped them to develop their critical analysis skills better than the virtual simulation, but they felt that the paper-based could not help them in developing their problems solving skills.

Students agreed that the virtual simulation contributed to a more innovative and original experience, but they mostly

disagreed on whether they preferred it to the traditional assessment form.

## VI. DISCUSSION AND FUTURE WORK

The results of this preliminary study did not help us to conclude the effect of the gamified VR simulation for authentic assessment. This was down to the quality of the graphics and the interaction with the characters of the gamified VR simulation.

The gamified VR simulation has been originally designed in Unity and we are currently re-designing it in Unreal Engine which provides greater realism and smoother character animation. We are also integrating analytics in the VR simulation to collect information that could help us later analyze the learners' journey and compare this too gained knowledge.

To evaluate our student's learning experience and whether the gamified VR application, CrimOPS, can help them achieve some of the intended learning outcomes (ability to understand a case and its salient features) we are planning a study involving the whole cohort of approx. 125 second-year students in criminology/soc/crim, registered on a Forensic and Criminal Psychology module. This will provide adequate data to evaluate our research questions. The class will be divided into two groups: the first one will use the paper-based assessment instrument, and the second the virtual reality game. In the successive run, we will switch the groups and then administer the survey. A challenge we are facing is accommodating this large number of students to experience the resource using immersive VR. To address this we will create two prototypes one to be accessed as WebVR and one as an immersive VR resource.

## ACKNOWLEDGMENT

This project has been funded by the University of Westminster Quintin Hogg Trust.

## REFERENCES

- [1] M. Sheen, H.A.K Yekani, and T.R. Jordan, "Further Evidence for Using Online Discussion Boards in the Classroom," *Teaching of Psychology*, vol. 46(2), 2019, pp. 158-163.
- [2] A. Bonasio, "Immersive Experiences in Education", 2019. Retrieved from <https://documents.pub/document/immersive-experiences-in-education-immersive-experiences-in-educatin-1-about-the-author.html> [Last accessed 1/05/2022]
- [3] B. Akhgar, A. Redhead, S. Davey, and J. Saunders, "Introduction: Serious Games for Law Enforcement Agencies," in Akhgar, B., (ed.) *Serious Games for Enhancing Law Enforcement Agencies - From Virtual Reality to Augmented Reality*. Security Informatics and Law Enforcement, Springer, 2019, pp. 1-11.
- [4] M. Fullan, J. Quinn, and J. McEachen, "Deep learning: Engage the world change the world," Thousand Oaks, CA: Corwin Press, 2018.
- [5] J.E. Douglas, and C. Munn, "Violent crime scene analysis: Modus Operandi, signature and staging," *FBI Law Enforcement Bulletin* vol. 61(2), 1992, pp. 1-11.
- [6] R.M. Holmes, and S.T. Holmes, "Profiling violent crimes: An investigative tool," Sage: London, 2009.
- [7] User Experience Questionnaire, Retrieved from [<https://www.ueq-online.org/>] [Last accessed 1/05/2022]
- [8] C. Jennett, A.L. Cox, P. Cairns, S. Dhoparee, A. Epps, T. Tijs, and A., Walton, "Measuring and defining the experience of immersion in games." *International journal of human-computer studies*, vol. 66(9), 2008, pp. 641-661.