REVRLaw: An Immersive Way for Teaching Criminal Law using Virtual Reality

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Abstract. Computer games have now been around for over three decades and the term serious games has been attributed to the use of computer games that are thought to have educational value. Game-based learning (GBL) has been applied in a number of different fields such as medicine, languages and software engineering. Furthermore, serious games can be a very effective as an instructional tool and can assist learning by providing an alternative way of presenting instructions and content on a supplementary level, and can promote student motivation and interest in subject matter resulting in enhanced learning effectiveness. REVRLaw (REal and Virtual Reality Law) is a research project that the departments of Law and Computer Science of Westminster University have proposed as a new framework in which law students can explore a real case scenario using Virtual Reality (VR) technology to discover important pieces of evidence from a real-given scenario and make up their mind over the crime case if this is a murder or not. REVRLaw integrates the immersion into VR as the perception of being physically present in a non-physical world. The paper presents the prototype game and the mechanics used to make students focus on the crime case and make the best use of this immersive learning approach.

Keywords: Educational Games, Cognition, Interactive Learning Environments, Virtual Environment, Head Up Display (H.U.D.)

1 Introduction

Although the name and the concept of virtual reality sound familiar, coming up with a precise answer is surprisingly hard, as even the casual inquiry into the matter opens a whole series of additional questions. However Craig et.al. [6] rightly defines VR as *"a medium composed of interactive computer simulations…giving the feeling of being immersed…"*, while Zhuang and P. Wang expressed it better and finely as a high end Human-Machine Interface, that combine various technologies such as computer graphics, image processing, pattern recognition, artificial intelligence, networking, sound systems and others to produce computer simulation and interaction, which gives

the feeling of being present through multiple synthetic feedback sent to sensorial channels like virtual, aural, haptic and others [7].

Most educators agree that the interactive nature of e-learning and mobile technologies increase the teacher and student communication. But to date, learning on social media and other e-learning platforms has been a poor substitute for classroom learning. To address this issue a number of academic institutions have introduced *blended* [8] and *flipped* [9] learning strategies. In the former classroom strategy, students learn through a "blended" model of in-person (with a teacher) and technology-based instruction with some student control over time, place path and/or pace of the curriculum. In a flipped classroom model, students gain the necessary knowledge before class, typically through the use of educational technology such as online videos, and during class time they explore that knowledge in greater depth through various methods including discussions, project-based learning and laboratory experiments guided by a teacher.

In an effort to motivate and engage students in these new "hybrid" environments, instructors have recently started introducing game-based learning experiences as part of the learning process in the classroom as well as part of the online instructional materials. The incorporation of game elements in non-game contexts is widely referred to as "gamification" [4]. Gamification is being increasingly recognized as the process/technique of extracting motivating and engaging elements found in games and applying them to real-world productive or educational activities [1]. The successful incorporation of gamification particularly in educational context is challenging. One of the trivial aspects behind virtual learning environments is to establish what motivates users, optimizes their feelings and engage them in the actual scenario. This process is what is called User-Cantered Design (UCD) [4].

Virtual reality can be used to support gamification learning purpose as it tries to alter a person's perception of reality by tricking the senses and providing artificial computer-generated stimuli [2]. The ultimate goal of VR is to create a perfect illusion, an artificial experience so realistic that it is practically indistinguishable of the real thing. It is, however, a somewhat utopian endeavor. On the other hand, tricking human senses is much harder than tricking the mind. Human's mind is good at abstract thinking and ready to accept some degree of inconsistences. It is capable of *"filling in the Blanks"* left by the missing or malformed information. As human senses, however, are attuned to distinguishing minute differences a complete illusion is not even necessary. An easier, more achievable goal is creating a believable experience by providing the sort of artificial stimuli that are just good enough to prompt the mind to complete his own illusion. *This can be achieved by* multimodality interactivity.

Multimodality implies the usage of more than one mode of behavior or action. In the case of immersion in a virtual environment, this means engaging more than one human sense. Our perception of reality and sense of presence is always multimodal. Our senses do not operate independently. A multimodal approach can enhance the feeling of immersion as various artificial stimuli can serve to complement each other.

However, despite the increased number of systems featuring intelligent agents, in various learning domains, and despite the immersiveness of interactive technologies there are limited developments that have incorporate VR as part of teaching [3]. In this paper the game presented is a simulation of a tutorial that teaches the 'Law of murder' modified form the original book-learning approach into a VR interactive game. Students are presented with a case, they are asked to apply the law and decide if this is a murder or not. During the game the main principle of 'learning by doing' is applied. One of the objectives of the game is to make students to focus on the topic and make the best use of the 'learning momentum' using appropriate set of evidence.

The selection of a law-establish VR game is because of the interactivity in a murder case scenario, the atmospheric view and the multimodal interactivity with Intelligent Agents (also known as NPC's – Non Playable Characters) which adds some high complexity in the game scenario. Previous games that tried to use crime investigation as part of their theme were quite successful. *"Criminel"* is an IOS game for iPads by 4PM, a small indie company [16]. The similarity with the proposed project is that the player needs to be observant to notice all the key information and be able to put them together to come to a conclusion as to what really happened. "*Murdered: Soul Suspect"* [17], a 3rd person game requires to place together evidence to find out who their own murder is. One of the interesting points is the way hints are displayed to direct the player to the evidence due to the floating text. On the other hand, *"L.A. Noire"* [18] is a story driven open world detective game which mostly revolves around interrogating suspects and following up on leads. The dialog conversation with an intelligent agent is one of the strongest points for the game as the player needs to establish the validity of peoples statements before making a decision on what they believe happened as well as the examining of evidence via close up inspection.

In section 2 of this paper we present the REVRLaw game design scenario. Section 3 includes key-game mechanic elements based on heuristic research that are essential for this VR game scenario. In section 4 there is an evaluation of the prototype focusing on the user interface and gamified elements following by the conclusion with directions for further extension to address user experience feedback form the law students, as well as directions for further development of the framework.

2 Game Design

REVRLaw game has been designed following a UCD process, aiming to address specific educational requirements in Higher Education for Westminster Law School at the University of Westminster, who will use the simulation as teaching and learning tool. The project is based on a VR multimodal interaction, which includes collectable items and interaction with NPC's to obtain verbal information.

In Law school instructors give students either a problem question to gauge their ability to apply the law to a fictitious case to advise a client; or an essay question to look at their critical reasoning skills. The above is a typical problem question. Students have to read the facts/information to spot the relevant offence (in this case murder). They

then have to research the source, definition and elements of that offence, with a view to applying it to the facts and concluding by advising a client. It generally resonates with the following Criminal Law module aims as validated:

- Identify the theories and concepts that underpin the theoretical framework of Criminal Law and stress competing perspectives
- Develop the ability to identify issues in terms of policy and place the Criminal Law in its wider context
- Increase understanding of the nature of judicial reasoning and legal argument
- Enable students to analyze fundamental offences and defenses that form the core of Criminal Law and appreciate the wider contextual dimension of the subject
- Enable students to apply a wide range of research skills, particularly of sources of law and academic materials, and develop effective writing skills with limited supervision.

Murder is a core offence on the Criminal Law module that is taught in the first semester. As part of a tutorial, they answer a problem and/or essay question on it with a view to putting into practice the above aims. Traditionally, for problem questions, they present them with a set of written facts similar to the above and they have to advise a client. This is one place where Oculus Rift CSI will fit in: in supplementing the traditional, written problem questions as a means of analyzing information and the law to advise a client.

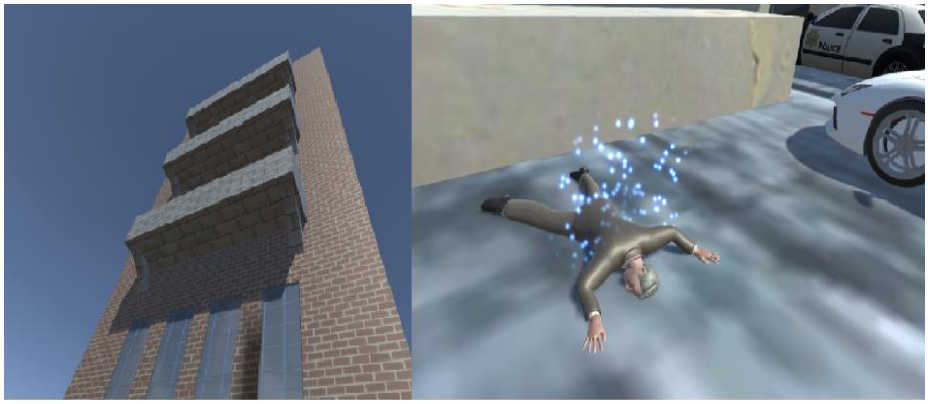

Fig. 1. A screenshot from the game scenario. On the left the crime building and on the right the victim. For supporting player, we use collectible appearance.

Players have to adopt the standpoint of a police officer who has been called out to the office complex upon hearing someone who has been killed. The actor will arrive in the crime scene (Fig. 1) and see the victim laying in a pool of blood. The player will then have to research/know the law of murder and take a walk around the scenario and identify items that are collectable and valuable to the case in order to obtain information, like the life insurance, letters etc. – and also speak to other NPC ‘s– in order to put together an evidential picture. Once they have this, then they can analyze it to assess

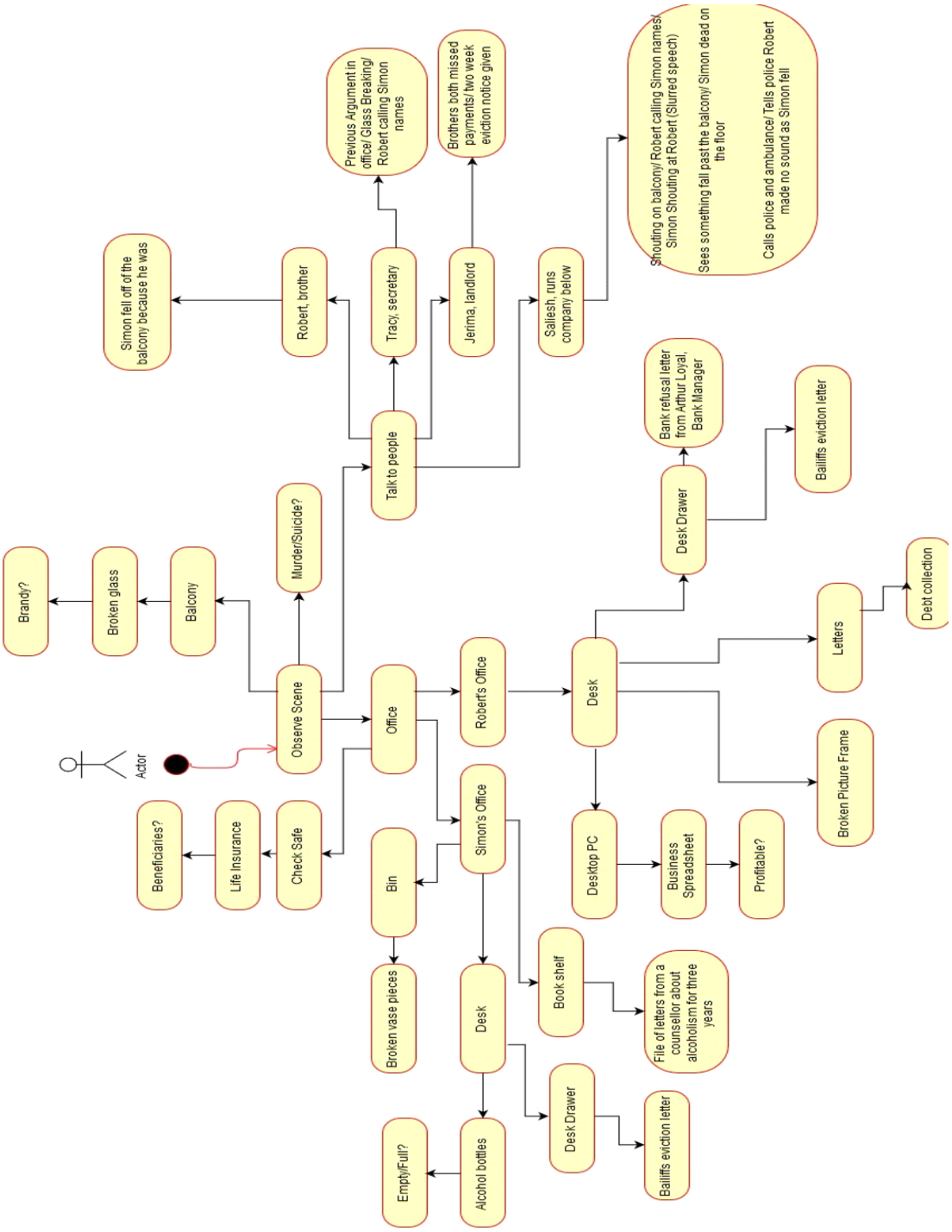

Fig. 2. User Activity Diagram – Event sequence and codex release

to what limit Robert (the accused Avatar) has the *"Actus Reus of murder"* (AR) and the internal state of *"Mind Element"* (MR) of murder – and decide whether to charge him for murder. That is what the student must analyze/fine out. The extents to which all the clues/evidence that have been built in to the scenario show that Robert has the AR and MR of murder. Fig. 2 is a Use-Case diagram for the player-avatar with all possible multimodal interactions and the sequence of events that need to follow to release specific hidden codex's to obtain further vital information.

3 Level Implementation

The game has been developed using Unity 3D game platform coupled with 3DSMax and ICT Virtual Human toolkits to design both scenario elements and Virtual Agents. As the game has been designed using the UCD philosophy we tried to incorporate video game heuristics chosen based on previous qualitative reviews [5], concerning game/play story and the virtual interface. Some key-heuristics are summarized in Table 1 below:

Fig. 3. Interaction with NPC in the game – Server room.

Table 1. : Heuristics summary for REVLAW

No	Heuristic	Reference Source
1	***The player should be presented with "clear goals" early enough or be able to create her own goals and "should be able to understand and identify them". There can be "multiple goals on each level", so that there are more strategies***	**[11-14]**

to win. Furthermore, the player should know how to reach the goal without getting stuck.

- The game will start with a briefing by a police officer.
- Hints will appear near certain objects to show what the player should be thinking e.g. "I wonder what is in that safe".
-

2 ***The player should "feel that they have control over the character" and that they have "impact over the game world". They should also be able to "respond to threats and opportunities".*** **[10-12 & 14]**

- The player can choose what evidence to rely on and which to discard as irrelevant – Fig 4
- The player will be able to choose their own approach to gathering the information.
-

3 ***The storyline should be "meaningful" and support the game play and be "discovered" throughout the game.*** **[12,14]**

- The scenario will be devised by the End User
- There will be a lot going on and a lot to uncover.
- As the player uncovers elements the player will see flashback to what happened.

4 ***The game should be responsive to the player's actions. There should be consistency between the game elements, settings and story. It should "suspend disbelief" and be planned from the beginning to the end.*** **[10, 12 & 14]**

- When the player interacts with an object there will be immediate feedback.
- The scenario will be realistic.
- There will be atmospheric sounds.
- The dialog will be planned and mapped out.
- Once the player has marked a certain number of evidence as key they will be invited to make a decision

5 ***The player should have a clear understanding of what is going on and be given the room to make mistakes.*** **[11]**

- The player has the choice to make a piece of evidence key or not – Fig. 4

6 ***There should be varying degrees of difficulty" for a "greater challenge". The game should be "easy to learn but hard to master.*** **[10, 12 & 13]**

- Once the player has started uncovering evidence it will become harder and harder to find all the last little bits.
- It is not essential to find them all, they need only find enough

7 ***The artificial intelligence should be reasonable" and "visible to the player, consistent with the player's expectations" while remaining unpredictable.*** **[10, 12, 13 & 15]**

- NPC's will have a set routine and will act mainly as background characters – Fig 3
- During the dialog, NPCs will have different reactions based on what you say forming a basic level of AI using if statements and some randomization – Fig 3.

8	***The player should be able to identify game elements such as avatars, enemies, obstacles, power-ups, threats or opportunities.*** - As the player approaches an avatar they will be prompted to talk to them – Fig 3 - When the player looks at an item they will be prompted to interact with it – Fig 1	**[10, 11 & 14]**
9	***The interface should be as non-intrusive as possible. It should be consistent in control, color, and typography and dialog design.*** - There will be no HUD - A 3D interface will appear in the form of a hologram when the player accesses their inventory.	**[11-13]**
10	***The player should be rewarded with positive feedback to get the game moving without any delay in understanding.*** - The police officers in the game will be positive in their responses to your findings. - The player will reward themselves through discoveries and understanding.	**[12]**
11	***Input methods should have the appropriate level of sensitivity and responsiveness*** - The Oculus Rift and Controller will be balanced together to get the right range of motion as the player turns.	**[10-12]**

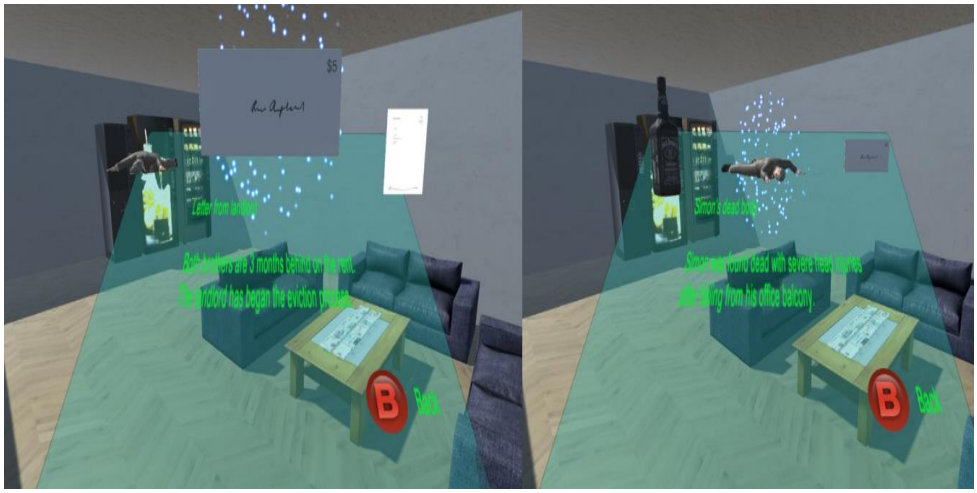

Fig. 4. Interaction with collectible items. As part of storing data through the investigation and re-examine them we use an iteration mode. The focused (middle) reminds to the user the information obtains. At the same moment the user can transverse using the pad left and right option to release previous collectible information for re-investigation based on new retrieved facts.

4 Experiment and Data

The above described game was developed for the "Criminal Law" module, at the University of Westminster, that is attended by over 300 students. A proper testing will be designed for these students and is expected to take place in September-October 2016. Up to spring 2015, an evaluation has been completed from computer games students prior to the release to the law department, to ensure that main development mechanical issues can be identified and addressed before the end-user evaluation experience from the law department.

4.1 Evaluation procedure and apparatus

The pilot evaluation of the platform was carried out with 16 subjects (10 undergraduate students and 6 member of staff) with only 50% having previous experience using Oculus Rift. The study took place at the University of Westminster, London premises and each participant was tested individually. Each session lasted for approximately 20 to 30 minutes. The participants had to use each system for 10 minutes and then answer a short questionnaire. The questionnaire consisted of 20 questions in total. All the questions were multiple choices on a Likert scale of one to five (one being the least favourable answer and the five the most favourable answer). The evaluation focused on usability issues, system capabilities and system learning. All participants used the same apparatus.

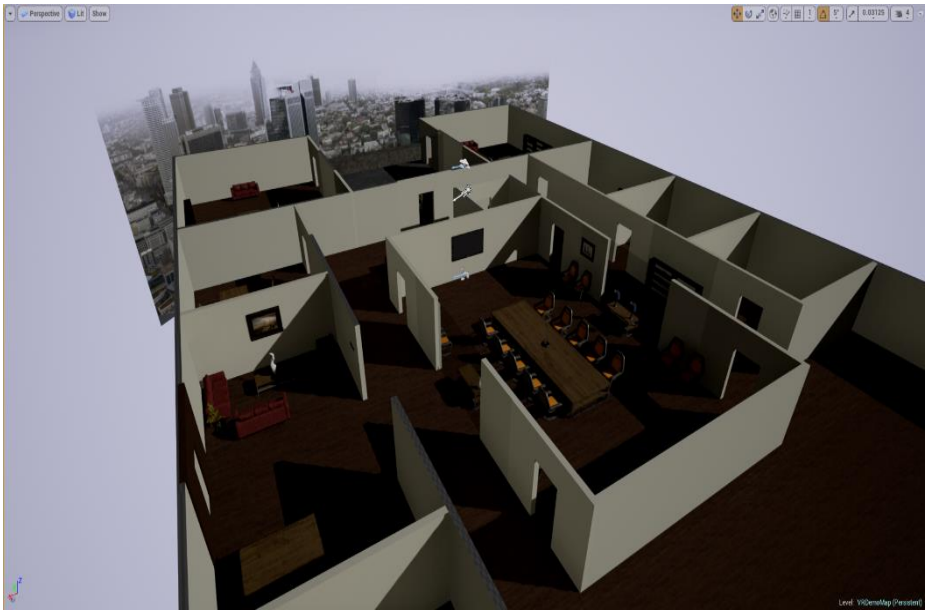

Fig. 5. 3rd person screenshot from the primary investigation scene

4.2 Results

Seven questions were targeted in assessing the general usability of the UIs and scenario playability and to identify potential bugs issues. The results revealed a very positive assessment regarding the usability of the UIs (Table 2 questions 1-7). Participants found that using the VR system generally was easy to use, not very complex and they considered that they did not need to learn many things before starting to use it and adapt to its atmospheric world view. They found it consistent and not cumbersome and that they did not need any technical assistance. Additionally they felt very confident in using the UI and they were willing to use it frequently. Overall they had a pleasant experience using VR with the Xbox pad.

The next part of the evaluation focused on the systems' capabilities (Table 2, questions 8-11). The aim was to test the systems' speed and reliability along with other technical characteristics a VR is a very expensive tool to process in real time and needs high specification PC's and good quality graphic cards. The results were again very positive along the scale regarding the speed and the reliability with a small discrepancy over the user feedback on the click-events as part of collision-noise due to precision – for the project we used the standard bounding box and sphere functions that Unity engine has rather than creating more systematic approach, but with the possibility of speed cost.

Table 2. User Interface (UI) Usability, Capability & Learning Scale results based on Likert Scale obtain from 16 users.

System/UI Usability	Average Likert Scale	UI Capabilities	Average Likert Scale
1) I found the UI unnecessarily complex	1.3	8) UI Speed	4.4
2) I thought the UI was easy to use	4.2	9) UI reliability	4.1
3) I think that I would need the support of a technical person to be able to use this UI	1.8	10) UI tends to be noisy	3.6
4) I found the various functions in the UI well integrated	4.8	11) Designed for all level of users	4.1
5) I would imagine that most people would learn to use this UI very quickly	4.1		
6) I felt very confident using the UI	3.4	**UI Learning**	**Average Likert Scale**
7) I need to learn a lot of things before I could get going with this UI	3.4	12) Exploring new features by trial and error	4.2
		13) Messages on the screen	4.8

The last part of the evaluation focused on aspects related to learning the UIs learning capability (Table 2, questions 12 & 13). Participants felt that they could easily explore the environment and therefore get to know more the rooms and possible do more object interactivity, and become familiarize with the VR concept. A very interesting aspect of the testing was the messages on the screen. The participants felt that they were extremely helpful as well as their presentation style.

5 Conclusions

In this paper we presented the initial step over the development of a serious game simulating platform based on a real crime scenario to support educational purposes for the law department of Westminster University using Virtual Reality - REVRLaw. We analyzed the game using a number of evaluators targeting in first stage the usability of the game features, both form mechanics and hardware perspective. The usability evaluation of the UIs revealed some very positive results. Participants in general found the system very easy to use, not complicated and they thought they were consistent and did not require a lot of effort to be learned. However, the majority of the participants had prior experience of such UIs and that had also affected their perceptions. Furthermore, they found the technical capabilities of the UIs very acceptable and the demands for learning the system very easy.

The experimental process indicated that future work should be focusing on three main steps. Firstly, the system performance will be evaluated from the law students to obtain an end-user experience based on the quality of information they will be able to understand and use, as well as compare it with their current learning curve of using standard books to evaluate the crime case. This will help us identify potential logical errors/missing to match the teaching criteria and update the game. The second step will be to integrate latest human computer interaction hardware like PrioVR, STEM or Kinect 2 to provide greater accessibility to the player and then to evaluate the effectiveness of the varieties of these immersive environments with the new control systems against traditional GUI interface and other PUI interfaces. The final stage will be to expand the game into a proper framework by creating further hypothetical scenarios for different level of law scenarios.

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