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Game Development: Gimmie Chocolate

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Chapter 1

Introduction

The project undertaken was to develop a 2D platform adventure game in Unity and research relevant topics about gaming.
The game development aspect of the project involved the use of the programming language C#, the cross-programming game engine Unity, and the integrated development environment Visual Studio 2019.

Project objectives:
- Design and develop a 2D platform game in Unity.
- Research how to develop multiplayer games and attempt to make a multiplayer mini-game within the main game.
- Implement saving state of the game.
- Build upon existing game development knowledge to better understand how games can be created.
- Research topics such as gaming addiction, state of the art in gaming, and women in games.
- Produce a literature review on researched topics.

This dissertation includes the following sections: Methodologies used in research and development for the project, a literature review that summarises the research conducted for the project, an explanation of the game's system design and architecture, and a critical analysis of the project against the project objectives. A conclusion at the end summarises the project. The links to the GitHub repositories for this project can be found in the appendices A and B.

Chapter 2

Methodology

2.1 Research Methodology

At the beginning of the project, the idea of creating a game was established, however the type of game to be developed was yet to be defined.

In order to decide what genre of game would be chosen, research was conducted on the types of games within the gaming industry. This turned out to be a broad topic, with over 30 different genres of game on the market. The wide range includes games such as puzzlers, Role-Playing Games (RPGs), Shooters (FPS & TPS), Platformers and Real-Time Strategy (RTS).

During research information on game types was gathered. The developer considered and evaluated each genre of game and decided that a platformer style genre was the best option for the project. Some popular platform games include those from the super mario series and crash bandicoot series.

Game creation was a relatively new concept to the developer, therefore the developer chose a game genre that was challenging but also piqued their interest.

In addition to game development, a literature review was conducted.
While researching, the topic of gaming addictions appeared several times in articles, journals and websites. This disorder has only been recently diagnosed by the World Health Organisation (WHO) and became a subject of deep interest. It was therefore decided that for the literature review portion of the project, gaming addictions would be explored.

The newest gaming technology needed to be investigated in the literature review.

In order to develop a game, knowing what is current on the market and understanding the most popular, cutting-edge technology is essential.
Many interesting discoveries in relation to the future of gaming were unearthed during research.

While deciding on the details of the game, analysis of protagonists in video games lead to the discovery that women are underrepresented and misrepresented within the gaming industry. As a female developer, it felt important to take inclusivity into account for the game being developed. Therefore the topic of women in gaming was chosen as a significant area of research. It also encouraged the developer to include a female protagonist for the game.

Methods for researching the topics Women in Gaming, State of the Art in Gaming, and Gaming Addiction for the thesis of the project, included analysing and criticising literature on the subject matters. Many different articles, journals, books, and websites were scrutinised. This scrutiny allowed the developer to form opinions and challenge some of the research. The developer was also able to highlight areas that have not been explored, and require more investigation.

Statistics and facts were provided that illustrated the growing problem of gaming addictions and backlash women face in the gaming industry. The statistics also emphasised modern technology trends in relation to gaming.
It was considered wise to use a variety of resources to conduct research so that bias could be avoided, and a wide range of material could be studied.

Sites such as Google Scholar and ResearchGate, as well as the ATU library database were utilised to carry out research. These resources were chosen because they are free to use and provide a range of articles that aided the formation of the thesis. These research platforms are also reliable, recognised platforms for genuine studies and were recommended for use by the project supervisor and other lecturers.

At the beginning of the project, keywords and phrases were brainstormed that could be used to find relevant research. The keywords such as "state of the art in gaming", "misrepresentation of women in games", and "gaming addiction" were entered into search engines on the research platforms. Then journal articles and conference papers were selected after reading the abstract and confirming the paper was well-written and relevant.

2.2 Development Methodology

The development portion of the project began by first designing the game on paper. Features of the game were decided along with a story-line to give the game context.
Levels were mapped out in a similar fashion to a story board, to help prepare a basic idea of what they would look like in-game.

The supermario series features pipes that teleport a player to a different point in a level. This inspired a secret level concept within the game, and was used to make the game more exciting. The secret level provides an opportunity to score extra points.

Assets from the Unity asset store such as sprites and audio, along with online images, were gathered for the game's graphics. These components were necessary to make a more eye-catching and engaging game. It was decided that free assets would be used because they were more accessible and allowed for free development.

It was important to think about coding methodologies before development began. When developing on a larger scale, a key principal is keeping code clean, maintainable and concise.
Coding conventions such as properly named variables, commenting code and reusability of code were taken into consideration. It is good practise to follow the protocols mentioned. Utilising them contributed to becoming a better developer.

Using folders to keep organised within Unity's editor helped group all elements of the game in a cohesive way. Keeping scripts, sprites, audio, and other components of the game separate from each other allowed easy maintenance of the project, so the components mentioned could be quickly located throughout development.

The original game included a multiplayer element which was to be featured as a mini-game. Two players would take on small game quests together and work as a team to achieve fun and exciting goals. Making a multiplayer mini game meant development of single player and multiplayer games could be learned.
It also allowed for a back-up solution of a single player game if the multiplayer idea failed.
Coding a mini-game within the overall game was a new challenge that had never been taken on by the developer before.

Multiplayer tools were researched and Mirror Networking was selected for use

with multiplayer elements. This tool was chosen because many resources were available for troubleshooting if problems occurred. Other multiplayer network options that were considered included Unity's Netcode for GameObjects and Photon.

Testing is an important part of software development. Most of the tests conducted were unit tests. The coded elements were broken down into small tasks to make them more achievable and less daunting, for example player movement, damage to player from enemies, enemy movement, scoring, saving player position, saving player score, etc.

After each section of code was completed, it was tested to ensure it worked as intended. In addition to this, new components were tested to check new functionality did not affect existing code.

Most of the testing was done by running the game within the Unity editor and inspecting to see if the code worked properly with the game elements. The Unity console was used for simple debugging tasks.

At the beginning of the project a GitHub repository was created so that all work related to the dissertation could be uploaded and stored for convenience. The repository also served as a back-up of files in case they were lost or damaged.

The development methodology used was helpful in keeping the project organised and creating a starting point for coding the game. Planning out how the game would look and operate was essential because it allowed the developer to envision the game, and get a sense of the end result. Having guidelines to follow ensured the overall success of the project. The methodology for development mimicked a real-world scenario, preparing the developer for future game-related projects in industry.

Chapter 3

Literature Review

This literature review portion critically assesses beliefs about women in gaming, and provides perspectives on feminist issues in video game play. There is a discussion about the latest gaming concepts within the metaverse and cloud services . Technology trends in Virtual Reality (VR) and Augmented Reality (AR) that are transforming the rapidly growing gaming industry are explored. Recently Gaming Disorder (GD) has been recognised as a diagnosable condition by the World Health Organisation (WHO). The effects of pre-existing mental conditions in relation to GD are talked about. Factors that may contribute to the development of GD are also elaborated upon.

3.1 Women in Gaming

In recent years the gaming industry has expanded to include a diverse range of players. The typical profile of a gamer is a white male. However the demand for inclusivity within video games has attracted more people of colour, those who identify within the LGBTQ community, and women to play games and break into the industry.[1]

There exists a culture of misogyny within the gaming industry and many people experience various forms of abuse when trying to enjoy online video games. Women in particular have to endure sexual harassment and sexist remarks during multiplayer, team-based games. [1, 2]

In 2020 over 70 people from the gaming industry – the majority being women, detailed allegations of gender-based discrimination, harassment and sexual assault. Their experiences were shared through social media platforms including

Twitter, YouTube, Twitch and TwitLonger.[1, 3] The accused were various high-profile men in gaming, including streamers, YouTubers, game developers and talent managers.[1]

One woman who lead development for the video game Overwatch shared how the CEO, Omeed Dariani, of talent management agency Online Performers Group had acted inappropriately towards her and propositioned her for sexual acts.[1, 4] This lead to the CEO stepping down from his position, after he made a statement admitting to the allegations.[1] Other CEO's of major gaming companies, such as Riot Games and Activision have also faced accusations of a similar nature within their workplace. The allegations include sexual misconduct towards women and failure to act upon sexual harassment claims.[5, 6]

One streamer noted how sexual misconduct and abuse in gaming goes beyond a sole perpetrator or company, and that when many people speak up about their experiences, it shows there is "a problem with the industry".[1]
75.9% of women who play shooting games experienced some form of verbal harassment from teammates.[7]

In the past, gaming companies and social platforms for gaming have shown complacency and reluctance when dealing with the issues of misconduct through online video game playing. Allegations have not been addressed in favour of keeping peace with the typical profile of gamers.This was demonstrated during GamerGate.[1, 8]

GamerGate was a misogynistic online harassment campaign and a right-wing backlash against feminism, diversity and progressivism in video game culture.[9] The hashtag #Gamergate was used to spread online violence and misconduct between 2014-2015.
Despite an influx in the amount of female gamers, the trend of bullying and abusing them simply because they are female, demonstrated how a female presence in the gaming industry was not welcomed by all.[7, 10]

Women within the gaming industry, such as developers and those who were vocal about the misrepresentation of women in video games, faced hostility from other gamers. Women were doxed and sent rape, and death threats, leading many of them to leave the industry.[8] Some women were terrorised to the point of fleeing their residence after extremely violent and specific threats arrived at their addresses.[8, 10] Some gamers who tried to protect those who were targeted, also endured attacks from online trolls.[8, 9]

In response to GamerGate, social platforms did nothing to moderate the harassment.[8, 2] Free-speech policies on platforms such as Reddit, Twitter and Facebook lead to support of GamerGate attacks and subforums.[2] Despite Twitter allowing victims of abuse to block their attackers, the platform did not take any measures to state that harassment type behaviour was not welcome on their platform.[2] YouTube and Facebook made zero efforts to police pro-GamerGate content or recognise the violence behind it.[2]

Women experience discrimination based on the types of games they play. They are often assumed to not be interested in playing male-dominated games like first-person shooters(FPS), which usually contain elements of combat and war. Traits associated with masculinity, such as power and toughness are central to FPS video games.
It may be the case that for some men playing FPS games, the traits mentioned feed into their belief of women being less than men. This behaviour fosters an inequal environment between male and female players. This in turn may be partly why abuse towards female players is so frequently and openly conveyed. If a male player feels untouchable, they might believe they can do or say anything with little to no consequences.

92% of internet users agree that the online environment makes it easier to be critical of others.[7] Players may also bring their existing misconceptions about gender roles from the outside world, into the game world. Some people have a view of women appearing less competent in comparison to men, which can bring about hostile behaviour.

Women may not have an understanding of the types of games available to play due to assumptions that they will not have an interest in certain game genres. For example, it is believed that women dislike shooting games because they want to avoid direct competition.[11]
However this is simply a stereotype placed upon women by society, and not necessarily a fact for every woman's preference when gaming. Women may actually feel empowered by FPS games and be enticed to try them.
Playing a game that is against gender norms for a woman, provides a path for women to prove themselves and show that they are adequate gamers.

Exploring the subject of whether gaming is a source of empowerment for women, or if it is a space that perpetuates sexism, misogyny and negative feminine stereotypes found that 79.4% of female FPS game players did in fact feel empowered when playing. [7] These players also faced discrimination and bullying.[7]

Some women have reported feeling empowered when they play as a male character. Suppression they normally endure in the outside world, due to lack of equality and their gender, relaxed when they experienced playing with a male avatar.[3]

When a female player uses a microphone to communicate with their teammates in a multiplayer battle, they often are greeted with a barrage of misogynistic comments. This is unavoidable for the most part as a woman's voice gives away her identity.

Women face blame for their team's poor performance if victory is not achieved. The loss is piled upon the female player(s) because they are stereotyped as weaker than men and not categorised as real gamers.

Some players opt out of using voice chat technology in order to avoid being harassed, and in fear of attracting abuse from male players. The female voice feature in the game Halo 3 receives three times as many derogatory comments as the male voice, as well as more questions and messages.[3]

It has been said that both men and women can be bad at playing games. However when it comes to judging the performance of a female player, she is deemed bad at playing because she is a woman, not because she is unskilled. Men do not have this problem.[3] Women are sometimes expected to play games in an advanced manner to earn the approval of their male teammates, at times needing to outplay the rest of their team to be respected in the gaming environment.[3]

Violence against women is a common theme when it comes to online gaming. In some cases the online harassment can take a step further and women are stalked by other players they encounter online. The Violence Against Women Act illegalised cyberstalking in 2006.[2]
Despite this, one in four women report being stalked and sexually harassed online. They also are met with difficulty when complaining to law enforcement, as they are not taken seriously.[2, 10]

During gameplay, women may experience harassment in the form of unsolicited flirtation.[10, 3] It is assumed that because a player is a woman, she has joined a game looking for a romantic relation with male gamers.[3] However most women do not play video games in order to attract male attention, or because they have any interest in forming relationships with men who play video games. This type of objectification is an experience that many women must put up with when gaming.[3]

Another form of sexism and prejudice in games occurs in role-playing games (RPG). Some male players view female players as delicate, fragile and dainty.[7, 3] Due to this image of women in RPG's, male players will gift them items that may help their performance within the game. This implies that the female player may not be up to par, without special power ups, etc.[7] It is also a form of unwanted attention because the female player has not asked for extra help, or indicated in any way that she is okay with receiving the items gifted to her. To avoid conflict and keep peace within the game world, many women accept the gifts despite not wanting them.

Usually when women identify as someone who plays video games, they are referred to as "girl gamers" rather than being labelled a "gamer" like their male counterparts.
The term "girl gamer" can be viewed in a sexist light, as female video game players are being segregated under a different, unnecessary term. Perhaps this is because people do not view women who play games to be equal to men who play games. It also shows that someone who is a "gamer" is automatically presumed to be male.[3] "girl" is a term used for female children or adolescents. Not all females who play games are children. Including the term "girl" in relation to female gamers, emphasises the fact that women who play games are seen as weaker and less capable. It may be seen as a way of infantilising women.

During childhood girls have reported that game consoles were purchased for their male siblings, or placed in their brother's room, giving them less access to play games, while also re-enforcing the stereotype that gaming is only for men.[11]
From early ages, girls are encouraged to engage in nurturing types of activities, while boys play aggressive and competitive games.[11, 12]It can be said that girls feel discouraged to play video games because it is not an activity that they are introduced to.

Paying continuous attention to which games should be played based upon a person's gender, contributes to the marginalisation of female gamers. It forces certain narratives in relation to the video games women should be allowed to play or are expected to engage with.[11]

Gaming is often targeted towards men, with many video games including content that appeals to male fantasies.[12] Women may feel uncomfortable with these designs and be conscious that certain games are not meant for them, or they are not supposed to play them. This is especially the case for games that sexualise

women and create unrealistic female characters.

Sports games such as the EA FIFA series target a male audience. Football is dominated by men, with all-female teams being less popular.
The FIFA series, coined as the best-selling sports game in the world, only included women athletes from the FIFA 16 series of the game, released in 2015. The first ever FIFA game was released in 1993. The first and only woman to appear on the cover of the game was in 2023.[13]
The inclusion of female characters in FIFA games occurring in the late 2010's, highlights the lack of representation of women in games, as it took 22 years for them to be included in the FIFA series. It also underlines the idea that women and girls may not enjoy playing a video game if they cannot visualise themselves within the game. The notion that gaming is only for boys is also strengthened by the prolonged absence of female characters.
The representation of women within games is often misleading and inaccurate. Visual portrayals of female characters are presented by overtly sexualised body types, and unrealistic images that do not depict the appearance of the majority of women.[7] Women are also underrepresented, with few protagonists of video games being female.

It can be argued that in a male-dominated industry, male game developers are designing characters that fit their preferred stereotype of women, instead of creating a realistic character that all women can enjoy playing the role of.

Research indicates virtual avatars of women are quixotic, salacious and inaccurate representations.[14]
One study found that hypersexualised female characters can contribute to the male perception of women as objects, fuelling negative female stereotypes.[15] It was also discovered that when women play as these types of characters, they become more conscious of their own body and have more body-related thoughts.[15, 14]
Sexualised avatars produce more self-objectification compared to non-sexualised avatars.[14] This may be a factor that could damage self-esteem.

3.2 State of the Art in Gaming

As gaming has become more popular, new technologies are being readily developed to enhance the way games are played. Virtual Reality (VR), Augmented Reality(AR) and Cloud Based Gaming have been introduced into the gaming industry, propelling the gaming experience into a new world of fascinating possibilities.

3.2.1 Virtual Reality

Virtual Reality (VR) provides a three-dimensional environment to gamers, letting them enjoy an immersive experience of a game. To achieve this, gadgets such as headsets, glasses and bodysuits are combined with stereoscopic displays, motion tracking, and software to enable users to interact and explore virtual surroundings.[16]

Applying simulation techniques that immerse users into virtual worlds, deceives the human senses. This means perceptual cues sent to the brain are aligned with the virtual reality.[16] The cues can be acoustic, visual, haptic, smell and motion stimuli.[16] This highly-stimulating experience has transformed entertainment provided by games, increasing the appeal of gaming to make it more fascinating and interesting.[17, 18]

The demand for VR has soared in recent years. It's allure is driven by the use of advanced VR hardware by those who want a taste of the entrancement this technology provides, or are looking for the latest accessories and new ways to play video games. VR provides an exceptional way to bring players into the heart of a game, letting them take the physical role of a protagonist.[16] This delivers an unforgettable gaming escapade.

Playing games with VR equipment versus playing them on a computer monitor has been proven to appeal more to gamers.[19] VR created a better, more captivating experience, with results stating that VR improved the following qualities of gameplay: sound, graphics, enjoyment, creativity, engrossment and overall satisfaction.[19]

VR gaming is not only limited to games that are playable for fun or leisure time. A category of gaming called serious games implements VR technology. Serious games help individuals learn or train through gaming.[16]

Research suggested that patients who endure repetitive and intensive rehabilitation processes for upper limb strokes, can find motivation and feel engaged, by playing video games that are designed to include exercises that may help in recovery.[20]

Using serious games to teach about different cultures utilises VR to create virtual experiences that help others learn about cultural heritage in a special, engag-

ing way. Historic sites, buildings, monuments, and famous art can be replicated through VR for people to observe and feel as though they are brought back in time to experience different cultures.[16, 21]
Simulations of past events, such as battles, may appeal to younger audiences who enjoy battle games.[21] VR creates an opportunity for this type of adventurous and engaging learning.

New companies that enter the gaming market are bringing with them, state of the art technologies and ideas that have never been seen before. Their innovative software and content offerings are contributing to the ever-growing market for VR. The VR market has been predicted to grow up to USD 53.44 billion by 2028.[17]

The recent prominence of VR is partly attributed to equipment for VR gaming becoming more affordable.[22]
Possibilities of cloud VR may also increase the adoption of this style of gaming.[22]
Some of the most well known and popular VR games include: Arizona Sunshine, Batman: Arkham VR, Half-Life: Alyx and Horizon: call of the mountain.

3.2.2 Augmented Reality

Augmented Reality (AR) combines computer-generated content with real world scenarios, to create an interactive experience. Information can be provided to users, or their environment can be altered visually to include 3D digital components within their surroundings. AR content can include visual, auditory, haptic, somatosensory and olfactory stimuli.[23]

Gaming has been the primary focus of Augmented Reality, however AR has the ability to improve all aspects of living, by making life simpler, more enjoyable and entertaining.[24] Devices such as smartphones or glasses can be used to deliver an AR experience. The most common uses of AR are currently seen in car Heads-Up-Displays (HUD), google glasses and smartphone games, such as Pokémon Go.[23]

AR technology uses hardware components that are usually found within mobile devices, such as processors, sensors, display, and Global Positioning Systems (GPS).[23] This has made AR more accessible to users, leading to the inclusion of AR in everyday life with the expansion of new technologies.

Applications use 3D programming to bring animation and digital information from the computer program to AR markers in the real world. If an AR application receives information from an AR marker, it executes code and produces the correct

image for the user to see.[23]

AR and VR are similar technologies. Using software VR transports the user into a virtual world, immersing them into a completely artificial, stimulated environment. AR on the other hand, mixes reality with virtual elements, mapping virtual information into a user's current setting.[24, 23]
Often AR and VR can be combined to achieve a specific goal and overall experience for a user.

The use of AR within the gaming industry has proven to be popular and a success. Gamers say the AR technology in video games is more thrilling and engaging.[24] Enhancing games with AR delivers an unimaginably creative gaming experience that is unforgettable. AR is considered to be a big part of the future of gaming, redefining traditional games as we know them.[25]

One of the latest trends in the gaming industry uses AR to create location-based gaming.[24] Users are encouraged to explore their surroundings and travel to new locations, where they can collect items within a game, or unlock special in-game privileges. This unique experience expands from non-AR games that are limited to a single screen.[24] It encourages people to go outside and meet others in person, who are also playing. Location-based AR games are a more enriching gaming experience, enhancing the traditional games players are used to.

Pokémon Go is a location-based mobile application that uses GPS and digital compass technology that detects a user's position. Objects in the real world are then incorporated with AR generated objects. A player can find various different Pokémon characters and capture them, depending on their location.[24]

The popular social media platform Snapchat uses AR in the filters offered to users. Snapchat utilises AR with markers. Markers are based on image recognition.[24] Black and white markers detect an augmented object. When a user points their camera at a recognised marker, embedded digital content is displayed. Images are coded into the system beforehand which makes them easier to detect.[24]
The figure below represents the framework for AR in mobile games.[24]

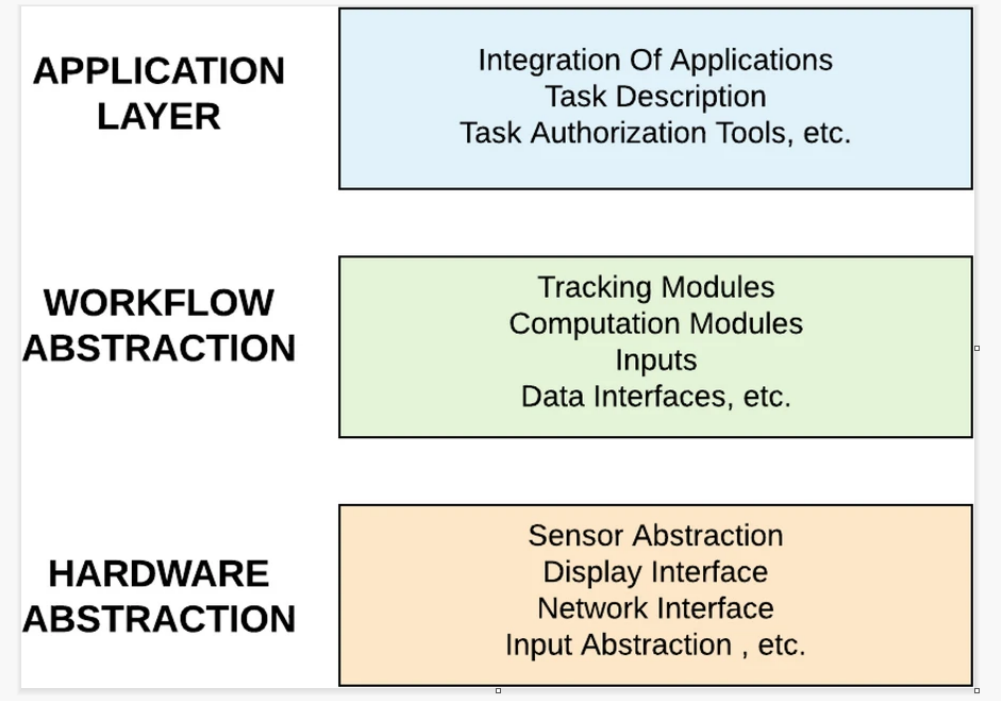

Figure 3.1: Framework for AR in mobile games.

To program AR applications the following software can be used by developers: Unity, Vuforia, ARToolKit, Google ARCore, Android Studio, and AR Spark Studio. The most popular software to use for AR is Unity.[24] AR gaming allows for collaboration and development of relationships through multiplayer games.[26] Many kinds of scenarios are possible with AR gaming as numerous designs, virtual opponents and models are available for creation.

Pervasive gaming is a genre of gaming where the player's experience extends into the physical world. AR technology makes this possible. One mobile games company described pervasive games as those that "surround you".[27] A main goal of pervasive games is to develop applications that are context-aware and analyse information from the environment.
It was found that physical, pervasive games are much more enjoyable and users prefer tangible interactions compared to using a keyboard to play a game.[28]

AR can also be applied to serious games. A case study investigated the benefits of serious AR games. The results of the case study suggested that AR interactions are generally preferred over traditional video games. Compared to video games, AR games are easier to learn with and adapt to. Within the case study, an AR puzzle game ended up being a very effective learning resource.[24] A game that

mixes the real world with augmented objects creates excitement and fun, leading to a higher potential for a successful educative experience.[24, 29]

According to nine studies, the use of AR games in education boosts learning performance and increases student motivation and enjoyment by 58% and 10% respectively.[24]

Based on reports by imarc group, the global AR gaming market will see a growth from $6.39 billion in 2021 to $38.03 billion in 2027.[30]
Current AR games that have attracted large audiences include Angry Birds AR: Isle of Pigs, Five Nights at Freddy's AR, and Harry Potter: Wizards Unite.

3.2.3 Cloud-Based Gaming

Cloud computing has facilitated revolutionary changes in networks and the remote utilisation of resources. In relation to gaming, cloud computing has modernised the way classic games are played. Traditionally a PC or console is needed to play video games.

As the gaming industry is progressing and becoming more competitive, companies are discovering ways to improve gaming and boost user experience. Achieving this can be done by issuing design and content upgrades to include superior graphics and new gameplay scenarios.[22]

To keep up with the new changes, consoles and computers require renewal which can become expensive. Having to buy new gaming equipment to stay within trends is unaffordable for most people. It also narrows the market of the gaming industry.

Offering video games through cloud providers eliminates hardware upgrades that might limit some players.[22] There is no longer a need to frequently purchase expensive gaming systems.

Nowadays, due to cloud based gaming, games are available online and on-demand. Users no longer need physical copies of games. They have endless selections of games to choose from that are readily available to download onto their devices. There is no need for extra hardware or software to play a game. Client-end hassle is significantly reduced. Games playable online process their content at the server. Rendered images then get transmitted to the client.[31]

Advancements in technology have turned cloud gaming into a popular concept

and it is considered a main gaming platform, along with boxed games and on-solid games.[31]

Large investments are being made to fund the development of games that can be played online.

Cloud gaming services are provided through the internet, simplifying the way video games are accessed.[31] This type of service has become an advantage for devices that do not hold a lot of computational power.[32] Running high quality games has turned into a possibility for game players that use devices which would not normally be capable of sustaining the games.

Combined developments in mobile, cloud and graphic technologies have created a path for mobile cloud gaming. Mobile users can play games that run on remote cloud servers, on their devices. This concept is termed as Gaming as a Service (GaaS). In simple terms, GaaS uses cloud technology to serve video games on demand.
A significant benefit of GaaS is that the computation is not the job of the client, which is usually a weak user device. Instead powerful cloud servers handle the computation. This helps reduce power consumption on devices and also allows for other cloud services, such as storage, to be provided.[32, 33]

The presence of smartphones worldwide ensures the likelihood of a person carrying a mobile device. Most users rely on their mobile not only for it's typical phone functionality, but also as a gaming device. Over 18% of Apple's AppStore consists of mobile games. These apps are playable due to the persistent cloud connection on mobile devices.[33]

One of the current trends in the gaming industry is transitioning video games to a mobile platform. To facilitate this, large cloud bases are being used to deliver video game content anywhere, so they can be playable at any time. All of this is happening without having to consider the limitations of a device or game requirements.[33]

When playing video games on traditional computer systems, like a home PC, game software often pushes the computer system to its limits. Mobile devices have much less power and significantly reduced running time compared to a computer desktop. Cloud based gaming allows offloading of complex processing tasks to cloud servers.[34] This means mobile devices are able to cater to gamer needs when it comes to playing popular video games on a system with reduced running

time.

Although cloud based gaming has some significant benefits, there are also some disadvantages associated with this budding technology.

Some cloud based gaming services require fees in order to enjoy their benefits. Paying money monthly is a common way in which gamers are required to experience cloud gaming. One study found that only a small number of gamers are willing to enter monthly fee plans for cloud gaming.[34] This suggests improved business models would contribute to a higher success rate for the use of cloud based gaming. The idea of monthly subscription services is not always appealing or considered beneficial when taking into consideration what is being offered for money.

Another study looked at differences between cloud gaming where clients are connected over a LAN network. This is common in cloud based gaming at home. Versus a standard game client.[34, 35] It was observed that overall quality of the gaming experience was degraded when a gamer used in-home cloud gaming clients.[34, 35] It was also discovered that highly skilled gamers find in-home cloud gaming displeasing and were unsatisfied with it.[34, 35]

The disappointment gamers experienced with in-home cloud based gaming centres around problems with low latency. This is especially the case for skilled gamers who need a smooth gaming experience to be able to play to their full potential. If latency restricts a player too much, it can cause games to feel like they are unplayable.

The key to a pleasant cloud gaming experience at home is having a reliable and stable internet speed. Users who do not have access to this will be at a disadvantage. Cloud gaming is very sensitive to network latency.[35] Gamers who play action games are more reactive to response delays.[35] This could be due to the fast-paced nature of an action game. If the game lags in any way a player is immediately hindered, which can cause frustration and dissatisfaction.

Predictions have been made for the cloud gaming market to grow rapidly. Allied Market Research reports it will grow to $21,954 million by 2030.[36]

Companies including Amazon, Nvidia, Microsoft, Sony and Google are launching their business into the cloud market and providing some of the most prominent cloud gaming services. Vortex, Boosteroid, Shadow, Amazon Luna, Nvidia

GeForce Now, and Nividia GameStream are popular cloud based gaming services.[36]

3.2.4 Metaverse

The metaverse is defined as a spatial computing platform that provides digital experiences as an alternative to, or a replica of the real world. Key aspects of civilisation such as social interactions, currency, economy, trade and property ownership are contained in the metaverse. The spatial platform is built on blockchain technology.[37]

By 2024 the metaverse is predicted to be an $800 billion market.[37] Due to it's endless potential and cutting edge technological advancements, investors such as Microsoft, Facebook, Apple and Google are heavily investing to turn the metaverse into a reality.[37, 38]

Using VR headsets, AR glasses, mobile apps and many other types of technology, the metaverse will allow limitless interactions where users can collaborate and have fun. Various scenarios will be supported, turning the metaverse into an exceptionally large-scale and dynamic system.[37]

Expectedly, the metaverse has gained traction in the gaming industry. Gaming companies have already taken advantage of the immersive metaverse world and some games are becoming popular in the metaverse.[22] Some of these games include Axie Infinity, Sandbox, Krystopia and Alien Worlds.

Synergies between the metaverse and the gaming world involve musicians holding metaverse-based concerts. Popular singer Ariana Grande held a virtual concert in collaboration with the online game Fortnite, utilising the immersive environment of the game to showcase music to her fans.[22] Over 78 million players tuned in. Popular game Roblox allows for an experience in the metaverse, where developers can create games and digital assets, which they can then trade with players.[22]

As innovative AR and VR technologies are shaping a new generation of gaming, new computing paradigms like the metaverse are becoming a reality. In the VR realm, the metaverse was introduced as the 3D internet. A vision containing a web of virtual worlds that allowed avatars to travel across them was realised in Openism's Hypergrid.[38]

Current development of the metaverse hopes to see a future where social VR platforms are compatible with multiplayer online video games, as well as open game worlds and spaces that integrate AR.[38] An example of how this idea would play

out is users meeting and interacting in virtual spaces, in the form of 3D avatars. This form of socialisation is possible, however some restrictions and limitations exist.[38]

The next frontier within the metaverse aims to combine cross-platform technology with AR and VR, to facilitate meetings with users in VR worlds and others in AR environments.[38]

Metaverse gaming faces some limitations in regard to the integration of VR and AR technology. Currently equipment for VR and AR is expensive. Despite promise for mitigation in regard to the high cost, there remains a barrier to mass adoption of gaming in the metaverse for this reason.[38]

Other concerns include levels of distraction in a user when immersed with an AR game. Accidents can occur when a user is not paying full attention to their surroundings. Players may be harmed if the game they are interacting with encourages a dangerous activity. Therefore it is important that the environment a player is in, while engaging with these applications, is considered carefully.

In relation to VR there are health concerns.[39] Users have reported experiencing motion sickness, nausea and dizziness when immersed for long periods of time, in virtual worlds. Some VR equipment can be heavy in weight, risking body fatigue in users who exercise headsets and glasses for extensive amounts of time.

Uncontrolled gaming can lead to excessive hours spent using VR equipment, especially since it allows for such captivating gameplay. There is a risk of developing an addiction to gaming if significant abstinence from the physical world is endured.[38, 39]

3.3 Gaming Addiction

In 2018 the World Health Organisation (WHO) declared Gaming Disorder (GD) as an addictive behaviour. In the 11th revision of the International Classification of Diseases (ICD-11), GD is defined as a pattern of digital or video gaming behaviour characterised by impaired control over gaming. A gaming addiction is diagnosed when a pattern of behaviour is formed for at least 12 months that results in severe dysfunction in personal, family, social, educational or occupational relationships.[40] Gaming takes precedence over other interests and daily activities, and time spent gaming continues or escalates despite the negative effects it

may cause.

There is a correlation between existing mental disorders and GD. Symptoms of GD such as social withdrawal and loss of interest in daily activities are also behaviours seen in individuals who suffer from mental health conditions, like anxiety and depression.[41] Therefore it can be interpreted that individuals who have pre-existing mental disorders are more likely to develop a gaming disorder.

The relationship between a person and a custom avatar they create within a video game, can lead to GD.[42] Low self-esteem, brought about by anxiety and/or depression can make a person more likely to become significantly attached to their online avatar.

Providing the ability to customise an in-game character allows an individual to deviate from their actual appearance, and represent themselves in an entirely different light to reality. Instead of reflecting a true image, some individuals opt to depict their appearance in styles they prefer, or would not usually express in a real life scenario.

Some people may find it easier to socialise and make online friends with a different appearance. If the individual prefers the way they look in-game and the social opportunities that their online appearance enables, they are inclined to not want to spend time away from the life they create with their avatar. This style of attachment to an avatar has shown negative associations with social skills and positive associations with depression.[42] This behaviour and attachment act as precursors to an addiction to gaming. They highlight ways in which avatar customisation affects individuals who suffer with image issues.

During the investigation between avatar customisation and gamers with low self-esteem, inclusivity was not explored. Lack of diversity in regard to avatar customisation may be a negative contributor to a player's self-esteem.

When customising an avatar, if there is a lack of playable female characters or certain body types, skin colours and textures, some players may feel underrepresented. Particular physical attributes, such as acne, dark skin tones or the option to include scars on a character, are not included because they are deemed unattractive.

Female characters are often misrepresented, mimicking unrealistic ideals due to narrow beauty stereotypes that exist in society for women. 35% of women and

girls feel the lack of diversity in avatars negatively impacts their self-esteem.[43]

While some individuals choose to falsely represent themselves, others who do not do this can gain pessimistic views on their body image, if they are unable to create a true representation of their appearance within a game. Not feeling good enough damages a person's self esteem, causing negative thoughts that contribute to them feeling unattractive. This type of psychological turmoil can be the onset of development of a gaming disorder.

Overtime depression can escalate, leading an individual to engage in addictive behaviours that are associated with GD. Sufferers of severe depression and anxiety often turn their back on the real world and are more likely to socialise through online platforms, such as video games, in order to meet their basic needs. This type of overuse of online games risks the development of GD.[44]

Adolescents are more at harm of developing GD than adults. This is because an adolescent brain is not fully matured and they lack the ability to regulate their emotions and self-control.[44] Monitoring the time spent gaming can be difficult for adolescents, leading to long hours spent engrossed in online games.[44] The more time spent gaming, the more likely one is to become addicted to it.

Emotional stress in young adults, caused by various different factors, such as school assignment deadlines and examinations, has a high association with GD. Gaming provides a means of escape for some people, allowing them relief from the distress of their daily life.

The idea that adolescents find relief from negative emotions through gaming, is solidified by a study that showed online gaming has a positive effect on relieving stress, and can be psychologically beneficial to a certain extent.[45] The more time an individual spends playing games to alleviate stress, the more likely they are to demonstrate addictive behaviours in relation to GD.[45]

Children now grow up with technology such as computers and tablets being used for educational purposes. Interactive games can be used at home and in school to help children learn fundamental concepts necessary for their development. Frequent use of online platforms and lack of screen time supervision could make children addicted to the internet, providing a pathway that starts GD.[7]

GD affects 1.96% of the global population according to a study conducted in 2020. Research has stated it is more common in males than females.[41] This indicates

that the worldwide rate of gaming disorder is low, affecting a small percentage of the global population. However gaming addictions are a newly established disorder that requires more research.[41]

The trends in development of state-of-the-art technology, like VR, AR, cloud-services and the Metaverse will encourage more internet use. The internet and online games will become more available as technology advances. Gaming will evolve and be taken to new levels through the creation of equipment that will provide impressive and unforgettable immersion in virtual worlds. The inevitable growth of technology speculates that a higher number of people will suffer from GD.

Chapter 4

System Design

The system of the game was designed to be simplistic and understandable. This was achieved by reducing code dependencies and organising the project in a cohesive manner. Avoiding writing excessive lines of code for each piece of functionality made the system easier to comprehend, and helped prevent confusion as development progressed.

4.1 Unity Hierarchy

Within the Unity editor, there is a Hierarchy window that displays every GameObject contained within a scene. The GameObjects range from things such as models, to cameras and prefabs. GameObjects are the base class for all objects in a scene. (The figure below describes how all of the objects within the game are derived from GameObjects.)

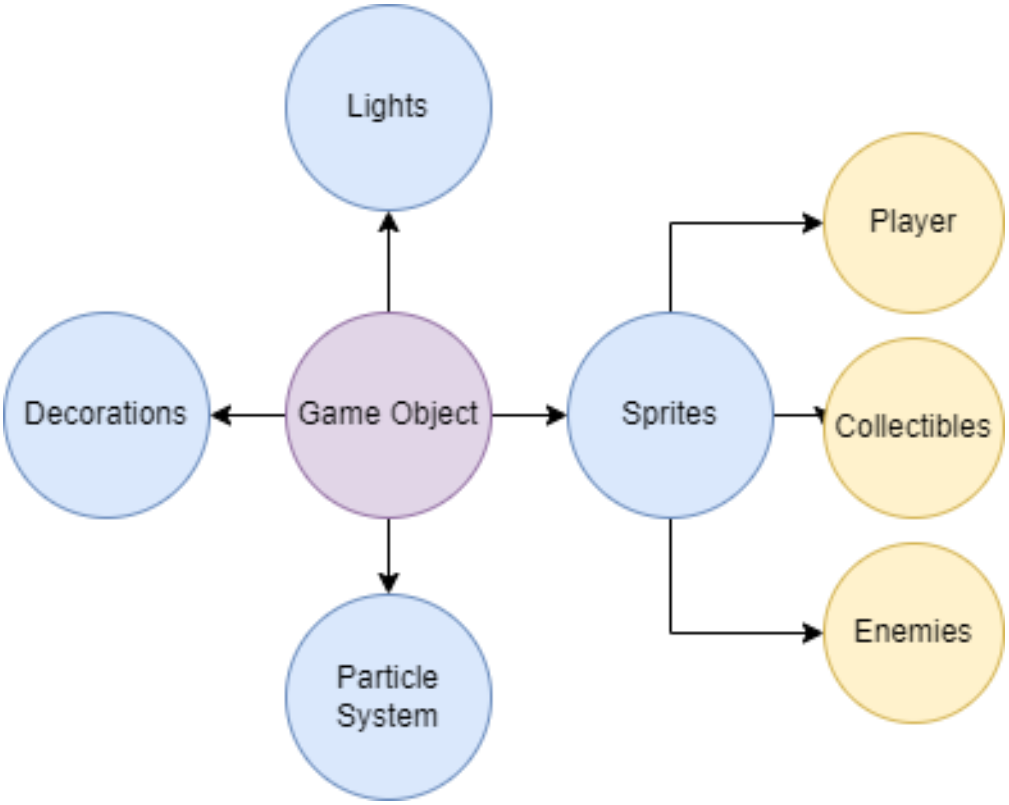

Figure 4.1: all objects are derived from GameObjects

The Hierarchy window was utilised to sort the GameObjects into groups, depending on their role in a particular scene.

Within the Hierarchy the GameObjects were categorised into sub-sections such as: Canvas elements, Scene decorations, Background/Terrain, Enemies, Player, Collectible Items, Camera.

Organising the GameObjects like this helped to keep them in order, so they could easily be located within the Hierarchy. It also reduced clutter within the Hierarchy as the sub-sections could be collapsed and expanded to hide or view the necessary components of the game.

4.2 Components & Tags

To make the GameObjects functional, components were added to them. Components include physics related elements such as rigid body and colliders, particle

systems, and scripts to assign code.

Tags and sorting layers were attached to GameObjects so they could be referenced within scripts that contained code for the game.

Specifically, enemies, collectibles and the player character utilised tags. The tags provided an easy way to access certain GameObjects within the code, allowing actions to be performed based on choices made within the game. For example, when the player collides with a GameObject that has an 'Enemy' tag, code for player death will execute.

The components allowed the designer to turn the initial concept into a functioning game. They act in a similar way to the object oriented design pattern: decorator pattern. Behaviour could be added to the individual objects dynamically, without affecting the behaviour of other objects in the class.

4.3 Parent-Child Objects

Parent-child relationships can exist between GameObjects in the hierarchy. A parent can be created when any GameObject is dragged and placed on another. The GameObject that gets attached to the parent will subsequently become the child. When a parent-child relationship exists between GameObjects, the child GameObject performs it's changes relative to the parent GameObject.
Collectibles in the game are parent to the particle system, which becomes the child. This design choice was made so the collectible and particle system would be grouped together and their position easily changed during the level design stage, if necessary.

4.4 Prefabs

Some GameObjects had the potential to be reusable, for example the player, enemies and collectibles.
Unity allows the ability to store GameObjects, complete with all their components, property values and child GameObjects by using the Prefab asset system.

GameObjects that were used in multiple places in a scene or across scenes of the game, were converted to prefabs. The prefab can be considered as a template

for a particular GameObject that will be reused. Converting GameObjects to prefabs is preferable to copying and pasting, because prefabs can be edited and any changes made to them will be automatically synced across all instances of the prefab in the scene(s). This also means broad changes can be easily applied and repeated edits do not need to be made to every copy of the GameObject that gets reused.

Settings of individual prefab instances can be overridden. Altering a prefab instance in this way is usually done when a different version of a prefab is desired. This can be achieved by creating prefab variants which inherit the properties of a base prefab but have overrides which take precedence over the base values.

Within the game the collectible candy utilised prefab variants in order to create new collectibles, that shared the functionality to be collected, but used different sprite images to change their appearance.The candy available for the player to collect are chocolate and gummy bears.

Prefabs help to demonstrate the importance of code re-usability, which involves recycling existing code to perform the same function or a similar function.

4.5 File Setup

To keep the overall project in Unity organised and clean, a simple yet sophisticated file system was created.
Different folders were used to store all of the game related content. The top-level folder was the Assets folder. This folder contained several other folders for scripts, sprites, audio, fonts, animations and scenes. Separating all of the game content in this way meant that everything from art, code and audio could be located quickly. It also prevented clutter and disorder.

4.6 Input Keys

Unity has an Input Manager that enables definitions to be created for input axes and their associated actions. Key, Button or Virtual Axes controls may be used. To define the player's jumping movement control the key option was used. The key refers to any key on a keyboard, such as space or letter keys.

Physical keys can map key codes to the layout of a physical keyboard and ignore differences in letter placements on the keyboard, which may exist depending on regions that users are based in.

For example, most standard keyboards read keys "QWERTY" on the first row of letters. However on other keyboards, the first row of letters may be read as "AZERTY". Therefore if specific controls are scripted, their physical position on the keyboard will be different if the keyboard has a QWERTY or AZERTY layout.

Using physical keys means unity will map an ANSI/ISO "Qwerty" layout for the location of the keys, regardless of the actual user's keyboard layout. Specifying "Jump" will always refer to the space bar key.

Physical keys were taken into account when designing the user controls for the game. As a result, the user controls are universal and work for any keyboard layout.

4.7 Enums & Animations

To control the player animations, an animation variable was created in the PlayerMovement script. This variable was in the form of a mutually exclusive enum called AnimationState.

It is only possible for the player to be in one animation state at any time. Using AnimationState allowed for the creation of a custom type that had values only created in the enum. Developing for animations in this manner and using one variable for the animation changes, helped to keep the code clean.

The enum allowed for a finite set of values to be defined. Each state in the enum corresponded to an int value. e.g. idle = 0, running = 1, jumping = 2, death = 3.

```
private enum AnimationState { idle, running, jumping, death}
```

Figure 4.2: enum AnimationState definition

Inside the Unity editor's Animator window, which corresponds with the c# code for animating, an int parameter called 'state' was created. Under the Unity

inspector, the state parameter was assigned int values that matched with the enum created in the PlayerMovement script.

The code that handles the animations is contained within the ChangeAnimation-State function of the PlayerMovement script.

Inside the ChangeAnimationState function, a local variable of type Animation-State is defined. This value is also called 'state'. The value of the local variable is assigned depending on what animation needs to be applied to the player. e.g. moving left/right or jumping.

Only having one variable to change the animation state erased the issue of managing numerous boolean values.

```
private void ChangeAnimationState()
{
    AnimationState state;

    // change animation state.
    if (xDirection > 0f) // moving right.
    {
        state = AnimationState.running;
        sprite.flipX = false;
    }
    else if (xDirection < 0f) // moving left.
    {
        state = AnimationState.running;
        // Make character face opposite direction.
        sprite.flipX = true;
    }
    else // idle
    {
        state = AnimationState.idle;
    }

    // jump animation set seperately so the character won't run or idle in mid-air.
    if(rb.velocity.y > 0.1f)
    {
        state = AnimationState.jumping;
    }
```

Figure 4.3: Changing the animation state in ChangeAnimationState function.

At the end of the function, the local variable is passed into SetInteger(). This piece of code sets the value of the int 'state' from the Unity animator, to the value of the enum.

In order for the animator to use the enum value, the enum is cast to an int. This is necessary because unity does not know about the AnimationState enum.

Casting the enum to it's corresponding integer value allowed the unity animator to use the enum value. The enum is called one time, at the end of the ChangeAnimationState function to prevent repeating code and syntax errors.

```
// cast enum to int so it can be used by animator.
animator.SetInteger("state",(int)state);
```

Figure 4.4: Cast enum to integer value.

Example using idle state:

- - Set the condition for 'state' in the unity inspector to equal 0.
- - 0 is the enum value for idle.

4.8 Serializable Fields

While developing the game, some private fields within the scripts were defined with SerializeField attributes. Adding this attribute made the fields accessible within the Unity inspector. Accessing fields in the inspector let their values be changed for convenient testing at application run-time.

Various fields accept the SerializeField attribute, including: classes that inherit from UnityEngine.Object (GameObject, Component, MonoBehaviour, etc), built in types (Vector2, Vector3, LayerMask, etc) and basic data types (int, float, bool, etc).

Hard-coded values were not implemented throughout development for the game because they were not suitable for this project. Using variables to define int/float/string/bool values made the code more legible and allowed for any values to be easily changed when they were used multiple times within a script. For example, changing the speed of a GameObject in a scene or when referencing the index of an array.

4.9 Leaderboard

In order to make the game competitive, leaderboard functionality was included. The leaderboard stores a player's high score and displays it in a list on screen, with other high scores. A total of 5 scores can be seen at once. They are listed in order of lowest to highest.

Creating the leaderboard involved an online creator tool.[46] The online leaderboard stores information sent to it within a cloud database. Various methods can be used within c# code to access the stored information.

A public key is generated when the leaderboard is created. The public key maps to specific stored data within the cloud database. To ensure the stored data for high scores of the game could be easily obtained, the public key was held within a variable in the leaderboard script. It was important to store the public key within a variable so that it could not be altered by mistake, as the public key was a long encryption.

References to the scores earned in the game are contained in a Text Mesh Pro (TMP) list. This is the only way to reference text from the unity editor in a c# script.

'LeaderboardCreator.GetLeaderboard' is a call back function, viewable in the Leaderboard script. This function is called whenever a GET request for the leaderboard is completed.

'GetLeaderboard' returns a value that can be accessed in the 'msg' function.
The 'msg' function was developed to use a for loop which sets text elements, namely the player's username and their score, from the TMP list to the names and scores on the generated leaderboard.
If any empty values exist in the TMP list, they are replaced with values from the leaderboard that is fetched. If the leaderboard is already populated with entries, they are displayed to the user.

'SetLeaderboardEntry' takes parameters for string username and int score. This method is linked to the submit button displayed on the leaderboard screen of the game.

'LeaderboardCreator.UploadNewEntry' is used to upload brand new entries to the leaderboard. HTTP SET methods are utilised by 'UploadNewEntry'.

For the leaderboard to work properly, a LeaderboardManager GameObject handles correspondence between leaderboard scripts and the relative GameObjects. When the leaderboard scripts were attached to the LeaderboardManager, TMP text elements and buttons could use scripted functionality.

A unity event that accepted string and int as input was used to invoke functionality to submit a score to the leaderboard:
'SubmitScoreEvent.Invoke' obtained a reference to the input username and score. Then once the submit button is clicked, the event is called. This is possible because the leaderboard is listening for the event.

Using an event permitted communication with the leaderboard without having a direct reference to it. This reduced dependencies between components so null references could be avoided, aligning with the design decision to keep components loosely coupled and the code clean.

Unity OnClick events that are part of unity button functionality were used to link score scripts with coded functions. For example, When clicked, a submit button calls setLeaderboardEntry. Utilising these features offered by unity granted dynamic passing of the player's username and score.

A call to GetLeaderboard in made within the Start function of the Leaderboard script. Doing this populates the leaderboard with all entries from the cloud so that previous scores are displayed whenever the game is loaded.

4.10 Saving state: Save, Load, Create game

The state of the game can be saved. Specifically the player's position and their high score may be saved. When the player starts a new game, quits and then opts to load their most recent game, they will be able to continue gameplay from their last point in game.

Data is saved in a file on the computer. The data is stored in a readable JSON format. Storing the data in JSON has many advantages. JSON is simple text and therefore suitable for transfer across platforms and operating systems. JSON can also be readily displayed as it is simple text.

JSON is compact and lightweight with strings being two thirds of the size of data stored in XML. As the state data is stored on the computer, it is beneficial

to keep the files on a smaller-scale.

A singleton class was created to act as a data persistence manager. The data persistence manager script keeps track of the current state of the game. It orchestrates the logic that goes into saving, loading and starting a new game.

Using a singleton creational pattern created a global access point for data persistence. The class can be accessed anywhere in the program, however it can only be modified from a single point, within the singleton class.

The singleton ensures code cannot be written to replace a previously created instance.

There is also a GameObject called DataPersistenceManager, which contains the data persistence script mentioned. This kept the unity Hierarchy clean.

An interface called IDataPersistence was implemented to save,load or create a game. When the interface is loaded references to any script that implements it are gathered and stored. Using an interface means any script in the project that needs to perform save, load or create actions simply implements the interface. Scripts can initialise whatever they need to from the saved data.
Using an interface provides a better alternative to implementing multiple inheritances. Abstraction was achieved by the use of the interface. It also preserved the loose coupling concept of the overall design of the project and helped make the code easy to Along with making our code easy to maintain.

The FileDataHandler.cs script persists data to a file outside of the game. Game data within the GameData.cs script is converted by the FileDataHandler methods into a compressed format. JSON data is also converted back into game data by this script. This is also known as serialisation and de-serialisation of data. (see figure below) Processing the data in this way maintains user-centric information within the game.

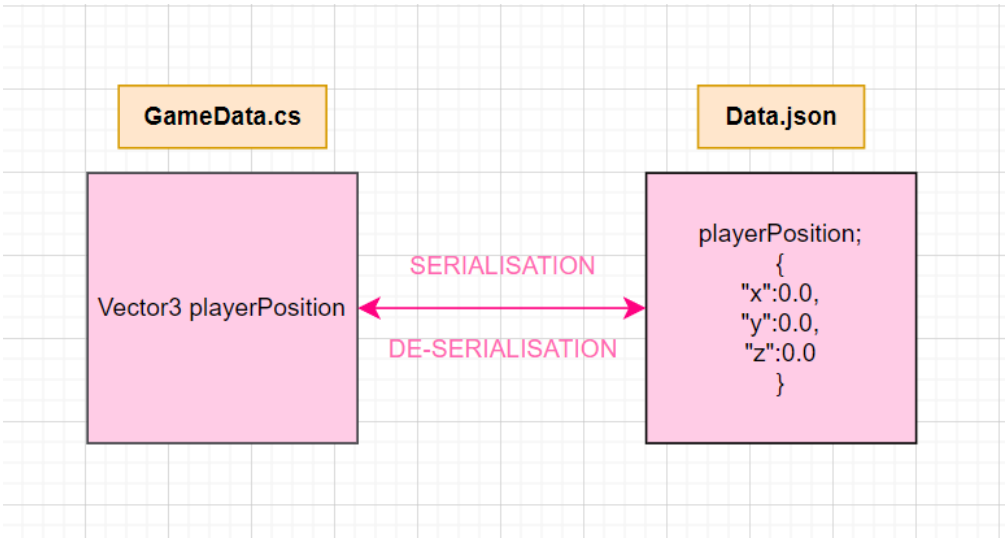

Figure 4.5: Serialisation and De-serialisation

An advantage of keeping the FileDataHandler.cs script separate is that if the method of storage is to be changed, e.g. to the cloud, A different handler can simply be written, such as a cloud handler. Most of the system would be unaffected by this change.

Example of saving the game state: When there is no saved data to load, a new game is started. This creates a new game data object.
Then, when the game is saved, the DataPersistenceManager passes the game data object by reference to each script that implements the data persistence interface. These scripts then modify the game data object and the DataPersistenceManager uses the FileDataHandler to convert game data to JSON and write it to a file.

Chapter 5

System Evaluation

The objectives of the project were as follows:
- Design and develop a 2D platform game in Unity.
- Research how to develop multiplayer games and attempt to make a multiplayer mini-game within the main game.
- Implement saving state of the game.
- Build upon existing game development knowledge to better understand how games can be created.
- Research topics such as gaming addiction, state of the art in gaming, and women in games.
- Produce a literature review on researched topics.

The majority of the goals were met and as a result, a successful project was delivered. However despite the achievements, some improvements and changes could be made to reduce weaknesses of the system.

Designing and developing a 2D platform game was a main objective of the project. This objective coincides with the third goal of building upon existing game development knowledge, to expand game development skills. A better understanding of the way the Unity editor and the c# language was achieved.The developer gained new skills such as coding a leaderboard and saving certain states of the game. The developer took time to understand what had been coded. During this project the developer's knowledge was broadened by the discovery of different ways to write code. For example there are several ways to code player movement and animate characters in the game. The developer was able to try several implementations of something, and then choose which was preferable.

Confidence was gained as game development progressed because the developer was able to become more familiar with the Unity environment and the c# lan-

guage as a whole. Building upon these skills is considered a great advantage and has made the concept of developing games an area of deeper interest. This may open doors for the future when considering career opportunities as the developer feels more encouraged when it comes to making games.

For an imaginative and easily inspired person, the task of coming up with the game concept was not difficult. Executing the ideas and implementing them was one of the biggest challenges. It is considered a significant accomplishment to have created a game that is very similar to the original idea.

Implementing the multiplayer option into the game was partially successful. However due to some issues, multiplayer was not included at all in the final version of the game.

One issue that became apparent after multiplayer was incorporated into the game, was that some asset files became corrupted. This caused errors when opening the unity project. The errors stated that certain packages were missing from the project, despite no action being taken to remove any of the packages that were mentioned in the error messages. Encountering errors in development is common and is likely to happen. Time was needed to fix the errors and debug. This particular issue was fixed by cleaning the file system of the PC. This was because there was a corruption issue with OneDrive and the Unity files. Then the Mirror networking packages were reinstalled into the project. Facing this exact problem was not expected however it was a lesson learned.

The multiplayer mini-game caused the single player mode to stop working. This happened because Mirror's NetworkIdentity component kept spawning onto the character in the game. The NetworkIdentity waits for a client to join the game before game-play can begin. Single player mode was not set-up for a client to join the game and so it made the single player version of the game impossible to play, as it would not start and continuously waited for the client to join.

In attempts to fix this problem, research was conducted and several forum posts were consulted. No relevant answers to the problem could be found. Through analysing the problem some possible solutions were explored. This included creating separate character prefabs for the different modes, and deleting the player then re-introducing it to the game. However none of these ideas worked. This problem occurred halfway through the project timeline, with more time multiplayer may have been possible. Developing multiplayer games was an entirely new concept. Ensuring the entire game worked was a priority over attempting multiplayer mode

with a limited knowledge. Many parts of the game were coded in ways where changing them to multiplayer elements would mean starting from scratch.

In hindsight, adding multiplayer from the beginning of the project may have been a better idea. In the future, more research will be conducted to explore solutions.

The option to save the state of the game was included. This fulfilled the 3rd project objective. This was challenging because the developer had no prior experience in saving game states.

The position of the player and their high score can be saved. If the game is quit, the option to play again and start a loaded game is available. Upon playing a loaded game, the character will appear in its last known position, with the highest score displayed in the top right corner of the screen.

Learning how to save game data by serialising it in JSON format to a file, was an opportunity to become familiar with serialisation and de-serialisation. Prior to making the game, this was a vague, difficult concept for the developer. However the developer achieved serialisation and de-serialisation within unity and c#.

To improve the state saving feature, the file that holds game data could have been encrypted. This was not achieved because of time constraints, however research on how to encrypt the file was carried out and it is possible.

One of the biggest strengths of the project is the loose coupling of the saving state code. Making use of interfaces and the singleton approach helped to separate the code so that, if in future, the game is converted to cloud-based gaming, the save features can be easily manipulated to facilitate the change.

The system could be strengthened by making all coded elements as independent as the saving state code. This can be revisited in future development.

Building upon existing game development knowledge was important, and a major goal for this project. Game development became an unexpected interest for the developer while learning about it during a college module. The intrigue into creating games was the driving force for the project. A better understanding of how the Unity editor works has been achieved. Confidence in game development and skills in c# and Unity have been gained.

Research during the project led to a deep insight of the gaming industry. The

main topics of study included:
- Women in Gaming
- State of the Art in Gaming
- Gaming Addiction
Research shows that women have been negatively affected by the gaming industry. Learning that women can be misrepresented and underrepresented in games led to the use of a female character within the game.

Discovering new and upcoming technology that is re-defining the gaming world was fascinating and eye-opening. Gaming is a flourishing industry that is beginning to grow in unimaginable ways. Much of the future of technology is based on equipment used for immersive games.

Gaming addictions are a newly established disorder. Learning about gaming addiction and diagnosis was very insightful. Being open about mental health is a recent occurrence and a positive trend. Investigating causes and development of a gaming addiction was very informative.

Chapter 6

Conclusion

Overall the project was a success. A 2D platform game was delivered, along with a detailed literature review on: Women in Gaming, State of the Art in Gaming and Gaming Addiction.

During the research phase of the project insight was gained about the field of study. This included issues that are prevalent in the gaming industry and the latest technologies that will define a new, immersive era of gaming.

The development stage of the project provided the opportunity to learn new things about game creation, the Unity editor and the language c#.

Overall the game is a success and fun to play. Implementing a leaderboard that utilised a cloud database, and developing code so that a player can save their game, or load a previous game, were highlights of the project. These ideas can be used for other coding ventures.

Producing code that followed standard conventions is good practice and necessary for becoming an exemplary developer. Trying to adhere to what has been taught throughout the software development course re-instilled the importance of clean, concise and organised code.

Appendix A

First

The GitHub links to the repositories for this project are listed below.
- Code for game
https://github.com/alexandrac77/psychic-pancake

- Screentcast of project & Dissertation PDF
https://github.com/alexandrac77/fictional-journey

The following software needs to be installed to open the project.
- Unity 2021.3.12f1
- Unity Hub
- Git
Clone a copy of the repository in your chosen destination directory.
Open the unity project within the unity editor
Open the Unity Hub
Add the clone directory and open it
Once Unity opens the project, press play to experience the game.

Appendix B

Second

Citings for tutorials & unity assets used for the coding aspects of the project. [47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66]

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