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Master Thesis in Informatics: Games Engineering

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Auf den Spuren von Jack the Ripper - Ein Serious Game zu einem ungeklärten Kriminalfall

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I confirm that this master thesis in informatics: games engineering is my own work and I have documented all sources and material used.

Munich, 15.06.2021 Andrea Müller

Abstract

Over the last decades, many non-traditional topics have been covered by *Serious Games*. This includes games with *Cultural Heritage* purposes. In comparison, Jack the Ripper is a historical person that has been featured in the media abundantly to a point where the myths around Jack the Ripper may be more prevalent than the actual facts. With the *On the Trail of Jack the Ripper* game, a *Serious Heritage* game was created with the purpose of introducing the Whitechapel murders of 1888 to its players. In order to present different angles of the cases, the game does not only teach them about the incidents themselves, but also focuses on the circumstances in which they happened. Thereby, its aims to dissolve myths and intends to raise *Cultural Awareness* for the living conditions of people in the East End, including poverty and antisemitism. The way the game plans to transfer this meaning is by the *Historical Reconstruction* of crime scenes and the recreation of inquest days or police documents At the same time, the game also intends to raise *Heritage Awareness* by offering real newspaper articles, historical police drawings and transcripts of dialogues by journalists of the time. Furthermore, the player will take the role of a fictional detective who, given the available methods of 1888, reconstructs the story of crime with the help of historically accurate documents and some that were modeled after them. To ensure a learning outcome, the game uses detective work techniques and Augmented Reality features, both of which support the learning by offering immersion and context accuracy.

Kurzfassung

In den letzten Jahrzehnten wurden einige unkonventionelle Themen in Serious Games behandelt. Dazu gehören zum Beispiel Spiele, die einen kulurerblichem Zweck erfüllen. Im Vergleich wurde die historische Person Jack the Ripper reichlich oft in Medien zur Schau gestellt, bis zu dem Punkt and dem die Mythen, welche sich um Jack the Ripper ranken, verbreiteter scheinen als die Fakten. Mit dem *Auf den Spuren von Jack the Ripper* Spiel wurde ein Serious Game mit dem Zweck erschaffen den Spielern die Whitechapel Morde von 1888 näherzubringen und nicht nur die Vorkommnisse selbst vorzustellen, sondern auch den Fokus auf die Umstände zu legen in denen diese passierten um die Fälle aus verschiedenen Blickwinkeln zu betrachten. Dabei ist das Ziel sowohl die Mythen aufzulösen, als auch Kulturbewusstsein für die Lebensumstände der Menschen im East End zu schaffen, die Armut und Antisemitismus beinhalteten. Die Art und Weise durch die das Spiel die Bedeutung des Themas vermitteln will, ist durch historische Rekonstruierung der Tatorte und durch die Nachbildung von Untersuchungen oder Polizeidokumenten. Gleichzeitig zielt das Spiel darauf ab ein Bewusstsein für Kulturelles Erbe zu schaffen indem es echte Zeitungsartikel, historische Polizeizeichnungen und journalistische Abschriften der Zeit verwendet. Des weiteren wird der Spieler in die Rolle eines Detektivs gesetzt, welcher mit den in 1888 angewandten Methoden und mit Hilfe von historisch replizierten Dokumenten den Tathergang rekonstruieren soll. Um die angestrebten Lernziele zu sichern, verwendet das Spiel Detektivsarbeit und Erweiterte Realität um durch beide Immersion und Kontextgenauigkeit zu schaffen die das Lernen des Users unterstützen sollen.

Contents

1. Introduction

Games have been a part of today's culture for years and with the generation of "*digital natives*" [42], who grew up with with digital media, digital worlds and games become more and more important in our daily lives. In 2019, the average person in the United States spent more than half an hour per day on playing on weekend, and over 20 minutes on weekdays, while the average 15 to 24 year old uses games for nearly an hour every single day, and even over an hour on weekends [1]. The number of *gamers* is also constantly growing, and is expected to grow even further in the next few years [36]. Thereby, the time to play games is often borrowed from other activities. The importance of games gets clear in a 2021 survey, where over half of the participating gamers admitted that they skip sleep to play video games, and over ten percent are even skipping work [46]. This integration of digital worlds into our lives was enabled by the progressing technology facilitating access to smartphones, computers and consoles. Playing digitally has never been easier. Even though, many modern games become more and more complex and harder to play, players make efforts to be good at games. The effectiveness of learning in and through a fun environment has been proven multiple times in the last twenty years and there is still more to research even until today. How does a game have to transfer knowledge? How much fun is enough fun? How immersive is enough immersion? What genre of games can achieve the best results? In this thesis, a full game was created, that aims to teach players about the Whitechapel murders in 1888 by putting them into the shoes of a detective who investigates the five canonical victims of Jack the Ripper. In doing so, the users should learn how detective work looked like at the end of the 19th century and in what circumstances the serial killings happened and how the press reacted. The game should also raise awareness for Cultural Heritage of Victorian London. In order to support the learning objectives, the game uses *Augmented Reality* as a motivation and as a means of Historical Reconstruction. Therefore, in this work, the theoretical concepts underlying the purpose and design decisions of the game are introduced in Chapter 1, starting with *Serious Games*, *Cultural Computing*, and *Augmented Reality* and ending with detective games and Jack the Ripper. Afterwards, in Chapter 2, related scientific, as well as commercial games are presented that approached the same themes this game does. When the theoretical foundation is built, there will be a detailed description of the gameplay in Chapter 3, including the explanations why certain design choices were made, followed by an evaluation of the finalized game in the following Chapter. Finally, an outlook will be presented on how the game can be changed or further improved, based on the results of the evaluation which will be summarized in a conclusion in Chapter 6.

1.1. Serious Games

The term *Serious Games* (SG) is well established nowadays. A google Search on "*Serious Games*" renders about 865.000.000 results (11.05.2021), while in the beginning of 2007 the number was as low as 1.090.000. Today's SGs find applications in fields like military or governmental purposes, in educational learning but also in corporate, culture, and healthcare. While detailed definitions differ across many literature sources, the main purpose of SGs is considered to be not only simple entertainment [49] but rather an educational method that allows the player to achieve learning targets through a fun experience [34]. SGs are considered a domain on its own, but they often overlap with multiple other domains, such as "e-learning, edutainment, game-based learning, and digital game-based learning" [49]. Here, e-learning refers to computer enhanced learning, edutainment to education by entertainment, game-based learning (GBL) to applications that have defined learning outcomes and digital game-based learning (DGLB) to GBL that is restricted to a digital medium. The main difference that seperates SGs from these domains is, that the design of a SG should be implemented in a way that there is a balance between gaming and learning. This means that the entertainment part should support the learning and not only add a fun layer to the tool [34]. This makes SGs a complex artifact used to educate users [29] and, thereby, add a meaning to the game [35]. It has to involve pedagogical strategies based on teaching, learning theory, learning approaches, evaluation and user feedback [29] to include the education but also offer ways to keep the player from being distracted, keeping him focused on his learning and direct the player's motivation towards the relevant content instead of only the game [35]. In this thesis, SGs will be considered as a union of two aspects. On one hand, they are games and as such are interactive, have a set of rules that enable and constrain the player and lead to a concrete goal by offering challenges and giving feedback. On the other hand, the game's main purpose is to fulfill an educational goal while using the entertainment as a supporting feature to augment the outcome, ensure the learning motives, and, thereby, giving meaning to the game [64].

Catalano et al. [5] set a guideline on how to construct an effective SG. First of all, the learning has to be situated in a way that the deploying environment is suitable and fitting to the context of the use. This means that there is a difference between SGs made for corporate organizations (e.g. competence development) and an academic natural approach. The amount of contextualization has to be set so that the user's needs are satisfied, not the ones of a stakeholder. Second, ideal learning conditions are met, when the cognitive load is minimized. A game interface that is not intuitive enough to make the player understand the rules, restrictions, and interaction methods takes time away from actually playing and learning the game. Another factor that is playing into the cognitive load is the complexity itself. Overly complex games need to facilitate their approaches in order to give the user space to learn. In general, the best approach mentioned by Catalano et al. [5] is to involve the learner in the game flow immediately from the start, and design the interface as easy and clear as possible. A third aspect is to engage the learner constructively, as unmotivated players tend to learn less than immersed ones. The learner's engagement has to be kept high and triggered anew during the game. One example for a bad practice for engagement is to

have the player do repeating tasks. A good approach is to give the player hints that keep the learner from being stuck or block the game's progress. Furthermore, real-time feedback and self-evaluation are mentioned as an important factor. The fourth characteristic is to facilitate the learning task. While the complexity of a SG should be high enough to require efforts, in order to keep the user from being bored, they also have to be easy enough to be conquered. This goes hand in hand with the second point (minimalizing the cognitive load). Catalano et al. [5] describe three stages that should be met repeatedly during the learning process:

- The briefing phase raises the attention of the users and exposes them to their objectives while also explaining the game's rules.
- The facilitation phase aims at helping the players by giving them learning guidance.
- The debriefing phase gives the learners the chance to consolidate what they learned and apply it into reality or into action during the game.

Here, especially the second point is considered to be a difficult design challenge. The fifth and last mentioned feature pertains flexibility, reusability, and exploitablity that give value beyond the games scope. Here, flexibility can mean to present multiple learning outcomes with the same game or multiple ways of conquering the same goals. Reusability is met, when the SG can be used for multiple contexts, such as knowledge transfer and Cultural Awareness. The state of exploitability is close to the previous conditions. However, it is fulfilled when a SG is portable and interoperable, when an app for mobile deployment is used or when it is distributed via stores. All the mentioned conditions can make a SG useful in a way it was not thought to be, depending strongly on the game design [5]. During the implementation of the *On the Trails of Jack the Ripper* game, these five characteristics were taken into account. Another principle that this project relied on is the Input-Output-Process model as depicted in

Figure 1.1.: Input-Process-Output game model [19]

Figure 1.1. Garris et al. [19] introduced this visualization that shows a way how learning in a game-based approach can be improved. The left side of the figure shows what the player can absorb while playing: *Instructional Content* and *Game Characteristics*. An educational game is created when those two features are combined. In this case, the *Game Cycle* comes into play, where *Judgements*, *Behaviour* and *Feedback* are repeatedly and continuously applied and, thereby, create a self-motivated learning situation for the player, making the concept an essential part of the working process [19].

One open question remains: How do people learn? An answer to that can be found in Figure 1.2 from which some of these principles have been integrated into the design of the implemented game.

Learning techniques	**Leaning activities**	**Possible game genres**
Practice & feedback	Questions, memorization, association, drill, imitation	Game show competition, flashcard type game, mnemonics, action, sports game
Learning by doing	Interact, practice, drill, imitation	Strategy game, action game, role playing game
Learning from mistake	Feedback, problem	Role-play game, puzzle game
Discovery learning & guided discovery	Feedback, problem, creativity play	Adventure game, puzzle game
Task-based learning	Understand principle, graduated tasks	Simulation game, puzzle game
Question-led learning	Question/ questioning, problem	Quiz or trivia game, game show competition, construction game
Situated learning	Immersion	Immersive style game such as role-playing game, flashcard game
Role playing	Imitation, practice, coaching	Role-playing game, strategy game , reflex game, adventure game
Constructivist learning	Experimentation, questioning	Building game, constructing game
Multisensory learning	Imitation, continuous practice, immersion	Game in which introduce new technologies such as locatable sound or force feedback, reflex game
Learning object	Logic, questioning	Games which are becoming object-oriented
Coaching	Coaching, feedback, questioning	Strategy game, adventure game, reality testing game
Intelligent tutors	Feedback, problem, continuous practice	Strategy game, adventure game, puzzle game, reflex game

Figure 1.2.: Interactive Learning techniques [43]

1.2. Cultural Computing

A field where SGs are often used is *Cultural Computing* (CC). It covers "the application of computer technology in the field of culture, arts, humanities, or social sciences" [21], and accordingly also *Cultural Heritage*. Even though the computability of culture is not clear [60], it is still a way to translate culture by using a scientific approach to represent the core aspects of a culture [52]. Haydar et al. [21] use another definition of CC by comparing it to a computer technology that can "enhance, extend, and transform human creative products and processes" [21]. Here, the meaning of culture plays an important role. "Heritage is our legacy from the past, what we live with today, and what we pass on to future generations. Our *Cultural* and *Natural Heritage* are both irreplaceable sources of life and inspiration" [54].

With these words, the UNESCO World Heritage Center starts their *World Heritage* section on their official website. They further classify monuments, groups of buildings and sites as *Cultural Heritage* and natural features, geological and physiographical formations, but also natural sites as *Natural Heritage* [55]. Especially for *Cultural Heritage* there is a side to it that can be described as "intangible" (word used in [34]) which includes further aspects outside of the official definition like tradition and social, philosophical or ethical values, practices, customs and religious beliefs but also language, expression and folklore. Mortara et al. [34] describe these aspects as often difficult to preserve but also talk about the ability of SGs to communicate this legacy effectively. For this purpose they were able to split *Cultural Heritage* games, which are considered SGs, due to their learning objective significance in three categories:

- Games with a focus on *Cultural Awareness* concentrate on non-physical heritage such as language, customs and traditions but also spiritual beliefs, folklore and rules of societal behavior. The speciality of games in this category is that they manage to offer a holistic experience instead of only constructing a physical setting.
- *Historical Reconstruction* goals in a game are met when a specific historical event, process or period is faithfully reconstructed. This reaches from digitally rebuilding archaeology to recreating a religious activity. An application field for *Historical Reconstruction* can, for example, be a historic battle that was documented only by writings and comes to life by reconstructing the area and including remakes of physical remains.
- Games that fall under the category of *Heritage Awareness* can have two main goals. On one side, architectural/natural (A/N) *Heritage Awareness* games use an immersive and realistic reconstruction of a given, real location or offer engaging mechanisms to motivate the player into a real experience and to make him appreciate and learn the architectural or artistic values of a place. On the other side, artistic/archaeological (A/A) *Heritage Awareness* games involve the player in the legacy that comes with physical artefacts, history, art and archaeology. Thereby, cultural tourism games would fall into the first category, while virtual museums games into the second.

Following this definition, Mortara et al. [34] also give guidelines on how a *Culture Heritage* SG should be used and designed. This will be discussed later in Chapter 2.1.1. However, an important conclusion they draw from their work is that an effective SG must fulfill two criteria: a meaningful and appealing environment and also an intuitive and suitable interaction paradigm. They visualize this result in Figure 1.3 [34].

1.3. Augmented Reality

The last two sections introduced concepts that used words like immersive, realistic, motivating or appealing and are among other things "used to describe a computer system or image that seems to surround the user" [38] or in context "of a game, performance, work of art, etc. [...] seems to surround the player or viewer so they feel totally involved in the experience, often by

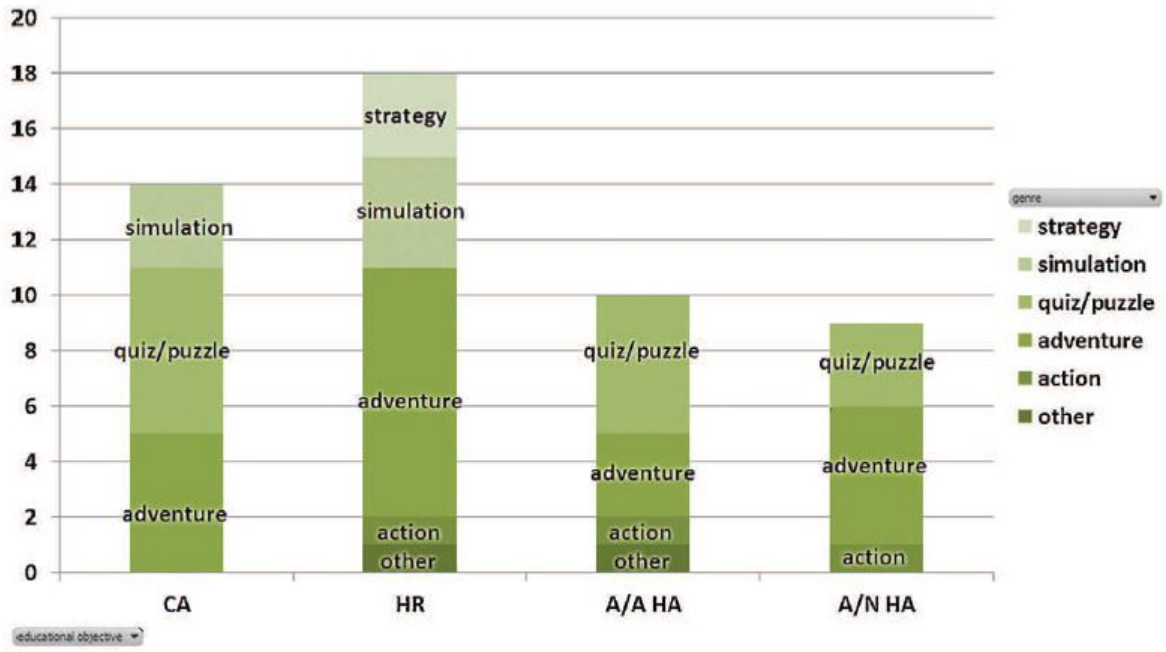

Figure 1.3.: Reviewed SGs according to primary learning objective and game genre [34]

using three-dimensional computer images" [39]. In other words, immersion can be described as a "feeling of virtual involvement" [32]. *Augmented Reality* (AR) and *Virtual Reality* (VR) are at present well known concepts but their relationship to the real space and everything in between was formalized as far back as 1994 by Milgrim and Kishino [33]. As seen in Figure 1.4, they defined the *Reality-Virtuality Continuum*. The continuum encompasses the field of *Mixed*

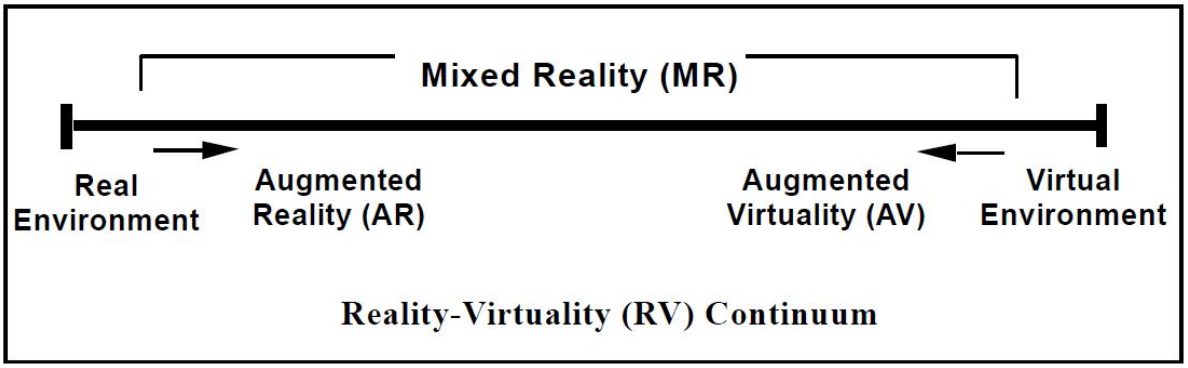

Figure 1.4.: *Reality-Virtuality Continuum* [33]

Reality (MR) that lies between the reality (the real world) on the left and the virtuality (an entirely virtual world) on the right. Accordingly, AR is a MR that combines reality and virtuality, but never the entirety of one or the other. Therefore, AR spaces blend together with real environments while VR spaces appear as part of the real world [33]. AR is bridging

the gap between reality and virtuality. It nowadays finds application in multiple fields. It can be used in hospitals, maintenance and repair of complex technical tasks, entertainment and sport, information visualization of big data, tourism and architecture, military, and also teaching and educating tools [45]. This is partly due to the fact that AR can be integrated in different forms. For example, the tracking can be realized by markers, known as *Marker-based* tracking. Here, the system employs a camera to detect markers that are located in the real world. The markers itself are used to place the position and orientations, of objects that can be viewed virtually. According to Rigby et al. [44], this method is widely used due to its ease and cost effectiveness and its performance efficiency. They also mention that possible challenges of this approach are that the lighting and visibility conditions have to be good for the camera to correctly track the marker. Another challenge is, that the markers itself may lack in aesthetics or may even not be allowed on historical sites and in museums. Besides *Marker-based* tracking, cameras can also detect geometric features in the environment. This optical tracking may fail when there are no definite features available. In public sites, there may not be the possibility to implement this method. However, it would keep the designers from having to integrate markers whenever they cannot be integrated easily or meaningfully. Besides the *Picture-based* tracking, it is possible to have a *Location-based* one by relying on satellites or beacons and use GPS to calculate the current position of the device. This can turn out to be complicated indoors, but also outdoors, as GPS positioning often performs poorly and is not accurate enough to augment concrete objects to concrete positions. Therefore, it is rarely used [44]. Of course, a hybrid technique of the three can also be implemented to balance out the disadvantages of each. The more stable a system is, when adding multiple tracking techniques, the higher are the performance costs. This would lead to a decreased user experience, one of the key features of AR: the player experience [27].
The usage of AR has increased continuously in the last decades, especially in the field of Cultural Heritage SGs with multiple tour guide solutions, virtual museums or monument reconstruction games. The reason for this popularity lies in the advantages that come with AR features. First of all, AR is a technology that, compared to VR, is very feasible, not only for designer and programmers but also on a customer level. Smartphones and tablet computers are commonly available and an easily accessible and portable AR device for almost every person. Thereby, AR games are not static anymore and do not need a fixed location to be played at. Also, there is no need to introduce and produce new AR only devices. Second, the distribution of applications for mobile devices has become very easy with multiple online distribution platforms such as app stores directly on the device itself [44]. These two arguments also support the fact, that an easily shared technology leads to a broader range of participation and awareness [27].
Especially in SGs, AR has become a key technology, as it is able to bring learning into authentic environments and, therefore, enhance learning and engagement but also change the percepted reality of the user in order to mix digital content and direct physical objects [57]. However, a question remains: what do we actually get if we combine AR and SGs? The combination of both differs when it comes to different application fields. For example, AR can be used when the real objects cannot be touched or otherwise interacted with

because they are fragile or simply do not exist anymore. Another application field can be the reconstruction of outdoor sites, when these sites are not accessible or, again, do not exist anymore. Reconstructed buildings can be integrated into the real world by a digital overlay or appear completely digitally on screen. This opens up a much broader spectrum of possibilities and a superior user experience [44]. Another reason to combine AR with SGs is, that methodological, *Thinking-based* designs improve the learning outcome if the game is interesting and entertaining with features that are popular among users [57]. As introduced in Chapter 1.1 and Chapter 1.2, an immersive technology, like AR, that does not draw away the attention from the learning outcomes, but supports and enhances the learning and content is necessary for an effective *Serious Heritage* game and its learning outcome.

1.4. Jack the Ripper

An understanding of AR and *Serious Heritage* games are the foundation for the introduction to the content of the *On the Trails of Jack the Ripper* game that was implemented during this thesis. Jack the Ripper is a recognizable name, even now, more than 130 years after his murder series. A world-wide audience is attracted by multiple articles, books, and chapters that have been released since 1888 [9], many of them literary or dramatic works. His case is considered "one of the most famous unsolved mysteries of English crime" [23]. Often, he is described as a monster (see for example [9], [26], [20]) and the myth around him persists until now. However, the prominence around his name and his actions comes from a combination of different angles that have to be taken into account like "crime and violence, popular culture, poverty and philanthropy, history and mythology" [20]. While a dozen murders that happened between 1888 and 1892 are speculated to be attributed to Jack the Ripper [23], only nine of them are listed in police files in the national archives: "Emma Smith, Martha Tabram (or Turner), Mary Ann 'Polly' Nichols, 'Dark' Annie Chapman, Elizabeth 'Long Liz' Stride, Catherine (or Kate) Eddowes, Mary Jane (or Jeanette) Kelly, Alice 'Clay Pipe' McKenzie and Frances Coles" [20] and only five of them are considered canonical: "Mary Ann Nichols (found August 31), Annie Chapman (found September 8), Elizabeth Stride (found September 30), Catherine Eddowes (found September 30), and Mary Jane Kelly (found November 9)" [23]. Figure 1.5 shows a summary of these five victims' general information. In the following, an overview of influences and circumstances that came with the murder series is given.

Historical Background

In the 19th century, the crime rates rose in Victorian England, partly because of the Industrial Revolution that enabled women and children to work which was often feared to end in a moral decline of the country. As a result, women often resorted to prostitution in order to earn money. Due to the absence of a authority figure at home, the education of children and the youth dropped resulting in a higher chance of the younger generations to fall into criminal behavior [63]. With this change, the mindset of Victorians seemed to shift as well. A popular opinion began to rise, that criminality was hereditary and therefore, also connectable

	Name				
	Mary Ann Nichols	Annie Chapman	Elizabeth Stride	Katherine Eddowes	Mary Kelly[a]
Life-style					
Prostitute	+	+	+	+	+
Destitute	+	+	+	+	+
Alcoholic	+	+	+	+	+
Age	42	47	45	43	25
Date of Death	Aug. 31	Sept. 8	Sept. 30	Sept. 30	Nov. 9
Crime Scene	Buck's Row (Durward St.)	Hanbury St. Spitalfields	Berner St. Aldgate	Mitre Sq. City of London	Miller's Ct. Spitalfields
Body Position	Supine	Supine	Supine	Supine	Supine
Clothing	Fully; sans underwear	Fully; comb & coins at feet	Fully; undisturbed	Fully; pulled up	Bedclothes
Injured Areas					
Face	Bruised both jaws	Bruised, swollen		Nose cut rt. side	Nose cut off; forehead skinned
Extremities		Right ring finger abraded			Left leg skinned
Chest		Bruising	Shoulder & clavicle bruised		Breasts amputated
Abdomen	Jagged cut left–right. cross-cuts	Wall removed	—	Oblique cut up rt.–lt. liver stab	Opened
Organs Removed	Omentum cut	Uterus, vagina, bladder, intestines on rt. shoulder	—	Left kidney, intestines on shoulder	Liver by feet, intestines draped on the mirror

Figure 1.5.: Information about the five canonical victims of Jack the Ripper [13]

to physical features [9]. At the same time, an environmental spatial segregation divided London's East End (the area beyond London's eastern fringe) and West End [26]. The East End has been known for its immigrant population and its poverty and was looked down upon by the middle and high classes of London's society [12] which were even considered polar opposites: the rich and the poor. Especially the increment of immigrants, the growing number of Jewish refugees and Irish workers led to an overcrowding of the district. In 1891 about 57 percent of all Jewish immigrants lived in Whitechapel [48]. In total, London's population grew from 1.8 to 4.5 million [9]. In Dorset Street, where the fifth canonical victim and parts of the fourth one's apron was found, 256 people lived on 1 acre (about 4050 square meters). However, poverty maps made in 1889 show that among the ten poorest districts, only three lay in the East End and are not even connected to the Ripper murders. Annual reports of sanitary conditions also reveal, that the death rate of children under five years of age in London was 26.3 percent while in Whitechapel it was 26, so slightly under the London average. Furthermore, London's mortality rate due to alcoholism was at about 0.75 percent overall, and only 0.15 in Whitechapel. The same picture applies to violent deaths such as execution, suicide and homicide,where the average rate was about 0.55 percent but only 0.36 percent in Whitechapel. Also, 98 lodging houses were reported in Whitechapel when the

murders occured, which was the densest concentration in London, the highest amount in Dorset Street [48].

Press and Newspaper

As seen in the last section, living conditions in Whitechapel were bad, but not worse than other districts in London. Yet, the East End was connected to poverty more than every other district, even before the Jack the Ripper murders. A main reason for this is how the press and newspaper viewed the districts in the east. West Enders considered Whitechapel a district full of criminals, prostitutes, and layabouts. Law-and-order journalism in Victorian London tried to peak the reader's interest mostly by speculation and exaggeration to increase the level of mystery and arouse the readers curiosity [9]. News of Jewish immigrants ran trough the press. In 1886, the *Pall Mall Gazette* newspaper wrote: The "foreign Jews of no nationality whatever are becoming a pest and a menace to the poor native born East Ender" [26]. National attention was drawn to an immigrant problem and linked to the poverty rates. On June 30th 1888, the *East London Advertiser* published a paper in which they describe the competition from foreign Jews for the hard driven locals with high rents. According to Jones [26], newspaper reports of Jewish convicts were highly debated, even after the convicted were already hanged and started an antisemitic feeling within Whitechapel and further hostility towards the community [26].

The newspaper played a role in distributing information about the murders as well. According to Curtis [9], police photos were never released to public. Instead, crude prints were provided by the *Illustrated Police News* and other papers, leaving space for imagination and false information to spread through the public. As seen in Figure 1.5, the victims with the most severe injuries were Eddowes and Kelly. However, they received only two (Eddowes) or one (Kelly) inquest sessions. Curtis gives a reason why the first three victims received up to five inquest days. He comes to the conclusion, that editors seem to worry about publishing medical evidence given at inquest days like the removal of the uterus or pelvic cuts as it seemed unfit to print while bullet wounds and fractured skulls were commonly written about. In general, the information about wounds and the medical examination was reported by surgeons and medical experts to a coroner who had the sole responsibility of initiating criminal proceedings. To give an example, on the first day of Nichols inquest, Dr. Llewellyn (who examined the victims body) read from his notes about the injuries he found. In the report of the *Times* reporter, the doctor's words are quoted, including the cut throat. When Llewellyn starts to describe the abdominal injuries, the article becomes vague and stops quoting. An equal evasiveness appears in the *Morning Post*, *Reynold and Lloyds*, and most reporters by focusing on five missing teeth. According to Curtis [9], this led to a widespread misinformation among the public even until today.

Police

Media and imagination played one part in the "*mythification*" of Jack the Ripper. The fact that he was never caught played another. According to Eckert [13], in 1888, scientific investigation

was not up to modern standards. However, microscopy, medical chemistry and pharmacology was already used since mid 19th century. During the Jack the Ripper investigations, no chemical examinations were performed to find out the degree of intoxication of the victims or the usage of chloroform. The information about the drinking came from witnesses who claimed to have seen the victims before their deaths. Especially chloroform had been available to the public since 1847 from hospitals and would have given a reason as for why the victims did not make a struggle or scream significantly. Additionally, forensic medicine as well as pathology was considered medical speciality in London and Scotland. Police surgeons were called to the crime scene and were the first to inspect the severity of the wounds. They attended the post mortem examination and were schooled in sexual attacks, including "spermatozoa, blood, hair and skin fragments" [13]. However, none of these techniques were used, mostly due to missing adequate equipment for documentation, like photographic examination [13].
Besides the unused capabilities, the fact that London had two entirely separated police services had an impact on the cases. According to Beadle [48], the largest police department was the *Metropolitan Police*, with Charles Warren as their commissioner. He led "three assistant commissioners, four chief constables[...], thirty superintendents, 837 inspectors, 1369 sergeants and 12025 constables" [48]. The city of London itself had its own service, headed by James Fraser, who was absent during the Jack the Ripper murders and who led one superintendent, 14 inspectors, 92 sergeants and 781 constables. Despite the amount of over 14000 officers, only 8773 were not absent or deployed for different cases to protect a populace of nearly 5.5 million people, leading to understaffed situations all over London. Furthermore, the cases of the different victims were investigated by different divisions of the *Metropolitan Police*, splitting the information and complicating the work of supervisor Abberline. According to Beadle, Londons police was overwhelmed, receiving about 1400 letters, trying to watch every slaughter house in Whitechapel and following clues. Nevertheless, the police was heavily criticised even by Queen Victoria. When arresting John Pizer on tenth of September, because of his nickname "Leather Apron" and the found leather apron on the scene, his Jewish origin fueled newspaper with speculations that Jack the Ripper was a Jewish immigrant. When Eddowes was murdered on London city police ground, they were brought into the case while a part of her missing apron piece was found on Metropolitan ground what forced both parties to work together. However, they clashed, when the apron piece was found under a graffito saying "The Juwes are the men That Will not be Blamed for nothing" [48]. Metropolitan police wanted to erase the graffito, trying to prevent antisemitic riots. City police wanted to keep the clue for photography, leading to more criticism towards Metropolitans.
Even trying a technique, that was considered new, the usage of bloodhounds, turned out unsuitable while stories emerged in newspaper that the dogs were lost or bit the police [48]. Today, actual city police investigations cannot be reconstructed due to the destruction of the files during the second World War and their missing cooperation with *Metropolitan Police*. Multiple mentions of suspects were found in letters between different divisions but often not with a name and all ruled out in the end [48].

Summarizing the last sections, the Jack the Ripper murders are investigated until now with

great interest due to misinformation that has been spreading since the murders itself. While Jack the Ripper is connected to a violent murder he is also the anti-hero of a story that is often exploited by conspiracy theorists, movie makers and dramatic media [20]. Yet, the events led to a police reform and an effort to clear London of its slums while they are giving a valuable insight in Victorian culture and thinking.

1.5. Detective Games

In the *On the Trails of Jack the Ripper* game that was made during this thesis, the players ares supposed to work as a detective during the ripper murders. Often, the term detective work is used when players need to piece together clues found in the environment in the game, in detective games or non-detective stories. Playing the detective then means reconstruction a plot that has happened in the past, by finding and connecting the traces that were left behind [30]. Most games of the detective genre are adventure games where users are presented lock-and-key puzzles and can proceed to the next story bit after solving them. Then, they can find the next piece of evidence and eventually reveal the culprit [15]. The players themselves do not necessarily need to perform actual detective work and simply follow a given plot with trial and error in the puzzles until they finish the game. Instead of focusing on the solving of the case, many adventure detective games build on character complexity, consequences of the investigation and the story itself, making the player witness the investigation more than doing it. These methods can be found mostly in modern detective fiction [30]. Fernández-Vara [15] investigated Sherlock Holmes in detective games and gives two most general and primary areas to improve these type of games. On one side, examine and interpret evidence and on the other side, model insight thinking [15], [7]. In his toolkit, Brown [31] names four aspects to detective work, the first to find connections and make deductions, which are coherent with Fernández-Varas areas. The other two, expose lies and follow leads, can be taken as an addition. In every detective novel there are two plots. The first one is the story of the crime, which normally has already happened when the plot begins. The second is the story of the investigation that is uncovering the first one. Furthermore, there are three kinds of detective stories, starting with the whodunit. Here, the first story, the one of the crime is the main driving point and the investigation story is usually a puzzle-like type. In addition, the plot of the detective itself is irrelevant and he is therefore considered untouchable. The next one is called the thriller, and has the detective's work, his point of view and his story of unraveling the truth at its focus. In this case, the detectives are the narrators of the story and their safety and life not guarenteed at all. At last, the suspense is the third kind and a mix of both. The story of crime is open for the reader and the emphasis of the novel is on the future of the detectives. According to Todorov [51], each of these categories has a historical precedent and a period in which they were popular and often used. Thriller types were predominant in America after World War 2, whodunits used by authors like Arthur Conan Doyle, Agatha Christie and Edgar Allan Poe around the 19th century.
This categorization allows to differentiate between games in which the player acts like a detective, doing the detective work and the ones in which he follows the detective and

watches him do the work. These two types can then be called "puzzlebox detective games" and "adventure detective games". Puzzlebox games follow a strict structure in a whodunit style by letting the player lead the investigation and thereby enact it. In adventure games, the player follows a defined investigation path in which detective work can be integrated. A game that focuses on uncovering the story of the crime, without prescribed paths, it is a puzzlebox. If it focuses on the story of the investigation and is led on how to investigate, it is an adventure type game. However, games can be a mixture of the both types [30] and yet, most games revolve around the adventure aspect, often by using multiple choice questions and waiting until the player pick the correct choice. This ensures that in the end, the player reaches the end and right conclusions to solve the mystery but it also "may be less compelling [...] when the answers are all given" [25].

1.6. Goals

The Goal of this thesis is to create a *Serious Heritage* game, that introduces the Jack the Ripper murders to the players and teaches them not only about the murders itself but also the circumstances in which they happened in, including the living conditions in London, police work and newspaper handling of the murder series. Furthermore, the player will take the role of a fictional detective who, given the available methods of 1888, reconstructs the story of crime with the help of historically accurate documents and ones that are modeled after them, newspaper articles and contemporary investigation methods. To ensure a learning outcome, the game uses detective work techniques and AR features, both of which support the learning by offering immersion and context accuracy.

2. Related Work

In the following sections, multiple examples from all introduced genres will be presented as a reference to the current state of the art but also to give insight into projects that received positive and negative feedback from which conclusions were drawn before implementing the *On the Trails of Jack the Ripper* game of this thesis.

2.1. Serious Games

In the previous chapter, the term *Serious Game* was introduced and connected with the topics CC and AR. To display examples of these areas and to give a lucid categorization, the following SGs are grouped into *Cultural Heritage* works, historical and AR ones. Nevertheless, the presented games often turn out to belong in more than one of these categories, which will be pointed out in the respective sections.

2.1.1. Cultural Heritage

Icura is a game that was released in 2010 and fits into the adventure genre. During the game, the player embodies a tourist visiting Japan for the first time, given only little information about Japanese culture. The goal is to get the precise address of his host by overcoming several obstacles and subtasks. While the user walks through a realistic 3D virtually reconstructed Japan, he is able to see multiple buildings, streets, temples, landscapes, and aesthetics and also comes in contact with Japanese culture and etiquette. The goal of the game is to raise cultural interest but can also support the planning of a coming trip. The single player game offers realistic graphics, clearly defined sub goals, and a final score sheet in the end. In addition, the player is supported by an information agent that acts like a virtual tutor that helps the player with feedback and hints and prevents him to get stuck midway [17]. *Icura* was evaluated not only by the designers themselves but also by multiple SG papers. From a pedagogical view, its strong points are the immersive environment in which the learning-by-doing method thrives the best. It enables the learner to build knowledge by interacting, exploring, and manipulating. The learning content is organized in sub tasks and sub units with different difficulty levels. For some of the tasks, objects in the scene have to be combined or used. As an example, the user has to utilize the steam coming from a tea pot at one point in the game, to lift a sticker off the wall [5]. The evaluation done by the designers consisted of a test before and after the game to check on learning objectives and outcomes in the form of multiple choice quizzes. Here, the first test is used to determine the knowledge a player already brings into the game. The second is used to measure the improvement made during the game. The user then gets feedback on how well he performed in the quiz and can reflect on what he

answered incorrectly. In the first evaluation by the designers, they found out that on the first test, 5.05 correct answers were given compared to 10 correct answers on average in the second test. They concluded that *Icura* successfully communicates the learning objectives [17]. The game has been used by Catalano et al. [5] to further investigate its capability to transmit higher-level knowledge. Therefore, they expanded the testing group, and introduced a game analysis survey after the playing session. Here, testers could rate factors that in their opinion contributed to the learning. Afterwards, they evaluated themselves on a five point scale, including the dimensions "effectiveness, efficiency, usability, ability of the game to motivate on the learning topic, and engagement" [5]. The results are visualized in Figure 2.1.

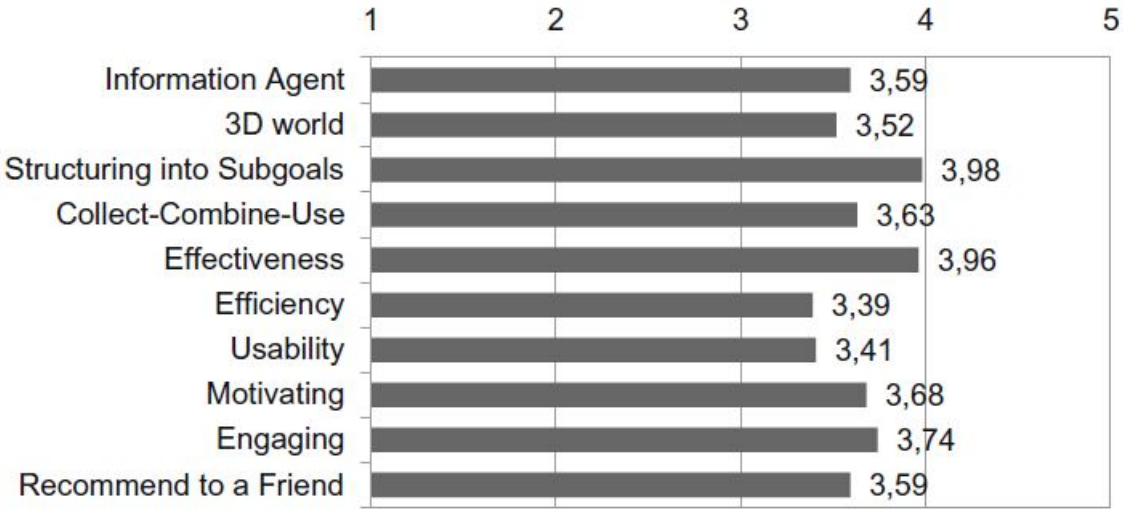

Figure 2.1.: Average ratings of game aspects in the game analysis survey of the *Icura* game. Scale stretches from 1 equals poor to 5 equals excellent [5]

According to Catalano et al. [5] the information agent was rated with an average of 3,59 but had a large variation (standard deviation 1.17). The players gave two reasons for this result. On one side, the agent helped whenever a user got stuck, avoiding deadlocks in the process. On the other side, players felt like the interaction with the agent hindered the flow of the game and did not pay attention to it. Most helpful according to the ratings was the division into subtasks. The 3D aspects were rated diversely. While users with gaming experience rated the 3D environment positively, less experienced testers gave lower ratings (standard deviation 0,96). Users that gave lower ratings suggested a 2D environment, as the controls of a 3D were too difficult. Another feedback that was given throughout all testers was, that the combination action of clicking on one item and connecting it to another by right clicking was not intuitive, which reflects in the low usability score. Nevertheless, the effectiveness was rated very positively, and had the lowest standard deviation (0,82). Negative aspects were brought to attention in the efficiency category, as the walking time was felt to be stressful and unnecessarily increased the time spent on the game. All in all, the game was felt to be a well balanced experience between fun and education, as 27 responded that the game was already balanced, 10 said that the game should be more or slightly more fun and 17 wished it to be more or slightly more

educational [5]. As a conclusion it is to record, that the advantage of the SG *Icura* is the direct interaction of players with learning material, compared to traditional learning. It became evident that educational objectives should be embedded as tasks and exercises and, therefore, the goals and learning objectives must be clear from the beginning of the game design process.

2.1.2. History Games

One main aspect used in historical SGs is the reconstruction of *Serious Heritage* (*Heritage Reconstruction*), either of a specific historical period, an event or a process which has happened in the past. Often, they involve art, sociology, and archaeology. An example of such a game is *The Battle of Thermopylae* which goal is to deliver not only the battle, its importance, and context but also the warfare of the opponents, their differences in culture and strategies. The first half of the experience consists of a movie, explaining what events preceded the battle and freezes at times where explanation is needed so the user gets a lot of information right at the start. After the cinematics, the playing part begins, where users embody one of two famous generals and observe their preparation for battle. They walk around in an environment that was made and rendered with the same graphics as the cutscene in the beginning. Then, they have to find their accessories and weapons and one by one assemble their equipment. During this quest, they come in contact with culture and battle preparations but also war tactics and strategy. Hereby, the target objects are scattered throughout the camp, forcing the player to explore the whole ground and learn about all the planted information in spots like armor repairs, camp fire, food preparation or resting tents. When all quests are done, the game zooms out to a book in which the outcome of the battle is narrated to soften the brutality of the actual fight. Regarding the learning outcomes, the game can serve multiple purposes. It can deliver understanding of the narrated times, trigger the attention for the context, teach about Persian and Greek camps, and convey two points of views for the same battle. For players that already have knowledge about the times, it can be used as an assessment system to discuss and consolidate their understanding. As a bonus, the designers included a museum educator that additionally gives commentaries to the game, extra information or answers upcoming questions. He can also start and lead a discussion when necessary. To evaluate their work, in situ observations were made along with face-to-face questionnaires. All asked visitors could answer the majority of questions after the movie and after the game. It is noted that the asked questions referred to naming dates, equipment parts and event facts. Their combination of elements of text, interaction, 3D environment and movies, and verbal explanations turned out to be overall successful [6].

Comparable games can be seen in other approaches (see [14], [53]) where the learning outcome was not enhanced by the playful approach. The *Hellenic Cosmos* is a non-profit *Cultural Heritage* foundation in Athens and introduced three methods. The first one is called *Tholos*, a VR theater made of semi-spherical screens showing the agora of Athens in three different periods. While one museum educator leads the users through the agora, another presents information to the listeners and triggers dialogues between them. The second approach is called *Kivotos* and includes four back projection screens placed so they define a

three square meter area where a small group of people is led into. Inside, they are presented with multiple shows and sites, mostly archaeological reconstructions of, for example, Olympia or Miletus. The last method is a typical exhibition, with placards to read, reconstructed pictures and objects. The methods were rated by visitors and afterwards evaluated. Visitors were asked which of the three approaches was the most suitable for learning of ancient Greece. *Tholos* and the typical exhibition was mentioned the most. However, the designers took into account, that 86 testers used *Tholos* and 23 the normal exhibition and they concluded that the exhibition is considered the most suitable exhibit for learning by far. The reasons mentioned were that a normal exhibition allows the testers to have control over their time spent on each object, and involved more information than the other methods. In general, the designers come to the conclusion, that *Tholos* and *Kivotos* are suitable for obtaining a global idea of spatial details and feeling, while the agora exhibition had higher learning outcomes as it contained more knowledge, richer communication means (mostly text), and allowed control of the visit duration [53].

Comparing these two examples of well received and less well received methods, a few points protrude. The best results were made when connecting elements of text and interaction. 3D environments or presentations (VR elements in the *Hellenic Cosmos*) help if they are used as an supportive factor. Furthermore, negative approaches include 3D elements as the sole mean of knowledge communicator, when it comes to learning but also that whenever visitors could not participate directly by playing their part and only listen, they achieved less learning objectives. These outcomes correlate with the insights introduced in Chapter 1.1.

The so far presented historical games helped to give an indication of what characteristics support *Serious Heritage* games in general. To take a closer look at Victorian London, the most popular games that come to mind include "*The Chaos Engine* (Renegade Software 1993), *MediEvil 2* (Sony Computer Entertainment 2000), *Alice: Madness Returns* (Spicy Horse 2011), *Assassin's Creed Syndicate* (Ubisoft 2015), *The Order 1886* (Ready at Dawn 2015), *Bloodborne* (FromSoftware 2015) and *Vampyr* (Dontnod Entertainment 2018)" [47]. To compare two of the given examples, Sigoillot presents *Assasins Creed Syndicate* and *The Order*. The two games are comparable because they were released in the same year and both take place in the same setting. However, they present a high number of differences. *Assasins Creed* is a stealth-action game and puts the player into the roles of two assassin twins in a uchronic story. With its open world design, it encourages the player to explore and experiment. Also, it gives the user the opportunity to face problems in different manners. To give an example, climbing a tower can be done with a hook, by taking the stairs or through normal climbing. While playing, the plot can be put on hold to do quests that lead the player through the Victorian London. Compared to that, *The Order* is a third-person shooter which takes place in 1886 and places the player in the shoes of an organisation aiming to fight off mythological creatures. Here, the user cannot divert from the main story as the game is plot-driven and the events appear in an event ordered fashion. The camera is set closely to the main character, creating a cinematic effect that is supported by multiple cutscenes. To keep the players attention, the game relies on Quick Time Events (QTE) in which the player has to perform a task in a limited amount of time. According to Sigoillot [47], QTEs either require complex inputs and,

thereby, create stressful moments where the player feels the same amount of stress as the character to create an immersive experience or are too simple and ruin the immersion. In general, the Victorian London the game presents belongs more to a steampunk genre than a realistic Victorian interpretation. Even though it possesses rich graphics and triggers a feeling of realism, the city itself is never really seen completely and not used in any plot quests. However, during the game, the player comes in contact with Victorian newspapers, props, and the appearance of non playable characters. As a conclusion, the player wanders through realistic and reconstructed streets that never contribute to the plot or gameplay. Nevertheless, the setting is important for the game. *The Order* has a dark plot and uses the setting to reinforce the dark atmosphere [47]. In *The Washington Post*, Byrd [50] summed up: "Although the storyline invokes weighty subjects like colonialization and socioeconomic inequality, it fails to address these topics in any substantive way" [50]. Sigoillot [47] concludes, that for a player who wants to know more about or even immerse himself in Victorian London, the experience will be the same, independent of his intentions, might they be of historical, anthropological or casual nature.

On the other side, there is *Assassins Creed Syndicate*. The game integrates needed objects into the surroundings, forcing the player to develop an observational attitude. By climbing tall buildings, a user can get to a viewpoint, where points of interest will be shown to him that will then stay on the map. This way, the player gets to see the environment from multiple angles. Ubisoft recreated the Victorian setting by hiring a historian to aid the developers in creating an authentic environment. However, as the scale of the whole city would take up too much time to walk through, they recreated the districts according to the historians research but shortened the distance in between the districts. The game further features crowds, that build during the day where crowds were common in Victorian London times and empty at night, and children that are poorly clothed referring to the circumstances as described in Chapter 1.4. Summed up, the game creates realism by using the realistic environment during the game [47].

As a conclusion of this comparison, it becomes clear, that setting the atmosphere in the right century or simply using Victorian times to create a feeling of anxiety isn't enough to establish a real historical experience. It is the interweaving of environment and gameplay that reaches the best results.

2.1.3. AR Games

Reasons to use immersive features in a SG have been introduced in Chapter 1.3. However, there remains the open question of how immersive is enough immersive which was discussed by Cummings et al. [8] by comparing 83 studies and aggregating 115 effect sizes. In their work, they matched the following methods to handle immersion:

- Tracking level: number and types of degrees of freedom with which a user is tracked by an immersive system. This includes a natural versus abstract handling of the controller, the ability to scan many details or only some at the same time, and the possibility to interact with the objects in view.

- Stereoscopic vision: differentiation between monoscopic and stereoscopic visuals.
- Image quality: elements that influence realism and quality.
- Field of view: the users total view.
- Sound quality: influence of the presence of sound.
- Update rate: rendering rate of the virtual environment.
- User perspective: first person perspective versus third person perspective.
- Overall high versus low: influence of many features that produce operational confounds. For example: A head-mounted display compared to a desktop PC.

From all found results, they only included studies that featured a manipulation of at least one of the mentioned features and self-reported measure of user preference. Also, they excluded studies without sufficient detail to determine immersion or who did not report enough details to calculate an effect size. Their results can be seen in Figure 2.2.

Independent variable	K	r (weighted)	95% Confidence interval	N	χ^2	Variance attributable to sampling error (%)
Immersion (all studies)	115	.316	.295 to .338	6998	2069.179*	15
Update rate	4	.529	.311 to .747	41	4.391	100
Tracking level	22	.408	.360 to .456	1566	319.772*	8
Natural vs. abstract mapping	7	.360	.279 to .441	587	133.295*	6
Many vs. some	6	.645	.546 to .745	390	44.578*	1
Some vs. none	10	.281	.204 to .358	645	189.786*	32
Field of view	14	.304	.246 to .363	1081	487.886*	5
Image quality	10	.150	.086 to .214	855	259.432*	39
Stereoscopy	18	.320	.257 to .383	928	270.748*	16
Sound	13	.260	.203 to .317	757	202.378*	30
User perspective	2	.234	.003 to .464	72	38.775*	100
High vs. low	32	.339	.294 to .385	1698	476.491*	30

*$p < .001$.

Figure 2.2.: Meta-analysis results for overall immersion and individual immersive features. With correlation coefficient r, sample size K, number of paired observations N, correlation between immersion and presence chi-squared, and heterogenous p [8]

During their work, Cummings et al. [8] discovered, that a complete focus on immersion had a medium effect on the feeling of presence, while individual features varied in their effect sizes, not only in terms of influence on presence but also in their practical implications. For example, the update rate was found to have a large effect size of 0.529 but only based on four studies. Apart from that, the tracking level (0.408), stereoscopy (0.320), and field of view (0.304) emerged as strong features, while image quality (0.150), resolution (0.234), and sound (0.260) had low effects. Therefore, they concluded that immersive systems should focus on

tracking level, stereoscopic vision, and field of view and not on auditory stimuli and quality visuals [8].

An example that combines the previously discussed features is the game *Oppidum*. It is a SG for two players with the purpose of conveying basic knowledge about the life and history of the early Celts. During the game players build up a small Celtic village, research technologies and accomplish different tasks given by quest cards. By exploring their villages, gathering rune stones, and reading informative texts, players gain knowledge about the Celts, which comes into play when challenging their opponent to a quiz war. To win the game, players compete for victory points that are obtained through completing different task and winning quiz wars. The game uses digital replicas of Celtic buildings forming a *Historical Reconstruction* of an exemplary settlement that could have been build in the Latène period. It also raises *Cultural Awareness* by adding historically accurate information to the game elements like quest cards and technologies as well as their visuals without trying to be intrusive. This combination also raises *Heritage Awareness* as their buildings were modelled after archaeological finds. As a *Serious Educational Game*, on one side, it uses educational strategies like quizzes and exploration as elements to motivate players to learn and also memorize the content. On the other side, the learning material is transmitted in an immersive way, as every building is physically a game card on the board, but rendered with a smartphone to visualize an augmented 3D building. This way, AR is used as a visually pleasing factor to increase the motivation of users to play the game. Furthermore, it aims to use the competition of player and opponent to encourage the users to learn by their own will and, thereby, increase the learning outcome. The constant need to draw new quest cards brings additional variety into the game in order to keep the player interested. In the end, the game tries to give players general knowledge and also spark further interest in an entertaining and supportive way. This project aims to endorse these main goals by augmenting the learning outcome with a new learning method and keeps the game content itself historically accurate. It also increases the accessibility of the game to a broader target group, that fits the current home office times without trying to take away from the board game and digital hybrid. Eventually, to support all this, the project also intends to create an even more entertaining space where players can better enjoy their learning time and immerse in Celtic times [40].

Measuring the game against the findings of Cummings et al. [8], it becomes clear that the game has a high update rate, as the augmentation changes in real time according to the smartphone position and orientation. Taking a closer look at *Oppidums* tracking level, it offers a natural mapping, where the players decide themselves where and what they want to scan. In the game, the smartphone is used as a controller similarly to filming a video. As smartphones are, due to their all day presence, considered easy to handle, the tracking itself is therefore easy to handle as well. The augmentation thereby reacts to the gyrometer in the smartphone and a turning of the device is mirrored in a different augmentation pose, rendered in real time. It also gives the user the freedom on how many markers he wants to scan, by holding the phone closer or further away from the board. Another strong point regarding this feature is that the user can interact with the augmentation, for example, to touch interesting objects and get information about them or accept tasks via augmented

buttons. In terms of Field of View (FOV), the game can be played with a smartphone or tablet, the later offering a bigger screen. The last feature to take a look at is the stereoscopy. While augmented buttons in the game offer a monoscopic visual, the buildings are, in relation to board size, made with realistic dimensions, providing graphics with depth and objects that can be hidden by walls when looked at from a different angle. In conclusion, *Oppidum* is a game that can be used as an example in which AR has been integrated well into a game.

2.2. Detective Games

In their paper, Larson et al. [30] introduced multiple detective games, that offer different approaches to detective work. One of them is the 2015 game *Her Story* [2] in which a player is presented with a police desktop that provides him with access to a police interview database. To see entries in the database, the player has to enter keywords into a search bar, that he hears while watching videos or guesses by drawing conclusions. Whenever a keyword is connected to videos, the game presents the first five hit results. Thereby, parts of the story are revealed and new keywords can be drawn. During the game, a player does not get help or feedback and in the end, the solution to the case is not revealed, forcing the users to draw their own conclusion and deciding for themselves whether they have seen enough or want to search on. By using only writing words, listening, and repeating the process as game mechanics, the game aims at offering real detective work, drawing conclusions on what the user hears and sees and prevents cheating through hints. Similar to a real case, the actual truth is not revealed, encouraging the player to stop playing, when he himself feels satisfied [2]. This interaction can be described as the "rawest form of the story of crime" [30]. In 2019, a sequel was released, called *Telling Lies* [3] that uses the same function of typing keywords and receiving videos in which these words are mentioned. Due to this, a player can start guessing words, but due to the five video limit, a player will get stuck with the same five videos. In contrast to its prequel, *Telling Lies* offers four stories that are connected, introducing more complexity into the game. Furthermore, a time limit was added, as this time the software is on an anonymous laptop loaded with a stolen NSA database. The game play stays the same. However, this time, the players character is a part of the story as well with stakes in the plot and he is offered a choice in the end [30]. As introduced in Chapter 1.5, both games provide the same detective work aspects of the given toolkit. First, they allow the player to connect the information they receive in the videos. Second, they have to make deductions, to comprehend the story and deduce new keywords. Third, the player also has to expose lies even though, the exposing itself does not necessarily change the outcome of the game. At last, the player follows his own leads and can suspect new tags. Because of the completely open way on what lead players want to follow the game is an example of a puzzlebox detective game, focusing on the first story, the murder story itself.

Another game that falls in the detective game genre is *Return of Obra Dinn* [41]. Here, the player slips into the role of an insurance worker, whose job is to recreate what happened on a ship in the 19th century. While playing, the user can see the frozen image of death of 60 people on the ship for whom he has to answer these questions: Who are the victims? Who

or what killed them? And how were they killed? Here, the user receives no help besides a positive feedback if all three questions have been answered correctly. Most of the cases depend on each other, for example, by finding out one answer of one case, the player can solve another. While the single cases follow linear paths, the way he approaches the solving of the connected mystery is not set by the game. This way, the user is forced to work out the cases on his own, without a forced order in which to solve which case. Because of this, the game is a combination of puzzlebox detective game and adventure detective game. During a case, clues can be found in the words someone says, how they are standing related to each other, what objects or weapons they carry, and in the list of passengers the player was given in the beginning. *Return of Obra Dinn* also includes three of four toolkit aspects: Find connections in the cases, deduce the culprit and victim, and follow leads by reconstructing what happened on the ship. The game does not expose lies, as there are no victims to question.

As an example for an adventure type game, *Disco Elysium* [28] does not follow any puzzlebox structure. The game starts by introducing the main plot: the investigation of a murder by the main character who suffers from amnesia. During the game, the player can deduce suspects and question them to solve the case, but the further the game advanaces, the further it reveals a plot, that is only about to happen. This way, the story is focused on the second story, the investigation story with all the inhabitants of the city that turn out to be more than just witnesses but entities with political interest and motivation. In contrast to the puzzlebox games above, here, the player remembers stories from his past, which expose his relation to the case and his influence on the outcome. The outcome of the game is held "banal" [30], which supports the emphasis on the investigation itself. While players get to experience all four toolkit aspects, the story of the murder plays a minor role, while the story of investigation is heavily focused on.

The above listed detective games are commercial games, due to the fact, that there are close to zero detective SGs studies. Nevertheless, about a month before the due date of this thesis, Jaffrey et al. [24] introduced their *SherLOCKED* game, that aims to educate about cyber security. The game is divided into three levels. The first focuses on key cyber security terms and concepts, the second on security attacks and related services, and the last on broadening the topic. The player slips into the role of a detective in a 2D top-down view and is able to walk his character freely through in rooms where he can find questions that are attached to objects. He then has to solve three cases, one for each level. Reaching a new level is accomplished when enough questions are answered correctly. In the first level, the players character has to prove to a hacked customer, that he knows enough to work on the case. After he proves it, by answering enough basic questions, he has to show his client how he got hacked, and finally, he has to secure the customers house by answering safety questions. Whenever a correct answer was given during the game, the answer turns green, when correct or red, when false. This way, the user gets an immediate feedback. The designers also included a progression bar, to give the user feedback on how well he is doing. Furthermore, the game presents the final score after each level. This way, they aimed at introducing competition to the game to motivate players to get good results. An evaluation was made in the end in which 87,5 percent of 112 testers felt that the game helped

improve their knowledge and that their level of confidence increased. In addition, according to the testers, the games strongest points were its simplicity, 'retro' feel, and the instant feedback they received. Other participants mentioned that they perceived the gameplay as boring, as the tasks of walking, interacting, and multiple choice quizzes felt repetitive. The designers concluded, that the impact of a variety of question styles should be researched more. Another conclusion that they drew is, that it was important to have a link between the learning contents and the genre of the game, instead of creating a generic SG. A cyber security theme, according to the users, worked well with the detective genre. Other findings of the evaluation included that most testers favoured feedback on actions, competition, and narrative and that those were key to the positive feeling after the game. Least favoured ones were customization of characters or graphics, a tutorial, and a consistent theme. Finally, the testers suggested a better feedback option, mentioning coins or gold to collect [24].

2.3. Jack the Ripper in Media

The game *The Order* was already introduced in Chapter 2.1.2. Another unmentioned feature of the game is the Jack the Ripper character which is the head of the company that during the game turns out to contain the main antagonists. The game thereby rewrites history [47], by using the famous name as part of a setting, without ever telling the players anything in concrete or accurate about the person itself. Jack the Ripper was also used in a Downloadable Content (DLC) of the before mentioned *Assassins Creed Syndicate*. Here, one of the main protagonists has to investigate the Jack the Ripper murders, where the actual crime scenes were rebuilt accurately according to Gann [18]. In addition, related historical names were included, for example inspector Frederick Abberline from whom the character receives the assignment to catch Jack the Ripper. However, the game itself tells nothing historical about the victims, even changing their profession to assassins. It further does not mention their relatives, and focuses on catching the culprit. The game also forces the player to control Jack the Ripper, aiming to create realism and immersion by making the user connect with the character by taking control of him. Thereby, the gameplay becomes less clear and loses some of its simplicity, trying to implement a darker feeling than in its main story part. The player should compare the protagonists assassins duty to a serial killer, opening a question of morality. The focus is drawn from the murders itself to the murderer and his mythologization [18].

Another example of a game that features Jack the Ripper is called *Sherlock Holmes Versus Jack the Ripper* [16]. In this game, the user can play as either Sherlock or Watson to solve and investigate the Ripper cases. On one side, the game is built in a typical adventure game style. Hereby, the user has to solve multiple minigames, that are not related to the story itself, like picking a lock, piecing together torn paper, etc. Additionally, the player needs to run errands for the police through Whitechapel or do favors to witnesses before they reveal clues and information, sending the player through the district, which is constructed in an eerie fashion, similar to *The Order*. Thereby, the player is presented with an atmosphere that speaks of the circumstances in 1888, less with deeper facts about the culture and people. On the other side, the player is also tasked with some related minigames like recreating the murder

while Sherlock takes the role of Jack the Ripper and Watson the one of the victim. Thereby, they included police and newspaper records for parts of the script and recreated some of the buildings near the crime scene. It also includes several historical characters and names like Leather Apron or victim and street names, when progressing in the main story. Throughout the whole plot, the user can only proceed in the game when he finishes the given scenario correctly. *Sherlock Holmes versus Jack the Ripper* is implemented as an adventure game, but includes many detective work features, encouraging the user to combine clues and recreating the murder in a linear way. Even though the player impersonates Holmes as a character, he is not offered an actual choice on how to solve the cases.

To take a look at a SG project, Wu et al. [65] implemented a game, that is divided in a main plotline and multiple sub plotlines. The player investigates a fictional case that is set in the Victorian Era and follows a linear story that unfolds while playing. However, at the start of a level, the user draws a poker card, that decides on the sequential order of the story. After that, the user is allowed to decide on which level he wants to explore aiming to offer a non-linear flexibility. While playing, the character has access to a toolshop, in which he can buy cooking ingredients and maps. By following the directions on these maps, he eventually reaches the final destination. Furthermore, he is able to talk with a bartender, who reveals knowledge about people and culture which he can use in minigames to earn money. The interface offers a backpack for collected clues, a notebook, the maps, explanations, and the main menu. While the designers did evaluate their game, the process and the outcomes were not presented. However, they concluded that their game supports learning [65].

Outlook

Having presented multiple examples with vastly different results, the question of why those areas were combined to create a new game is still open. The main reason for the *On the Trails of Jack the Ripper* SG is to educate players and to create a game with meaning. Following the design principles of a SG raises the impact this game has on its users and extends the learning outcome. This outcome involves not only historical knowledge and dissolving of the many myths that revolve around the Whitechapel murders, it also contains the circumstances around it, how the police institutes investigated the case, how they did or did not work together, how the press reflected the incidents and thereby influenced the public view on the events, what the murders triggered in the London society, instead of only focusing on the murderer himself and his brutality. In general, this game aims to address what most of the Ripper games left out in the previous chapters, meaning everything that played a part in making the name Jack the Ripper famous. In its process, the game intends to raise *Cultural Awareness* for how people in Whitechapel lived, including living conditions, poverty, and antisemitism. The way the game plans to transfer this intention is by the *Historical Reconstruction* of crime scenes and the recreation of inquest days or police documents but it is also raising *Heritage Awareness* by offering real newspaper articles, historical police drawings, and transcripts of dialogues between coroners and witnesses by journalists of the time. These factors are all packed in a detective theme as it fits perfectly into the environment context,

which is a supporting factor of a good SG (as explained in Chapter 1.1). It also reflects the development of British literature. Arthur Conan Doyle's Sherlock Holmes stories first appeared in the 1880s and have become the most well known detective fiction of the 19th century [22]. Finally, due to the fact that detective SGs are sparse and there is not a lot of research about them, this game plans to contribute to this field in a scientific and immersive way, using AR for *Historical Reconstruction*, for overlaying relevant historical information, and add a feeling of presence, entertainment and motivation. It is to be noted, that including AR was considered carefully while planning the game. On one side, having a completely virtual game could be assumed to make the experience more realistic. However, VR setups are rather uncommon in private households. As the game is intended to be played at home and was intentionally made portable due to Covid-19 restrictions, VR would have made this nearly impossible. Including information about five cases into a single game was also assumed to generate longer playing times. Wearing a VR headset over a long time is considered to be challenging especially when users have to pay attention to the navigation on home screens that could differ in resolutions. This also relates to the way virtual environments are approached by users. Having users making first contact with VR, there is always the possibility that they focus more on testing out their borders and what they can do within the game, instead of focusing on the information during the game. All of this would have shifted the attention away from the learning content and simply would have added the layer of fun, which was described in Chapter 1.1 as a negative aspect. Eventually, the scientific research question is: Does a combination of SGs, AR, CC, and the detective genre obtain the same positive results as the presented works did.

3. Implementation

In the first two chapters, the basic terms and areas that this thesis revolves around have been defined and it has been shown how these concepts have been realized in scientific works or commercial games. In this Chapter, the implemented game will be introduced, starting with the tools that that were used, followed by the division of the game into two screens and the description of the game mechanics. The final part of this chapter will be the detailed description of all story segments and puzzles.

3.1. Used Tools and Technical Structure

The whole game was made over the span of six months with the help of a game engine, and an AR engine and was then deployed on two systems, all of which will be shortly summarized in the following.

Unity

Both the Windows application and the Android companion were entirely created using the Unity 3D engine [56] with version 2020.1.8f. Because of Unity's cross-platform capabilities, the game can easily be modified to run on other systems, like iOS or even on a website. However, since it relies on the interplay between the host application and the AR companion, certain limitations apply. First and foremost, the AR companion requires a camera to detect markers. Also, since the content of the host application is used as a marker for the companion, the screen size and quality is considered an important factor for the enjoyment of the game.

Vuforia

For the integration of the AR elements, the Vuforia engine [59] was used. Vuforia is an AR platform, that is used to easily integrate augmentations in projects. It was integrated into the project via a Unity plugin that allows precise tracking and easy integration in the Unity framework. The markers were uploaded through the developer portal [58] and logically connected through the Unity interface.

Platforms

The game itself consists of two applications. One one side, there is the Windows application where the main part of the game takes place. On the other side, there is the Android application that has to be installed on a private Smartphone or Tablet and is only used at

certain points in the game whenever a marker can be scanned. The markers are integrated into the computer game in the form of pictures, and where the possibility to use the smartphone in hinted to the player, when a trackable image appears. To be able to scan those markers, the mobile app needs a portable device with a camera and a touch screen to interact with the augmentation. The two applications are not connected, neither wired nor wireless. Therefore, after receiving the game, it can be installed and played without the need of a network connection. This means that connection losses cannot impact the game and if it is installed on a laptop and smartphone, the game is completely portable after the installation. Furthermore, while the game is designed as a single player, it can be used as a cooperative multiplayer, by installing the Android application on multiple devices or sharing one device between multiple persons. However, the game is not intended to be used with a shared device and a usage in this way is believed to decrease the quality of the game.

3.2. Game Mechanics

Players of this game will be put into the shoes of a detective who investigates the murders that happen during the storyline. The main aspect of the game is to visit historically relevant points in time, starting on the 31st of August 1888 with the death of the first victim and ending with the closing of the last victims inquest on 19th of November 1888. As the game is supposed to be a SG, these dates were taken from real events, which means the actual murder days, investigation times of the *City of London* police and inquest dates in order to be as accurate as possible. Using accurate dates also prevents the player from assuming or learning false information. The user decides when to end a day and if he does, he proceeds either to the next day or the next event on the same day. This way, the players can decide on their speed on their own, allowing both fast and slow learners to achieve good results. Once a users skips to another day or event, he can not go back again, as this would lead to feeling of traveling in time, which is not the purpose of the game.

A day normally consists of a reconstructed event, like the investigation of the crime scene, the interrogation of victims, suspects and other police members or the analysis of letters and newspapers that are included as pictures and transcripts. The gameplay includes multiple forms of detective work on different occasions in the game's timeline, so the user can get familiar with the general tasks without experiencing repetition. Most days end with a test in which the player can revise his knowledge and the learned information. These tests are designed in a way that they are diverse, too. There are quizzes with multiple answers and visual allocation exercises, but also tasks in which a user has to build sentences with given words, or in which he has to find lies in contradicting statements and more. As defined in Chapter 1.1, a good SG practice is to keep players engaged by motivating them. Repetition is one example of a bad practice which the game aims to avoid. Instead, it offers hints when players face difficult tasks that give advice on what to concentrate on. When a hint is available, a magnifying glass icon is displayed on the screen. The user can choose whether to see the hint or not but looking at it does not have an effect on the final score. When there are no such tips available, the icon disappears, in order to keep the interface clean. The same principle is

used with a camera icon that appears when a marker is displayed on screen to indicate that the user can scan the marker with his phone. Keeping the interface clear is a method used in an effort to minimize the cognitive load, which supports an effective learning environment. This way, the only constantly visible objects in the interface are either related to the current event or the current date on the top right corner of the screen. For the same reasons, the game does not have an extensive tutorial but encourages the user to use pen and paper whenever he wants. This method was allowed, as writing information down on your own recreates part of detective work, but can also be considered as a learning method. The introduction in the beginning also explains to a user that he is able to press the keyboard arrows up to scroll to an overview of the controls (See Figure 3.1), or down, to view a notebook of the already solved cases and to see his current score. Hereby, the score table can be seen as a progress indicator as it displays the received score and the maximal amount of points he could have earned, similar to the previously introduced *SherLOCKED* game. It also serves as a long term feedback and possibly as a motivation for the user to earn better results. The player can switch between these three screens whenever he wants, so he can access his progress and the controls when he needs it but can also decide to just stay on the event screen. Besides introducing the arrow keys, the short introduction at the start of the game also explains the magnifier and camera icons and the ability to skip a day. The controls differ slightly from task to task, but throughout the whole game a user will always only need his mouse and keyboard for the interaction with the computer game and his fingers for touching the screen on the mobile app. The smartphone application does not have an interface at all, in order to maximize the amount of the screen that is used to display the game's content as mobile displays tend to be rather small. The input controls on the smartphone screen do not differ from normal usage of a mobile phone: touching to interact with an object, holding to drag the object or zooming by touching and dragging with two fingers. This way, the controls are the most intuitive for a player. In order to facilitate the controls even more, objects that can be clicked on are further highlighted with a hand icon, so users don't skip over enlargeable objects and miss crucial information. The control page and all icons can be seen in Figure 3.1.

3.3. Story Segmentation

The game is logically divided in three segments which were set according to real dates. The first victim was murdered on 31st of August 1888 and her inquest ended on 22nd of September that same year. Meanwhile, the murder of the second victim happened on the 08th of September, while the inquest into the first murder was still running and hers ends shortly after the first on 26th of September. Since the dates overlap, they were put into the first segment. The next two victims were murdered in the same night of the 30th of September 1888 and the inquest ended on 23rd of October and 11th of October respectively. Their cases will be thematized in the second part of the game as there is a connection between both murders. The case of the last victim who died on the 09th of November and whose inquest ended exactly ten days later, forms the last segment. This segmentation allows to integrate conclusive exercises at the end of each part. Therefore, the user works on the respective cases

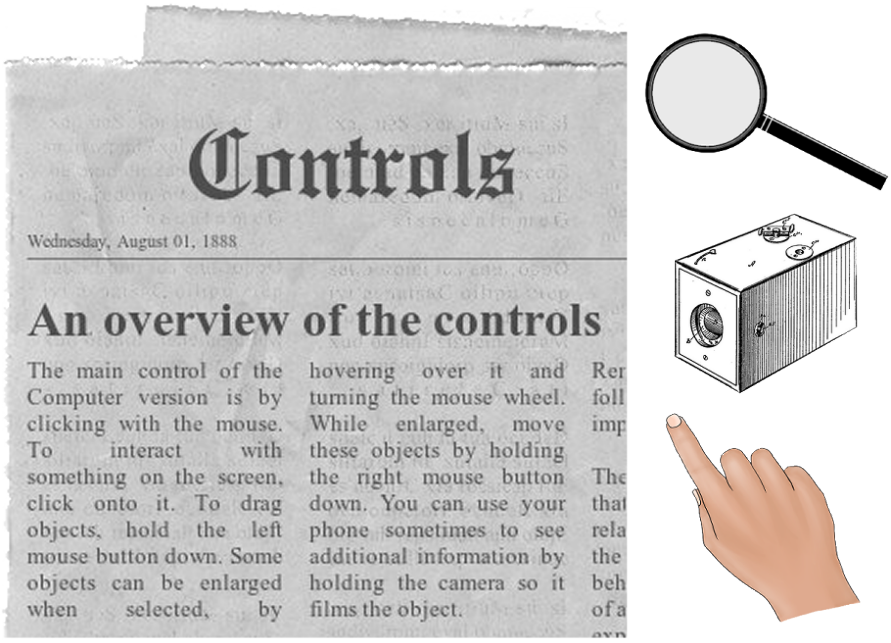

Figure 3.1.: Control panel that can be viewed during the game (left) and from top to bottom: magnifier, camera, and touch icon (right)

several ingame days and solves several tasks that include detailed aspects of the investigation and is encouraged later to reflect on the learned information as a whole. For the conclusion at end of each case, the user needs to combine all knowledge that was accumulated during the investigation. In doing this, the investigation days of each murder are constructed in a linear way, solving given tasks and following the games plot in an adventure detective game fashion. This is necessary, as one of the serious factors come from the historical accuracy, making the player relive the events in the correct order and at the correct dates. A negative aspect of this type of game that was mentioned in Chapter 1.5 is, that repeating a quiz until the user gets it right might decrease the user engagement. To counter this aspect, it is not possible for the player to repeat games and quizzes. This is supposed to work as a motivation to the player to make him think before answering. However, every task in the game gives the user direct feedback when his answers were right or corrects wrong answers, so the player still experiences the needed learning effect. At the end of the last case, the user will be presented with an overview of the total score he reached.

3.3.1. Mary Ann Nichols and Annie Chapman

Part one of the game spans over eight days in which the player has to do multiple tasks and quizzes which are going to be presented in the following. By the time Mary Ann Nichols died, the case of Martha Tabram, another victim of an 1888s murder was still in the minds of the people and initially connected to the Jack the Ripper murders. Nevertheless, the murderer

of Tabram used a different methodology and years later she was determined unlikely to be a victim of Jack the Ripper. During the planning phase, an idea came up to include her murder in the game and have the user rule her out as a Ripper victim later. However, due to the fact that she was counted as a Ripper case for a very long time, even after the murders, she was not included in the final version of the game to avoid confusing players.

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The game starts a few hours after the first murder has happened and presents a text on the screen that says: "A body was found tonight at Bucks Row. From what we know already, a bonnet was found near her left hand. Also, there was a stencil found in her Petticoat with the mark 'Lambeth Workhouse, P.R.'. Go see if you can find other evidences!". Right at the beginning, the user gets two useful information snippets. The gameplay itself then begins with a map and an empty table. The map can be interacted with by the player, indicated by a touch symbol. When clicked, the map enlarges and shows London's East End with a circled place, again with the header "Bucks Row", and a historical photography of the street. At the same time, the camera icon appears on the top of the screen, suggesting to use the mobile device to scan the image. The picture functions as a marker, and by scanning it with the mobile phone camera, the user will be presented with a 3D historical reconstruction of Bucks Row of 1888 augmented onto the image as seen in Figure 3.2. The street is aligned in a first person perspective, instead of a top down view. The motivation for this design choice was to show the scene from the perspective of one of the investigators. This feature was used to enhance the immersion.

While viewing the augmentation, the user can zoom into the scene and discover various objects, including blood, a handkerchief, a toothbrush, a mirror and mud. Most objects can be seen in Figure 3.3. When he chooses one of those objects, it will appear enlarged on screen, together with a description of the object. For example, clicking on the mud reveals the information: "Mud without traces". The augmentation allows the player to view the scene from different angles and look at the buildings around the crime scene. It also reveals that the murder happened in an open street without cover. This style of uncovering clues works as variation to reading information. It also supports the detective theme of the game. Recognizing that the street is open and without corners to hide, is not an obvious fact that needs to be found out for the plot. However, it reflects the small details a good detective has to consider. While searching for clues, the game does not tell the player when all of the information he needs or can get was found and he has to decide for himself when to proceed. This way, even though the order of the investigation is fixed, the game offers a modification that approaches the puzzlebox detective genre. Needing to decide for yourself when to end the investigation is a feature that was also used in *Her Story*, which was introduced in Chapter 2.2. When the player chooses to end the day, he receives a message stating that he cannot return. On the one hand, this works as a warning to the player to not simply skip a task. On the other hand, it is an attempt to make the player rethink his choice and force him to to commit to his actions. The investigation is followed by a multiple choice quiz, as this is considered to be an easy quiz for an entry into the game. The user is confronted with

Figure 3.2.: Bucks Row 3D reconstruction augmented on an image of Bucks Row (See [4])

Figure 3.3.: Objects that can be found on the scene in Bucks Row

three questions, one after the other, asking for information that could be found in different ways. The first question asks about what object was not found on the scene of crime. Here, the user is given the names of three objects he found, some intentionally held ambiguous, and the option "Cart Tracks". Of course, those tracks weren't found on the scene. However, the user will not know whether he simply didn't find it. At this point, the user needs to make the connection between the found mud, that had "no traces" and the fact, that cart tracks would have left traces in the mud. This conclusion was also drawn by the supervising police officer in 1888. After he chooses his option, the correct answer is highlighted in green and stays on the screen for multiple seconds, before the next question is displayed. This way, he immediately gets feedback on whether he was right or not. The next question asks where the murder occurred, an information a player could have gotten from the map, as the street name was mentioned there. Here, wrong answers state other street names that existed at the same time in London and will be relevant in the process of the game. The last question wants to know whether there was a hint to the background of the victim. The correct answer would be "*Lambeth Workhouse*", which was mentioned only in the initial text. The user will not find anything else, that is related to the victim. This first quiz aims to remind the user that he has to be attentive in order to have a high score at the end. For every correct answer, the user will receive one point, but he will not lose any for wrong ones. In contrast to the following tasks, the total amount of three points that can be scored in this quiz is intentionally low, as the user still need to understand on what level the game will rate their work. After the task, an overview is presented, in which the questions, the given answers and the correct answers are repeated. The player will also see his first results by the score he achieved.

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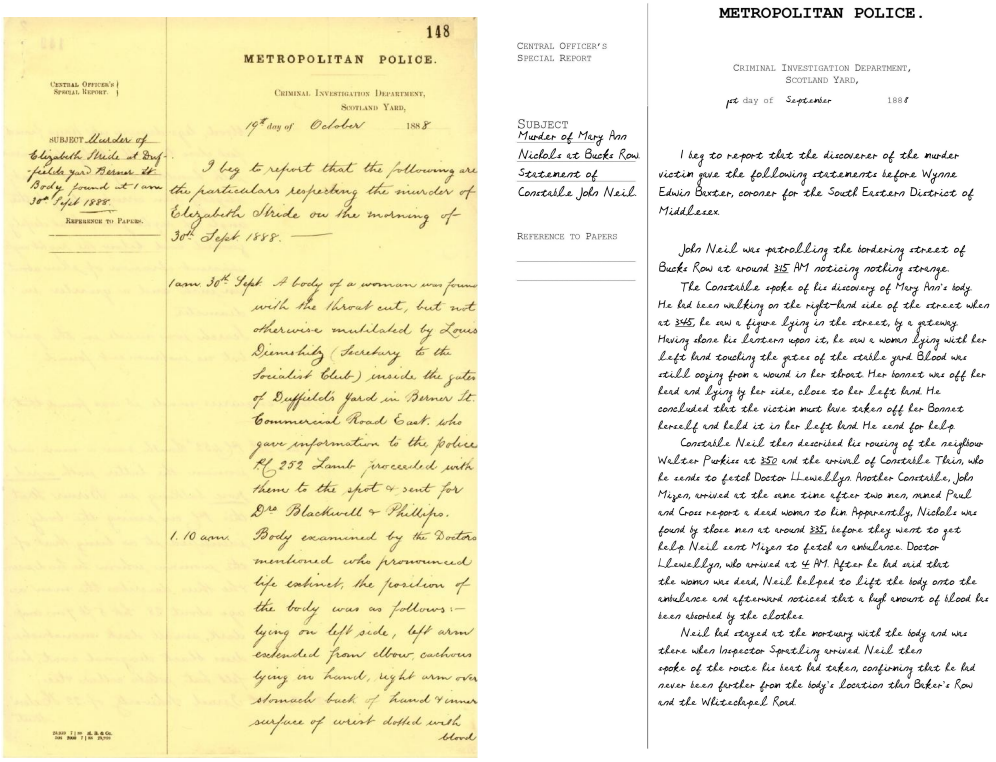
On the next day, the player can find three written statements on his table, one from the constable who found the victim, one from the doctor that inspected the body and one from the father. The statements can be enlarged for better reading. As a design, the statements were remodelled after real police reports that were collected at the end of the 19th century. An original document can be seen in Figure 3.4 on the left, and the reworked report for this case on the right.

The content of these statements comes from inquest transcripts that newspapers in 1888 released. The texts included time stamps and other information, with special emphasis on the times. At this point in the game, the player also gets his first hint: "How was the course of events?". The hint should help the player focus on the right information inside the statements, as much of the information in the statements was included for informative purpose and for accuracy. He can read the statements as long and often as he wants to. After ending the investigation, the next quiz appears. This time, the user is presented with eight different points in time in the form of timestamps, from which five were mentioned in the statements before. He has to find those five and connect them to five of the six given events, including "Nichols dies", "Neil sees nothing", "Doctor arrives", and more. Basically, a player has to prove that he understood what happened, and when. He has five time slots at the left, and five at the right. Dragging a snippet to one of the slots will lock them in place, until he moves



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METROPOLITAN POLICE.

CENTRAL OFFICER'S SPECIAL REPORT.

CRIMINAL INVESTIGATION DEPARTMENT, SCOTLAND YARD,

19th day of October 1888

SUBJECT Murder of Elizabeth Stride at Dutfields yard Berner St. Body found at 1 am 30th Sept 1888.

REFERENCE TO PAPERS.

I beg to report that the following are the particulars respecting the murder of Elizabeth Stride on the morning of 30th Sept 1888.

1 am 30th Sept A body of a woman was found with the throat cut, but not otherwise mutilated by Louis Diemschitz (Secretary to the Socialist Club) inside the gates of Dutfields Yard in Berner St. Commercial Road East. who gave information to the police. PC 252 Lamb proceeded with them to the spot & sent for Drs Blackwell & Phillips.

1. 10 am. Body examined by the Doctors mentioned who pronounced life extinct, the position of the body was as follows:— lying on left side, left arm extended from elbow, clenched lying in hand, right arm over stomach back of hand & inner surface of wrist dotted with blood

CENTRAL OFFICER'S SPECIAL REPORT

SUBJECT Murder of Mary Ann Nichols at Bucks Row Statement of Constable John Neil.

REFERENCE TO PAPERS

METROPOLITAN POLICE.

CRIMINAL INVESTIGATION DEPARTMENT, SCOTLAND YARD,

1st day of September 1888

I beg to report that the discoverer of the murder victim gave the following statement before Wynne Edwin Baxter, coroner for the South Eastern District of Middlesex.

John Neil was patrolling the bordering street of Bucks Row at around 3:15 AM noticing nothing strange.

The Constable spoke of his discovery of Mary Ann's body. He had been walking on the right-hand side of the street when at 3:45, he saw a figure lying in the street, by a gateway. Having done his lantern upon it, he saw a woman lying with her left hand touching the gates of the stable yard. Blood was still oozing from a wound in her throat. Her bonnet was off her head and lying by her side, close to her left hand. He concluded that the victim must have taken off her bonnet herself and held it in her left hand. He sent for help.

Constable Neil then described his rousing of the neighbour Walter Purkiss at 3:50 and the arrival of Constable Thain, who he sends to fetch Doctor Llewellyn. Another Constable, John Mizen, arrived at the same time after two men, named Paul and Cross report a dead woman to him. Apparently, Nichols was found by these men at around 3:35, before they went to get help. Neil sent Mizen to fetch an ambulance. Doctor Llewellyn, who arrived at 4 AM. After he had said that the woman was dead, Neil helped to lift the body onto the ambulance and afterward noticed that a high amount of blood has been absorbed by the clothes.

Neil had stayed at the mortuary with the body and was there when Inspector Spratling arrived. Neil then spoke of the route his beat had taken, confirming that he had never been further from the body's location than Baker's Row and the Whitechapel Road.

Figure 3.4.: Police Report [37] of 1888 on the left and a reworked statement, adapted to the game task on the right

them again. As soon as a time and an event are placed in the same row, they are considered connected and a line is drawn visually between the snippets to indicate, that the time relates to the event. A user does not necessarily have to understand what he has to do right away. The mini game is constructed in a way, that a user has to move snippets in order to see the ones who are below them. Dragging them away with the mouse is a mechanic that is listed in the control overview. The player can experimentally move the snippets around and onto a highlighted slot. By filling all slots, the connection lines will appear, indicating that slots build pairs. The user has to search for the way to solve this task, like detectives have to come up with witty ideas to solve mysteries as well. When all five slot pairs are filled, the finish button appears, where the player can finally log in his answers. When he does, the correctly chosen snippets are highlighted in green for the feedback. The results of this first try will be saved in his score, giving him one point for each correctly positioned snippet. Afterwards, he can rearrange the snippets if he did something wrong and check the solution again in order to understand the real course of events. However, his score will not change after his first try. He is then able to skip the day.

08.09.1888

The player is now at the 08th of September, where the second murder happened, so he sees the map he already opened once, with a second place circled and the name Hanburry Street. The user should know by now, that his is the crime scene of the next case. In addition, he gets another picture, this time a police drawing of the crime scene of the murder, that was released in a police news article a few days after the body was found. He also finds the photography of the first crime scene and can revisit it if he likes. However, he will not see anything new there. The camera symbol appears, and he can scan the picture for a 3D reconstruction of a house. The second victim was murdered in a back yard, so the user has to open the front door of the house, and then walk through the passage to the back by clicking on the arrow. He then arrives in the yard where he can again search for clues again. During the planning phase, a mini game was considered to be included here, where a user had to pick the lock of the house. However, this idea was discarded, as one major aspect of the living conditions was that people rarely locked the gates to their yards, as they had to be used frequently, even at night. Working hours often started early in the morning and residents regularly came home late in the night. Due to this fact, the player can simply proceed into the back yard and find multiple objects and clues on the floor. When he clicks on a discoverable object, its name will automatically be registered on a paper note that appears whenever the player interacts with an object of interest. The note itself can be hidden afterwards. He also gets a short description of which objects he found. This time, there is blood, a letter that he can open to find two pills, a toothbrush, a comb, a handkerchief and a leather apron. When clicking on the latter, he receives the text: "A leather apron. Who does it belong to?". This is a question that came up during the investigation in 1888 and will become relevant in the process of this case. In contrast to all other object descriptions, the apron is the only one that includes a question which indicates that something about this object has to be found out. As soon as the player decides to end the day, he is prompted to categorize the found evidence. In order to do so, he has to put images of the clues he found, into one of the category boxes "Common objects", "Possible clues", and "Biological products". This partitioning was chosen as it is important for the user to notice that there are objects that were carried around normally, for example a toothbrush that was also found on the first crime scene. The player is also required to decide whether the found apron or the pills in the letter are possibly clues to be researched. He can drag and drop the objects into the labeled containers on screen. When all objects are inside one of them, he is able to check on his categorization. Objects that were correctly sorted will display a green checkmark. Objects that were sorted into the wrong category disappear. The quiz aims to teach the user to make decisions on what is relevant for the case. This kind of detective game work can feel kind of rigid. Investigating clues, that turn out to be not relevant is usually a part of detective work. However, ruling out clues that were not ruled out originally, would also take away from the serious factor. In this case, the seriousness was chosen over the detective theme.

10.-13.09.1888

The next investigation day starts with a newspaper article, which the user can enlarge and read. Again, this newspaper article was originally released after the second murder and reveals that the police suspects a connection between the leather apron and the murderer and also believes that the two murders were done by the same person. The user can also look at his second hint stating: "How are these persons related?". From this, the user can assume what the next test will look like and can focus on connections between the witnesses. Beside the newspaper, the user has access to two names of witnesses that he can click on in order to interrogate them. These are John Davies, who discovered the body while leaving for work, and second, Timothy Donovan, the lodging-house keeper of 35 Dorset Street, where the victim has been residing most of the times. Selecting one of them by clicking on their names will open an interrogation window, in which the player can ask one of two questions at a time. The answer is displayed in a box below. Each witness has a catalogue of questions and respective answers. Posing a question will insert the next possible question into the same field. This way, the user can go through all questions and choose which information he wants to know first until the pool is empty. Thereby, the questions he can ask are real questions that the coroner of the case asked the witnesses on the current date (eg. for Davies and Donovan: 10th of September 1888) and the answers are the given ones from the same hearing. As the inquest stretched over multiple days, the user can proceed two more times to the 12th and the 13th of September. Amelia Richardson, a resident of Hanburry Street 29, James Kent and James Green, who were informed of the murder by Davies while searching for help, and Fontain Smith, the brother of the victim become visible on the 12th of September as new witnesses to interrogate, since their inquest day was set on this date. On the 13th of September, John Pizer will appear among the persons to interrogate. However, the user will learn, that he is not a witness, but rather the first suspect the game is introducing. The suspicion of the police was initially caused by the leather apron that was found near the body. John Pizer was a jewish shoemaker, known by the nickname 'Leather Apron' that referred to the apron he wore during work. It later turned out, that his apron and the one the scene were completely different. Pizer was also suspected because he had a prior conviction for a stabbing offence. However, the press picked up on the leather apron murderer and made him infamous over night. The newspaper article the user has access to even features the words "leather apron" in the headline. He was called to court on the 13th along with the leading inspector Joseph Chandler and the police surgeon George Baxter Phillips. In this chapter of the game, the user is able to lead his first interrogation, and can draw a lot of information out of the answers. It will be explained to him how the victim was found, how Davies tried to find an officer for help, and how he included Kent and Green. The user will be further told how the witnesses ran into Chandler, who was on patrol that night and who later called the surgeon to inspect the body. From Phillips, he will get the information of how the body was mutilated and that the railings were free from blood. This information will be needed in the final conclusion task. The next time the player ends the day, the game continues with the following exercise. Users will see all the names of the witnesses they interrogated, including Pizer, and a series of questions that ask for relations between the given witnesses. An exemplary question can

be seen in Figure 3.5 The quiz tests whether the player has understood how the witnesses

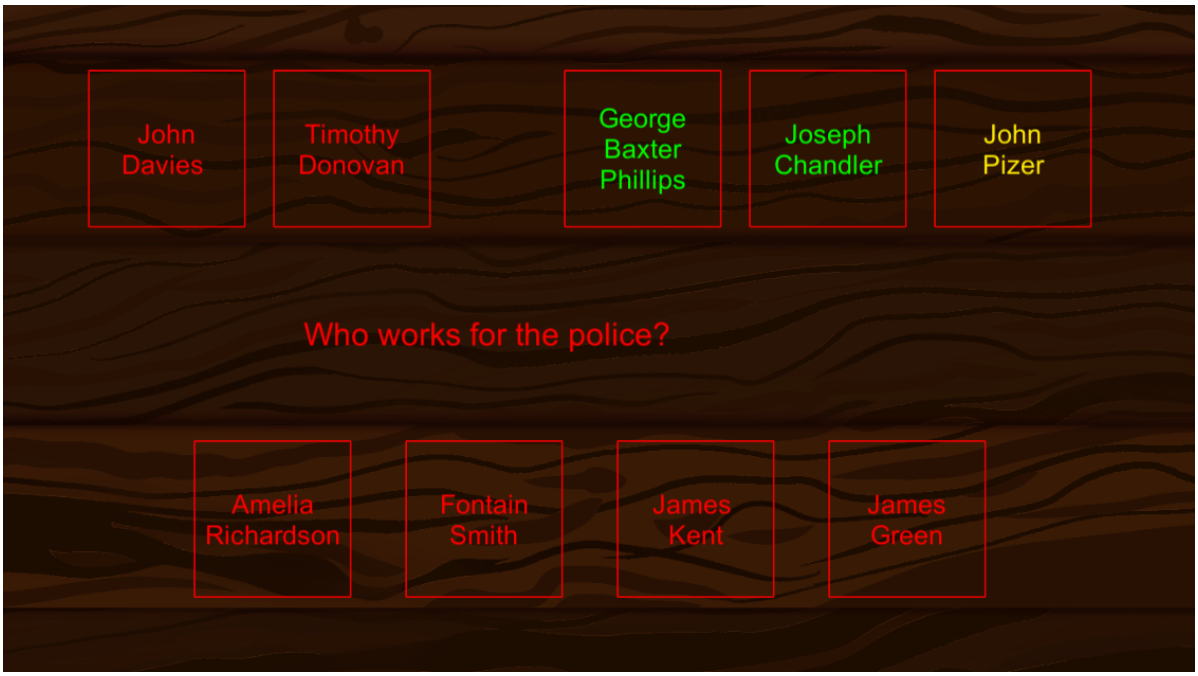

Figure 3.5.: Relations-quiz of the second murder case

were related, by asking questions like: "Which of the witnesses are working for the police?" and "Who works at Hanburry Street?", the place where the murder happened. The game is basically a refined version of the first single choice quiz, where the user now has to select one or multiple persons by clicking on them. If he does, the selection is highlighted by turning the names yellow. When the user wants to finalize his selection, he can press the "Check" button to see whether it is right. The correct solutions are highlighted in green, to give the user immediate feedback. Selected people that did not belong to the solution stay yellow. After working through all questions, the player is allowed to proceed.

22.09.1888

The next day the player can experience is the day Mary Ann Nichols inquest was closed with the conclusion: murderer unknown. This day is used for the user to draw his own résumé, based on all the information he was offered during the previous events and answer the question if the victim was really murdered at Bucks Row, where she was found, or if she was killed elsewhere and was then dragged there. This question also came up in the investigation of 1888 and was heavily discussed. The user is given three initial statements, as seen in Figure 3.6. The player has to connect the statements "Newspaper suggests the murder happened elsewhere" and "Doctor suggests that the body was dragged there" and find a statement that would fit as a "would mean" conclusion. In the given Figure, one possible wrong answer is displayed. In this case the right answer would be, that there was not enough

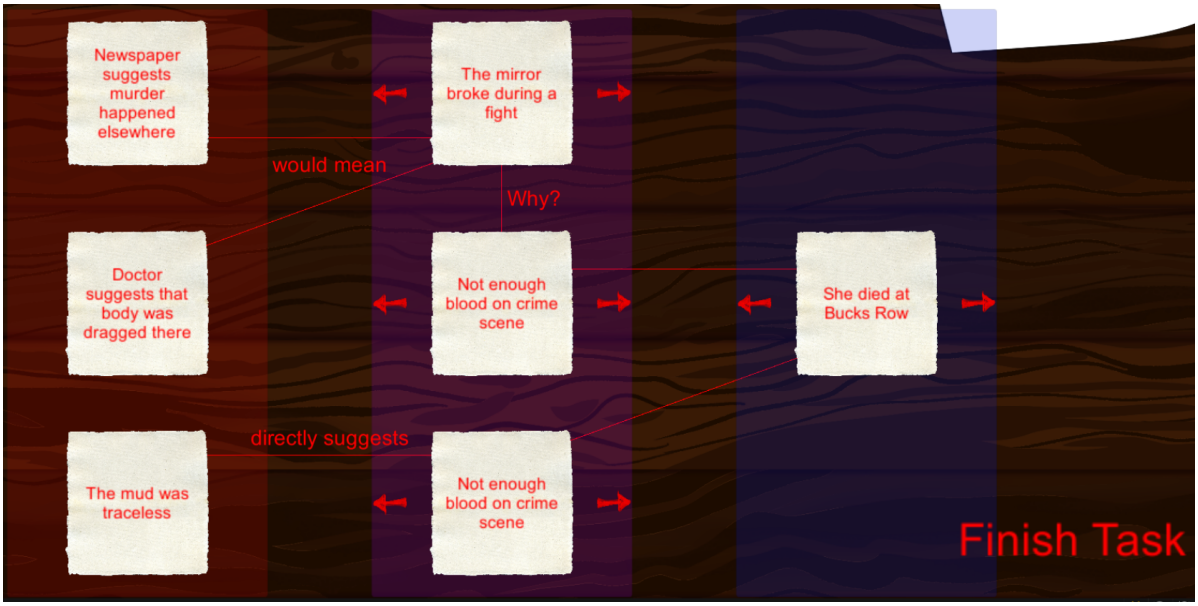

Figure 3.6.: Concluding quiz for the first murder in Bucks Row

blood on the crime scene, so both entities suggest that the murder did not happen there. However, the answer to this was given in a previous task, where Constable Neil speculated that the clothes absorbed most of the blood, which explains the little amount of blood on the crime scene. The statement on the bottom left of the same Figure repeats the information, the user found when investigating the 3D scene augmentation: The mud that was found did not have any traces. Together with the question from the 31st of August, about the cart tracks that were not found near the scene, the user should conclude, that there was no way the victims body could have been transported there. Both trains of thoughts should lead the user to the conclusion that the victim was really murdered where she was found. This final question was included because in 1888, the location of the murder was discussed as well, and the police came to the same conclusion. This section is also used as a revision of previous knowledge with the intent of repeating information without producing a feeling of having repetitive quizzes. Hereby, the structure of the game was influenced by the *Sherlock Holmes versus Jack the Ripper* game introduced in Chapter 2.3. They use a similar connection puzzle, that looks the same after each murder. As there is no scientific evaluation of the commercial game, this task was included in this game.

After the conclusion, the user will be shown a screen with additional information about certain circumstances in London. He will be told that there were five canonical victims of Jack the Ripper and that in the years before the events, London's East End population grew to 80000 inhabitants due to refugees, mainly from Russia. He will also be told that work and housings conditions worsened steadily and more than half of the children born there died before the age of five. The user can also see his final score for the investigation of the murder scene, the time reconstruction and the final question of the murder place, as well as a sum of what he scored and what he could have scored.

26.09.1888

Four days later, the inquest of Annie Chapman was closed as well. This time, the game offers a way to draw a conclusion. The user is gives two facts at the top of the screen, each of which can be either a sentence or its negation. For example, Figure 3.7 shows "Doors to yard normally unlocked" and "Yard was frequently used by strangers" on top of the screen. He can change the statements to "Doors to yard normally locked" and "Yard was rarely used by strangers" respectively. He has to chose which is correct, the negation or affirmation, and then think about what this means. The lower sentence has to be chosen so it fits the upper two predicates. In this example he can chose either "Murderer climbed over the pailings" or "Murderer entered through the gate". The answer to this question was already discussed in the interrogation of Doctor Phillips on the 13th of September, when he tells the player, that there were no signs of blood or damage on the pailings itself. When a user has locked in all three choices, he can press a "Solve" button, after which correctly chosen assertions are highlighted in green, while incorrect ones in red (compare Figure 3.7).

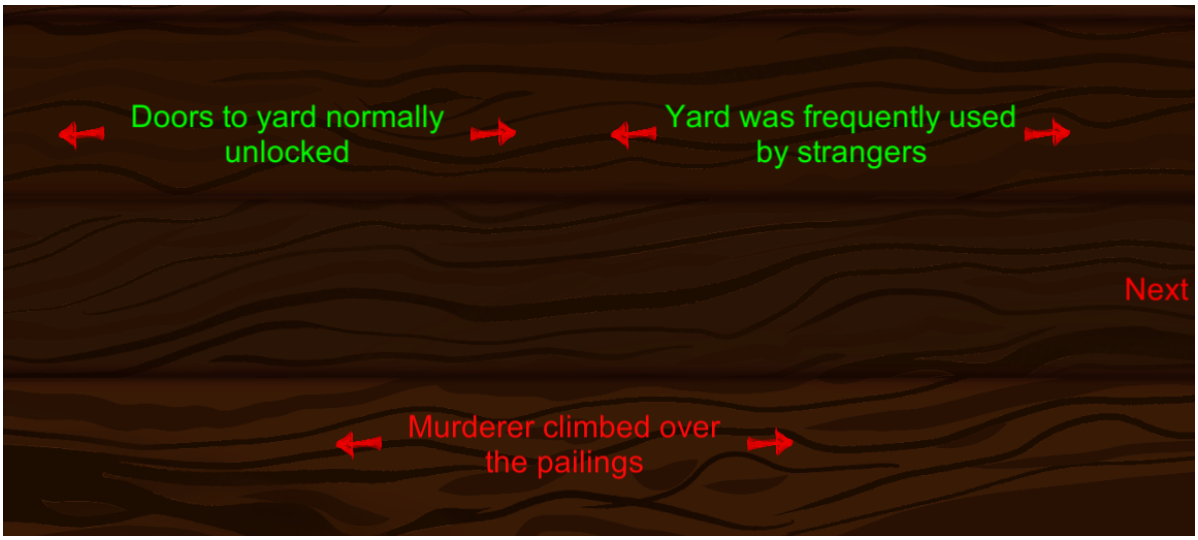

Figure 3.7.: Concluding quiz for the second murder in Hanburry Street

Finishing all combinations, the game explains some background about Jack the Ripper, for example, the initial belief that he must have had anatomical knowledge in order to cleanly cut and extract organs. As an attempt to clear up some of the myth behind the Ripper, it is also explained that modern theories include a disorder of collecting body parts as trophies. Also, it hints towards the emphasis of the following segment of the game by mentioning that detectives were sparse in 1888 and police work not yet refined. The Jack the Ripper murders only accumulated to the need of a police reform. Afterwards, the user gets to see his scores of this case, including the investigation of the murder scene, the relation quiz, and the Conclusion, as well as the added score, and the score he could have gotten. The player can eventually skip to the next day, completing the first Chapter of the game.

3.3.2. Elizabeth Stride and Catherine Eddowes

The third and fourth victims, Elizabeth Stride and Catherine Eddowes were killed in the same night. While Stride was found with only a cut throat, minutes after her death, Eddowes mutilated body was found a few hours later. The common belief is, that the Ripper was almost caught in his act when he killed Stride and then had to flee. Being interrupted, he chose another victim and killed Eddowes. As the inquest days of both cases happened at almost the same days, the second part of the game switches between case three and four, so the difficulty rises. The inspection starts on the day of the murder.

30.09.1888

Completing the first part included eight event days and six exercises. As a means of lifting the players mood after working through the first segment, he will be given a simple task of assembling the map that shows the third murder scene. Here, the map is taken from old blueprints of the region and simplified for clarity. When the map is completed, the player will see the screen as displayed in Figure 3.8. On the right side is an input field in which the player can type in words. The field's header tells him what to do: Request new witnesses. The currently available witnesses are listed below the input field and when the name of a new witness is typed into the field, that name is also added to that list. It is up to the user to find the correct names from the current witnesses' testimonies. Thereby, the button grid on the left side of the screen is starting to fill as seen in Figure 3.9 and is complete when eight names are in the list.

Figure 3.8.: Stride Investigation start

As the user does not know the names of any of the missing witnesses yet, he has to interrogate the ones the already sees. By clicking on on of their names, an interrogation page opens that contains the map with the crime scene highlighted continuously in red. If a

Figure 3.9.: Half filled (left) and filled list (right)

witness was called, that lived in one of the houses on the map, the house is marked in blue. This adds a visual layer to the interrogation. The statements the witnesses give are taken from inquest transcripts that were released in newspapers shortly after the inquest ended. In order to interrogate witnesses, the user starts with two keywords: "Time" and "Dark". Using one of the keywords simulates questioning the witness. A possible question could be: What time was it when you went home? The questions were intentionally not written explicitly, to prevent a simple dialogue reading. Whenever a new information is given that might be relevant, a new keyword is added to the list. The player can use this word to ask new questions and receive new information. Whenever he learns of a new keyword, he also has to talk to previously interrogated persons, as they might have something new to say, when confronted with another keyword. This is also pointed out in a hint the user can look at which tells him to "Question witnesses again when there is new input".

Two facts are important to mention here. First of all, the interrogation mechanics were influenced and modelled after the game *Her Story*, which was introduced in Chapter 2.2. Instead of having the user type in keywords, the user has to look for names. He also has to revisit persons again and again as he is able to find ten keywords in total. Another resemblance to *Her Story* is that the user does not get the information when he found all keywords or all witnesses. Whenever he feels like he found everything he can or wants to, or cannot find new information, he can proceed. The second fact is, that this puzzle intends to break the rigid way of most detective games that offer the interrogation of a single witness and then the next, by having the user jump from witness to witness and thereby, simulate real progress during a case. This kind of detective game was introduced in Chapter 1.5 as a puzzlebox detective game.

If a user continues, he will receive the information that another murder happened during the same night. In fact, the murders happened in different districts, falling into the jurisdiction

of two different police departments: the "City of London police", in whose region Stride was murdered and the "Metropolitan Police" that was responsible for Eddowes' killing. As already depicted in Chapter 1.4, the different departments did not work together well. To keep this atmosphere for the player, he will not be able to question the witnesses himself, like he could in Strides case, but will instead speak with the Metropolitan Police head, Charles Warren, Constable Edward Watkins who found the body, and Constable Alfred Long who found a piece of Eddowes' missing apron further away from her body below a graffito. The user still has the same hint about re-questioning witnesses when new information is found. In general, the game mechanics of the policemen interrogation is close to the last one. Instead of keywords, the player this time receives small icons, displaying various items, including the head of the victim, blood, other policemen, and more. The change from words to visuals was introduced as it was a chance to evaluate the impact of text versus pictures on users. However, he cannot request additional witnesses because of the reasons stated above. Instead of the same map, the user is now offered a different map, related to the person he is currently questioning. The player starts with only one picture to question all three of them: Eddowes' head. Charles Warren, for example, will respond to the picture with: "The victims name was Catherine Eddowes. We found a pawn ticket with her name on it. Her sister and her daughter confirmed her identity. She was found by Constable Watkins on his patrol at around 1:35-1:45am". Similar to the last event, users will have to ask around for new information, interrogating the policemen over and over again, until he receives no further information. In doing so, he will learn from Constable Long, that a missing piece of Eddowes' apron was found multiple streets away under a graffito, that Warren has ordered to be washed away. Asking Warren about the graffito leads to his confession. He had it be erased in order to prevent more anitsemitism. He also explains that there have been antisemitic movements (due to Pizer being Jewish and demonized in the newspaper) which he did not want to see escalated. Speaking to Long again, will reveal the inscription of the graffito: "The Juwes are the men that will not be blamed for nothing". Using the blood image on Warren also uncovers that the wounds that Eddowes suffered included part of her ear, that was laid on top of her and mentions a letter. By pressing him on this letter he promises to hand you a letter he received from someone calling himself Jack the Ripper.

01-16.10.1888

Continuing on to the next day, the "Dear Boss" letter that Warren received will end up on the players desk. He can open it and will be able to view images of the real letter. Furthermore, the camera icon appears, indicating that the user can scan the letter with his mobile phone. If he does, he will see an Augmented version of the letter, which can be read better. He can also decide to decipher the originals on his own if he likes. An example of the first Dear Boss letter page and its augmentation can be seen in Figure 3.10. Later on the same day, the Saucy Jack postcard arrives, which the player can examine in the same way as the letter before.

On the 16th of October, the user will get another letter forwarded and this time, the game gives him some information with it. Due to the high number of reports about Jack the Ripper, who is yet to be caught, people start to get angry at the police and form their own home

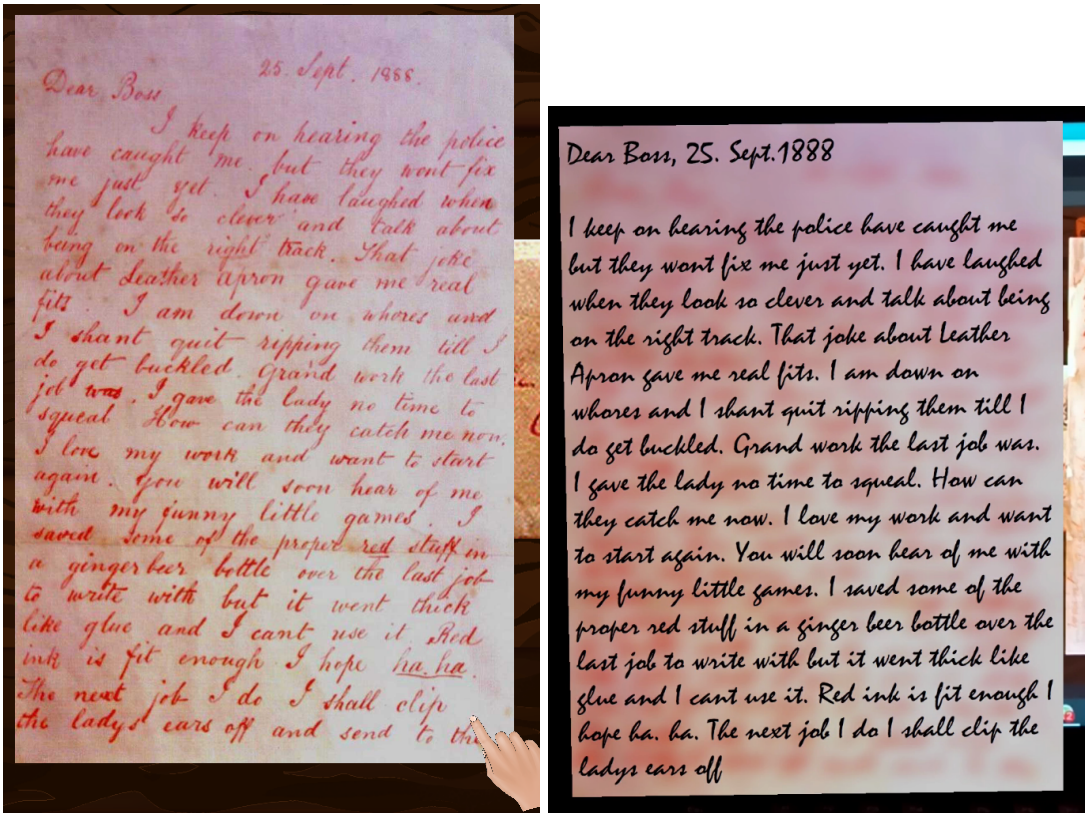

Figure 3.10.: The first Dear Boss letter page [10] (left) and its augmentation (right)

guards in an effort to secure Whitechapel. George Lusk, chairman of the home guard receives a package with half a kidney and the letter with the words From Hell on it. After examining the letter, either as it is given or with an easier to read augmentation, the user eventually reaches another task, in which he has to transfer his knowledge about the interrogation and the letters. The user will get another set of questions which he has to answer. "Was Elizabeth Stride heavily mutilated?" is one example of such a question. As multiple and single choice questions were already used in part one of the game, this time, the user has to assemble sentences with given word snippets. In total, there are 33 snippets, each with a different word or time on it. To answer the exemplary question above, the player has to assemble the words "SHE", "WAS", and "NOT" or "WAS" and "NOT". This approach allowed a break from the strict choosing of given answers, while limiting the number of possible combinations so that the mechanics could be implemented efficiently. The puzzle asks about the murder times of both victims but also about the contents of letters, using questions like "What organ was found in the From Hell letter?". There are also questions regarding the graffito where the player has to prove, that he remembers the connection of Eddowes murder and religious motives. Whenever a correct answer was assembled by the user, the answer gets highlighted in green, otherwise red. If the answer is false, the correct answer will be displayed immediately, so the player can link the correct answer to the question in his head.

20.10.1888

After being confronted with a lot of textual information, he is now presented with a copy of the "The Illustrated Police News", a newspaper based on comics and released by the police as a reaction to the sinking trust of the people. At this point, the interface shows the camera icon, as multiple small parts of the paper can be scanned with the smartphone camera. If a scanable section is found, it is augmented with a box, that surrounds the respective section. Furthermore, the augmentation shows the source of the snippet and when it was historically seen released. In addition, most augmentations also display a question or a statement under the box. As an example, one of the newspaper pages show two men, that supposedly are prime suspects in the case. However, the drawings of these men were made up by using stereotypical features like shadowing, distinctive shapes, and more. In this case, the augmentation states that the portraits were made up. Another snippet shows a beheaded body with no limbs and pretends to show one of the victims. However, none of the victims was ever beheaded. To encourage the player to reflect on why this drawing was released, the augmentation asks: "A beheaded body without limbs?". To facilitate the viewing and examining of the newspaper and to show all the necessary details, the images can be enlarged by using the mouse wheel to zoom in.

23.10.1888

The newspaper insights are called upon in the task on the next event day. On the 23th of October, Strides' inquest was closed. Eddowes' inquest has been closed before, due to the lack of witnesses. On this conclusion day, the user is asked multiple questions, focusing on the circumstances, including police work, newspaper influence and societal reactions. This time the quiz is kept easy and the user can only chose one out of two options. In the beginning, he is confronted with multiple statements, starting with: "The police is well equipped". He has to either affirm or deny the statement. The answer could have been found in the newspapers, that depicted policemen with open carts that they used instead of real ambulances. Whatever the user chooses, an explanatory texts appears, either in green, if the user chose correctly, otherwise in red. For the example statement, the text says: "The police was poorly equipped. They used simple, man powered, wooden carts for carrying bodies. If they weren't offered blankets from near residents, they didn't cover the body". Thereby, the user also gets more detailed side information about everything revolving around the murders. These information play an important part in really understanding how Jack the Ripper became so famous. That is why the difficulty of the questions do not matter at this point. The user is supposed to learn key knowledge, the atmosphere and factors that surround the killings, that are sparsely represented in comparable works. For that reason, no detailed questions were asked. After the yes or no statements, he will get a few more questions, including: "Why does the police reveal information?". The answers to these questions cannot be found directly in the game. The user has to actively reflect on the information which the game aims to encourage at this point. In the example case, he can choose between "To show the people they are still investigating" and "To demonstrate the cruelty of Jack the Ripper". In this case, the user has

to differentiate between police informing and newspaper reports. The correct answer would be the first one, they want to inform. In terms of learning and raising awareness for Cultural Heritage, giving the correct answers do not matter.

After having answered all question the user reaches the end of the second part of the game. He will see another concluding text, this time focusing on the victims, for example. Background information about why Stride and Eddowes needed to return to occasional prostitution. The name Jack the Ripper and any further information about him was intentionally left out in this concluding page to keep the focus on the two victims. As usual, the player can then access his score including the newspaper evaluation and the conclusion of the double murder, as well as the accumulated score and the maximum amount of points he could have reached.

3.3.3. Mary Kelly

Having covered multiple types of investigation, knowledge retrieval quizzes, tasks, and exercises and having presented the user multiple angles of the Whitechapel incidents, the game uses a completely different approach for the last case. The third part of the game includes only one murder which is presented in a storytelling style.

09.11.1888

Mary Kelly was murdered on the night of the 09th November and suffered from the heaviest of mutilations up to a point where she was only recognizable by her ears and eyes. This time, the player can follow the story on how her body was found. The user will be led through the story, almost in a narrative way. As seen in Figure 3.11, the user will get an image, taken from newspaper drawings and in this case, the drawing of John McCarthy who found the body. The user will also see a timestamp on the left side in order to get a feeling on how long the respective events lasted. Below, the player can read the story about what happened when Mary Kelly was found. On the right side of the image, the next part of the story can be accessed.

Following the story, the user will learn how the body was found by Thomas Bowyer who is a coworker of the owner of the house in which Kelly lived and who collects the doss money. When she doesn't respond to him knocking on the door, he looks inside the window and sees the heavily mutilated body. He runs to the police station to where he finds Inspector Walter Beck and Detective Walter Dew. According to their inquest statements, Bowyer was out of breath and could barely mumble a word. This was taken as a motivation for the following puzzle. The user has to solve a riddle before he can proceed, involving 13 statements. Each of them gives a certain type of information like "Elizabeth Bushman lives in a corner room of Miller's Court building". He also gets a picture and the camera icon is visible. When he films the marker, a reconstructed 3D floor plan appears where the user can change between the first and second floor by shaking his phone. Every room is indicated by a number. The first floor can be seen in Figure 3.12.

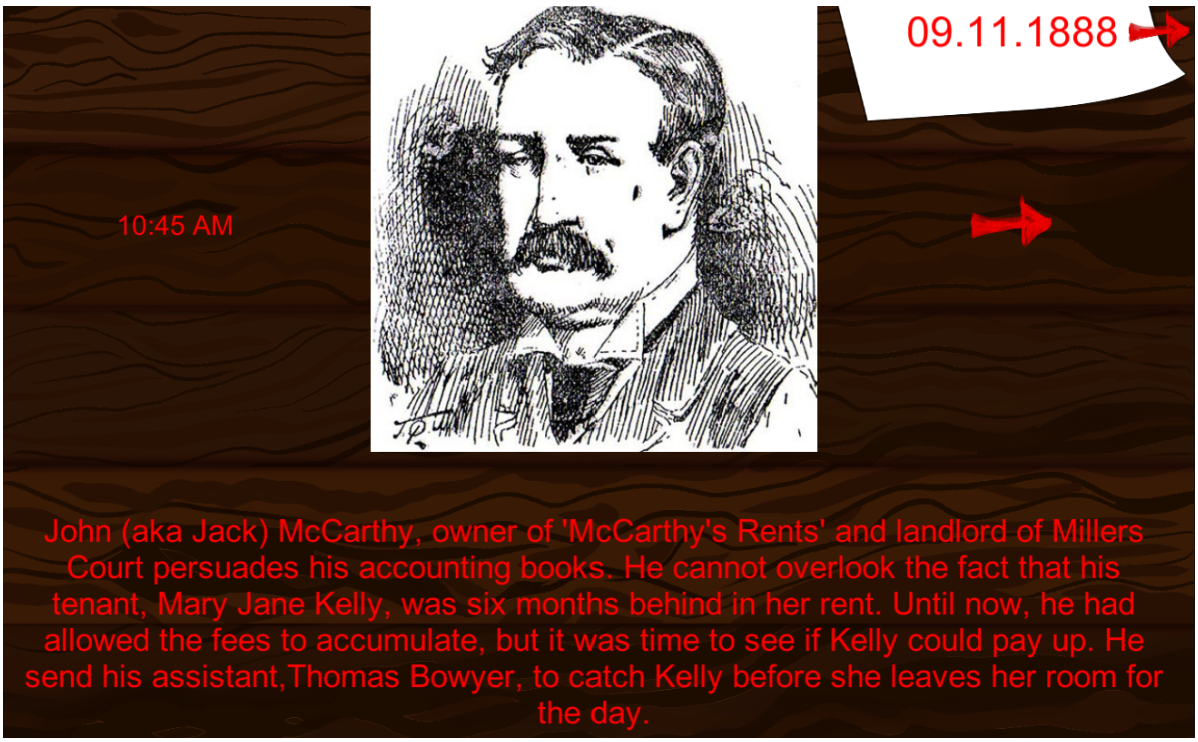

Figure 3.11.: Beginning of the last murder case [11]

The user has to take the role of Dew and Beck to solve a logic puzzle, where he has to find out who lived where in order to find Kellys' room, by using the information of the statements he is given. This time, the user can interact with the augmentation when he clicks into one of the rooms. A box will appear, that is connected to that room in which only three dots are registered in the beginning. Touching the dots offers him a list of names, all of which have to be linked to one of the rooms. By choosing a name, it gets registered into the box. Until another name is chosen, the current one stays inside the box and is considered locked in. Only when all rooms are connected to a name, a "Solve" button appears that solves the allocations. Correctly connected names and rooms are once again highlighted in green, wrong ones are overwritten by the actual solution and are displayed in red.

Directly after the logic puzzle, the user gets the next task. He has to take notes into his notebook in which a fill-in-the-blank text has to be solved that verifies the users knowledge of what happened until now. After filling the blanks, correct answers turn green, false ones red and are corrected at the same time. Hereby, the missing words in the blank spaces include the victim's room number, the victim's name, and the number of neighbors. The quiz is kept simple as it was assumed, that by this point in the game, a player will have absorbed a lot of information already. Therefore, the difficulty was reduced in order to reduce the cognitive load.

After solving the notebook quiz, the story continues in the same fashion it started, in the form of a visual novel. The user is told how inspector Abberline and doctor Phillips arrive

Figure 3.12.: First floor of Millers Court, where Kelly lived and was murdered

at the scene and how Abberline sends for bloodhounds. It also mentions that the usage of hounds to sniff out murderers was a new and untested technique. While waiting for the dogs, no one was allowed inside the room. By proceeding in the story, the player will then learn, that the hounds never came, as their owner refused to bring them since he did not get paid for it. This is unknown by inspector Abberline, who waits two hours in front of the crime scene. Eventually, superintendent Arnold arrives and orders the door to be broken down by the owner of the house.

After the previous events, the user has to solve another fill-in-the-blank text in the same way as before. This time, he has to proof his knowledge about the hounds, whether using them was a modern or old technique, which doctor was called and who eventually broke down the door. After this, the player can end the day.

The inquest of Mary Kelly lasted for only one day until the coroner decided that they will not come to a conclusion with the clues that the police found. This inquest day was used for another task. Here, the user will get another set of statements of four persons: inspector Abberline, doctor Phillips, the victim's partner Jospeh Barnett, and the neighbor Mary Ann Cox. The game uses five inquest statements per person, that the user can read like he would be talking to the persons himself. The actual statement is displayed on the right and a notebook on the left. Inside the book, a newspaper drawing of the witnesses face is displayed together with their name on the left side. On the right, the summarized statements of each witness is given to the player in the form of one to two sentences. The user can read trough all of them and eventually end the day to the 12th of November when the original inquest was held.

12.09.1888

Having the summarized statements, the user gets an overview of the summaries and can compare them to each other. He can chose which witnesses statements he wants to compare. By doing so he will have five notes on the left side of the screen and five on the right. From each side, he can choose one, which is then highlighted with a blue box. Overall, the statements contain three contradictions that the user has to find and point out. He can do so by selecting two statements and pressing the "Object" button. If he found a real contradiction, the boxes turn green, and a short correction of the lying victim is displayed. If a player chooses wrongly, the boxes turn red and the user is told that there is no contradiction here. Finding a lie results in a point, while choosing two truths, result in the loss of a point. When the user chooses two statements, that have been a contradictory a second time, the boxes will turn yellow, the game tells him that the contradiction was already found and he can go on. He will neither gain nor lose any points in that case. Hereby, the lies were taken from existing statements and were not made up. The contradictory statements of the witnesses were taken as one of the reasons why Kellys' case was closed so fast. The user can proceed for one more time, and read the final conclusion of the fifth case. This time the user gets a short résumé on what happened in Whitechapel. He is also informed that the presented five victims are only the considered canonical ones. Afterwards, the score of the last case will be displayed, including the logic puzzle, the police work analysis, and the revealing of contradictions, as well as the final and the highest possible score.

As an ending page, the user will get a summary of all the points he received, listed and sorted by case and his final score. With this number, he can measure himself against other players if he wants to.

4. Evaluation

An evaluation of the Jack the Ripper game was never planned, due to Covid-19 restrictions. However, to include feedback, the game was tested by eleven people (n=11) that were mostly between 18 and 39 years old (M=32).

In order to have a basis on which a SG can be tested, the evaluation should include three fields. First of all, there needs to be a test on whether a user has learned something during the game. Second, as a computer game, it should be evaluated in terms of usability, meaning how users interact with the game. Third, the game should be analyzed regarding its player experience (PE). Wiemeyer et al. [62] consider the experience of the player an important factor as it describes how well the players interact with the game. Here, usablity is used on a technical level, while PE describes the personal and individual experience and, therefore, denotes its quality on a psychological level. This level contains multiple aspects of play, including tension, challenge, and immersion. Especially the last is important as the connection to SGs has been drawn in Chapter 1.1.

There are two psychological models that can be applied onto SGs. On one side, the generic model that is based on self-determination theory (SDT), the attention, relevance, confidence, satisfaction (ARCS), the flow, and presence and immersion. Here, SDT focuses on multiple dimensions starting with the in-game autonomy, determining whether a player is free to make decisions and choices in the game. It also includes the equilibrium between the challenges during the game and the competence of the player. Additionally, the relatedness of players to other players in the game play a role, as well as physical, emotional, and narrative presence. Lastly, it considers intuitive and easy to remember controls. The ARCS proposes the four name giving properties as main strategies. A balance between high and low attention has to be found, as information, that is not put into the focus is often unrecognized. Besides attention grabbing, the game should offer a feeling of relevance and, therefore, meaningfulness. Players that try to be successful by making an effort further gain confidence. In addition, a feeling of satisfaction has to be met within the player, based on their accomplishments. The term flow is used when users show intrinsical motivation, which is considered high when their sense of time and their surroundings are lost while playing. Thereby, nine categories act upon the flow: an equilibrium of skill and difficulty, automatical combination of actions and awareness, defined objectives, immediate feedback, a focus on the current task, control, loss of the sense of surroundings or the sense of time, and autotelic experience (ibid). Closely related to flow is presence, also described as the feeling of being present, as introduced in Chapter 1.1 which is similar to to immersion and which connects the presence with personal experience. On the other side, there is the domain specific model that takes gameflow, fun of gaming, core elements of gaming experience, and play heuristics into account. The term gameflow is used when the flow, as introduced previously, of a game is analyzed and is often synonymous to

enjoyment. Aspects that play a role in this field are social interaction, immersion, feedback, defined objectives, control, skill, challenge, and concentration (ibid). When talking about fun in games, players are considered to have fun when they experience a sensory or imaginative immersion, positive, and negative emotional responses and challenges but also with flow, tension or competence. The mentioned core elements of gaming experience basically include two factors: video game perception and puppetry. The first one characterizes how the player perceives his environment during the game, including graphics, or sound. Puppetry is used to describe the way a player interacts with a game, based on his personal goals, rewards and his control over his actions. The last element, the play heuristics, include fields like gameplay, coolness (immersion), and usability [62].

To examine the learning objectives, a tester received a questionnaire before and after playing the game in the form of a *Google Forms* document. This way, the learning process could be tracked without the necessity to be present. Furthermore, all testers participated at one of two testing days. The first day included seven testers, the second one five. All users had to fill out the first questionnaire and were given the computer game and the android application afterwards, which they had to install. They received help on how to install the files on their respective devices. After that, they all started both applications and were told that they only need to use the mouse and the keyboard. During the testing, questions about the content of the game were not allowed. On some smartphone devices, a few objects turned out to be colored in pink, probably due to an incompatibility with the android versions. In this case, their display was supervised to make sure they see everything they have to in order to complete the puzzles. In the end, everyone was able to utilize both applications to proceed without contextual drawbacks. The second group was given the same information about the game and no contextual questions were answered. Questions from the first questionnaire were repeated in the second in order to have a means to check previous answers with current ones. The learning objective questions can be seen in Figure A.1 in the Appendix.

The usability and player experience were tested after they finished playing. All testers ended the game and filled out the second questionnaire immediately. In order to keep the answers anonymous, they had to chose a unique password at the beginning, which they had to fill in in the second file, so the two versions could be matched to each other. Besides the password, the users had to fill in some demographic information like gender, where they could either chose male, female or other, and age group. The latter had the options "Under 18 years", "18 to 28 years", "29 to 39 years", "40 to 50 years", and "Over 50 years". Thereby, these questions were taken from Wangenheim [61], who constructed a model for the evaluation of educational games (MEEGA+), which supports the evaluation in terms of user motivation, learning, and experience. This questionnaire was chosen, because it tests most of the features that Wiemeyer et al. mentioned in a categorized way. It covers all parts of the ARCS, by questioning the factors focused attention, relevance, confidence, and satisfaction. Hereby, the focused attention also includes questions about whether users lost track of time or the sense for their surroundings, which at the same time, measures the flow. Furthermore, while it does not pose questions about the autonomy, it still includes the in-game competence, by questioning the challenge factor and the presence. Since the game is currently designed as a

single-player game, factors like relatedness to other players in the game play a minor role.

Besides this, they were also asked two general questions: "How often do you play digital games" and "How often do you play non-digital games (card or board games, etc)", both of which could be answered with either "Never", "Rarely: from time to time", "Monthly: at least once a month", "Weekly: at least once a week" or "Daily: every day". The last section of the questionnaire (see Appendix Figure A.2) consists of substantial questions, starting with "Does the name Jack the Ripper tell you anything?". A participant could only answer with yes or no. Here, every tester answered with yes before and after the game, indicating that everyone that participated already heard about the name. The next questions allowed open answers. For example, they were asked if they knew how many canonical victims were murdered. None could give the correct answer. Six stated that they don't know, others mentioned numbers between nine and twenty. After the game, 100 percent of users gave the correct answer. In addition, they had to state how old the victims were. Again, no one wrote down the correct ages. More than half stated that the victims were very young, ranging from teenagers to "not older than 25". Afterwards, all of the users could state the correct answer. However, when asked what the victims did for a living, five gave a correct answer before the game, one stated he doesn't know, and two stated wrong answers. In the second questionnaire, everyone was able to tell the right professions. The next questions asked about the context of the murders, having the user answer how many police institutes worked on the case, where only two participants knew the answer beforehand, while nine were correct in the second run and the other two could not remember. Users were further asked how developed the police was. Five answered underdeveloped, from which two stated that this was due to the fact that modern analysis was not invented yet. Another four answered that they do not know, and two thought they were more developed than comparable countries. After playing the game, all eleven answered correctly stating the underdevelopment. Another question covered the media and inquired to know if the press reported about the murder series. In the first run of questions, only four testers gave a definitive yes, another four answered with probably, and two with I don't know. In the second run, ten players gave a definitive yes, and even included the differentiation between common and police newspapers, while one stated "police published stuff", excluding the public newspapers. The next questions asked how the court was dealing with witnesses and how Jack the Ripper got his name. In both questions, zero correct answers were given. Afterwards, nine users answered the first one correctly, and ten the second one. Finally, the users were asked if there was religion or politics involved. Hereby, the politics were not thematized and the question was used as a control to see if users were getting information of different sources in order to be able to answer the final question, as all content-wise questions were asked again in the second questionnaire. However, 100 percent of users could not give an answer to the question about religion before and everyone could connect the antisemitism afterwards. The last question that was included in the first list was: "Do you know anything interesting/worth mentioning about Jack the Ripper?". Early answers included that Jack the Ripper has been caught years later, which is not proven, or that the name is known through media, books, and games. The same question was asked after the game and now, players gave answers like "he had no knowledge of anatomy and made fun of

the police by writing letters" and many stated that he was never caught. The correct answers given before and after the game can also be seen in Figure A.1 in the Appendix.

The second questionnaire repeated the last mentioned questions, in order to check if the player could improve their knowledge. Additionally, players had to give answers to questions about the usability and the player experience, all of which could be answered with either "Strongly disagree", "Disagree", "Neutral", "Agree", and "Strongly Agree" and were taken from the MEEGA+. However, questions about cooperation and communication with other players were left out, as the game was not designed as a multiplayer game. The catalogue of the questions can be seen in the Appendix (Figure A.3) and are listed in the following as well. The first nine questions are used for the analysis of the usability of the game, the rest for the player experience.

Regarding the demographics of the eleven participants (n=11), 45% of the testers consider themselves female, 55% male. Furthermore, there were no testers under the age of 18 and none between 40 and 50 years old (M=32). Instead, 55% were between 29 and 39 years old, one was over 50 (9%) and the rest between 18 and 28. Speaking of the frequency of which the users play digital games, again, 55% stated that they play digital game daily, while 27% play rarely, 9% weekly and another 9% never. In terms of non-digital games, 46% said they play monthly, 26% rarely, and 18% weekly. No one chose the options daily or never. This means that we have a rather balanced distribution of males and females, with 10 out of 11 players being between 19 and 28 years of age and a median of 32. More than half of them are playing digital games daily, and non-digital games at least once a month or weekly.

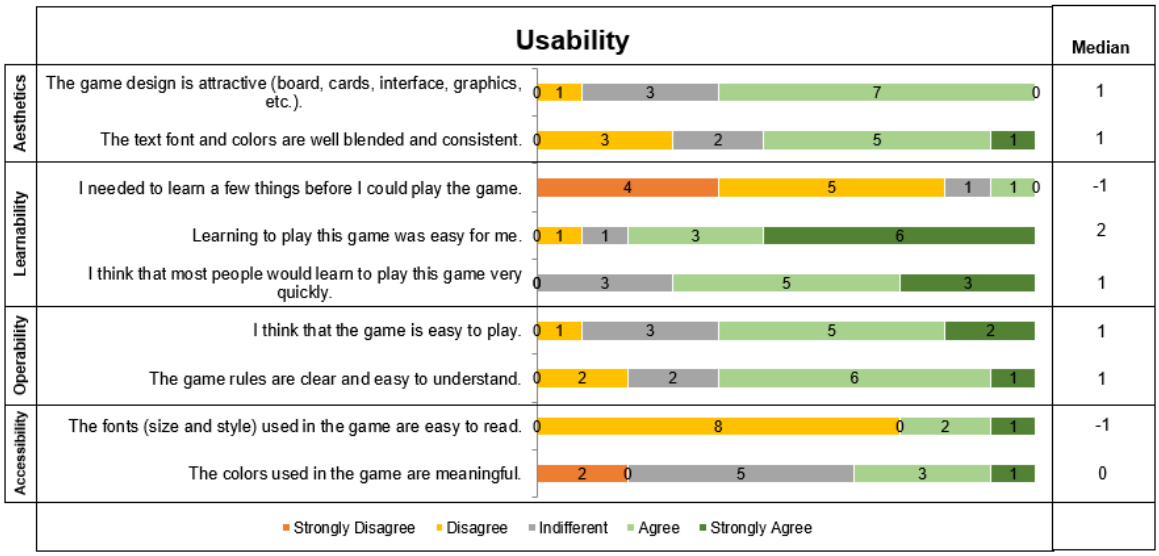

Figure 4.1.: Usability measurement of the *On the Trail of Jack the Ripper* game

The results of the usability evaluation can be seen in Figure 4.1. Here, the aesthetics were rated with the help of questions about the attractiveness of the design and how font and colors blended together. These questions about aesthetics aim to test whether the game interface

enables a pleasing and satisfying interaction for the user. The keys to the visualization are listed at the bottom of the figure. The exact amount of people who chose the respective answer is further displayed directly on top of the bar. In order to analyze the (rounded) median, "strongly disagree" was weighted with -2, "disagree" with -1, "indifferent/neutral" with 0, "agree" with 1, and "strongly agree" with 2. According to this measurement, both usability ratings scored a median of 1. The aesthetics of the game can, therefore, be considered positively.

The next three questions tested the learnability of the game, meaning they evaluated if the game could be used by the participants to achieve the given learning goals with effectiveness, efficiency, freedom from risk, and satisfaction in the context of use. As seen in Figure 4.1, the question "I needed to learn a few things before I could play the game" scored a negative value of -1. However, if having to learn a lot before being able to start playing is considered negative, a median of -1 can be considered positive here. This is supported by the next question, "Learning to play the game was easy for me", which received the highest median possible. According to Wiemeyer et al. [62], the way users perceive the difficulty to control the game plays an important part in flow and gameflow. Achieving high scores here raises the quality of the flow in the game. The participants were also asked whether they think others would easily learn the mechanics of the game, which they answered with a median of 1. In terms of learnability, the game scored positive results as well. Looking at the operability of the game, which describes the degree to which the game has attributes that make it easy to operate, it received a median of 1 in both cases. The last two questions revolved around the accessibility and whether the game can be used with low/moderate visual impairment, whether the game visuals were easy to perceive and whether they were meaningful. Here, the answers scored a negative value in terms of being readable and a neutral one on meaningful. This shows an area in which the game can improve. According to the evaluation, the game mechanics are easy enough for players to get into the game without much effort and proceed in the plot easily.

The results for the player experience can be found in Figure 4.2. Here again, the distribution is visualized and the median can be found on the right side of the Figure. The Player experience was rated by evaluating six categories. The first one is labeled confidence, and tests whether the player feels confident that he can learn with the game. This question received ten positive ratings and one neutral one. This means that testers felt like they were able to make progress in learning about the content, for example, through an increasing level of difficulty, or by being able to remember information during the game. Similar votings can be seen in the next category about the challenge the game poses. Besides rating if the game is appropriately challenging for the user, he also has to state whether these challenges are introduced at an appropriate rate or if they become repetitive or monotonous over time. Eight users considered the challenges appropriate for their skills, and ten stated that the challenge increases in a sufficient way. Especially the last question was rated highly, with a median of 2 and the rest with a median of 1. Furthermore, in all three questions, only one vote was negative. The evaluation shows, that the game is adequately challenging with respect to the learners competence. The third category checked for the feeling of satisfaction the games

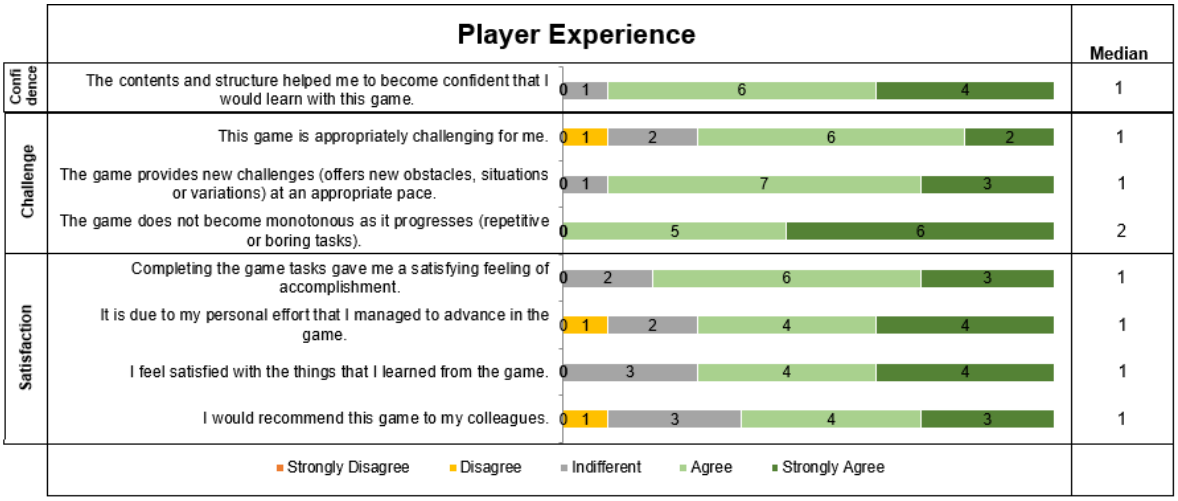

Figure 4.2.: *Player Experience* measurement of the *On the Trails of Jack the Ripper* game, questions one to eight

invokes in a player. Hereby, the first question asks the users to rate if the completion of the game left a satisfying feeling. More than half of the users agreed to this statement, and more than a fourth strongly agreed. Testers were also asked whether they perceived an advance in the game as an effect of personal effort. Eight out of eleven testers gave a positive rating, from which four strongly agreed. The same rating can be seen when players were asked whether they felt satisfied with what they learned through the game and also whether they would recommend the game to their colleagues. The testers gave eight positive responses for the first and seven for the last. In all four questions about the satisfaction of users, only two negative votes were given. As a conclusion, the participants seemed to feel that the dedicated effort they took resulted in learning. The fourth field (as seen in Figure 4.3) that plays a role when it comes to user experience is fun. When testers were instructed to rate whether they had fun, eight agreed, two strongly agreed and one gave a neutral answer, leaving no negative results. However, when they had to state whether something happened during the game which made them smile, for example game elements, two disagreed and four gave a neutral vote. Only three agreed and two strongly agreed, which means that more than half of the participants gave a non-positive score. Evaluating the testers feelings of pleasure, happiness, and distraction, the game poses a fun experience overall, but not in single events in the game. The fifth area that is part of the experience is focused attention. This category evaluates the attention, focused concentration, temporal dissociation, and absorption of the players. In relation to previous ratings, this area achieved the worst results. According to four negative and one neutral vote about whether something interesting at the beginning captured their attention, only half of the players were able to focus on the game right from the start. Furthermore, only four participants in total felt like they lost track of time while playing, or forgot about their surroundings. In general, only one median was positive, the others neutral. Catching the attention of the player turns out to be another area of the game

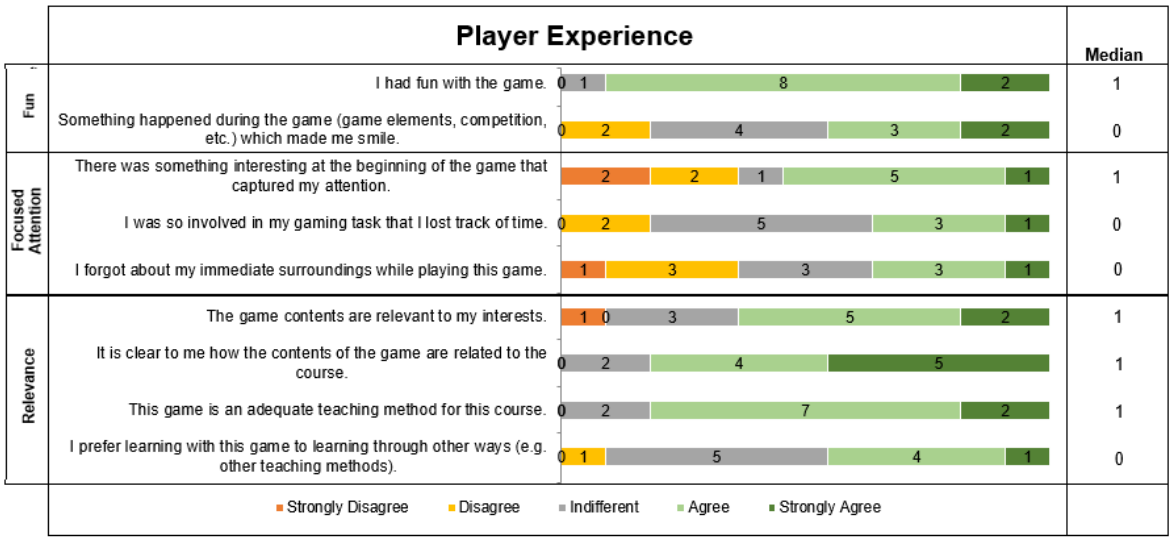

Figure 4.3.: *Player Experience* measurement of the *On the Trails of Jack the Ripper* game, questions nine to seventeen

that can be improved. The last factor that plays a role is relevance. When asked if the game falls into a field of interest for the players seven of eleven gave positive ratings, while one strongly disagreed. Nevertheless, there were no negative ratings for the questions "It is clear to me how the contents of the game are related to the course" and "This game is an adequate teaching method for this course". Furthermore, both statements received nine positive votes. In the last question, five participants stated that they would rather learn through the game than through conventional methods, while another five felt indifferent and one would prefer other ways of teaching. As a result, students overall seem to realize, that the educational objectives are consistent with their goals.

Comparing the results of the evaluation with the player experience model of Wiemeyer et al. [62], the game was able to achieve the best results in the ARCS model in terms of satisfaction, relevance, and confidence. However, the evaluation also showed that the attention of the user during the game is not yet balanced enough to receive a more than neutral overall rating. Nevertheless, the game was able to show its strength in the SDT field, as it received positive scores in the challenge field, including evaluations about the user competence, controls, and presence. The amount of autonomy a user possesses was not tested, as the game was built in a way, that would recreate the events to be closest to history in order to include as much accuracy as possible. This was a design choice that can be discussed in a future project. As already mentioned above, users considered the flow of the game as positive. Lastly, the game seems to offer an overall fun experience to all participants, but less so for single events in the game.

After all these questions, the users were further asked to state three positive and three improvable aspects of the game. Most participants mentioned the same aspects, revealing a clear trend in both, positive and negative parts of the game. Positive answers included

the detail, artwork, and original content that was included. Most users also mentioned the immersion and AR reconstruction as positive features, together with the challenging tasks. This may be due to the fact that the AR elements were included so that users were able to interact with them. Streets could be inspected from multiple sides, buildings could be seen from multiple floors, objects could be found and collected, some of which could further be inspected to reveal more information. They also liked the variety of exercises and mentioned that they were happy they were able to re-read information. While the relevance of the game received rather neutral results in the PE evaluation, the accuracy and the content was still positively perceived. As suggestions to improve the game, most answers included the heavy use of textual information. Many suggested a switch to audio feedback, or a shortening of the amount to read. This reflects in the ratings about focused attention. Including different kinds of input could raise the results in this area. Another point that was mentioned multiple times was the length of the game. Most users played for more than four hours which made the playing more strenuous and stressful. Testers also named difficulties with the scanning of Vuforia on their phone, which was mentioned previously as well. Some players further experienced problems with the lighting when trying to scan markers. It is to be mentioned here, that participants did not state anything about the detective theme or work, neither positively, nor negatively.

5. Future Work

Revisiting the results of the previous Chapter, some weak points could be observed. First, the player experience results showed, that the attention aspect of the user during the game is not yet balanced enough to receive a more than neutral overall rating. While the game was considered to be fun in general, the individual events and tasks could not protrude. This might be due to the fact that the question asked whether something made the players smile during the game while the setting of it can be considered as dark. Investigating cases in which victim's bodies were mutilated may not offer much space for positive feelings like smiling or laughing. Due to this, and the fact that only eleven testers were found, the game needs a larger scale testing with thorough and detailed psychological questions.

Second, in terms of fonts and style, the game can be improved further, as seen in the evaluation of appearance. The text of the game was held in red most times, often on a dark background. In combination with an average of four hours of playing time, this likely poses a strain on the players eyes, which led to a lower rating. In following works on the game, the design should be changed in a way, that makes it easier for the users to concentrate on. This also includes a change of the high amount of textual information and textual exercises to a variety of different output options. While in Chapter 2.1.3 audio information was found out to have a lower effect on the learning objectives, users mentioned their wish for an audio inclusion into the game. A combination of both could be offered which leaves the choice to the player whether he wants to read a text or hear it. Thinking about interrogation events, a voice-over could also help to increase the immersion as audio statements from witnesses or the police suggests a realness or a feeling of actually talking to somebody. A switch in how information is presented also introduces the opportunity for more variety in tasks, a fact that was very positively received, not only in the user experience evaluation, but also in the users direct feedback.

Third, the game showed technical issues with the Vuforia application on smartphones with low resolution cameras or older Android versions. Since AR is a core feature of the game and the augmentations were mentioned as one of the strongest and most positive aspects of the game, removing them would be an unfavorable choice. The problem can only be solved by either switching from Vuforia to a more stable tool or to offer testers a standardized device. The second option would then remove the portability of the game. In any case, a deeper integration of AR into the game could enhance the experience even more. The reconstruction of other crime scenes can be taken into consideration, as well as more games that rely on augmentations. Another way to implement more of the well perceived elements of immersion could be introduced through a complete switch form a computer game to a tablet and smartphone game. This way, the game could reproduce the feeling of holding documents when holding the tablet and work with built in features, like the gyroscope of the

mobile device, and more.

Fourth, taking the user feedback into account, the game has to be adjusted in terms of mechanic explanation. Some testers wished for more descriptions on how to use the phone, or how to navigate when interacting with augmentations. The idea, that adjusting the controls to the way a smartphone is normally used did not turn out to be intuitive for every participant. Therefore, the smartphone app needs an extra introduction into the mechanics and controls. While a larger tutorial does not seem to be needed according to the usability results, small control hints for the phone can be integrated in the future.

A fifth point could be the autonomy of the players. The amount of autonomy a user possesses was not tested, as the game was built in a way that would recreate the events as such that it is closest to history in order to include as much accuracy as possible. This was a design choice that can be discussed in a future project. Furthermore, players did not mention anything negative about posing as a detective or doing detective work, but they also did not mention it positively. This may be due to a lack of clarification that the user plays a detective. It is likely that in the current version, a user solves the case out of a third person perspective, where he interacts with the game, that forces him to do events in a way the game intends to and solves it in a predefined manner. Even through efforts of including more open tasks, the plot itself turned out rigid. Therefore, the game was not able to offer a puzzlebox detective style as introduced and highlighted in Chapter 1.5. Possible ways to involve the self-controlled actions that puzzlebox games rely on are to look out for multiple historical events that happened at the same day and have the user decide which one he wants to investigate first. A fitting example is the second segment of the game, where two victims were murdered in the same night. The game forces the player to investigate the victim that was killed first, but this could easily be implemented in an open way. Talking about the double murder, users brought up these events in the evaluation. According to the players, the puzzles felt new and uncommon. This experience relates to the detective game insights brought up in Chapter 1.5 and Chapter 2.2. Another way to induce more autonomy is to include more open types of tasks and events. Implementing them in an open way would also include more of the puzzlebox elements. An example where this can be realized are the conclusion pages. Users are currently forced to answer one question. In the first murder, this is the question of "Where was the body killed". The game could be adjusted, so that the users are offered more conclusions they can draw and are able to finish or solve the game when two of five possible conclusions are drawn. This way, the players can decide for themselves which insights they consider the most important.

Besides everything that has already been mentioned above, players additionally expressed their wish to be able to go back and revisit older cases and scenes. This feature can be easily integrated into a menu or into the notebook. However, revisiting will prolong the game. With four hours of play time, learning new things will become harder for the user, the longer the game takes. Ideally, a shortening of the plot, without losing the relevant information would give the game a further upgrade. If such a way can be found, the topic offers a lot more information about the murder series, as only a small part of what can be learned was integrated in the current game. A remastered version of *On the Trails of Jack the Ripper* could

include more aspects, for example, victims that were connected to Jack the Ripper then, but were later excluded as they did not follow the pattern. A future version of the game might include victims that have to be ruled out by the players. Also, many theories of possible suspects exist, from which only few were covered in the game. This offers another aspect the game could include.

On the technical side, the mobile application and the computer game could be connected. Thereby, the computer version can send updates to the smartphone, and in the process replace the camera icon on the screen. In addition, instead of the notebook a user can see when pressing the arrow key down, the smartphone can be used as a notepad that the player detective carries around while investigating.

A feature that was not included into the game due to time limits of the project was an advanced and sophisticated hint system. Currently, hints are included where users were assumed to become stuck. There are multiple ways in which to improve this feature. First of all, a hint database could be constructed where every task has a certain amount of hints. Lingering for a set amount of time on the same task could prompt the game to throw a certain predetermined amount of hints within specified time intervals. Alternatively, the game could react to the users needs. Here, looking at hints could cost either points or money, that can be found during the game, similar to the wishes of testers of the *SherLOCKED* game introduced in Chapter 2.2.

The last point that needs to be mentioned here is the lack of social interaction. A possible way to improve learning could be by introducing a way of cooperation. Having two users search for clues, or handing one the task to inspect the crime scene and the other the task to interrogate witnesses and then having to explain to their partner what they learned in order to finish tasks could be a way to establish more learning methods. In the current game version, a player can use pen and paper he brought with him to write down information, through which he can learn. By forcing players to communicate, the explaining of learned knowledge offers the listener to learn by audio input and the explainer to learn by rephrasing information. A network connection, as proposed previously would then help in connecting users that are playing together but over a large distance.

6. Conclusion

In this work, a goal was presented at the end of Chapter 1. There, the basic goals were set to create a *Serious Heritage* game, that would introduce the Jack the Ripper murders to the players, as well as its circumstances. Users should take the role of a detective that tries to reconstruct the story of crimes by inspecting historical documents, newspaper articles and crime scenes and further interrogate victims in a realistic and historically accurate way. The learning outcome was aimed to be achieved by using AR features in order to have 3D reconstructions and immersion, as well as detective methods like finding lies, connecting pieces of information, and more. By the end of Chapter 2, these goals were defined in more detail. *On the Trails of Jack the Ripper* aims to be a SG that educates players and transfers a sense of meaning. It uses serious design principles to raise the impact of the game and extend the learning outcome. This outcome should include not only historical knowledge, but also the dissolving of myths about Jack the Ripper and give insights about police work, media coverage, and their influence on London's citizens. Players should end the game with knowledge about how the name Jack the Ripper got famous and what entities played parts in this fame. In the process, the game intends to raise *Cultural Awareness* for living conditions, involving poverty and antisemitism. To transfer this knowledge, the game uses *Historical Reconstructions* of crime scenes, but also recreations of inquest days and police documents. At the same time, it aims to raise *Heritage Awareness* by offering newspaper articles, historical drawings and more. To set the gameplay into a fitting context, the detective theme was included, to give reason on why the player should solve cases and introduce a motivation to proceed. The detective theme also offered an opportunity to do research as detective SGs are sparse and their possibilities are not yet sufficiently studied. The last goal was to integrate AR into the game in a way, so that it creates immersion, a qualitative *Historical Reconstruction*, motivation, and entertainment. Eventually the final research question could be broken down to: Is a combination of SGs, AR, CC, and the detective genre able to obtain positive results in terms of learning objectives, usability and player experience.

In Chapter 3, the taken steps, measurements, and design choices were explained in detail, covering every single aspect of the game. The later evaluation showed, that the game hit its mark and left its players with insights about the learning objectives, including police work, living conditions, and media coverage of the incidents. In detail, the game was able to offer challenges through multiple different tasks with an appropriate increase of difficulty and a balance of challenge and solvable quizzes that formed the well perceived flow of the game. Furthermore, the inclusion of AR to create immersion and a feeling of reality and fun turned out to be one of the most mentioned positive parts about the game. It was able to introduce AR elements in a way, where they can be interacted with, where a user can zoom into, can touch and find objects, where players can turn buildings, move through floors and

select rooms on screen. Additionally, covering all five canonical victims while still keeping users motivated was supported especially through the high amount of different puzzles and varying events, which was eventually even considered one of the strongest points in the player experience evaluation. Making the player into the detective worked, as users in general had fun during the game, but turned out to play a minor role in the experience.

The games strong and weak points were detected and discussed in Chapter 5 and built a basis for further work on the game. In general, *On the Trails of Jack the Ripper* set a basis for the evaluation of multiple fields and also multiple game mechanics in general. It also introduces detective tasks and work to the SG world to research on. To answer the question from the beginning of this thesis: Yes, a combination of a *Serious Game*, *Augmented Reality*, *Cultural Computing*, and the detective genre has received positive results in this thesis and is expected to receive even better ones if improved with the propositions in this work.

A. Tables

A.1. Learning Objective Questions

Question	Before	After
Does the name Jack the Ripper tell you anything?	-	-
How many canonical victims did he murder?	0	11
Do you know anything about the victims professions?	5	11
Do you know how old the victims were? If so how old?	0	11
Do you know anything about the housing situation in London when the murder series started?	5	11
How many police institutes worked on the Jack the Ripper cases?	2	9
How developed was the police during the murder series?	5	11
Do you know if the press reported about him during his murder series?	4	10
How was the court dealing with witnesses back then?	0	9
How did Jack the Ripper get his name?	0	9
Was there religion involved in the cases? If yes, how?	0	10
Was there political interest involved in the cases? If yes what interests?	0	11
Do you know anything interesting/worth mentioning about Jack the Ripper?	-	-

Table A.1.: Demographic information used in the first questionnaire [61]. Shows correct answers before and after playing

A.2. MEEGA+ Questionnaire

A.2.1. Demographics

What is your age group?
What is your gender?
How often do you play digital games?
How often do you play non-digital games?

Table A.2.: Demographic information used in the first questionnaire [61]

A.2.2. Usability & Player Experience

The game design is attractive (interface, graphics, etc.).
The text font and colors are well blended and consistent.
I needed to learn a few things before I could play the game.
Learning to play this game was easy for me.
I think that most people would learn to play this game very quickly.
I think that the game is easy to play.
The game rules are clear and easy to understand.
The fonts (size and style) used in the game are easy to read.
The colors used in the game are meaningful.
The contents and structure helped me to become confident that I would learn with this game.
This game is appropriately challenging for me.
The game provides new challenges (offers new obstacles, situations or variations) at an appropriate pace.
The game does not become monotonous as it progresses (repetitive or boring tasks).
Completing the game tasks gave me a satisfying feeling of accomplishment.
It is due to my personal effort that I managed to advance in the game.
I feel satisfied with the things that I learned from the game.
I would recommend this game to my colleagues.
I had fun with the game.
Something happened during the game (game elements, competition, etc.) which made me smile.
There was something interesting at the beginning of the game that captured my attention.
I was so involved in my gaming task that I lost track of time.
I forgot about my immediate surroundings while playing this game.
The game contents are relevant to my interests.
It is clear to me how the contents of the game are related to the course.
This game is an adequate teaching method for this course.
I prefer learning with this game to learning through other ways (e.g. other teaching methods).

Table A.3.: Questions used in the second questionnaire [61]

B. Figures

Figure B.1.: Augmentation of Bucks Row

Figure B.2.: Augmentation of Bucks Row as seen by the user

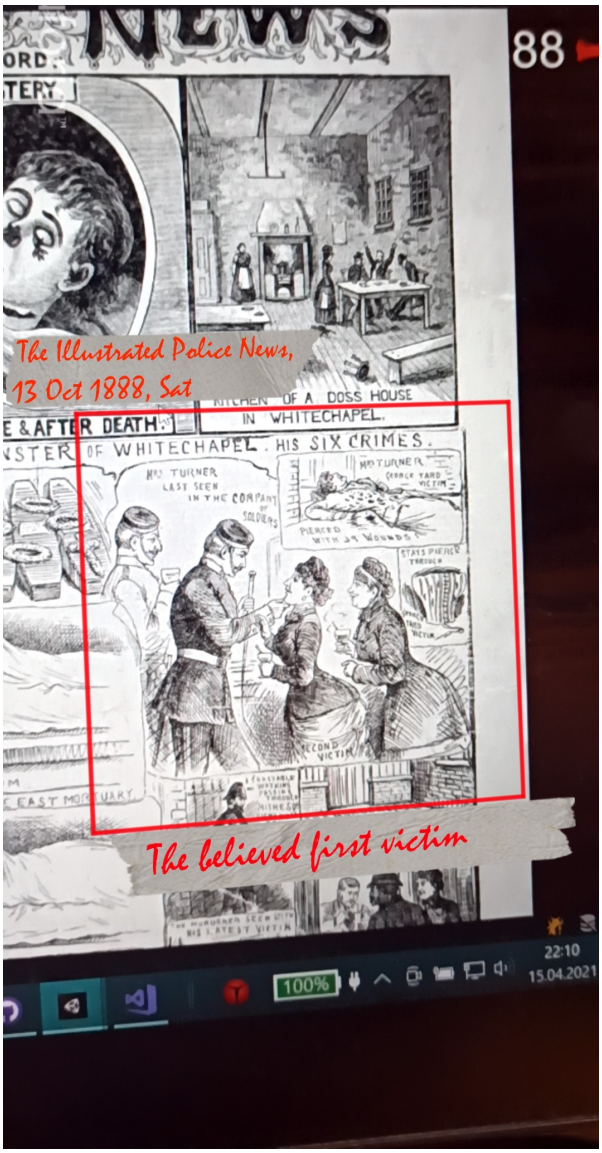

Figure B.3.: Newspaper augmentation

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