On the use of serious games technology to facilitate large-scale training in cybercrime response

Natalie Coull
Iain Donald
Ian Ferguson
Eamonn Keane
Thomas Mitchell
Oliver V. Smith
Erin Stevenson
Paddy Tomkins
United Kingdom

Abstract:

As technology becomes pervasive in everyday life, there are very few crimes that don't have some 'cyber' element to them. The vast majority of crime now has some digital footprint; whether it's from a CCTV camera, mobile phone or IoT device, there exists a vast range of technological devices with the ability to store digital evidence that could be of use during a criminal investigation. There is a clear requirement to ensure that digital forensic investigators have received up-to-date training on appropriate methods for the seizure, acquisition and analysis of digital devices. However, given the increasing number of crimes now involving a range of technological devices it is increasingly important for those police officers who respond to incidents of crime to have received appropriate training. The aim of our research is to transform the delivery of first responder training in tackling cybercrime. A project trialling the use of computer games technology to train officers in cybercrime response is described. A game simulating typical cybercrime scenes has been developed and its use in training first responders has been evaluated within Police Scotland. Overall, this approach to the large-scale provision of training (potentially to a whole force) is shown to offer potential.

Keywords: cybercrime, training, serious games, incident response

Introduction

Due to the evolving nature of technology and the consequent societal uptake, many crimes now involve computer technology to some extent. The term cybercrime is not limited to describing only those activities which violate the Computer Misuse Act, e.g. hacking, phishing ransomware and data theft. Technology has a footprint in virtually every crime. Cybercrime is a challenge like no other. It is global in nature, evolving on a daily basis and now accounts for a very large proportion of all crime — resulting in financial and physical harm. As a result of this, crime scenes have become highly dynamic, where police officers responding to an incident can be faced with any number of connected digital devices. Doing the wrong thing — or the right thing too slowly — can lose vital evidence and intelligence.

First responders, (those police officers who may be first on the scene when dealing with an incident or alleged crime) are typically tasked with identifying if a crime has been committed, identifying which devices could be relevant to the crime and how those devices should be handled. Police officers also need to consider how to interact with the victim and provide them with appropriate advice, which can be complex when social media may be involved in the incident. Currently, Police

Scotland officers have access to the 'First Responder Guide'; a 35-page guidebook containing information and advice about how to respond to incidents that have a technical element. While this guidebook is available online, it can be difficult to ensure that all police officers are aware of any modification or amendments made to the guide and difficult to measure engagement. While classroom based training could be an appropriate mechanism for cybercrime training, it can be expensive and time consuming and is not considered an effective mechanism for training Scotland's 17 000 police officers to the growing challenge of cybercrime.

There is a clear need for First Responders who can competently investigate cybercrime and therefore high quality, up to date training is imperative to ensure sound acquisition of evidence and response to victims.

Gamification

Rather than deliver traditional classroom-based training, the effectiveness of cybersecurity training through the use of games based learning to simulate cybercrimes and provide practise in incident response can be explored as an alternative to more traditional methods of training. 3D computer games (e.g. Assassin's Creed) afford visually rich and interactive environments that allow exploration of complex problem spaces, both for entertainment and in serious contexts. While younger police officers will be digital natives and therefore more likely to be comfortable with the idea of playing computer games, there is clear evidence that games can be engaging for even elderly users (Zelinski and Reyes, 2009). Games are an effective tool for getting people to participate in activities and providing users with an opportunity to interact with an environment that can replicate the real world. Games also help to drive intrinsic motivation and encourage behaviours that result in internal rewards like enjoyment, positive feelings and happiness (Glover, 2013, Muntean, 2011, Deterding et al. 2011). Consequently, these help to foster a drive to complete actions, such as learning. Research (Kumar 2013, Mekler et al. 2013, Hamari, Koivisto and Sarsa, 2014) indicates that games can deliver improvements in learning if designed correctly. Game features are also strong at feeding back to users. Leader boards, points, badges and progress bars are not in themselves 'fun'. However, feedback is the foundation for engagement, get feedback right and you retain users.

Proposed solution

Police Scotland is committed to ensuring that all officers are properly trained and equipped to protect Scotland's communities and businesses. Serious games are one mechanism that can be used to provide continually updated training in an environment which is engaging and measurable.

A collaboration between Abertay University, Droman Crime Solutions and Police Scotland, funded in part by the Scottish Funding Council's Interface scheme, has led to the completion of the first stage of our project, described here. This stage has led to the creation of a prototype with 3 crime scenarios built into it and an initial evaluation with some law enforcement personnel. Through this project, we want to show that the engaging and immersive nature of training in a virtual environment maximises the recipient's attention and delivers demonstrably more effective learning outcomes than traditional teaching models, providing better value for public money in building better skills of public services. Through this project, we aim to demonstrate that serious games can provide continually updated training in a way that is engaging for the user, which doesn't take officers off the streets for days at a time to sit in a classroom, and which can be delivered at a fraction of the cost of traditional training techniques.

At this stage, we have developed a playable prototype computer game to train and assesses police first responders in recognising, handling and prioritising digital evidence and devices at incidents of crime, or where networked devices might hold relevant investigative information. Initial feedback from a sample of operational officers has been very positive about its potential.

Our prototype has been developed using a serious games approach. The developed game can be delivered to tablets and smart phones, significantly reducing the overhead costs of classroom training. It simulates three scenarios based upon common incidents reported to Police Scotland, described in the next section.

Evaluation has been conducted with a small number of local police officers. Our initial evaluation demonstrates that the prototype has the potential to be scaled to force-wide proportions.

Methods

Our project, 'First Responder's Guide' is a novel fusion of cyber security and computer games technology to provide a new training tool that harnesses the interactivity of serious games to provide Police Officers with some of the essential skills they need to combat cybercrime. Importantly, this tool enables more effective training to be delivered at a significantly reduced cost, to more staff and without the need for lengthy and expensive classroom-based sessions. Improving the cybersecurity skills of law enforcement personnel will lead to improved response to cybercrime and better preservation of digital evidence.

The proposed training tool offers two key benefits over and above existing provision: (i) training can be self-paced and undertaken at flexible locations rather than requiring attendance at a specific time and place; (ii) serious games are more engaging for trainees than seminar-type events.

The first stage in our project, described here, led to the creation of a prototype that contained a virtual environment with 3 different crime scenarios. This stage consisted of 3 core activities:

- Game jam
- Prototype development
- Initial evaluation

Game jam

A game jam, popular in the gaming community, is an event where developers meet in a physical location to create one or more games over a short period of time (typically 24-48 hours). These events provide an excellent opportunity to focus on developing games around a particular theme and challenge the developers to develop rapid prototypes which can be presented to peers and industry at the end of the event. We used a two-day Game Jam for the first stage of our prototype development, as a mechanism for identifying a broad range of ideas and techniques that could be useful in a serious game environment for first responder cybersecurity training.

Students across our digital degree programmes were invited to sign up for the game jam. Over 50 students participated, forming 13 teams which consisted of representatives from our computer arts, general computing, ethical hacking, digital forensics, games production management and sound production degree programmes. At the start of the game jam, students were provided with the project brief and an overview of Police Scotland's current paper version of the First Responder Guide. Additionally, one of the project team, with experience in conducting digital forensic investigations as part of a criminal investigation, provided the students with an overview of the challenges involved in the seizure, acquisition and analysis of digital devices. Students had 2 days to produce their 'asset', i.e. their proposed game idea to train police officers in cybersecurity. At the end of the event, each team presented their asset to a team of judges and were scored according to proposed design, computer graphics, modularity and adaptability. The winning team's asset incorporated the following features:

- Adaptable to different mobile platforms and operating systems

- Virtual environment that could be 'explored' with objects that required user interaction

- Environment that allowed the user to navigate the crime scene from different views (2d, 3d and crouch)

- Objects in the environment which required 'time critical' decision-making

- Modular-design enabling changing or adding elements to suit new developments, different concepts, jurisdictions or culture

- Short game play — typically less than 5 minutes to complete a level

The winning team (called Fire Breathing Unicorn) were then invited to participate in the next stage of the project: Prototype Development.

Prototype development

This stage of the project was conducted over an 8-week period, in close collaboration with Police Scotland to develop the initial ideas presented in the game jam into a working prototype which could be used for an initial evaluation. The winning team, Fire breathing Unicorn, consisted of 3 students: 2 Game Design and Production Management students and one Computer Arts student. The student team met with representatives from Police Scotland on 4 separate occasions to develop 3 scenarios which would be incorporated into the prototype. These scenarios were selected to broadly represent the types of crimes involving a digital element that Police Scotland typically encounter. The scenarios can be classified as:

1. A pre-planned operation involving indecent images of children, where the police have received information that the inhabitant of a property has been viewing indecent images online. The suspect is not the only inhabitant of the property, and there are numerous different mobile devices located in the property which may or may not belong to the suspect. Additionally, the property is located close to a school and the police officer has to consider how best to approach the property.

2. A reactive enquiry in which a complainant has received threatening messages via social media. In this scenario, the complainant has received the messages from an anonymous account.

3. A spontaneous enquiry involving an attempted fraud of a business via spear-phishing. There are numerous different devices used as part of the business and the owner is unsure if their network has suffered an intrusion due to the confidential information contained in the spear-phishing email.

Within each scenario, the user is presented with a description of the brief, prior to entering the property. Upon entering the building, the user is required to navigate to the appropriate address and consider which law or regulation would need to be adhered to for this particular scenario. Once in the property, the user may encounter a non-playable character that they can inter-

act with. The user is then able to navigate around the property and interact with a range of different objects, depending on the nature of the scenario. Each object has a range of different interactive options, including seizure, photographing, powering off etc. Once the user has finished navigating the scene and chooses to leave the property, they are presented with a score based on how they interacted with the objects for that particular scenario. Where the user did not follow appropriate procedures, they are provided with feedback as to the appropriate course of action. This feedback can be recorded for a user over a period of time to measure engagement and improvements in behaviour. In addition to the features described above, the prototype also works on multiple platforms (iOS, Android, PC and Mac), crime scene with 3 rooms (bedroom, kitchen and living room), numerous assets (e.g. smart fridge, laptop, mobile phone), 1 static non-playable character, scenario editor and testing tools that will enable data analytics of user progress and engagement.

Initial evaluation

We conducted a qualitative evaluation of the prototype at the end of the first stage of the project. This evaluation was conducted with a small group of 10 police officers from Police Scotland. At the start of the evaluation, each participating police officer was interviewed to establish the following:

• Current level of training in cybercrime and incident response

• Current attitude towards training delivered via a mobile device

The participant was then questioned on hypothetical scenarios, similar to those in the game, and asked how they would respond to those scenarios. Participants were then invited to play the game on either a tablet or mobile phone, for each of the scenarios used in the initial interview. Game responses were recorded for each participant. Finally, participants were asked to complete a short questionnaire (online) which asked them questions about their experiences of the game and usability.

Results

At this stage, we have produced a working prototype which can be played across a range of different mobile devices and operating systems that allows users to navigate a virtual environment with three different scenarios (see Figure 1). For each scenario, users are initially presented with a description of the scenario (see Figure 2), before being allowed to navigate the environment. Whilst navigating the environment for each scenario, users are presented with a series of questions depending on their interactions with various different objects (see Figure 3). Users can choose between crouch mode, which enables the user to look underneath objects (Figure 4), standard 3d mode (Figure 5) and 2d mode (Figure 6). At the end of each scenario, users are presented with their score and feedback on any incorrect answers.
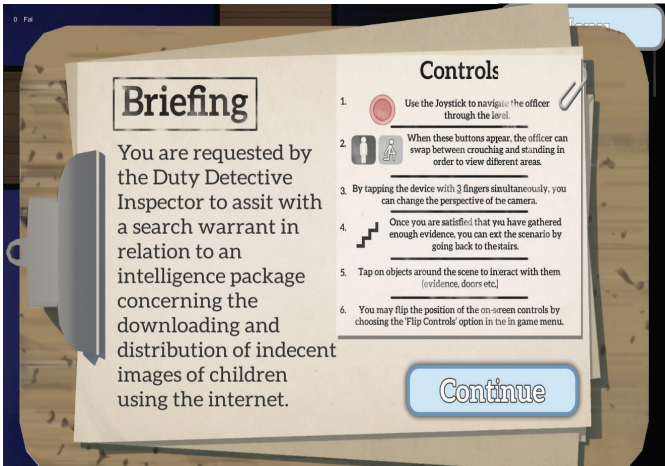

Figure 1: Prototype menu showing 3 scenarios

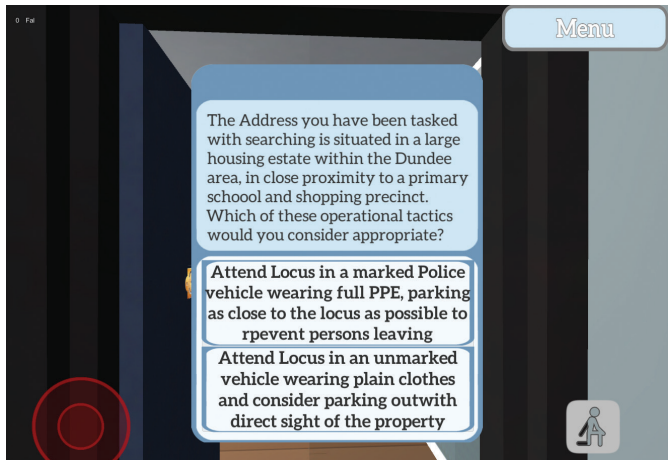**Figure 2: Description of pre-planned operation and controls**

Figure 3: Example of in-game question

Figure 4: Crouch mode

Figure 5: 3-d mode

Figure 6: 2-d mode

Our initial evaluation demonstrates that the prototype has the potential to be scaled to force-wide proportions. Feedback from our evaluation demonstrated that participants were very positive about using games on mobile devices for training. There was some disparity between the answers that participants gave to the interview questions and in-game questions. The questionnaire indicated that some participants found the wording of the scenarios rather vague, which made the questions somewhat ambiguous. Finally, some officers found the navigation controls difficult to use and indicated that they would prefer to be able to indicate via touch-control how to navigate, rather than use a virtual joystick. Overall, participants responded positively about their experience of using the game and its potential for providing training in cybercrime response.

Discussion

The initial prototype described here comprised a small proportion of the content and flexibility required of a full training package. The innovation for this project includes a wider range of challenges, educational content and operational scenarios, as well as delivering sophisticated analytics, management information and automated student assessment.

The next stage of the project will involve developing 3 different residential scenes of crime, each with 2 unique training scenarios and a range of art assets, some of which will embody digital evidence for crime. The scenarios will also embed the legal aspects of

training required by Police Officers. Each scenario will also incorporate an accompanying video of Police Officer briefings from senior staff to contextualise the scenarios in the real world. The next version of the game will be used for a pilot involving 100 operational community police officers, independently evaluated by the Scottish Institute for Policing Research (*www.sipr.ac.uk)* for educational benefit, student experience and performance in the workplace.

We expect the next stage of this project to deliver:

- A full content game for training police first responders in Scotland (c.17k officers);

- An independently evaluated pilot exercise for 100 police officers;

- Management information to assist strategic leaders in ensuring and enhancing the cyber resilience of large organisations;

- Increased publicity and public interest in cyber resilience, promoting safer practice online and mitigating the risk of cybercrime;

- Potential for enhanced care for victims of cybercrime through a trained and continually updated police workforce;

- Improvement in the prevention, detection and prosecution of cybercrime;

- A delivery model that could be applied to other areas of large-scale training needs;

- The use of serious games in training large numbers of police personnel in managing cybercrime is unprecedented worldwide, and the cost benefits compared to traditional methods promise to be disruptive of training methods across most disciplines.

References

- Coull, Donald, Ferguson, Keane, Mitchell, Smith, Stevenson and Tomkins (2017 - in press). "The Gamification of Cybersecurity Training", Transactions on Edutainment. Springer Berlin Heidelberg.

- Deterding, S., Dixon, D., Khaled, R. and Nacke, L. (2011). From game design elements to gamefulness: defining gamification. In *Proceedings of the 15th international academic MindTrek conference: Envisioning future media environments* (pp. 9-15). ACM.

- Glover, I. (2013). Play as you learn: gamification as a technique for motivating learners. In: *Proceedings of World Conference on Educational Multimedia, Hypermedia and Telecommunications 2013.* Chesapeake, VA, AACE.

- Hamari, J., Koivisto, J. and Sarsa, H. (2014). January. Does gamification work?—a literature review of empirical studies on gamification. In *2014 47th Hawaii International Conference on System Sciences* (pp. 3025-3034). IEEE.

- Kumar, J. (2013). Gamification at work: Designing engaging business software. In *International Conference of Design, User Experience, and Usability* (pp. 528-537). Springer Berlin Heidelberg.

- Mekler, E.D., Brühlmann, F., Opwis, K. and Tuch, A.N. (2013). Do points, levels and leaderboards harm intrinsic motivation?: an empirical analysis of common gamification elements. In *Proceedings of the First International Conference on gameful design, research, and applications* (pp. 66-73). ACM

- Muntean, C.I. (2011). Raising engagement in e-learning through gamification. In *Proc. 6th International Conference on Virtual Learning ICVL* (pp. 323-329).

- Zelinski EM, Reyes R. (2009). Cognitive benefits of computer games for older adults. Gerontechnology : international journal on the fundamental aspects of technology to serve the ageing society. 8(4):220-235.

CEPOL