

# ANALYSE HOW PUZZLE PLATFORMER GAMES ENGAGE THE PLAYER WITH THEIR MECHANICS AND DESIGN A PROTOTYPE FOR A GAME BASED ON THIS RESEARCH

## Abstract

In this project, I aim to research the design decisions behind successful puzzle platformer games and use these guidelines to create my own prototype of a puzzle platformer game. I will be analyzing existing game designers' methods for creating this type of game and collecting primary data from playtesting games within my sixth form. I will also be learning how to create a game from learning to 3D model to programming a game and using a game engine. I concluded that puzzle platformer games engage the player by offering them a challenge that the player enjoys solving and masters through effort that leads to the feeling of satisfaction. This knowledge is used to create my own prototype game and to hopefully help and inspire other game designers to create better puzzle platformer games.

By Elzbieta Stasiak

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## Introduction

This is a record of the complete process from my initial research into what makes puzzle platformer games fun to creating my own game. I investigate how existing, successful puzzle platformer games engage players by gathering advice from professional game developers about their methodologies and looking for common themes. I gather evidence of these methodologies working in games through playtesting with participants in my sixth form and analysing their feedback.

I also learn throughout this project how to create games through learning to create and animate 3D models as well as learning to code in C# and use the game engine *Unity*. The product of my project is the prototype of a game I develop using the information I learn about how to design the structure of a puzzle platformer and using the skills to develop the game. The final section of my project is the evaluation of my prototype to prove the research I conducted at the start was valid. Testing my prototype will determine whether my concept engages players and is successful as a puzzle platformer.

## Game Mechanics Research

### Interview with a Game Design Lecturer from Brunel University

At the start of the year, I visited *Brunel University* during their open day. I talked with Chris Cox<sup>1</sup>, a lecturer of the game design course at the university. From my talk with him, I started learning about the theory behind why games are enjoyable and how to design game mechanics. He told me about design decisions behind some of the most successful games that aren't always obvious to the player. For example, in *XCOM 2*<sup>2</sup>, there are two different game modes that work together so harmoniously that only having one would make the game less fun. In guerrilla ops missions, you find and gather resources for research which gives you better equipment for the missions which in turn allows your soldiers to survive longer and gather even more research materials. Another game, *Bioshock*<sup>3</sup> gives the player more information to form a strategy while playing. This is done by having the first shot from enemies always miss the player. The purpose of this shot is not to hit the player but instead to warn them that they are being shot, so they can work out where the enemies are and reposition behind cover. If the first shot did hit the player and the player died, they would get frustrated very easily because they didn't know how they died or where enemies were. The game *Assassin's Creed*<sup>4</sup> takes the opposite approach to *Bioshock* and hides information from the player. In the game the health bar misleads the player by showing them they have a quarter of their health left, when they actually have a third. The purpose of this is to make the gameplay feel more intense and rewarding for the player after surviving a battle like a swordfight because they managed to survive with a tiny amount of health.

When I visited *Brunel University* I wasn't planning on gathering information for my EPQ. However, after talking, Mr Cox gave such useful information I decided to include it in my EPQ. The advice he gave me also inspired me to look further into the theory of game design not just information on building the game.

### The Puzzle Platforming Genre

My project is focused on just puzzle platforming games. This made analysing games and the methodologies used to create them easier, as there were more similarities that I could incorporate

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<sup>1</sup> Cox, C. (2017). Personal communication.

<sup>2</sup> Firaxis. (2016). *XCOM 2*. Steam: 2K.

<sup>3</sup> 2K Boston, 2K Australia. (2007). *Bioshock*. Steam: 2K Games.

<sup>4</sup> Ubisoft Montreal. (2008). *Assassin's Creed*. Steam: Ubisoft.

into my own game. I chose to focus on the puzzle platformer genre as it is one of my favourite genres and is simpler to create than others such as shooters or role-playing games (RPGs) because there is usually only one way to complete a puzzle. The puzzle platformer genre is a popular hybrid genre that combines puzzle and platformer game mechanics. This definition I found from the website *vtropes.org*<sup>5</sup> explains the genre very well:

*“A common Puzzle Platformer format is having a player attempt to overcome obstacles and get to the exit in a series of rooms, often by use of a unique gameplay mechanic. Usually, the first few levels exist to demonstrate to the player the various mechanics the game utilizes, then throw him or her a few simple puzzles to show what the game is capable of, and then requiring the player to think outside the box, requiring more and more creative thinking to reach the goal. Locks and Keys may be in ready supply, as well as blocks. Then, of course, they get trickier and trickier.”*

## Game theory

To learn more about game theory I read *Designing Games*<sup>6</sup>. It is a book about the design structure of games and the theory behind some of today's best games. From this book, I learnt about game mechanics, events and the emotions behind play. A game is formed from mechanics, which according to this book are 'rule[s] about how a game works'. In a game, 'mechanics and players interact to form events', these events and the emotions they produce in players are what makes a game enjoyable to play. In puzzle games, the emotions the designer wants to tap into are of insight and accomplishment. The player will feel insight when the pieces of a puzzle click in their mind and they understand the solution. The satisfaction of completing a puzzle keeps players energized and willing to keep trying even if they fail. The balance of difficulty in puzzle games is very important because if a puzzle is too easy, the player will get bored and feel less accomplished when they complete it. However, if a puzzle is too hard, the player will give up.

## Game Designers Conference

I also watched a video on YouTube from the 2016 Game Designers Conference (GDC) called *Level Design Workshop: Solving Puzzle Design*<sup>7</sup>. In the video Jolie Menzel explains in more detail about the challenge of puzzle games and how to design engaging puzzles by letting the player figure out the solution of a puzzle but still making the solution seem achievable to the player. Players feel achievement when they have mastered the mechanics of a game and are able to solve a puzzle after the trials of discovering and experimenting with the mechanics. The difficulty in puzzles is affected by the number of steps it takes to complete a puzzle and the time between feedback. Introducing new mechanics or applying existing mechanics to new contexts also affects difficulty.

## Puzzle Game Testing

I gathered volunteers to playtest puzzle platformer games, so I could gather my own primary data about the genre. I chose to playtest two of the most well-known and successful games of the genre: *Portal 2*<sup>8</sup> and *Braid*<sup>9</sup>.

I chose *Portal 2* over the original *Portal*<sup>10</sup> game because it is a lot more refined and focused on the core game mechanics than the original. I also chose this game because I have already played through

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<sup>5</sup> Anonymous. *Puzzle Platformer*. Available at: <http://vtropes.org/pmwiki/pmwiki.php/Main/PuzzlePlatformer> [Accessed December 2017]

<sup>6</sup> Sylvester, T. (2013). *Designing Games*. Sebastopol, California: O'Reilly Media

<sup>7</sup> Menzel, J. (2017). *Level Design Workshop: Solving Puzzle Design*. Available at: <https://www.youtube.com/watch?v=0xBJwrm9C8w> [Accessed December 2017]

<sup>8</sup> Valve. (2011). *Portal 2*. Steam: Valve.

<sup>9</sup> Number None. (2009). *Braid*. Steam: Number None.

*Portal 2*, so I know all the solutions to the puzzles. The main mechanic of *Portal 2* is a gun that shoots and creates wormholes called portals. If you go through one portal you will come out of the other. You use the portal gun to traverse the levels yourself or to bring objects out of reach, closer to you. The objective of each level is to unlock the exit door, usually by finding and putting cubes on buttons.

The other game I chose was *Braid*. This was a game I hadn't played before, but I took advantage of a free trial to try it myself and use for the interviews. I chose to use it because although it is also a puzzle platformer like *Portal 2* and uses a lot of mechanics common to the genre like keys, it has been executed in a completely different way to *Portal 2*. This main mechanic of the game is being able to rewind time anytime you want to including to a time before dying. This enables the player to solve puzzles and collect keys and puzzle pieces to get through the levels.

### Conducting Interviews

First, I created a sign-up sheet for my interviews, to record the names, e-mails and days free after school of all the volunteers who signed up. I recorded e-mails of my volunteers to contact them and recorded the days of the week each person was free to help me schedule interviews. To gather volunteers, I asked anyone in my year who was interested in my project if they would like to help me test games and if they knew anyone else who would be interested. I chose people in my year because I want to target my game towards people around my age. I recruited 5 volunteers who tested both games and 1 who only tested *Portal 2*. Each session took 45 minutes, 30 minutes of playing the game and 15 for questioning. It took about 3 weeks to do all 11 interviews. I created a questionnaire (Appendix Document 1 & 4) to interview the players of *Portal 2* and *Braid*. After the first interview, I realised that the questions needed to be more specific, so I created a second improved version (Appendix Document 2 & 5). This worked much better, so I continued to use this version. For *Braid* I used the same questionnaire, but I changed the questions so that they were specific to *Braid* (Appendix Document 3 & 6). I also recorded the gameplay footage of each of the volunteers playing the game to analyse with the answers from the questionnaires.

### The results of the interviews

All the participants had varying levels of gaming experience and half knew about *Portal 2*, but all had never played it before. Overall the participants enjoyed *Portal 2*, finding the game fun and the story funny. Every participant found the game quite challenging because the solutions weren't obvious and required some trial and error or hints. Participants thought the portal mechanic was fun because portals could be placed almost anywhere, and they didn't like it when they couldn't use them. Participants liked the level design because they were progressive and showed them something new each time, but each had their own pace, so some thought the levels should have progressed more and have more variety while others wanted more hints to help them. Participants liked the art style of the game because it was realistic and detailed. The participants would play the game again because they felt satisfied after completing a level and wanted to try more. Participants required help with the controls and a couple of the solutions to the starting levels because there isn't much instruction at the start of the game.

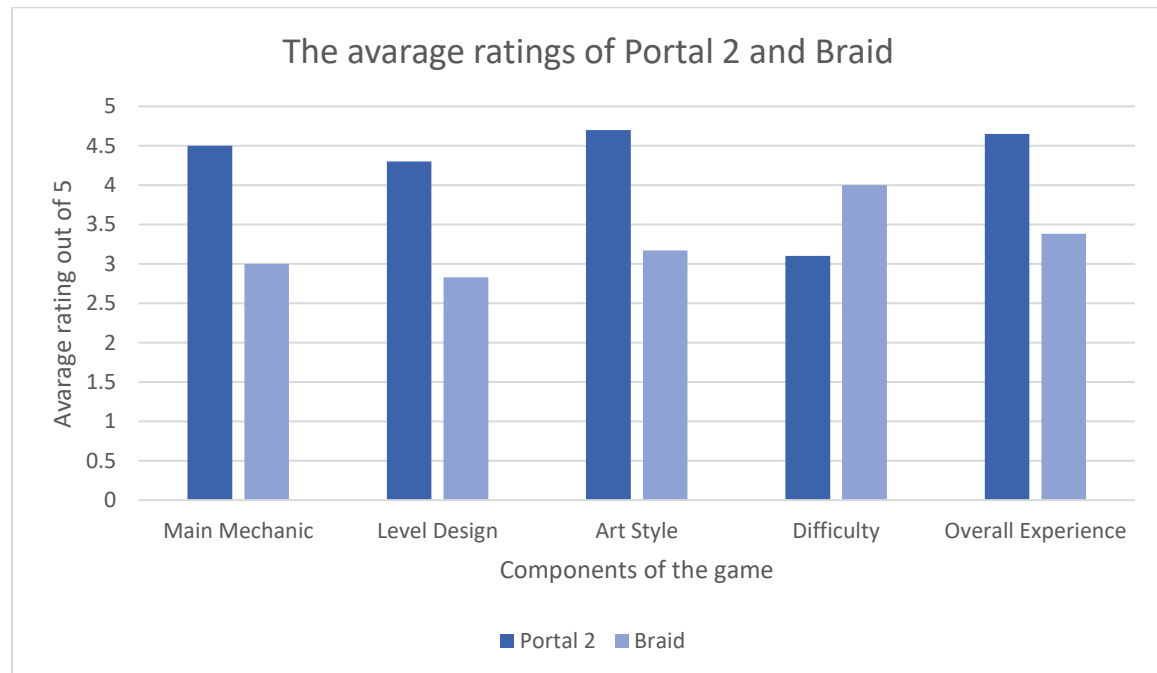
None of the participants knew about *Braid* or had played it before. It was enjoyed less than *Portal 2* overall because half the participants thought it was too challenging. They thought rewinding time was original but complicated to use. They found the level design familiar probably because of its

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<sup>10</sup> Valve. (2007). *Portal*. Steam: Valve.

similarity to popular games like *Super Mario Bros*<sup>11</sup> but the puzzles too tricky so some gave up. The art style was liked but felt like it was copying *Super Mario Bros* and the main character's design wasn't liked much. They thought the game was harder than *Portal 2* because the rewinding ability was tricky to use, and they had to redo a section if they didn't get it completely right. Only half the participants wanted to try the game again. Participants needed help with the controls but less so than *Portal 2*.

[Figure 1]



<sup>11</sup> Nintendo EAD. (2009). *New Super Mario Bros. Wii*. Wii: Nintendo.

## Learning 3D Digital Modelling

### Learning to Create a 3D Game

At the same time as I was researching, I also learnt how to create a 3D game. When I started this project I only had some experience of creating a simple 2D game without coding, so I had to learn all the skills I needed to create my game during this project which included 3D modelling.

### Choosing a 3D Modelling Software

First, I had to research and choose which 3D modelling software I wanted to use. I chose to only look at freely available software as a lot of modelling software costs hundreds of pounds for one license. The 3 modelling softwares I looked at were *Blender*<sup>12</sup>, *Maya*<sup>13</sup> and *3ds Max*<sup>14</sup>. *Blender* is open source which means anybody can view and modify the software code for their own purposes. *Maya* and *3ds Max* are both proprietary software which means only Autodesk's developers can modify the software and you must buy a license to use it. However, if you are a student you can use the software for a limited time, free of charge with a student license.

Software	Advantages	Disadvantages
Blender	<ul style="list-style-type: none"><li>▪ Open Source: no charge for use</li><li>▪ Many free online tutorials on how to use it</li><li>▪ Very customisable; no charge for modifying</li></ul>	<ul style="list-style-type: none"><li>▪ Many keyboard shortcuts need to be learned for efficient use</li><li>▪ Looks daunting to learn</li></ul>
Maya	<ul style="list-style-type: none"><li>▪ Free to use if you are a student</li><li>▪ The most popular modelling software used professionally</li></ul>	<ul style="list-style-type: none"><li>▪ The student license doesn't allow the commercialisation of any work made using it</li><li>▪ The free tutorials are hard to learn from.</li></ul>
3ds Max	<ul style="list-style-type: none"><li>▪ Free to use if you are a student</li><li>▪ Used professionally</li></ul>	<ul style="list-style-type: none"><li>▪ Has the least available free tutorial resources</li><li>▪ The student license doesn't allow the commercialisation of any work made using it</li></ul>

### Learning How to Use Blender

I decided to choose *Blender* because I found a tutorial video series on YouTube by the channel *Blender Guru* called *Blender Beginner Tutorial Series*<sup>15</sup> that was easy to learn from and fun. I learnt how to use Blender for two weeks during the summer. Since the tutorial was split into many 45-minute videos, I tried to complete one per day. The tutorial project was making a photorealistic scene of doughnuts on a plate and coffee (Appendix Document 7).

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<sup>12</sup> Blender Foundation. (2017). *Blender 2.79*. Windows: Blender Foundation.

<sup>13</sup> Autodesk Inc. (2017). *Autodesk Maya*. Windows: Autodesk Inc.

<sup>14</sup> Autodesk Inc. (2017). *Autodesk 3ds Max*. Windows: Autodesk Inc.

<sup>15</sup> Blender Guru. (2016). *Blender Beginner Tutorial Series*. Available at: [https://www.youtube.com/playlist?list=PLjEaoINr3zgHs8uzT3yqe4iHGfkCmMJ0P&disable\\_polymer=true](https://www.youtube.com/playlist?list=PLjEaoINr3zgHs8uzT3yqe4iHGfkCmMJ0P&disable_polymer=true) [Accessed August 2017]



### After learning Blender

I learnt how to use the many shortcuts in *Blender* and how they can make *Blender* a lot quicker and easier to use. I also have a 'cheat sheet' provided by the teacher of the YouTube tutorial that contains all the shortcuts and is a very reminder tool. I also learnt how to import a reference photo into *Blender* and how to position it, so it can be used as a guide for modelling an object. I found out that digital modelling is a lot more like changing the topology of a basic shape like a cube or sphere by adding vertexes, edges and faces and moving, rotating or scaling them rather than modelling with digital clay.

### 3D Modelling Skills Learnt

- Basic modelling using *Blender's* tools and features
- Adding materials and textures to models
- Lighting and camera setup in *Blender*
- Rendering an image and the optimal render settings for different computers
- Compositing a rendered image
- Using the keyboard shortcuts

## Learning to Use Unity and Program in C#

### Using a Game Engine

A game engine is a special type of software used to create games. I used a game engine to create my game because it has a lot of useful components I can use to create my game that will speed up the process, so I would not have to code everything from scratch. This definition I found from the website *interestingengineering.com*<sup>16</sup> explains the software very well:

*“A game engine lays the software framework to build and create video games. They provide features from animation to artificial intelligence. Game engines are responsible for rendering graphics, collision detection, memory management, and many more options. Game engines provide the tools for developers to create numerous gaming applications. Designers often reuse these engines to create other games which makes it a valuable investment. A game engine contains five components: The main game program which contains the game logic; a rendering engine which can be used to generate 3D animated graphics; an audio engine which consists of algorithms which are related to sounds; a physics engine to implement 'physical' laws within the system; and Artificial intelligence, a module designed to be used by software engineers with a specialist designation.”*

### Why I Chose Unity

At the start of my project I knew I wanted to use *Unity*<sup>17</sup> as my game engine. I chose it because *Unity* supports both C# and JavaScript. It is also compatible with *Blender*, so I can easily import any models I make into *Unity*. *Unity* and all its core engine features are free to use if you or your company makes less than \$100k profit from a game made with *Unity*, so I can use the personal edition for free and *Unity* doesn't take any royalties from games you make and publish using it.

The other game engine I could have chosen to use was the *Unreal Engine*<sup>18</sup>. *Unreal* is said to be better at rendering detailed graphics. However, photorealistic work is harder to produce and takes longer so I won't be producing high quality graphics. As such, I don't need a powerful graphics renderer. The only programming language it supports is C++, which is more complex than C# or JavaScript. *Unreal* does support a 'drag and drop' system that allows the user to create games without programming, but this would limit the features I could create for my game. *Unreal* is also free but takes a 5% royalty fee after the first \$3000 made in revenue per product per calendar quarter.

### Programming in C#

I chose to program in C# instead of JavaScript with *Unity* because it is a programming language specifically built for object-oriented programming. Although this is a language I have never used before, I was confident that it would not take long to learn as it was the third programming language I had learnt, and most programming languages use the same features.

### Learning Unity and C#

I found a video course teaching *Unity* and C# together on the online learning platform *Udemy* called *Learn to Code by Making Games - Complete C# Unity Developer*<sup>19</sup>. The course is comprised of over 300 videos and is split into separate projects where you create different games that focus on

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<sup>16</sup> Interesting Engineering. (2016). *How Do Game Engines Work?*. Available at: <https://interestingengineering.com/how-game-engines-work> [Accessed February 2018]

<sup>17</sup> Unity Technologies. (2017). *Unity 2017.3*. Windows: Unity Technologies.

<sup>18</sup> Epic Games. (2017). *Unreal Engine 4*. Windows: Epic Games.

<sup>19</sup> Tristem, B. (2018). *Learn to Code by Making Games - Complete C# Unity Developer*. Available at: <https://www.udemy.com/unitycourse/?start=0> [Accessed September 2017]

different skills. It begins by teaching basic programming in C# and then it progresses to teaching you how to create 2D games in *Unity 4.6* before finally teaching how to create 3D games in the newest version of *Unity* which is *Unity 2017.3*. I tried to complete anywhere between 5 and 15 videos a day since they were only about 15 minutes long on average. I watched 260 of the videos which were relevant to the game I wanted to create. I made eight games through this tutorial which were: Number Wizard, Text Adventure, Number Wizard with UI, Block Breaker, Space Invaders, Glitch Garden, 3D Bowling and Zombie Runner (Appendix Document 8).

### C# Programming Skills Learnt

- Programming using the object-oriented paradigm
- Learning the syntax rules for C#
- Using the IDE (Integrated Development Environment) *MonoDevelop*<sup>20</sup>
- Using *Unity*'s development code libraries with their API Manual
- Using new data structures such as vectors and quaternions and the methods and attributes associated with them
- Programming test cases using *Unity*'s testing code library

### Unity Game Creation Skills Learnt

- Creating Scenes/Levels
- Creating 2D and 3D game objects and linking them together
- Attaching code scripts to game objects to give them functionality
- Using *Unity*'s standard asset packs
- Creating objects with realistic physics and being able to modify the physics settings
- Creating terrains and adding realistic world lighting
- Creating areas for AI agents to traverse a digital environment
- Creating a UI (user interface) complete with menus and buttons
- Animating game objects, including those made in *Blender*

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<sup>20</sup> Xamarin, Mono Community. (2018). *MonoDevelop*. Windows: Xamarin.

## Creating my Game

### Initial Requirements

My game will be a puzzle platformer since this is the genre my project is focused on. I will make my game for PCs which is easier than creating my game as an App for phones as PCs have more powerful hardware which makes them better suited to games with 3D graphics. It will be a single player game because a multiplayer game would also be too complex to create and require substantially more time. It will be a prototype with few levels because the time constraints for this project would not allow me to create a full game.

### Ideas for Game Mechanics

I will be using the two games I tested *Braid* and *Portal 2* as inspiration. I enjoy the way both games allow you to play with the rules of physics in ways you can't experience in real life, for example by rewinding time in *Braid* or using wormholes in *Portal 2*. My game will also give the player abilities to change space and time. The main idea of my game is using the player's death to their advantage because there is no real consequence to dying other than losing progress or equipment. However, after dying the player has the advantage of knowing what is going to happen in the game and how to avoid dying the next time. The mechanics of my game will explore this advantage.

My first idea for a game mechanic is inspired by *Braid* and is a player ability. It is the ability to create a clone of the player after the player dies which repeats all the actions the player performs up until the player died. There will be no 'game over' screen after the player dies because it will break the flow of the game and there is no penalty for dying. Instead there will be a simple dying animation and a fade in and out while the level reloads.

My second idea is also a player ability and is inspired by *Portal 2*. It is the ability to teleport by switching places with the last enemy that killed the player. It can only be used by dying at least once due to one of the enemies in the game. Enemies that have been teleported should try to travel back to where they are originally supposed to be standing or patrolling.

### Enemy Design and Game Mechanics

The enemies will be simple robots with a limited field of view. They will guard the levels and patrol on a set path. If the player enters the field of view, the enemies will try and shoot the player with a laser that will instantly kill the player if it hits them. If the enemy doesn't have a line of sight to the player, the enemies will search for them by going to the position they last saw them at. I have chosen to make the enemies robots because my game is a sci-fi game.

### General Level Design

Each level will be one floor of an office building guarded by the robots. They will have one entrance and one exit which will be at opposite ends of the map. The player will have a top-down view of the whole map, which will help the player plan how they will solve each puzzle and see what effect their abilities have. The objective of each level is to get from the entrance to the exit but first the player will have to collect a key to open the exit door.

The player will control the game using mouse and keyboard. There are two control schemes that could work; one will have the character move using the W, A, S and D keys with their left hand and use the mouse to control abilities with their right hand. The alternative control scheme uses the arrow keys to control the character with their right hand and letter keys to control abilities with their left hand.

## Art Design

The art style will be simple and abstract to make it easier to model and animate. Less detail means it takes less time to model in *Blender*. If the graphics are simple, it also allows the game to run quicker and be able to run on less powerful systems. For the player, I will use a premade model with animations that I can modify because it will save me time trying to create a humanoid character which I am not skilled enough to model or animate properly yet.

## Modelling my Game Objects in Blender

The first part of creating my game was modelling all the game objects in *Blender*. I started to model the levels first since they are the simplest to do. First, I created a 2D plan in the 2D graphics software *Clip Studio Paint Pro*<sup>21</sup>. I used a grid and straight lines that snapped to the grid to draw a floor plan for each of the levels. I used the same grid for all the levels to make sure they were all the same scale. I also created a side plan, so I would know the height of the walls and I used the same side plan to make all the walls in all the levels the same height. I then imported the floor and side plans into *Blender* to use as a guide for modelling. I created 2D plans for each of the other objects such as the robot guards and the key with the same grid.

## Setting up my Game in Unity

I first set up the different scenes and levels in *Unity* and a menu system, so I could transition between the levels. I created a start menu, a controls scene, 3 different levels and an end scene. I then imported all the models I made in *Blender* into *Unity*. This is where I encountered the first problem; the materials I had added to my models in *Blender* didn't work in *Unity*. This was because *Blender* uses a completely different rendering engine to *Unity*; *Blender* uses a rendering engine that has been optimised for rendering still images in a lot of detail and it takes a few minutes on average to render a scene, *Unity* however uses a rendering engine that is optimised for real-time graphics and animated scenes which means it must render a scene in a sixtieth of a second. To fix this I had to create new materials in *Unity* that looked almost identical to the materials I had made in *Blender* and assign them to my models in place of the original materials. I then imported *Unity*'s standard assets for a third person player character. This isn't the final player character I would use for the game because I can't easily modify the character or its code, but I did use it as a stand-in to have a character I could control and test during development.

## Programming my game

The hardest part of creating my game was the programming because I had to figure out how to program all the different elements and test them to make sure there were no errors or bugs. I started by programming the guards' behaviour; I used a YouTube series created by *Unity* called *Stealth game tutorial*<sup>22</sup>. I modified the code I learned from the videos to suit my game. The videos were very helpful because there was a lot of maths involved in the AI (Artificial Intelligence) of the guards which went beyond my knowledge of A-Level maths. After programming the guards' behaviour and fixing most of the bugs I moved onto programming the player's behaviour and their abilities. I first replaced the stand-in I had used from *Unity*'s standard assets with a new player character from the unity asset store that was free to use from a package called *3rd Person Controller*

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<sup>21</sup> Celsys. (2016). *Clip Studio Paint Pro*. Windows: Celsys.

<sup>22</sup> Unity. (2014). *Tutorials – Stealth Project*. Available at: <https://www.youtube.com/playlist?list=PLX2vGYjWbI0QGyfo8PKY1pC8xcRb0X-nP> [Accessed January 2018]

+ *Fly Mode*<sup>23</sup>. I chose to use this player character because I thought the animations were better and the design fit the art style of my game. It was also easily modified so I could program my player's abilities. I then programmed the player's cloning and teleporting abilities; these were the hardest to program as there were no tutorials on how to code them, so I had to create these on my own. I created the cloning ability by recording the player's moves every frame and the teleporting was created by swapping the positions of the guard and the player. I decided to use the second control scheme I planned so that I could assign the abilities to the Z, X and C keys, since they are close together and easily accessed by the left hand. I then programmed and animated the rest of the parts of the level including the key, the doors and the audio including sound effects. While developing my game I made sure to check the licenses of any parts of my game that I did not create myself to make sure I could use them for free.

### Development Testing

The number of bugs in my game seemed to grow exponentially as I added more code so about half the development was bug fixing. I had to test each code module individually for syntax errors and logic errors before finally testing the whole game together. These are just some of the bugs I had to fix before my game was playable:

- The guards not noticing or shooting the player
- The level not reloading when the player dies
- The player getting catapulted out of the level after dying
- The guards shooting the player immediately after the level reloads
- The player sliding around the level when not being controlled
- The guards facing the wrong direction when shooting
- The key appearing in the floor
- The guards not switching places with the player when teleported
- The guards not working on any level other than level 1

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<sup>23</sup> Marques, V. (2017). *3rd Person Controller + Fly Mode*. Available at: <https://assetstore.unity.com/packages/templates/systems/3rd-person-controller-fly-mode-28647> [Accessed January 2018]

## Evaluation and User Testing of My Game

### Unforeseen Difficulties Encountered

Unfortunately, the hard drive in my laptop broke and got corrupted at the start of this year which made it unusable. Luckily, I was able to recover almost all my work from it and continue working on my desktop PC at home. I only lost the footage I had recorded of gameplay from the interviews of *Portal 2* and *Braid* because the sizes of the files were too large to back up. This meant I couldn't have my volunteers test my game until it was fixed. My laptop didn't end up getting fixed in time, so instead I managed to get my game running on the school laptops. I was able to test my game by bringing it into school on a memory stick as a runnable application, so the software I used to create the game wasn't needed to play it. The only problem with running it on the school laptops was that I couldn't record the gameplay from the interviews because the school laptops didn't have the software required to do it.

### Conducting User Testing

Four of the volunteers I used for previous interviews tested the prototype of my game. I also used the same format as previous interviews, so I could get a relative comparison of my game compared to the other games I tested. I conducted six interviews in total (Appendix Documents 9 & 10). The first two interviews were mainly to find any bugs or improvements to playing the game that I had not found through my testing. After these tests I used the feedback to add a couple of features such as creating a button to go back to the main menu on every level and adding a feature to reset the level when the player wants to instead of them having to die to reset the level. I also made a few improvements to the AI of the guards. The next four interviews were to evaluate my game and fill out my questionnaire.

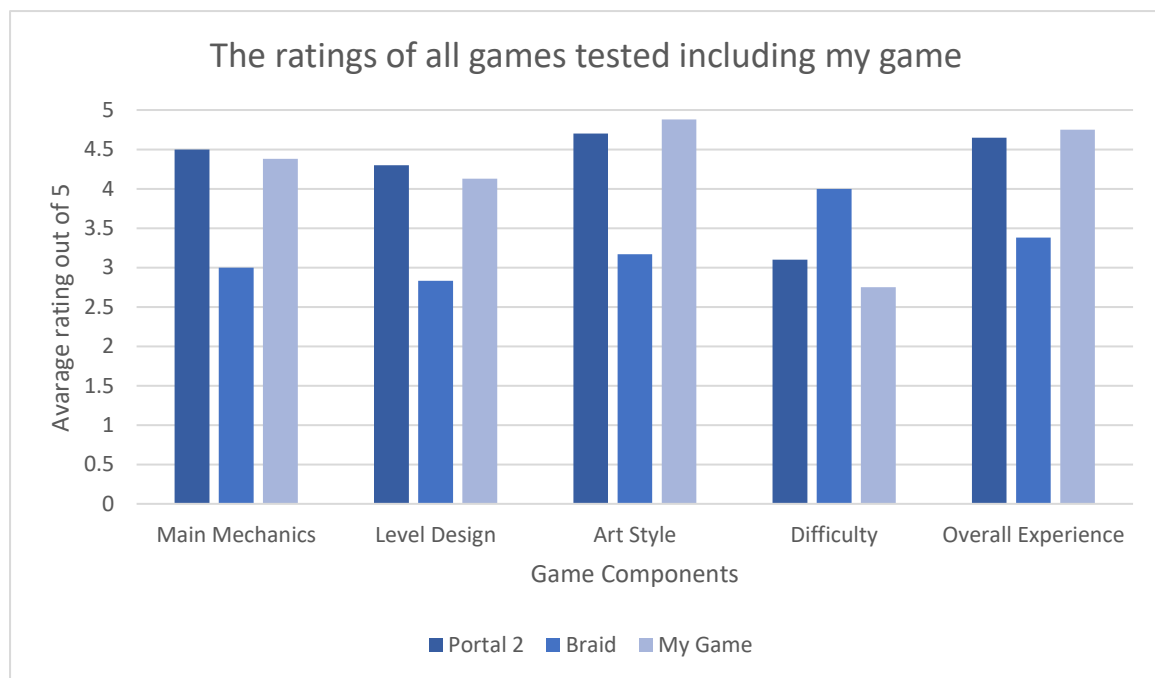
### Results of User Testing

Overall the participants enjoyed the prototype of my game. All the participants liked the teleporting mechanic as an interesting and useful way to get around the levels. The cloning mechanic was less liked than teleporting because they were confused about when it should be used, and the levels were able to be completed without using this ability. They liked the level design but found ways to complete level 1 without the need for abilities. They also found the player character was a bit difficult to control in the small levels. The art style was received very well as well as the sound design and found to be aesthetically pleasing even though it was simple. They didn't find the game too difficult overall but certain levels were more difficult than others.

Participants felt the game could be improved by introducing the controls gradually and adding more detail and depth to the levels as well as tweaking the speeds of characters in the game. All participants would play the game again and are interested in what the full game will turn out like. I also asked all the participants the optional question of 'What should I call the game?' because I still didn't know what to call it. The submission I liked most that will probably end up being the name was 'Quantum Clones'.

I have some concerns about the validity of my results in figure 2 since I the participants were people I knew. I think they were concerned about hurting my feelings, so I think they rated my game higher than it should have been, especially since it was the first 3D game I have made.

[Figure 2]



## Conclusion

From my user testing I believe I have created the prototype of a successful puzzle game. Figure 2 shows my prototype is as highly rated as the two published games I tested. This means I have successfully applied the knowledge I have learned from researching puzzle game mechanics and learnt all the necessary skills to create my 3D. My game manages to provoke a sense of challenge while providing players with unique mechanics that create enjoyable and satisfying experiences. The prototype still needs a lot of work and improvement before I can publish it as a full game, but I now have the skills to complete it and user feedback to give me advice on how to improve it. In the future I would like to add more levels and improve the graphics as well as improve the code so there are less errors. In conclusion, I achieved all the aims of my project and enjoyed making my game using the skills I learnt throughout the project.

A video of my game being played by myself can be accessed online using this link:

[https://drive.google.com/open?id=17Cd\\_fy7a4FvGW5LVcomTt2-hzKlwMmVq](https://drive.google.com/open?id=17Cd_fy7a4FvGW5LVcomTt2-hzKlwMmVq)



## Appendix

Document 1: Original blank Portal 2 Interview Questionnaire, side 1

### Portal 2 Interview Questions

Name of participant:

Date:

Were you aware the game existed?

If yes, have you played the game before?

First Impressions?

Rate the main portal gun mechanic: ★★★★★

What specifically did you like/dislike about this game mechanic?

Any other mechanics you especially liked?

Rate the level design: ★★★★★

What specifically did you like/dislike about the level design?

## Portal 2 Interview Questions

Rate the art style: ☆☆☆☆☆

Was the art style appropriate for the game?

Rate the difficulty of the game: ☆☆☆☆☆

Why did you find it this difficult?

Rate the overall experience: ☆☆☆☆☆

Would you play this game again, given the chance? Why?

Any final comments/impressions about the game?

Advice/Help required when playing the game:

Level (Chapter) reached:

## Portal 2 Interview Questions

Name of participant:

Date:

Were you aware the game existed?

If yes, have you played the game before?

What sort of gaming experience do you have?

Rate the main portal gun mechanic: ★★★★★

What specifically did you like/dislike about this game mechanic?

Rate the level design: ★★★★★

What specifically did you like/dislike about the level design?

Rate the art style: ★★★★★

Was the art style appropriate for the game?

## Portal 2 Interview Questions

Rate the difficulty of the game: ★★★★★

Why did you find it this difficult?

Rate the overall experience: ★★★★★

How did you feel when playing the game?

Would you play this game again, given the chance? Why?

Any final comments/impressions about the game?

Advice/Help required when playing the game:

Level (Chapter) reached:

## Braid Interview Questions

Name of participant:

Date:

Were you aware the game existed?

If yes, have you played the game before?

What sort of gaming experience do you have?

Rate the main time reversal mechanic: ★★★★★

What specifically did you like/dislike about this game mechanic?

Rate the level design: ★★★★★

What specifically did you like/dislike about the level design?

Rate the art style: ★★★★★

Was the art style appropriate for the game?

## Braid Interview Questions

Rate the difficulty of the game: ☆☆☆☆☆

Why did you find it this difficult?

Rate the overall experience: ☆☆☆☆☆

How did you feel when playing the game?

Would you play this game again, given the chance? Why?

Any final comments/impressions about the game?

Advice/Help required when playing the game:

Level (Chapter) reached:

Document 4: Original completed Portal 2 Interview Questionnaire, side 1

**Portal 2 Interview Questions**

Name of participant: [REDACTED] Date: 15/11/2017/17

Were you aware the game existed? *no*

If yes, have you played the game before? *no*

First Impressions?

Rate the main portal gun mechanic: ☆☆☆☆☆

What specifically did you like/dislike about this game mechanic?  
*shot far, convenient,*

Any other mechanics you especially liked?  
*Interesting*

Rate the level design: ☆☆☆☆☆

What specifically did you like/dislike about the level design?  
*Used timed bombs, with a death.  
repetitive*

## Document 4: Original completed Portal 2 Interview Questionnaire, side 2

**Portal 2 Interview Questions**

Rate the art style: ☆☆☆☆☆

Was the art style appropriate for the game?  
*Fit*

Rate the difficulty of the game: ☆☆☆☆☆

Why did you find it this difficult?  
*Not Motion sickness  
Hard puzzles, harder knowledge to go*

Rate the overall experience: ☆☆☆☆☆

Would you play this game again, given the chance? Why?  
*Yeah, maybe*

Any final comments/impressions about the game?  
*would like more varied levels,*

Advice/Help required when playing the game:

- Asked about buttons:
- Didn't always know where to go.
- Needed help with level
- Asked about dots on floor
- Needed help understanding cubes through portals
- Asked about bucketing

Level (Chapter) reached:



Document 5: Improved completed Portal 2 Interview Questionnaire, side 1

**Portal 2 Interview Questions**

Name of participant: [REDACTED]

Were you aware the game existed? *yes*

If yes, have you played the game before? *yes*

What sort of gaming experience do you have?

Rate the main portal gun mechanic: ★★★★★

What specifically did you like/dislike about this game mechanic?

*it was fun to use and to figure out how to get places.*

Rate the level design: ★★★★★

What specifically did you like/dislike about the level design?

*learnt a new way to use the gun each time - progressive.*

Rate the art style: ★★★★★

Was the art style appropriate for the game?

*graphics were good. It doesn't look outdated.*

Document 5: Improved completed Portal 2 Interview Questionnaire, side 2

**Portal 2 Interview Questions**

Rate the difficulty of the game: ★★★★★

Why did you find it this difficult?  
*Sometimes it was hard to see where you should shoot the portal, but enough trial and error seems to get you there.*

Rate the overall experience: ★★★★★

How did you feel when playing the game?  
*It was bit I had a lot of fun. It was quite funny too.*

Would you play this game again, given the chance? Why?  
*yes, it was interesting.*

Any final comments/impressions about the game?  
*~*

Advice/Help required when playing the game:  
*Help as Aug Lord*

Level (Chapter) reached:

Document 6: Completed Braid Interview Questionnaire, side 1

**Braid Interview Questions**

Name of participant: [REDACTED]

Were you aware the game existed? ☒ NO

If yes, have you played the game before? ☒ NO

What sort of gaming experience do you have?

Date: 11/12/17

Rate the main time reversal mechanic: ☆☆☆☆☆

What specifically did you like/dislike about this game mechanic?  
it was a bit complicated to use

Rate the level design: ☆☆☆☆☆

What specifically did you like/dislike about the level design?  
style was cool  
design was ok, it was v. annoying when  
couldn't solve puzzles so gave up  
hints would be nice

Rate the art style: ☆☆☆☆☆

Was the art style appropriate for the game?  
but too similar too <sup>super</sup>manobras

Document 6: Completed Braid Interview Questionnaire, side 2

**Braid Interview Questions**

Rate the difficulty of the game: ☆☆☆☆☆

Why did you find it this difficult?

It was hard to know how far back to travel  
& which clouds, puzzles would continue etc.

Rate the overall experience: ☆☆☆☆☆

How did you feel when playing the game?

frustrated

Would you play this game again, given the chance? Why?

NO, too much hard work

Any final comments/impressions about the game?

liked the sound effects

Advice/Help required when playing the game:

About controls

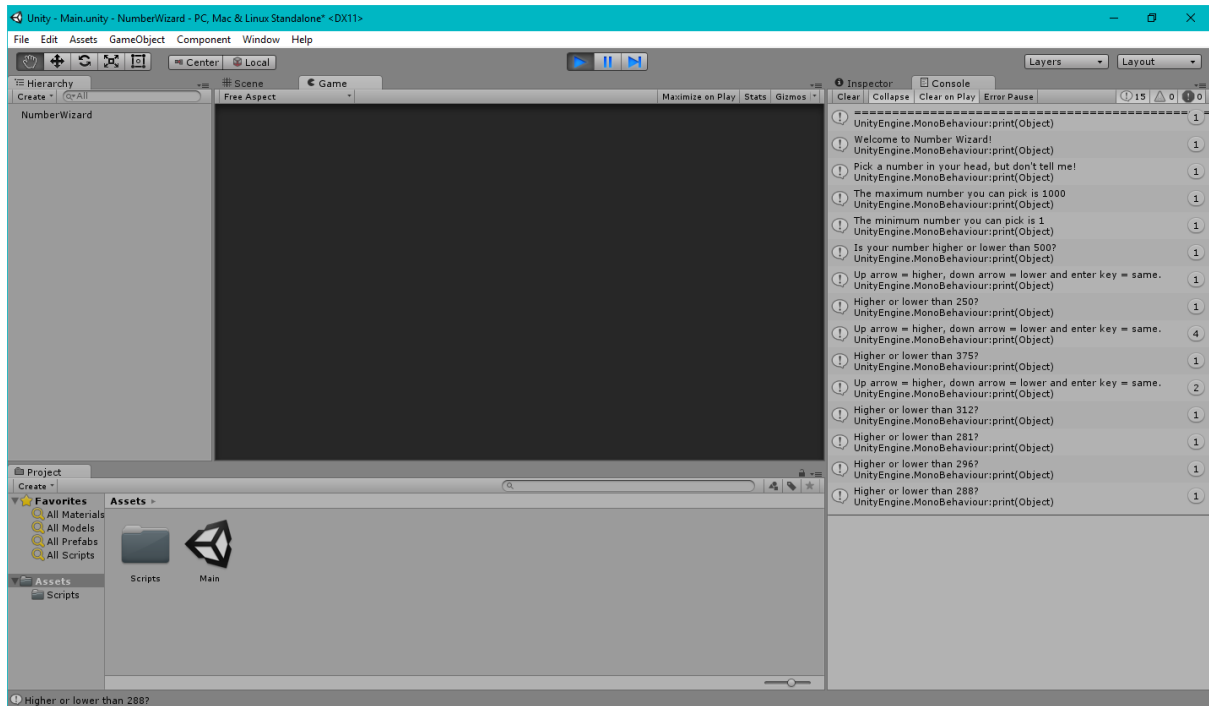
Level (Chapter) reached: 2

Document 7: Blender Tutorial Project Final Render

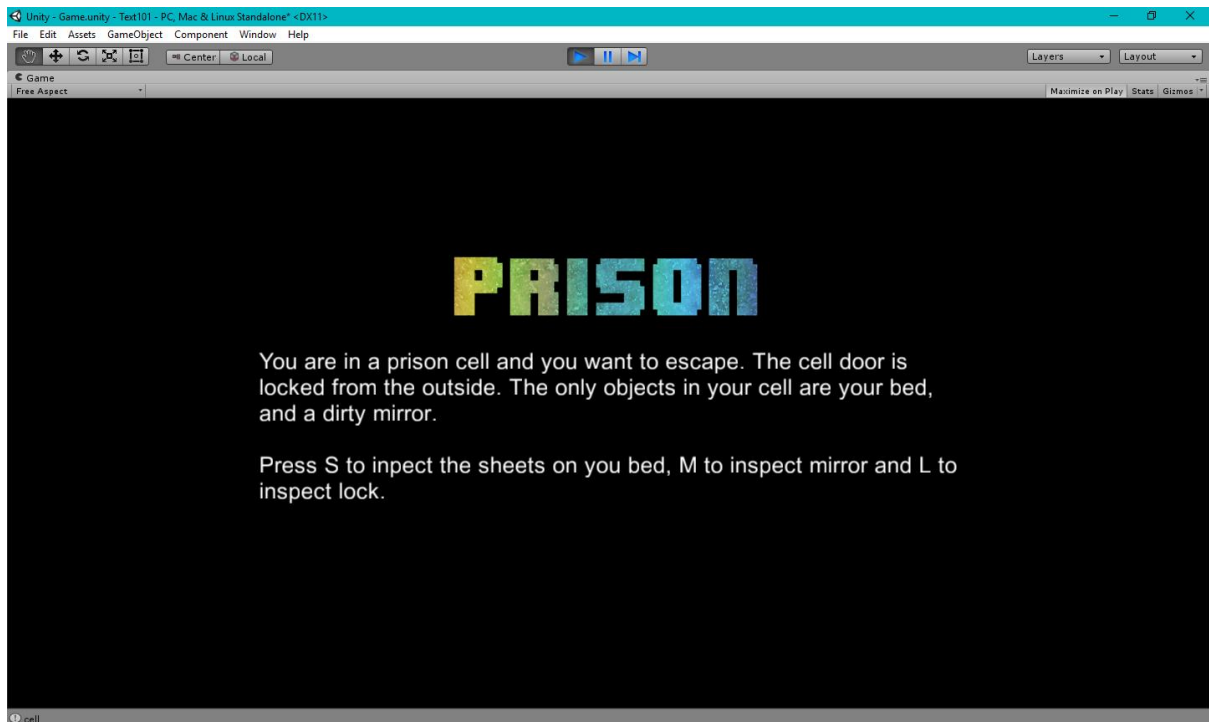


## Document 8: Images of Unity Projects

### Number Wizard

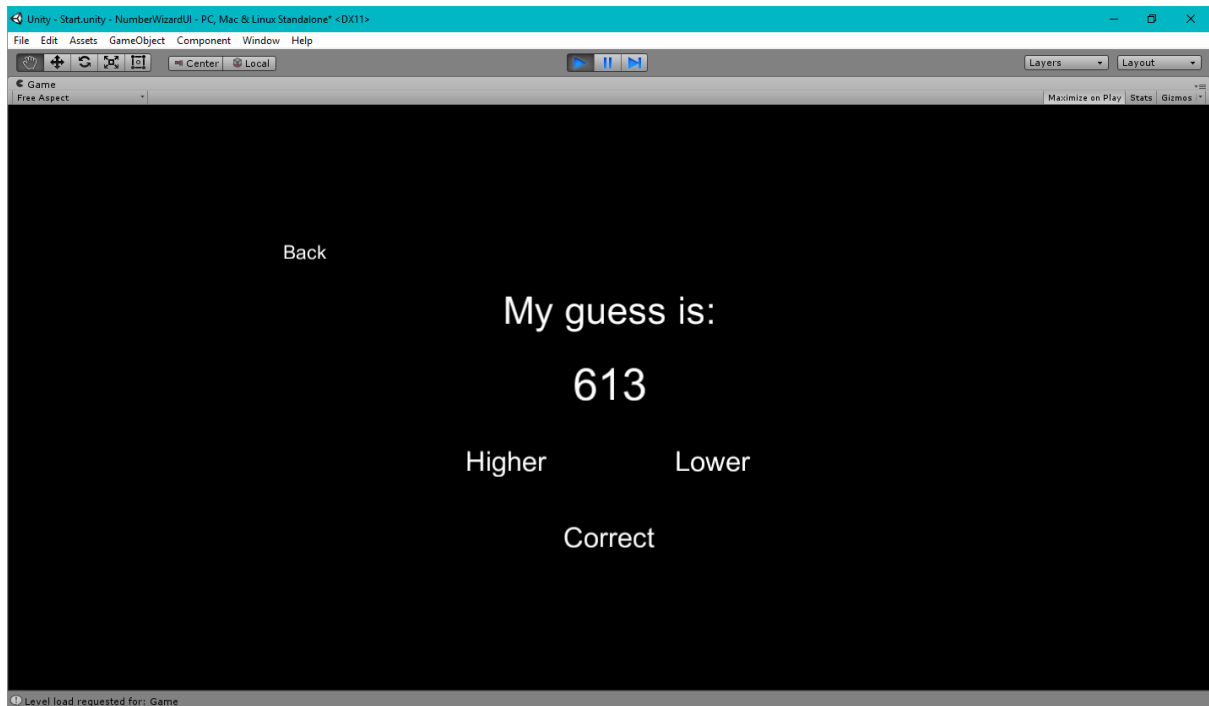


### Text 101

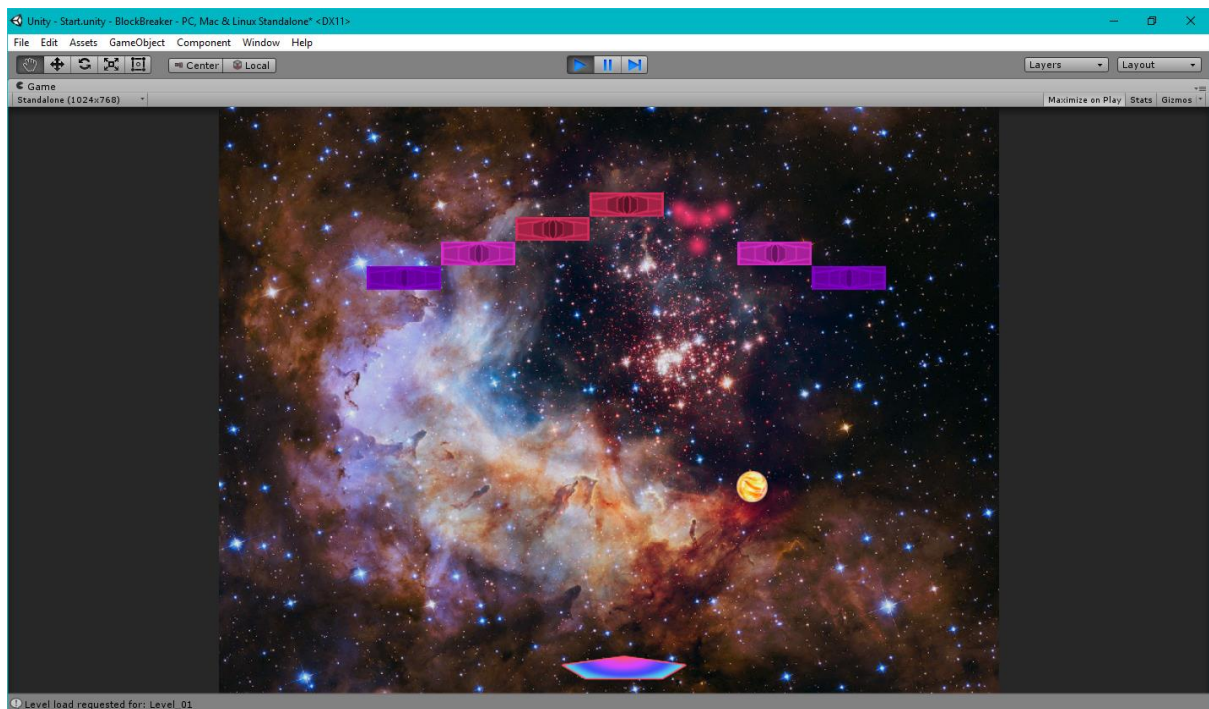




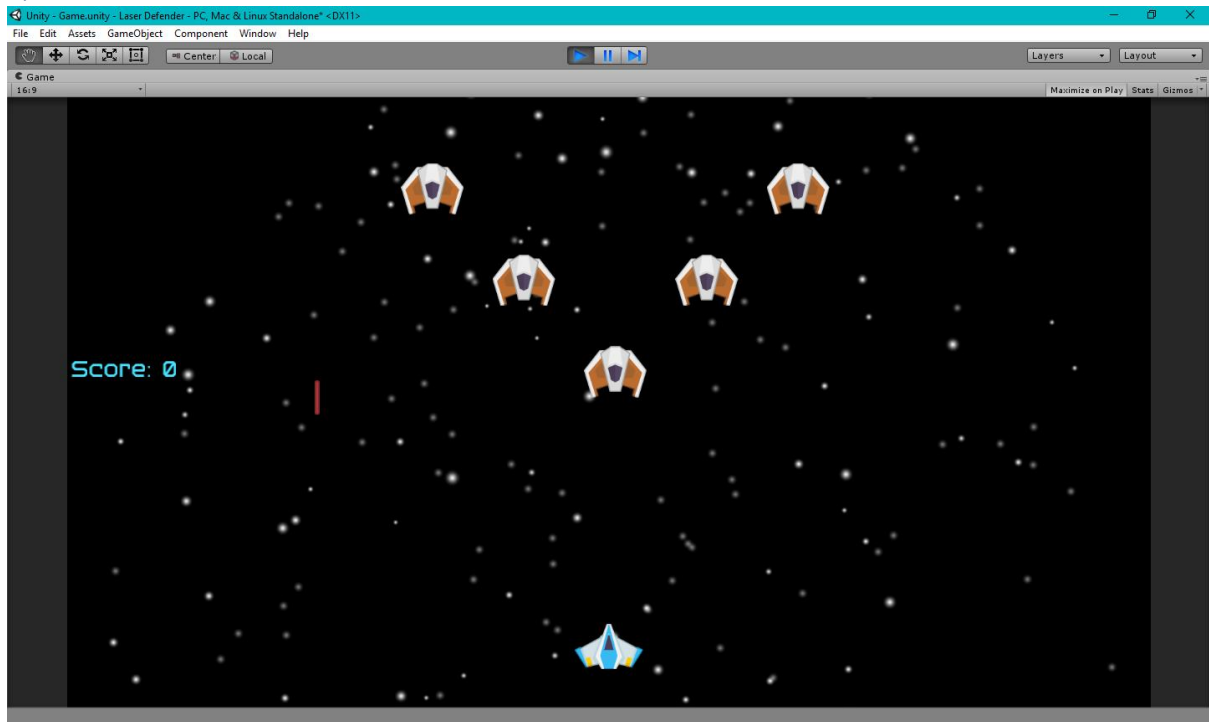
## Number Wizard UI



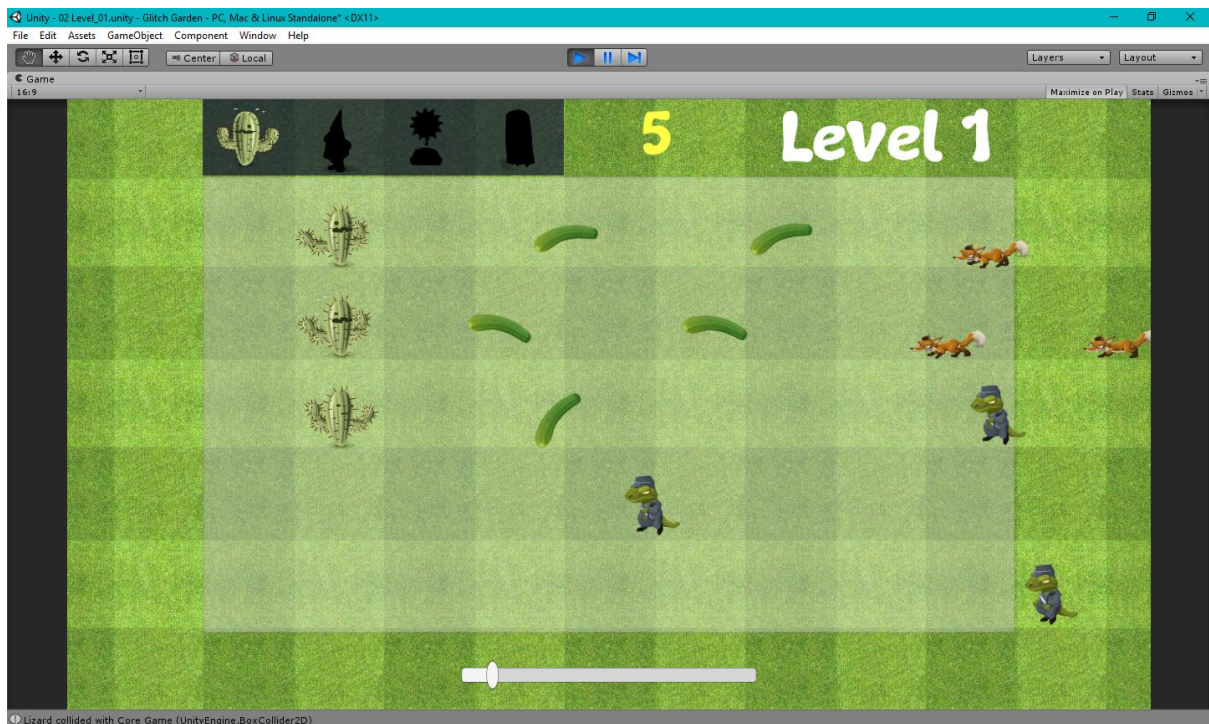
## Block Breaker



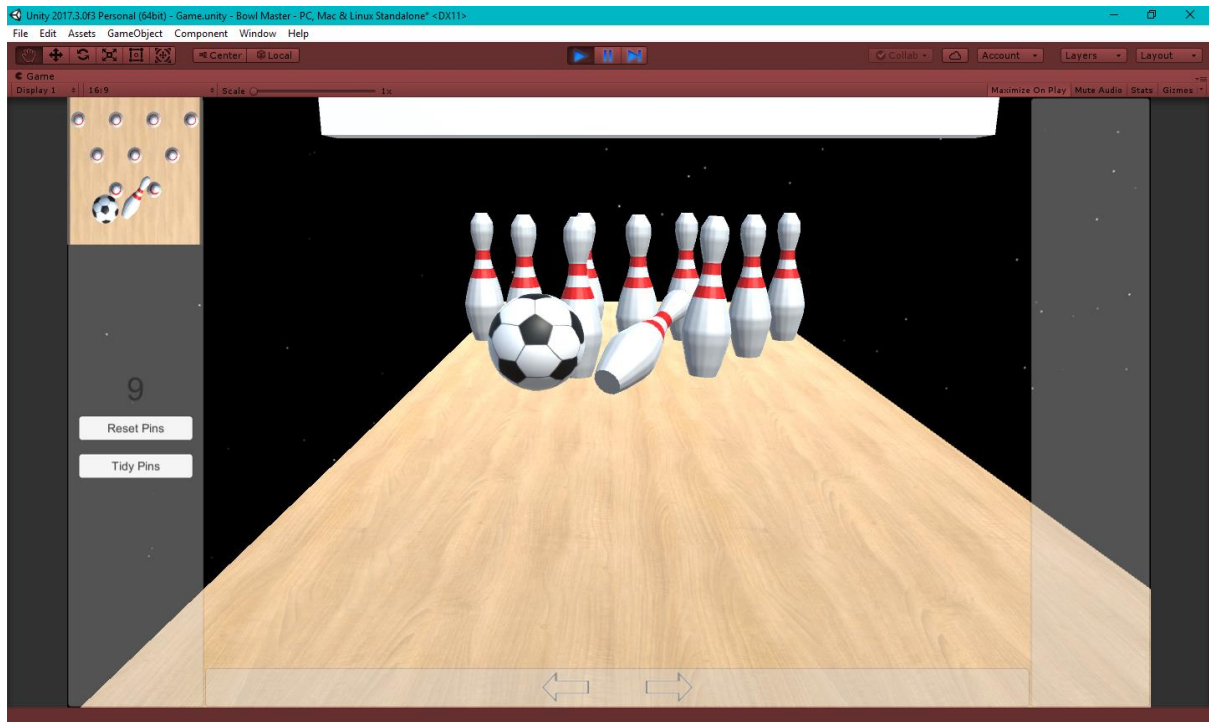
## Space Invaders



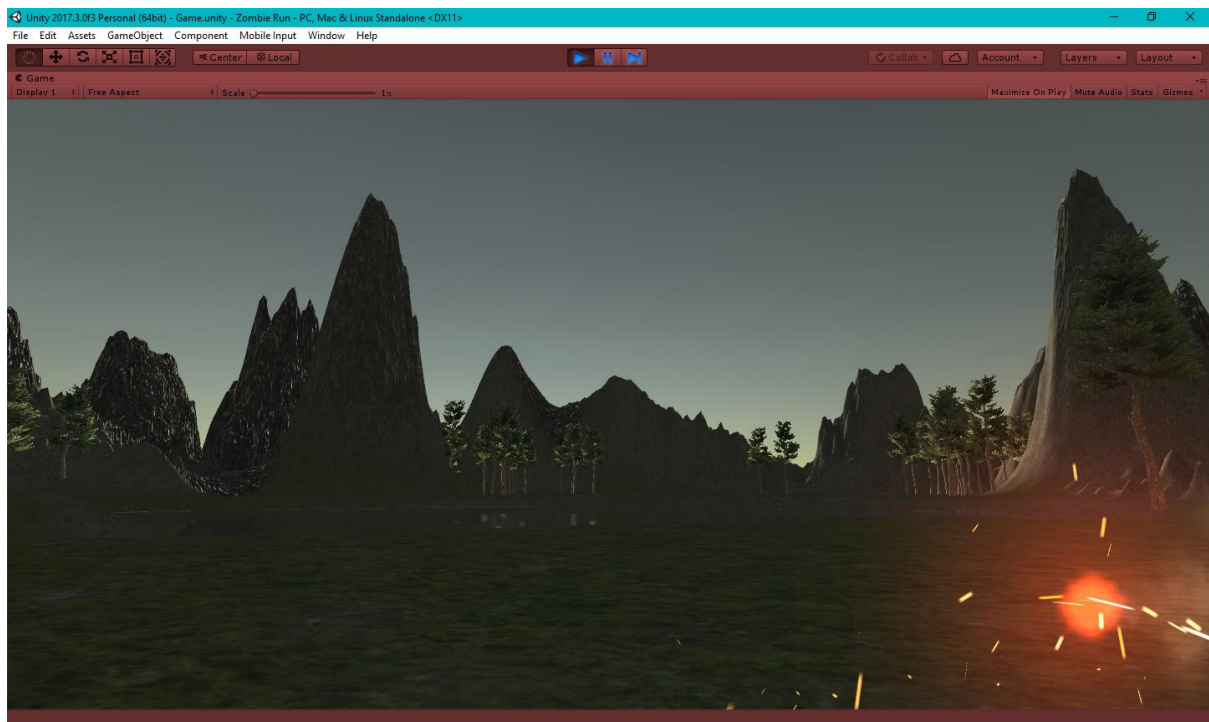
## Glitch Garden



## Bowl Master



## Zombie Run





## My Game Interview Questions

Name of participant:

Date:

Rate the main teleporting mechanic: ★★★★★

What specifically did you like/dislike about this game mechanic?

Rate the main cloning mechanic: ★★★★★

What specifically did you like/dislike about this game mechanic?

Rate the level design: ★★★★★

What specifically did you like/dislike about the level design?

Rate the art style: ★★★★★

Was the art style appropriate for the game?

Rate the difficulty of the game: ★★★★★

Why did you find it this difficult?

## My Game Interview Questions

Rate the overall experience: ☆☆☆☆☆

How did you feel when playing the game?

What improvements or features would you add to the game?

Would you play this game again, given the chance? Why?

Any final comments/impressions about the game?

What should I call the game?

Advice/Help required when playing the game:

Bugs found while playing the game:

Document 10: My Game Completed Interview Questionnaire, side 1

**My Game Interview Questions**

Name of participant: *Karen Ann Morgan* Date: *21-07-18*

Rate the main teleporting mechanic: ★★★★★

What specifically did you like/dislike about this game mechanic?

*Love switching places, makes you think about how you use the space you need to think differently about how you use the space you have. Same with cloning, it means you have to think & play completely differently.*

Rate the main cloning mechanic: ★★★★★

What specifically did you like/dislike about this game mechanic?

*Like how they could hold things*

Rate the level design: ★★★★★

What specifically did you like/dislike about the level design?

*Like - good to reach*

*Dislike - character has two 100% of way circle*  
*I keep getting stuck in walls*  
*Doesn't open faster*

Rate the art style: ★★★★★

Was the art style appropriate for the game?

*Yes, it's kinda funny*  
*Simple - doesn't distract*  
*Chronically pleasing*

*Yes but all appropriate for the game*

Rate the difficulty of the game: ★★★★★

Why did you find it this difficult?

*Low*  
*To find the best solution you had to think*  
*compelling about how to explain clone & teleporting.*

## Document 10: My Game Completed Interview Questionnaire, side 2

**My Game Interview Questions**

Rate the overall experience: <sup>interesting</sup> ☆☆☆☆☆

How did you feel when playing the game?  
good, interested.

What improvements or features would you add to the game?

- character movement was a bit more responsive?
- the robots are faster (more better @ killing you).

Would you play this game again, given the chance? Why?  
Yes, it ~~wasn't~~ has interesting game mechanics,  
or I want to play more levels. Also intrigued about a  
Story line. ~~very~~

Any final comments/impressions about the game?  
Lit.

What should I call the game?  
Quantum Clones

Advice/Help required when playing the game:

Bugs found while playing the game:

- Guards don't notice player all the time
- Guards don't accurately shoot