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Understanding Engagement within the Context of a Safety Critical Game

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ABSTRACT

One of the most frequent arguments for deploying serious games is that they provide an engaging format for student learning. However, engagement is often equated with enjoyment, which may not be the most relevant conceptualization in safety-critical settings, such as law enforcement and healthcare. In these contexts, the term ‘serious’ does not only relate to the non-entertainment purpose of the game but also the environment simulated by the game. In addition, a lack of engagement in a safety-critical training setting can have serious ethical implications, leading to significant real-world impacts. However, evaluations of safety-critical games (SCGs) rarely provide an in-depth consideration of player experience. Thus, in relation to simulation game-based training, we are left without a clear understanding of what sort of experience players are having, what factors influence their engagement and how their engagement relates to learning. In order to address these issues, this paper reports on the mixed-method evaluation of a SCG that was developed to support police training. The findings indicate that engagement is supported by the experience *situational relevance*, due to the player’s experience of *real-world authenticity*, *targeted feedback mechanisms* and *learning challenges*.

Author Keywords

Serious Games; Game Based Learning; Engagement; Player Experience; Business Simulation; Safety Critical; Police Training.

ACM Classification Keywords

H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous; K.8.0. General: Games.

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INTRODUCTION

The term serious games i.e. games that are used for purposes other than pure entertainment [13] is a wide reaching one that has been applied to a vast array of games that have been used for within education, advertising, training across a range of domains [6; 13]. In relation to training specifically, games have gained increasing popularity in the recent years and have been advocated as promising technologies for the support of training within sectors such as education, the emergency services, the military and healthcare [36; 44]. Many of these games can be described as safety-critical games (SCGs) since they are used to support training in domains where mistakes can have grave psychological or physical consequences in the real-world settings (e.g. law enforcement, firefighting, healthcare etc.).

While there are many reasons why serious games can support effective learning e.g. through providing authentic contexts and safe environments [11; 43], the perception that they are engaging is perhaps the most prevalent [e.g. 2; 21]. However, in relation to SCGs specifically, there are surprisingly few studies that examine the wider player experience and the factors that influence it. This is despite widespread consensus that engagement is a necessary part of learning [14; 22; 30; 41] and without a comprehensive understanding of how engagement and learning can be supported, there is a significant risk that an SCG will not be successful in achieving its aims.

Engagement is a complex construct and it has been conceptualized in a variety of ways. Within HCI, the emphasis has primarily been on “enjoyment”, which usually describes positive cognitive and affective appraisal of a game experience [31]. Similar, within game-based learning, there is a desire to harness the motivational power of games [25] through promoting intrinsic motivation [30] and providing the “fun factor” [45]. However, as Bogost [6] notes, the “serious” component of a serious game sometimes relates to the nature of the content and, in the case of SCGs, fun and positive affect may not be the most appropriate concepts to have in mind when considering what sort of player experience you want learners to have and how best to support their engagement.

In this paper, we describe the results of an evaluation of a SCG that focused on training police officers to take initial witness accounts from children. Through doing so, our research aims to provide an in-depth exploration of the factors that influence engagement with game-based safety-critical training.

RELEVANT WORK

Within this section, we first provide an overview of how engagement has been conceptualized within the field of HCI and games, as well as in relation to game-based learning. We then discuss the literature on safety-critical games and player experience evaluation. Finally, we provide some background to the project by providing a brief explanation of police training and then introduce the SCG developed.

Engagement and learning in Games

Mekler et al. [31] indicate that there has been a primary focus on enjoyment within studies examining player experiences. In their review of the literature, they note that the focus of evaluations is generally on the positive affective and cognitive appraisal of the game experience. While there are different ways to conceptualize engagement (e.g. in relation to immersion [8], flow [10] and presence [41]), it is generally described as existing on a continuum where players can be more or less involved depending on the exact nature of their experience [7; 9].

There are also many ways to assess engagement, including such as the Immersion Experience Questionnaire [24] and a scale to measure flow [42]. However, both these examples focus on understanding very specific aspects of the gameplay experiences; the IEQ emphasizes cognitive involvement and the flow scale relates to identifying an extreme experience rather than more general engagement. Another example is the Game Experience Questionnaire [32], which was designed to provide a comprehensive evaluation of the player experience. While Cairns et al [9] point out that validation work on the GEQ has not been published they also suggest the scale covers wider aspects of the gaming experience (e.g. negative affect such as frustration). They also note it has been widely applied, including in the context of educational games [e.g. 27].

In terms of the relationship between games and learning, it has long been argued that games are intrinsically motivating [30], where they are able to engage learners through a combination of fantasy, rules/goals, sensory stimuli, challenge, mystery and control [14]. Despite the acceptance that games can provide motivating experiences, designers of educational games still face a challenge in relation to effectively blending (presumably 'boring') learning with engagement and 'fun' with, as evidence by use of the term 'serious games'. There has been research looking at frameworks that can support this process [e.g. 19] while other work has argued that, rather than how intrinsic the 'fantasy' is within a game, learning content needs to be tightly coupled with core game mechanics in order to ensure that players will experience both engagement and successful learning [17]. In the context of education and

training, the risks of not considering the overall player experience are significant; if players do not find the game to be engaging, then learning is unlikely to result and the main purpose will not be achieved.

Safety critical games

The risk of providing an unsuccessful learning experience is especially severe within the area of safety-critical training. In these contexts (including domains healthcare, emergency services, crisis management etc.), the potential consequences of providing inadequate training could result in significant physical or psychological harm being caused to people in the real world. Though there are some exceptions [see 40 for a different approach], the majority of SCGs attempt to provide mimetic (rather than abstracted) simulations of practice due to a desire to provide realistic learning experiences within a 'safe' space [44] and to increase the chances of transferring learning outside of the game [43]. Game elements are usually used to convey different forms of information to players as a way of indicating progress and providing feedback on performance. Arguably, these sorts of games are quite different to serious games that are more abstract (e.g. that occur in a fantasy world) and which are less focused on supporting procedural forms of learning. However, despite the emphasis on safety-critical scenarios, engagement with SCGs is still sometimes considered as being about 'enjoyment', yet there are surprisingly few studies that examine the player experience in any real depth.

For instance, Di Loreto, Mora & Divitini [12] when providing an overview of serious games for crisis management highlight the importance of the "fun factor" in stimulating motivation to play and state that "a serious game is a way of providing participants with a fun experience from which they can learn more about themselves and their interaction with their world" (p 352). While the literature suggests that factors such as the level of realism, which is usually interpreted as graphical fidelity [e.g. 28, 40, 44] and feedback [e.g. 11; 18] are noted as being important to learning within a simulation-based context, it is unclear how they relate to the experience of engagement. Without a deeper understanding how these concepts relate to each other, there is a risk that learners will not spend the time and energy necessary to deeply engage in training when they are not requested to as part of an evaluation study.

With regard to police training, there are some examples of games that have been developed including one for dealing with accident investigations [4]. A 3D training environment was created for the Dubai Police force, involving a traffic accident scenario where officers are able to practice procedures such as placing traffic cones, photographing the scene etc. While they did find significant learning effects between those who used a game and a control group (who did not play the game), they did not look at comparing engagement between the game produced and any existing forms of training (as this did not exist). Additionally, they choose to focus on presence by adapting an existing

questionnaire [35] to measure the subjective experience felt by the participants of ‘being there’ in the accident scene.” [P.340; 4]. However, beyond looking at differences between novice and experts, it is unclear why they chose this measure. Since the focus of the scale is mainly on the experience of spatial habitation (which does not necessarily relate to engagement [9]) the findings do not provide much insight into whether learners actually found the game to be engaging. Though some open-ended comments were collected from participants, these do not appear to have been reported in detail. In addition to the fact that a comparison could not be made to any other type of training, it is thus quite hard to establish what it is about the game that led to learning and what factors influence player engagement.

In another example, Linssen et al. [28], present a preliminary evaluation of *Loiter* (LOitering Teenagers, an Emergent Role-play) a game that focused on training Dutch police officers in the interpersonal skills required for street interventions. In this case the emphasis was less on training officers to follow certain procedures and more on supporting the development of social interaction skills (including verbal responses and physical stance). The developers sought to represent feedback to players in the form of “thought bubbles” (that represent how game characters are reacting to the player) and flashbacks relating to previous actions. While the mechanisms appear to be an interesting way to make the effects of player actions more explicit, they did not lead to improvement in learning measures. The authors also mention they asked player to rate their experience on a number of Likert scales, but unfortunately little information is supplied about what scales were used, and the results are not presented. Some brief information is provided about open-ended comments, which suggested the game wasn’t very challenging. A further investigation into the overall player experience and how players engaged with the game may have yielded further insight into ways to improve the game and establishing how best to support player learning.

These studies indicate that engagement is often not given a significant amount of attention in the context of safety-critical games. Questions remain about what player experiences with these games actually involve and what factors seem to contribute to engagement. In order to further explore these issues, we present an evaluation of a game that was created for the UK police force to support the training of new officers in taking an initial account from a child witness.

Background to project

The Child Interview Simulator (CIS) was developed as a serious game to support the training of new UK police recruits in collecting initial witness accounts from children. In addition to learning, the trainees develop the necessary confidence to relate to children, which previously has only come from experience. The CIS provides an interactive scenario where one assumes the role of an officer that needs to interview a nine-year-old boy, who allegedly witnessed a

woman being attacked on his way home from school. The diagram in Figure 1 shows an overview of story structure, which consists of two distinct episodes. The first episode requires the trainee to take an ‘initial account’ from the child at their home, whilst the second episode takes the trainee through the process of how to conduct a full ABE (Achieving Best Evidence) interview with the child.

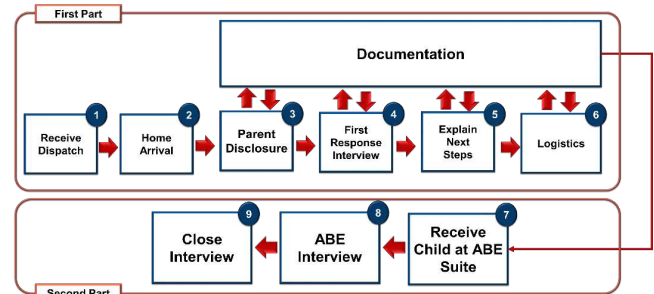


Figure 1. Story structure overview

The police domain and thus the police training experience have traditionally been driven by both empirical and experiential knowledge [33, 34]. In designing and evaluating this game we have taken insights from both the gaming and criminology literature to inform the development process. Police training is set within a safety-critical context where our focus is the training of new police officers. Engagement with learning is critical since it must lead to an embedded understanding for the police that will influence life and death decision making. To achieve effective real-world understanding the game must engage the learners in acquiring both tacit knowledge, and formal procedural knowledge.

The game was co-created with a multidisciplinary team (experts in child interviewing, police trainers, experienced police officers, game developers and academic researchers). An agile development approach was adopted, with iterative releases of the game that used storyboards, interactive mock-ups and subsequent software prototypes until the final version was produced.

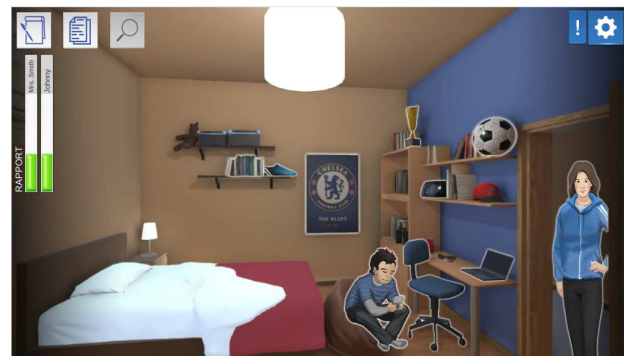


Figure 2. Screenshot of the bedroom scene (episode one)

Figure 2 illustrates a screenshot from the final game displaying the following interface elements: two parallel horizontal bars that represent rapport (indicated by a green feedback bar that moves up or down depending on the players interactions); a notepad icon, where players can refer to past conversations they have had; an ABE form

icon, which players are prompted to complete during their conversations; and the observe icon, which allows players to return to the room from the conversation menu. When entering the conversation mode, this scene is partially covered by the menu that enables players to ask questions about various topics via multiple-choice options. Different interactive objects are highlighted (with a white border), that invite players to observe these by clicking on them (thus opening up further dialogue options).

At different development stages, formative testing and validation was carried out that focused on different aspects such as game mechanics, interface design, and the dialogue engine. For example, testing was carried out to ensure that players would be able to interpret the emotions displayed by the characters [29], as this is a significant part of rapport building. The feedback collected at different stages yielded important insights that shaped many aspects of the SCG, including the storyline, aesthetics, content, dialogue and the mechanics. Further examples of these insights include:

- In an initial exploratory workshop, participants were shown existing games and interactive mock-ups with both 2D and 3D visual experiences. The conclusion was that the environment would benefit from the realism of 3D, but with the requirement of non-verbal communication cues (that associated with the emotional state of the child), would be easier to interpret with 2D.
- To contribute to rapport building, the game allows for the exploration of the environment by inviting closer observation, as a way of uncovering topics of interest to discuss with the different characters. The testing of the game demonstrated that the initial themes of football and electronic games needed to be extended as trainees had different backgrounds and required other clues to trigger their curiosity.
- The player needs to be mindful of building and maintaining rapport with the characters in the story, as this will unlock particular story branches and responses from the characters. It soon became clear that players had a low tolerance of convoluted story plots where the actions in one scene would impact on the outcomes much later in the game.
- Between each scene in a scenario, players are given detailed feedback on their performance along three dimensions (interview skills, rapport building and process). An assessment on each learning outcome was also given (fulfilled, partially fulfilled and fail), but feedback from the users indicated that it was necessary to provide further hints in the assessment of what to do differently when an outcome was not achieved.
- The dialogue interface was seen as crucial for the success of the game. With the release of the first full featured prototype, it was evident that interface difficulties created poor usability. A complete redesign of the interface was carried out, resulting in a simpler and more intuitive interaction flow.

METHOD

This research forms part of a larger Randomized Control Trial (RCT) within the UK, currently being conducted to elicit knowledge acquisition specific to collecting first accounts from child. As the RCT aims to collect quantitative data from over 100 participants, this aspect of the research is ongoing and will be reported in a later publication. The focus of this paper is on evaluating the overall player experience of the game, where data has been collected from a total of 65 participants. A mixed methods approach was adopted, that involved questionnaires and focus groups. The questionnaires provide background to the qualitative findings, which provides the main focus of the analysis.

Participants

Data was collected from a total of 65 new recruit police officers across two different UK police forces that were currently on their 13-16-week 'Initial Police Learning and Development Programme' (IPLDP). There were slightly more male (54%) to female participants, with 81% falling below the age of 35, and just under half (49%) having obtained a university level degree. Just over half the participants (52%) did not consider themselves as gamers.

Design Plan

Quantitative data was captured at two key points during the IPLDP, the first just after a 3-5 day witness interview-training course (the length depended on the force) and then again after interacting with the simulation. Although the interview training did not focus specifically on collecting first accounts from children, it provided the closest type of face-to-face training, so was used as a baseline for comparison. All UK police officers and staff are provided with a wide variety of online-learning training courses that are accessed via a Managed Learning Environment (MLE), maintained by the National Centre for Applied Learning Technologies (NCALT). Training involves a mix of mandatory and self-selected online training courses, which forms a large part of the IPLDP student training.

Qualitative data was captured post-interaction with the simulation through eight focus groups (which varied in number N=5-18) following a semi-structured interview guide. These typically lasted between 20-25 minutes and were led by one of the authors. Questionnaire data was collected via an online survey tool, while the qualitative data was audio recorded for later transcription, and took place within two police force training centers.

Measures

Two short questionnaires were used to capture participant's attitudes towards their different training methods. The first asked participants to rate the value of four types of training, *Face-to-face*, *Role-based*, *Online* and *Game-based* using a 5-point Likert scale (1=low, 5=high). This was administered just after students received the witness training, and then again after they interacted with the game. The second questionnaire was the 'in-game' concise 14-item version of the Game Experience Questionnaire (GEQ) scale [32], which measures seven components (*competence*,

sensory & imaginative immersion, flow, tension, challenge, negative affect, and positive affect). The same questionnaire was used to compare participants' experiences of the 3-5 day witness interview training with their experience of CIS. Although this questionnaire is aimed at player experience, using the same questions (with slight alteration) enabled us to compare the traditional face-to-face training, with game-based training. The concise version of the GEQ was selected to avoid questionnaire fatigue through having participants fill the GEQ multiple times. Additional questionnaires from the user experience field [26; 37] were collected post-interaction to capture usability, utility and overall quality.

The focus groups were guided by a series of around 12 open questions that acted as prompts to guide discussion. Questions focused on capturing five key areas, *Learning, Usefulness, Relevance and Engagement*, along with the general *Likes and Dislikes*.

QUANTITATIVE ANALYSIS

Quantitative questionnaire data was collected from participants and analyzed using excel and SPSS.

Quantitative Findings

Quantitative data was collected from participants, where they were asked to rate the value of different forms of training they had experienced. The Interview-Witness training consisted of both *Face-2-Face* and *Role-based* training, while police *Online* training forms a fundamental part of the wider IPLDP training program. The online training is used to support classroom training, where students take at least 5 or more courses per week, depending on the force requirement. Out of the 65 participants who took part in the focus groups, 45 also filled in questionnaires just after the Interview-Witness training, and just after the Simulation Game-based training. Since not all participants had prior experience of game-based training, only 24 of the 45 provided value ratings for this approach.

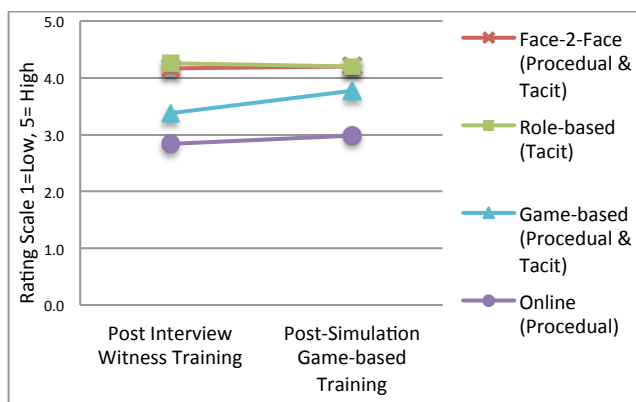


Figure 3. Value mean ratings comparing 4 different training methods between post-interview and post-game.

Participants' ratings for the value of *Face-to-Face* training (N=45) showed no change between post interview (M=4.2, SD=0.88) and post game assessment (M=4.2, SD=0.9). Similarly little difference was found for the *Role-based*

training (N=45) post-interview (M=4.3, SD=0.86) and post game (M=4.2, SD=0.75). Ratings for both *Face-to-Face* and *Role-based* training were generally higher than the two technology based training (*Online* or *Game-based*). However, the *Game-based* training (N=24) showed an increase in ratings post interview (M=3.4, SD=0.88) to post game (M=3.8, SD=1.07) after participants had interacted with the game, where a slight increase was also found for the *Online* training ratings (N=45) from post interview (M=2.8, SD=1.03) to post game (M=3.0, SD=1.17), see Figure 3.

The same 45 participants, also provided responses to the 14-item 'in-game' GEQ questionnaires for both the interview-witness training and game-based training (see Table 1). A paired-samples t-test was conducted to evaluate the difference between the witness training and game-based training ratings for each of the seven components within the GEQ. There were significant differences for 2 (out of 7) components; *'Flow'* $t(44)=-3.8, p < .001, d=0.57$, and *Negative Affect* $t(44)=2.24, p < .05, d=0.33$. No significant differences were found for the remaining 5 GEQ components, *Competence* $t(44)=1.3, p = .111, d=0.19$, *Sensory & Imaginative Immersion* $t(44)=-1.1, p = .283, d=-0.16$, *Tension* $t(44)=-1.7, p = .093, d=-0.26$, *Challenge* $t(44)=1.6, p = .111, d=0.24$, and *Positive Affect* $t(44)=-0.29, p = .775, d=-0.43$.

Five Items from in-game GEQ	Witness Training	Game-based Training
Flow**	M= 2.3, (SD= 0.89)	M= 2.9, (SD= 0.98)
Negative Affect*	M= 2.1, (SD= 0.82)	M= 1.8, (SD= 0.83)
Competence	M= 3.5, (SD= 0.66)	M= 3.4, (SD= 0.69)
Sensory	M= 3.4, (SD= 0.83)	M= 3.6, (SD= 1.00)
Tension	M= 1.8, (SD= 0.77)	M= 2.0, (SD= 0.99)
Challenge	M= 3.5, (SD= 1.01)	M= 3.2, (SD= 0.93)
Positive Affect	M= 3.3, (SD= 0.64)	M= 3.3, (SD= 0.72)

**Sig - $p < 0.01$, *Sig - $p < 0.05$

Table 1. Interview & game-based training GEQ comparison

Participants rated the game higher for *Flow*, indicating they found it more absorbing than the witness training, which was rated significantly higher for *Negative Affect*. Thus, CIS was experienced as more likely to hold attention, while the more traditional face-2-face witness training was viewed as being more boring and tiresome.

User experience ratings for the game-based training were also collected from the same 45 participants: *Usability* (M=2.9, SD=1.4), *Utility* (M=3.2, SD=1.4), and *Overall Quality* (M=3.1, SD=1.5) The ratings were all above average, indicating the CIS provided a reasonable user experience, with some areas for improvement, e.g. usability issues with the ABE form, text clarity, cross-force relevance (in relation to dispatch procedures) and problems with scrolling without using mice (as identified from the qualitative comments).

Overall the quantitative findings identified that the game-based training was more engaging than the interview witness training, as indicated by two of the components (*Flow* and *Negative Affect*) within the GEQ questionnaire. The value ratings (Fig 3.) for game-based learning also saw the largest increase (as compared to other forms of training) after participants interacted with the game. While these are useful indicators, these findings do not explain what aspects of the in-game player experience contributed to player engagement and why.

QUALITATIVE ANALYSIS

The qualitative data gathered from the focus groups aimed to unpick the factors and reasons behind participants' positive quantitative ratings through addressing the following research question: What factors influence engagement with game-based training in a safety-critical setting?

Qualitative data was collected from eight focus groups (involving 65 participants in total, including the 45 participants who completed the questionnaires) where the analysis involved in two stages; top-down and bottom-up coding. Two researchers were involved in developing the codes in order to increase the reliability of the findings [1, 5] – due to the interpretative nature of the analysis, inter-rater coding was not carried out [see 5].

In the first stage, the data was analyzed and coded using a thematic analysis. The themes were pre-defined by insights drawn from the literature e.g. engagement, usefulness etc. Key quotes from the data were categorized according to these initial themes (top-down analysis). The second stage, took a grounded theory approach [16] to analyze the sub-set of the data identified during the first stage. An open coding approach was taken where the data was cross-referenced across the coding groupings to identify new categories for the quotes (bottom-up analysis). The coding was guided by the frequency and fundamentality approach [1]. In summary, the initial analysis of open-ended data put an emphasis on those issues that occurred frequently or those that were deemed in this safety critical context to be of fundamental importance. The approach followed quality guidelines for research [20] and allowed the analysis to maintain links to existing literature knowledge whilst uncovering new themes that were novel to this project [1].

Qualitative Findings

The qualitative findings identified that safety-critical engagement appeared to result from experiencing **situational relevance** via **real-world authenticity**, **targeted feedback mechanisms**, and **learning challenges**. We discuss how situational relevance cuts across each of the other three themes. (Please note, each participant quote is labeled by number and focus group e.g. P1, F2 refers to Participant 1, Focus group 2).

Real-world authenticity

Within safety-critical settings there is a particular emphasis on learning authentic and relevant procedures. In police settings, for example, players must engage with key

procedural knowledge as this will be tested in court-cases to justify that they have had the right training and know the correct legal processes. The findings identified that many of the players compared this game with current online police training – although there is no current police training for collecting ‘initial accounts’ from children specifically – which they described as generally focusing more on procedural knowledge and processes. Players valued the way in which the gameplay was able to represent a more authentic situation, as it related to both the tacit skills of dealing with people, as well as learning about how to apply the correct police procedures. Typical online approaches focus the police officer on accurately stepping through the procedures, but without supporting tacit understanding:

“It was really current... the {current online training} I find some of them are ancient, and cause they don't seem real life to me I don't take anything from them” [P11, F 7]

During the development process, one of the key aims was to ensure that a realistic scenario was provided, which included police verification of visual images used within the game. Police experts were also involved to help create and verify the conversation dialogue. Qualitative findings identified that players engaged with the game due to its relevance to reality. In particular it was found that the authenticity provided by the gameplay created learning points and deepened engagement, leading to reflections on how players would later replicate (or not) this behavior within a real-world setting:

“It's the scenario, like you are sat in the police car at the beginning, you have to check the log, you have to call the operator... we've not actually done anything like [that], and it makes you think...what would I actually do on the job” [P7, G5]

Players particularly valued moments where they saw how the gameplay could transfer to real-life activities that they would be likely to encounter outside of the game. Again, their engagement was supported through realistic narratives and character responses within the gameplay:

“I liked you could ask too many questions ... they (the child) just get a bit bored of you... its like realistic in that sense” [P9, G5]

Some of the trainees were aware of barriers when engaging in the activity of talking to children, especially within this safety-critical context of child interviewing. A key finding was that not only did the trainees positively engage with the game, but felt it would impact significantly on their future practice:

“I do feel a little more prepared for going out there and speaking to children” [P5, F1]

In particular, the players noted specific learning points that would guide future practice suggesting that the game could have a longer term impact on their confidence:

"I am fairly confident interacting with children... So I am okay with that side, but the legislation bit, ... that's where the computer will give you the confidence..." [P8, F3]

Their engagement was also evidenced by comments indicating reflections on how they would apply specific learning points in future situations:

"I was thinking as I was going through, if I was to speak to a child now, I would change my type of questioning" [P8, F5]

The findings suggest that the game was able to support engagement through allowing players to take on a particular role and reflect on how this could impact actual practice. While they were aware they were playing a character within the game, they were also able to consider how their in-game identity related to their real-world identity; as one trainee explains:

"You learn to play the game, and you also develop a sort of skill base you can take to reality [P8, F3]

Feedback Mechanisms

Within safety-critical contexts such as policing, the concept of 'wasting time' is not only frowned upon but almost viewed as a dereliction of duty. A game for training can be seen as an inherent distractor, where gameplay could be viewed as wasting valuable time. To counteract this, yet still engage the player, relevant in-game feedback mechanisms were used explicitly to facilitate learning and as a way to make continual references to real-world practice.

In-game mechanisms were used to focus the learners' attention on specific learning points. Players noted the value of these learning points especially when poor procedural decisions within the game resulted in negative consequences. Many of these pathways resembled real life decisions, and players recognized that wrong decisions caused problems later, thus helping to embed their understanding. One example was when players failed to check the correct information (i.e. the address) in the log before making a house call, which results in them being attacked by an axe murderer. It is interesting to note that although this was recognized as being somewhat unlikely, the procedural learning point was perceived as relevant and thus reinforced and remembered.

"I got to the door, and I was like I don't even know which flat I'm supposed to be visiting, and it just made me think then, now when I go to a job, I need to know exactly where I'm going and what I'm going into" [P8, F1]

This particular quote highlights that for engagement in gameplay, the relevance of the learning point was more important than that of a realistic narrative.

In addition, the placing of interactive objects within the gameplay environment was intended to inspire realistic curiosity for potential police officers and provide prompts for discussion with the characters. Whilst interacting with

these objects achieved the in-game objective, we also found that this mechanism inspired players to see themselves as investigative police officers looking for 'clues' within the environment:

"Clues in like the trophies, football, you could click on it and it tells them what they're interested in..." [P6, F2]

Again, these sorts of examples show that the players are engaged in the narrative and immersing themselves in the role they are playing.

One of the key learning points of this game (that is critical for police when collecting a first account from a child) was for players to focus on the tacit skills of building trust and understanding the characters. This formed an important part of gameplay, where the players' attention was focused on the need to establish rapport through various feedback mechanisms. For example, by observing (through clicking on) various objects within the environment the officer can find topics of interest to communicate with the different characters prior to questioning, thus simulating being observant and picking up clues in the real-world. Through selecting various topics of interest the police officer gains the child's attentions and respect (if the appropriate questions are selected). Again it was the real-world relevance of this gameplay activity that made it engaging for the police trainees.

"Having a look around the room... that's what you do when you normally go into a room... you look around" [P7, F2]

To focus player attention on this learning more explicitly and to provide in-game feedback a Rapport Bar (the green level that increased or decrease according the players' gameplay – see Figure 2) was used to show the players' current rapport levels. This mechanism provided valuable in-game feedback that changed as a result of objects and responses, thus focusing attention on developing tacit social skills. Comments showed that the rapport bar increased player interest and aided motivation:

"You were conscious of that green bar, so it kept you alert the whole time" [P10, F7]

Even in cases where the player found the gameplay less interesting, the feedback provided by the Rapport Bar was able to positively influence involvement by providing a counterbalancing focus for attention and further stimulation:

"Cause you do want that green bar to go up, even if you're bored you want that bar to go up" [P4, F5]

In addition, this stimulating of attention also seemed to motivate some players to think more deeply about their learning through their gameplay, thus indicating a continued sense of engagement:

"You've got like a target, you concentrate on that green bar, and I thought... I've got to think about my answers here..." [P2, F4]

Learning challenges

The final theme concerns how engagement related to experiencing relevant learning challenges within the game. The players talked about the relationship between frustration and learning, which once they had overcome, produced a rewarding experience. When making decisions within the game, players were able to engage in safety-critical learning through the feedback mechanisms and different storylines (e.g. when they were faced with an axe murderer after following incorrect procedures). Arguably, engagement and learning were successfully woven together, as players became aware of their responsibility and took ownership for their learning journey by putting effort into the game:

“It does make you think... because it makes people actually do their own research” [P11, F1]

Similarly, players were able to clearly identify engagement as the pathway to successfully learning from the game. Several players also stated that while this was not a simple process, they valued the learning that resulted from overcoming challenges in the game:

“You have to engage in it to do well ... people may find that frustrating but ultimately you’re forcing that person to learn” [P9, F8]

For some this engagement was a simple relationship between feedback mechanisms reinforcing what they did and didn’t know. The feedback produced at the end of each scene would indicate if players had missed something, thus creating a further challenge for them to engage in:

“I just wanted to get all my stars but the thing that got me down was the process that I didn’t know, but then it got me dead annoyed... but it made sense” [P8, F7]

For others, the gameplay could produce a deeper more dynamic interaction between engagement, ownership and motivation, thus highlighting the value of sustained learning:

“It makes it more memorable... cause you can actually refer it back to the game, I would remember it” [P12, F8]

Ultimately the game was able to generate effective engagement that incited learner reflections around key learning points:

“Gaining your rapport. It’s common sense, if you think about it but you don’t always think about it.” [P2, F7]

DISCUSSION

Engagement is frequently provided as a rationale for the use of serious games. However, within the context of games that provide safety-critical training, the literature lacks a clear understanding of what sort of experiences players are having and what factors influence their engagement. In this paper, we explore these questions through presenting the player experience evaluation of a SCG that aims to train new police recruits in obtaining ‘initial accounts’ from child

witnesses. A mixed-methods approach was used that captured quantitative survey data on usability and game experience, while qualitative findings provided a deeper understanding of player engagement through identifying the factors that influence engagement and potentially learning.

The quantitative value ratings suggest that players preferred game-based learning to online-training, while the UX ratings suggested that the game was able to provide a reasonable user experience that was unlikely to get in the way of deeper levels of engagement. The GEQ results also indicated that participants found a 45-minute play session with CIS to be more absorbing than the 3-5 day training events, as well as being less boring and tiresome. While these results do suggest the game was somewhat engaging when compared to other forms of training, the qualitative findings were able to provide more in-depth insights into the experiences of players and how intrinsically learning and engagement were intertwined. In the context of SCGs engagement appears to be less about ‘enjoyment’ and more about the relevance of the game to players. The findings illustrate how situational relevance was supported through providing real-world authenticity, targeted feedback mechanisms, and learning challenges.

In relation to real world authenticity, previous research has investigated how the level of realism can influence learning [e.g. 38]. However, the focus tends to be on the level of graphical fidelity - with a consideration of whether higher realism can improve learning or even distract novices due to creating additional complexity [e.g. 39]. During the development phase, testing suggesting that 2D animation would be more effective in a safety-critical context, as it enabled players to focus more specifically on learning points. Furthermore, the qualitative findings indicated that relevance was more important than realism for engagement. Through providing a scenario based on the real world, the players were able to relate their gameplay experience to their practice. The authenticity of the game narrative may have helped players narrow the gap between their virtual and real-world identities (through adopting what Gee [15] refers to as a ‘projective identity’) where they could reflect on their own learning.

In addition, the relevance of the learning points seemed to be more important to players than attempting to provide them with a completely realistic environment. For instance, the fact that players would encounter an axe-murderer if they did not check the address properly was not a particularly realistic outcome but it did provide a valuable learning point that emphasized the value of following particular procedural steps.

These learning points were also facilitated through feedback mechanisms that helped to focus a player attention on the relevance of both tacit and procedural learning. Feedback is seen as an important way to support learning in games [18], though these findings also illustrate how feedback can support engagement through indicating in-game progress. While the rapport bar is obviously not

something that exists outside of the game, it was able to provide relevant real-time feedback on player actions that they could use to progress in the game. In addition, the interactive objects also supported engagement by prompting players to explore the environment and think about how they could create rapport with the other characters.

Feedback mechanisms are also closely linked to the learning challenges provided within the game. Players were required to try and build rapport and carry out the correct procedures, in order to effectively collect an initial witness account from the child. As in real-life, they had to engage in decision making, where their actions could result in different consequences. While wrong decisions may have caused short-term frustration, this also led to a stronger embedding of learning as players were provided with information about how to improve their performance. Challenge is generally seen as important for facilitating engagement in games [14; 30, 31], but also plays a role in learning, where, for example, Iacovides et al [22] illustrate the ways in which breakdowns provide opportunities for players to develop deeper understanding. While the feedback in the CIS may have challenged players, arguably this led to more rewarding experiences in the longer term where players learned how to improve their performance not online within the game, but in the real-world setting.

Through a combination of creating authentic experiences, delivering informative feedback and providing learning challenges the game was able to effectively engage players and create an absorbing learning experience. Both engagement and learning appeared to result from the merging of procedural tasks and tacit in-game feedback-mechanisms (e.g., active objects, rapport bar), which were interwoven with decision-making within the storyline (e.g. selecting appropriate questions, paying attention to information). In relation to creating a game within a safety-critical context, it is particularly important to ensure that relevance related to each of the three factors outlined – where engagement appeared to result from how players valued their in-game experiences for informing their practice as police officers.

Design implications

In relation to developing an engaging SCG, we suggest adopting a 3-step design approach: (1) identify the contextual relevant learning points (both tacit and procedural) for the game, (2) create relevant scenarios to represent those learning points and then (3) develop game mechanisms that produce and guide players through the scenario and key learning points. To ensure relevance, key stakeholders should be involved throughout the process and iterative testing will need to be carried with experts and members of the target population. This process can help to ensure that authentic experiences are provided along with informative feedback and appropriate learning challenges.

Based on our experience, we present the following design recommendations for guiding players through key learning points within an SCG (step 3):

Avoid assumptions about the gaming literacy of the target population: while the popularity of gaming has increased within society, not all trainees will be familiar with gaming controls and mechanics. The initial dialogue system had to be replaced, as it was too complicated for those who did not regularly play computer games. The audience for SCGs is likely to consist of people who have different degrees of familiarity with games. If basic controls can be mastered by non-gamers easily, then a much wider proportion of the target audience will be likely to experience engagement.

Players welcome complexity, but ensure sufficient support to solve the challenges: although players accept responsibility for wrong decisions that lead to failure, the learning experience does not terminate with completion of the narrative. It is important to adequately support reflection concerning mistakes through providing sufficient insight as to how to perform better next time, thus mitigating the short-term frustration. Doing so will help to ensure that players find feedback relevant and understand how it relates to their real-world practice. In some cases, this will be a matter of careful calibration, but in others, it may require a redesign of the narrative.

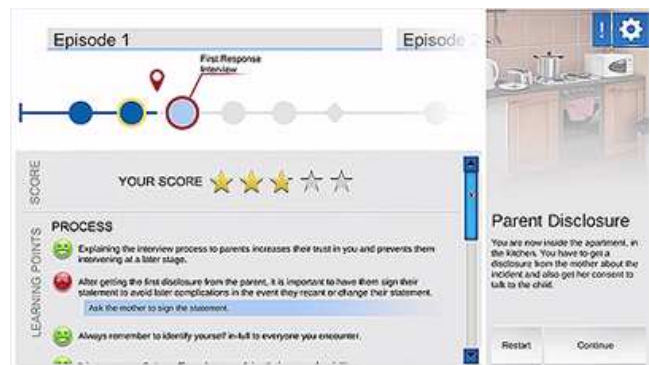


Figure 4: Feedback after one of the in-game scenes

Keep scoring as simple as possible: initially performance was represented by an overall score, decomposed further into the three dimensions (interview skills, rapport building and following process). However, players had difficulties interpreting the feedback so this was replaced with a simpler system (see Figure 4) that provided clearer feedback for what players needed to go back and focus on.

Limitations and future work

One of the main limitations of the study relates to the lack of equivalent police training in the collection of first accounts from children, which means direct comparisons could not be made with non-game based training. However, it is important that when developing novel approaches that at least a relative comparison is made, so we looked instead to more general forms of witness training.

Another potential limitation concerns the fact that we did not explicitly consider the impact of prior gaming experience outside of development testing. While engagement may have been influenced by how players

identified as gamers [23], this was not something that seemed to come out of the focus groups. However, future research could be carried out to explicitly focus on the influence of prior gaming experience on engagement and learning within a SCG.

In addition, we did not report any measures of learning within this paper, as the work is still ongoing. This research forms part of a larger body of current work that investigates the effectiveness of game-based training, involving a full randomized-control-trial that will collect knowledge ratings from over 100 participants. Instead we focus on understanding player engagement as a necessary component of the wider learning experience.

This research has created great interest within the police, with possibilities of developing further police-related game-based simulations that focus on a range of topics e.g. dealing with vulnerable people, online grooming, stop and search. There is also further potential to adapt the current prototype to achieve different learning goals. Additionally, there has been interest in the wider 'blue-light' (i.e. ambulance, fire-brigade) and disaster recovery contexts. The aim would be to develop a suite of game-based training packages that provide a cost-effective, engaging and effective approach that compliments current training needs. This would then provide further opportunities to examine player engagement and learning across a range of SCGs. The main three areas that require further research are 1) how to effectively design games for learning across a range of safety critical settings; 2) how best to evaluate any learning has occurred and 3) to examine the role of SCGs in future training practices.

CONCLUSION

Through the evaluation of CIS, we have been able to explore the factors related to player engagement in the context of games used for safety-critical training. While engagement is important to consider in relation to serious games in general, it has further ethical considerations for SCGs, where a lack of engagement and inadequate training could have severe consequences in the real world. These findings highlight how engagement is supported by experiencing situational relevance, due to a focus on real-world authenticity, targeted feedback mechanisms, and learning challenges. We also present a summary of a three-step design approach, which emphasizes the importance of incorporating both procedural and tacit learning points, and consider specific design recommendations for developing engaging SCGs.

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