

GAME BALANCING - THEORY AND PRACTICE

A REPORT SUBMITTED TO MANCHESTER METROPOLITAN UNIVERSITY
FOR THE DEGREE OF BACHELOR OF SCIENCE
IN THE FACULTY OF SCIENCE AND ENGINEERING



2020

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Abstract

Throughout the evolution of video game entertainment, the number one top priority has always been to make the game as entertaining as possible for the consumer. In game design there are a multitude of fundamental pillars that need to be considered and followed for a game to be successful. For this project I wanted to develop a product that would aid in the understanding of one of these pillars. The fundamental aspect I wanted to focus on was game balancing. Game balancing is instrumental towards the players experience of any game, depending on how it is balanced affects which market your game accommodates to and what feedback you would be getting from the general populous towards your game. That's why I asked the question, how does game balancing have an impact on the players experience? After doing some research I figured out how I wanted to approach this question. My methodology was to construct a first-person shooter simulation that I can use as a test environment for participants to attempt and then after completing the simulation the participants can fill out the survey I had constructed. **See appendix B for survey questions.** All participants were students at MMU and no personal information or data was required from them. This survey gave me quantitative data that I believed could be valuable in approaching an answer towards the main question of this project.

After interpreting and analysing the data I received back from the participants, I was able to construct and develop an answer towards my overall question. The results that I received from the survey were very interesting because patterns and similarity were clearly visible. It became obvious that a direct correlation could be identified between game balancing and a player's experience. Some of the trends that could be seen from the survey results mirror what we currently see in the game industry right now, which I believe further validates this research. Finally, I conclude that from the data that was gathered that increasing the difficulty using game balancing gave most participants that took part a more enjoyable experience. I was also able to identify that out of the three variables I was working on modifying the difficulty of in this FPS simulation, the health of the enemy AI had the largest impact on the players experience while their movement speed when chasing the player was the least impactful. I believe that the results I obtained from this project helped show how important game balancing is for the fundamentals of game design.

Declaration

No part of this project has been submitted in support of an application for any other degree or qualification at this or any other institute of learning. Apart from those parts of the project containing citations to the work of others, this project is my own unaided work. This work has been carried out in accordance with the Manchester Metropolitan University research ethics procedures and has received ethical approval number 13137.

Signed: Milad Shukri

Date: 29/2/2020

Acknowledgements

First, and most of all, I would like to thank my supervisor Dr Robert Cherry, for his guidance and complete support throughout my project who was instrumental to its completion.

Secondly, I would like to thank all the people that contributed and took part in my research by giving me the data I needed to determine these results.

And, finally I want to acknowledge the support and great love I have received from my closest friends, Jade and my family, my mother, Aisha and my father, Nureddin. I would not have made it this far without their support.

Abbreviations

| | |
|-----|-------------------------|
| FPS | First Person Shooter |
| AI | Artificial Intelligence |
| UI | User Interface |

Chapter 1

Introduction

The experiences that people create while playing games is one of the most important components to the development of any game. The players experience is determined by a lot of factors in game design, one of the largest factors being game balancing. 'Game balance is a game design concept where the strengths of a character or a particular strategy are offset by a proportional drawback in another area to prevent domination of one character or gaming approach.' (*Techopedia*, 2020). Despite the effort that is made, it is impossible to completely balance a game. The more complex the games mechanics and systems become the more difficult it becomes to reach a completely balanced state.

In every game genre there is a multitude of various factors and variables that can affect the overall game balance. For my project I focused on the FPS (First Person Shooter) genre, I designed a very simple zombie first person shooter simulation where you go around a map defeating a specific number of zombies. I can use this simulation to identify key areas of game balancing. The area of game balancing in this scenario I specifically wanted to focus on, was the AI of the zombies. I could have focused on a wider range of variables in this genre that could have determine the balance of the game (e.g., Environment, score-system, resource-management) but I wanted to narrow down my research to focus directly on three variables within the zombies AI (i.e., the damage that the zombies deal to the player, the health points that the zombies have and the movement-speed at which they chase the player). I feel that these three variables of the zombies AI have a direct impact on the balance of the game, therefore effecting the players overall experience of the game.

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As a result of determining these three variables of the AI, I could emphasise these aspects within my FPS simulation and allow for people to play the simulation and construct their own opinions on the balance of the game by filling in the survey afterwards. I made sure all participants of the survey were students at MMU and no personal information or data was required. I could then gather the data sets from the survey and identify which variables have certain influences on the balance of the game. I feel that the information I gathered from this project is very useful in determining how game balancing AI can have an impact on the general players experience. The reason I want to focus on this question specifically is because understanding how to balance a game towards a certain audience/s is crucial in the development of a successful game.

Depending on the audience you're trying to target it is necessary to modify the balance of the game to fit that audiences preferred difficulty. This can be seen clearly within the industry with the wide variety of differently balanced games when it comes to zombie AI enemies, these range from large quantities but easier to defeat enemies (horde like in nature) to much fewer in quantity but a lot more difficulty to defeat in nature. This range of differently balanced AI allows for multiple completely different experiences to be had in any game, which I feel makes game balancing a key point in understanding which experiences you want to create within any game.

My main aim for this project is to get a better understanding on the general consensus of how modifying and adjusting the balance of the enemy AI will have an impact on their experience of my FPS Simulation, from the research I have conducted I believe that game balancing in any form has one of the largest influences on the players experience. This means that it has a direct impact on the consumer, which is vital to understand in any industry not just this narrow market within entertainment. I hope with my results to open up a small window into understanding how the most minor of modifications and adjustments could have a significant impact on consumers.

The top priority of any video game is to be entertaining for consumers. So, understanding how aspects of game balancing can influence the entertainment value is very important. The majority of games in the industry balance their game manually by being able to set the level of difficulty, these levels of difficulty are defined by changing specific variables like increase in enemy health, damage or larger quantities of enemies, to make the game either easier or more difficult and then setting these at different levels like easy, normal, hard, very hard.

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These vary in name but usually have the exact same meanings from game to game. Some unique games within the industry introduce dynamic ways of balancing the game, this is usually done by the player making choices that effect the games difficulty while they are simultaneously playing the game. For my project I aimed to focus on the manual changes in the level of difficulty, I did this by changing specific variables like health, damage and movement-speed of the zombies (like what can be seen in the industry) to see how set levels of difficulty would have an effect on the players experience.

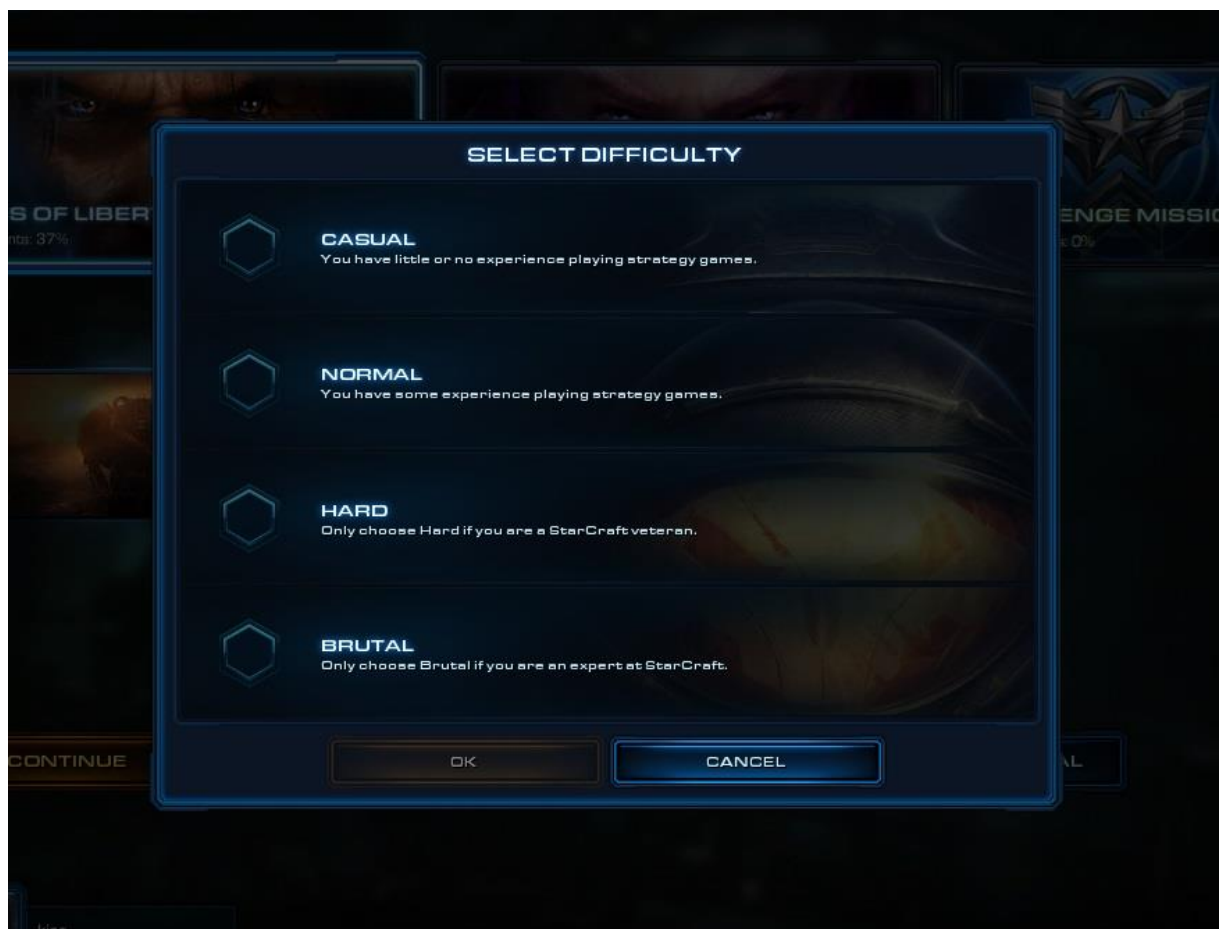


Figure 1.1: Example of manual set levels of difficulty seen in the real time strategy game StarCraft 2

Chapter 2

Literature Review

2.1 Background

Game balancing is a fundamental pillar of game design and is crucial in the development of any genre of game. For my project I worked on game balancing in the FPS genre by producing a small FPS simulation where the variables of the AI can be changed showing how game balancing effects the playing experience. Most of the games in the industry currently use what is known as manual game balancing techniques. This is where the variables are manually changed for different levels of difficulty, this could be set at the beginning of the game by the players decision using an “easy” to “hard” scale (**see figure 1.1**) as well as most games slowly increase the difficulty throughout the game. ‘Simply playing the game and getting experience with it, your audience will eventually become more skilled at the game. This is one reason why the later levels of video games are usually harder than the earlier levels.’ (*Level 12.0: Game Balance: Game Design Concepts*, 2020).

This concept has been tried and tested for decades within the game industry and seems to work consistently. Allowing for a range of different difficulties that the player can choose from enables a wider diversity of people that can play as it accommodates to a larger range of skills levels. This decision of what difficulty to play at also improves replay ability of the game as many consumers in the current market tend to play the game on higher difficulty the second time through as they have become more skilled.

CHAPTER 2. LITERATURE REVIEW

After researching the area of game balancing that I was focusing on, I discovered that there wasn't much research done on how balancing can impact the experience of the player. This is the reason behind why I constructed my overall question for this project. I felt if I could analyse and interpret the data, I received from the simulation then I would be able to produce an answer to my question. This answer would further aid in the development of a better understanding towards the influence that game balancing has on the player. The work that this project pushes towards could possibly be a net benefit towards understanding the fundamentals of game balancing and its importance in game design for the industry.

2.2 Existing work related to my project

There were two main papers about game balancing that really took my interest that were somewhat related to my project. The first paper was on "Dynamic Game Balancing: An Evaluation of User Satisfaction". This paper was very interesting to me because it's quite similar to mine as it talks about how "User satisfaction in computer games seems to be influenced by game balance, the level of challenge faced by the user." (*Andrade, Ramalho, Gomes, Corruble, 2006*) The paper talks about how players learning curves over time interact with the fundamentals of game balancing concepts and techniques. I believe that reading this paper really helped improve my understanding of the general field and I feel like my project interacts quite well with this paper.

The second paper that really took my interest was on "Extending Reinforcement Learning to Provide Dynamic Game Balancing". The reason behind why I felt this paper was interesting was because it talks about "innovative use of reinforcement learning to build intelligent agents that adapt their behaviour in order to provide dynamic game balancing." (*Andrade, Ramalho, Santana, Corruble, 2005*). I feel that using reinforcement learning to balance games is a very unique method of game balancing and we are currently slowly seeing more and more projects in the market that are trying to incorporate reinforcement learning into their games. "Reinforcement learning is the training of machine learning models to make a sequence of decisions. The agent learns to achieve a goal in an uncertain, potentially complex environment." (*Osiński and Budek, 2020*).

CHAPTER 2. LITERATURE REVIEW

Many believe that these forms of machine learning have an important future in game balancing especially when it comes to incorporating better Artificial intelligence into new games. I feel like this paper and my project show a good contrast in the methods used to balance games in the current market. I think we are starting to see a trend in the industry where development teams are starting to move away from manual game balancing and are starting to consider new ways of incorporating dynamic balancing techniques such as reinforcement learning to produce a better experience for players as well as fundamentally changing how games are designed.

2.3 The wider issues of this project

For my project I did a lot of research on how to develop the game while maintaining a minimal amount of errors. Thankfully using the unity engine to develop the game already starts the project off with a lot of software robustness. This meant that I don't have to worry about build errors or allow access to any special privileges as long as I don't mess around with the settings too much. When using unity, I knew that I would have to maintain version control to some extent to prevent any errors occurring if the software updates during the development of my project. To stop these issues from taking place I made sure that I stayed on unity version 2019.2.0b1 throughout the whole development process up to completion so that no problems would occur.

When producing the code for the game I made sure to check the debug console frequently to see if any errors took place that I would need to deal with before running the game. Unity has a great built-in function where if the errors in the code are potentially software breaking then it won't let you run the game at all to test it. However, if the errors are minor and don't affect the running of the application then the error output will just show up in the console while you run the game. I also made sure to comment, indent and document all my code to increase the overall readability of my work. So that if I or others wanted to read or make adjustments to the code in the future, it would be possible to do without wasting time on trying to understand how the code works. Thankfully all the programming errors I received throughout project were not very large issues and there is a considerable amount of resources online that allowed for me to learn and fix bugs in my product. Other than software robustness I couldn't really identify any other wider issues of my project, no personal information or data is required from the participants so no ethical issues were visible as long as I made sure not to let minors play the simulation which we were informed wasn't allowed anyway, the demographic that took part were all students at MMU.

Chapter 3

Methodology

3.1 Explanation of my methodology

For my project I wanted to ask one specific question, how can game balancing have an effect on a player's experience? The method in which I approached this question was by designing and producing a FPS simulation that focus on three specific variables of the enemy AI (Enemy Health, Damage that they deal to you and the speed at which they run towards you). People played this game and after completion proceeded to fill out a specifically designed survey, that assisted me in understanding the relationship between game balancing and the consumers experience. The reason I wanted to do a survey in this project is so that I could gather quantitative data to allow for a visual representation of the correlation between balancing specific aspects of the AI and the average players experience. I wanted to observe and see if a pattern could be identified between these two components.

The simulation consisted of five levels that were on the same map and had 10 zombies on each. The first level was designed to be a baseline where all of the AI was at its weakest and no variables were modified. The second, third and fourth level was the same as level one but with each one a different variable was increased. The second being the AI dealt more damage, the third being the health of the AI and the fourth was the movement speed at which the AI move towards you. Finally, the fifth level had all 3 variables increased to make the game more difficult and this was to see the overall contrast between level 1 and 5. I also considered implementing a simple ammunition system for the gun that is used to defeat the zombies. The reason behind why I didn't end up eventually adding it is because this brings in a different aspect of game balancing known as resource management balancing and I only wanted to focus on the balancing of the AI specifically. Maybe if I wanted to do future work on this project, I could come back and implement that feature.

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When creating the user interface for the game it was important that I kept it minimal and simple so that it didn't make the screen too busy and therefore take away from the experience of the game. For the UI I implemented a health count displayed in the bottom left corner, a description of what level the player is on in the top left corner, a kill count in the bottom right corner and then a cross hair in the middle of the screen to assist the player in aiming. I also added code that enabled a damage flash to occur when the player took damage. All the code for the UI was also put into the void update code in unity so that it would constantly update the information displayed on the screen like when the health decreases or the kill count increases.

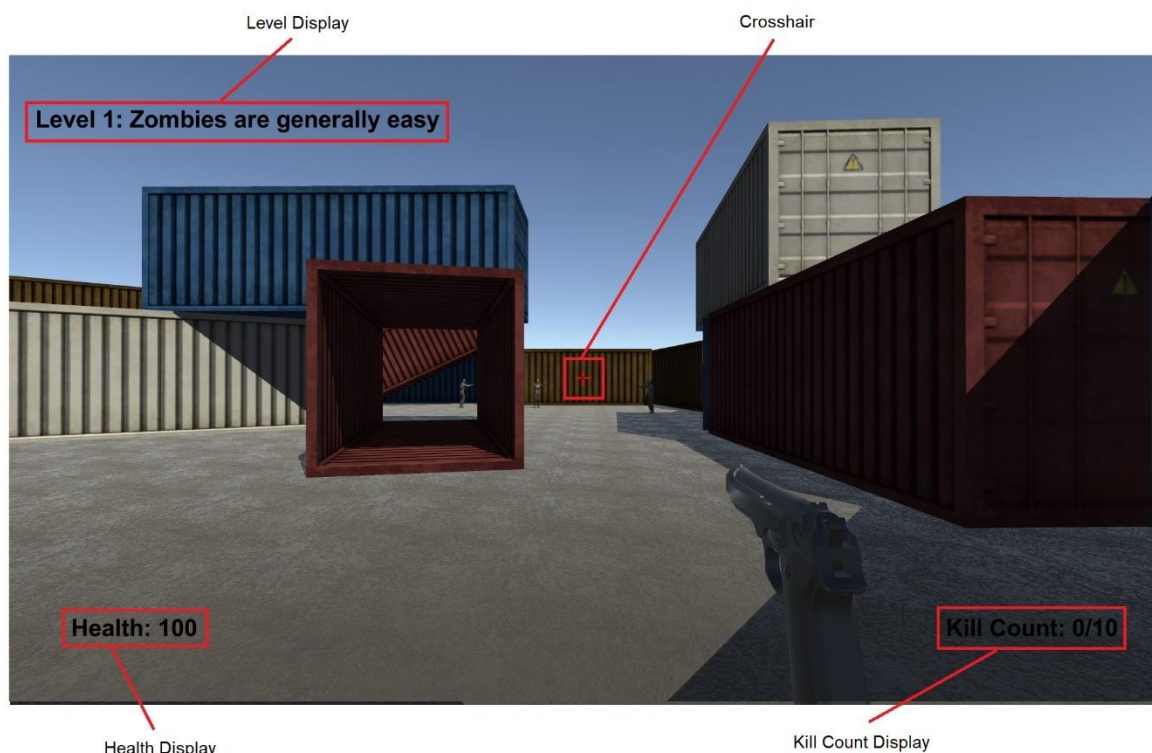


Figure 3.1: Example of the user interface from level 1

Towards the beginning of the project my main priority was considering how I wanted to construct this small game/simulation. Originally, I wanted to create it from the ground up, starting by developing the game engine and then working up from there, but I realized within the time frame I was given for this project that would not be realistic. The time frame was approximately about a year from the end of second year to the deadline for the project in February, which means it would of been quite infeasible to complete a suitable project in time, because of this I decided to look at different open source game engines that are widely known and used in the industry. The two main game engines that I identified to be suitable for this project was Unreal Engine developed by Epic Games and Unity which is developed by Unity Technologies.

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When considering which engine, I wanted to use I was mainly focusing on which language it would have to be programmed in as these two engines mainly use different languages, Unreal Engine being C++ and Unity being C-Sharp. Although I had some previous experience with Unreal Engine I ended up going with Unity because I am considerably more comfortable with programming in C-Sharp and I felt that programming at a decent speed and rate of productivity was very important for me to be able to reach my objectives and milestones on time.

```
// This grabs the vector 3 direction by getting the position of the player and minusing it by the zombies position
Vector3 direction = player.position - this.transform.position;

// This if statement checks to see if the distance between the players position and zombies position is less then 10
if (Vector3.Distance(player.position, this.transform.position) < 8)
{
    // Sets the y direction so that if the player walks up to the zombie they won't start tilting back
    direction.y = 0;
    // This uses a slerp for the rotation of the zombie to make it feel more human like and natural
    this.transform.rotation = Quaternion.Slerp(this.transform.rotation, Quaternion.LookRotation(direction), 0.1f);
    // If statement is to see if the magnitude is greater then 1
    if (direction.magnitude > 1)
    {
        // This plays the walk animation for the zombie when it is chasing the player
        TheEnemy.GetComponent<Animation>().Play("Z_Walk");
        // Sets the speed of the zombie when it starts to chase the player
        this.transform.Translate(0, 0, 0.075f);
    }
}
```

Figure 3.2: Example of the C# code used to develop my code

The Unity engine is a very diverse and powerful software that is used in a multitude of industries but is mainly a tool used for game design. It is widely renowned within the industry for being very easy to pick-up and allow for any person to start creating their own projects. This made it very enticing to use for my simulation and was one of a few key reasons to why I eventually picked it. Unity primarily caters towards programming in C-Sharp which was great because I already had an intermediate knowledge in scripting in the object-orientated language due to previous university assignments. I started by researching the scripts that I would need to create this game. After extensive research of looking into how other people have structured the scripts within their game it is clear that I would need to separate my C-Sharp classes into three sections, player-character, AI and environment scripts. This helped a considerable amount when organizing the work that needed to be done and allowed for me to structure a plan that i was able to use throughout the development of the project.

3.2 My method of data collection

For my method of data collection, I felt that a survey to be completed after the game is played would be the most appropriate way of collecting quantitative data. I wanted to collect

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quantitative data because it allows me to draw a picture of the general consensus towards game balancing on specifically the three variables I was focusing on. From the visualisation of this data I can get closer towards answering my main question for this project as well as increasing my depth of knowledge in this field. I wanted the game to have a smooth transition straight into the survey so that I did not waste the participants time. So that I could achieve this I made sure to have a button in the game that after completing the simulation leads you straight to a Google forms survey, where they can fill it out and submit a response.

For the survey itself I went for a simple Google forms survey because it is quick and easy to construct a simple survey which is perfect for what I was trying to achieve. When I was constructing the survey I took careful consideration into how many questions I was going to ask the participants, it was important that I made every question clear and concise to prevent any confusion and I also wanted to make sure that I didn't create too many questions as I felt this would waste a lot of the participants time. I also felt that having too many questions would produce too much data for me to manage and would in turn make it quite difficult to maintain and filter the data correctly, in the time I was given, if the data-set was too large then it could have a direct effect on the results and therefore making visual representations inaccurate. Due to that fact, I created only eight questions that are very specific and the results of which would give me the information that I need to produce a conclusion to the overall question of my project.

| Questions | Answer Format |
|--|--|
| Were you able to complete all 5 levels on your first attempt? | Yes or No |
| If no, which level/s did you fail? | Level 1 to 5 scale |
| Did you feel a difference in difficulty between level 1 and level 5? | Yes or No |
| Which characteristic when modified was the most difficult? | Higher zombie damage, Higher zombie health, faster zombie movement speed or didn't feel any difference. |
| I enjoyed the game more when the zombies were more difficult. | Strongly Agree to Strongly Disagree scale |
| Which aspect of the zombies did you feel had the least effect on their difficulty? | Higher zombie damage, Higher zombie health, faster zombie movement speed or felt they all had the same level of effect on the zombie's difficulty. |
| What do you feel would make the simulation more challenging? | A larger quantity of zombies that are easier to kill or Fewer zombies that are stronger and harder to kill |
| Finally, which of these do you think would produce a more enjoyable experience? | A larger quantity of zombies that are easier to kill or Fewer zombies that are stronger and harder to kill |

Table 3.1: Question format for the survey.

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As you can see from table 2.1, I tried to make sure that all my questions were constructed in a simple and easy way to understand so that participants could fill out the survey as quickly as possible. I also created the answer formats for each question to focus directly on the data I needed to collect to construct a better understanding towards the aim of my project. When releasing the project and survey for people to complete I wanted to try and gather as many results from participants as I could to make the results from the survey as reliable as possible. I also made sure that all participants were students at MMU and no personal information or data was required from them. I was fortunate enough to get a sample size of 50 people before I closed the responses so that I could measure and analyse the dataset that I had received. I was planning on having a larger sample size than 50 participants but due to unforeseen circumstances (coronavirus pandemic) I had to close the responses early as it was not possible to collect any more data. If there was more time for the simulation and survey to be run for people to play, then I would have been able to increase my level of accuracy as well as making it easier to identify correlations and patterns and singling outliers.

3.3 My method of data analysis

For my method of data analysis, I wanted to make sure that all the data I gathered from the survey could be visualized in graphs and charts to see if patterns and correlations could be identified. My main aim is to see if I could find any trends between balancing specific variables of the game and the players experience towards those aspects. My survey was produced on google forms which allowed for me to export all the data from the results into a .csv file for me to import into Matlab. I could then use the data from the .csv file to plot the charts that I need for the project.

'Matlab combines a desktop environment tuned for iterative analysis and design processes with a programming with a programming language that expresses matrix and array mathematics directly.' (*MathWorks, 2020*) I decided Matlab would be the tool I used to plot my graphs because I do have some previous knowledge on the software from other units. I also understand that Matlab would produce great visual representations of the data I have collected from my work with little to no ease. It would have been possible but highly impractical to manually plot all the data into graphs, this would also leave a very high chance of human error and uncertainty occurring. Using this software minimized the amount of human error occurring while also plotting the data precisely and as accurately as possible. It

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is crucial that when the data is plotted that the visualization is completely accurate so that we can have the best understanding of what the data represents. If the data is not represented precisely, then it makes it quite difficult to make any reliable conclusion on what I am trying to answer. Google forms already comes with pie charts of the results from the survey, but they struggle to represent the data completely from all aspects although they do help with giving an initial understanding of the consensus.

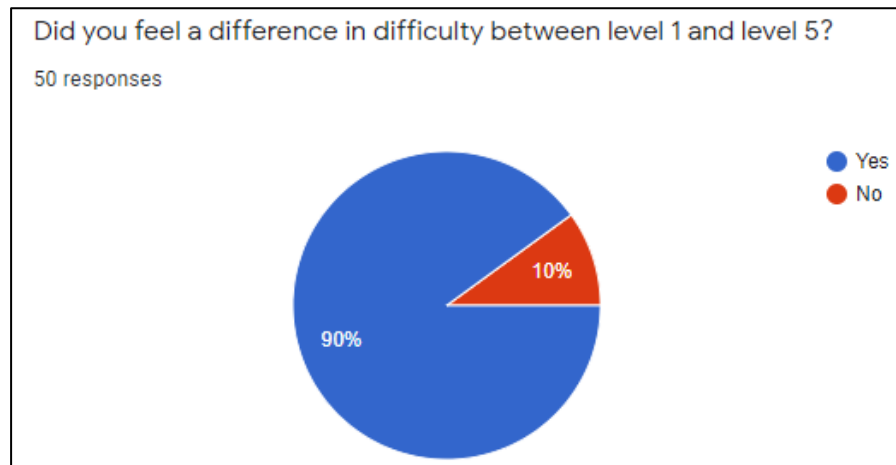


Figure 3.3: Example of the results from the survey

It is important for this project that I represent this data from all points of view to get the clearest understanding of what this data means to my project. It could be completely possible that my results are inconclusive, but there is a chance that I could be able to answer how game balancing influences the players experience. If it is possible to identify a direct correlation between the increase in a certain variable's difficulty and the experience that participants have then significant areas of my question can be answered.

3.4 Evaluating and justifying my methodological choices

I feel that the methods that I adopted for my methodology was quite the standard approach for quantitative research. 'Quantitative research is a method of research that relies on measuring variables using a numerical system, analysing these measurements using any of a variety of statistical models, and reporting relationships and associations and associations among the studied variables.' (*Quantitative Research - an overview | ScienceDirect Topics, 2020*) Game balancing is a very complex field with an incredibly wide range of applications but I wanted to focus on an incredibly small aspect of this field and produce a better understanding of it by applying my own skills that I have picked up since starting this project.

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For this project I aimed to answer a specific question about game balancing, I did this by constructing a game environment for players to test specific aspects of that question and then the results I got back from the research allowed for me to produce a conclusion that aids in the discovery of an answer.

This project could have been constructed as a mix of qualitative and quantitative research but I wanted to specifically focus on the quantitative area because I felt that gathering numerical data would allow me to draw a better picture of results when analysing the data. My end goal for this project is for anyone to be able to pick up this report and gain a strong understanding on “how can game balancing have an effect on a players experience?” from the visual representations of the data I gathered. ‘Graphs are a common method to visually illustrate relationships in the data. The purpose of a graph is to present data that are too numerous or complicated to be described adequately in the text and in less space.’ (*Slutsky, 2020*)

Under the time constraints that I had, I believed that the methods that I used to gather and analyse the data were the most suitable for the scenario I was in. If a longer timeframe had been given, more variety in the methods of gathering data would have been added, with the current state of the project all the data gathered was from one area, this was the survey. With access to more time, participants could have had their gameplay recorded and observed to see if any patterns could be identified in the participants playstyles. This would have allowed me to see if a relationship could be discovered between the players playstyle and the balance of the game as well as the players experience, which would have been quite interesting to see. Unfortunately analysing and understanding all the recording data that this would have produced would have been very time consuming for me to fit into this project due to already being on such a tight schedule throughout the academic year. I also believe that identifying behavioural patterns in a participant’s play style is not really the focus of this project and I do not consider myself qualified to analyse and evaluate such information. Nevertheless, these are the justifications behind why certain methods were introduced and why other methods were dismissed for this project.

Chapter 4

Findings and Discussion

4.1 Explanation and interpretation of my results

After careful deliberation of the results that I gathered from the survey, I have discovered some quite interesting information from the participants that attempted the simulation. All of the data was plotted using Matlab where I programmed the charts from an imported csv file I obtained from the survey. **See appendix A for Matlab source code for plotting data.** The first question I asked the participants in the survey was, “Were you able to complete all 5 levels on your first attempt?”, I believed that the answers from this question would help me lay a foundation on understanding the general skill level of the people that took part in this project ,these were the results that I obtained.

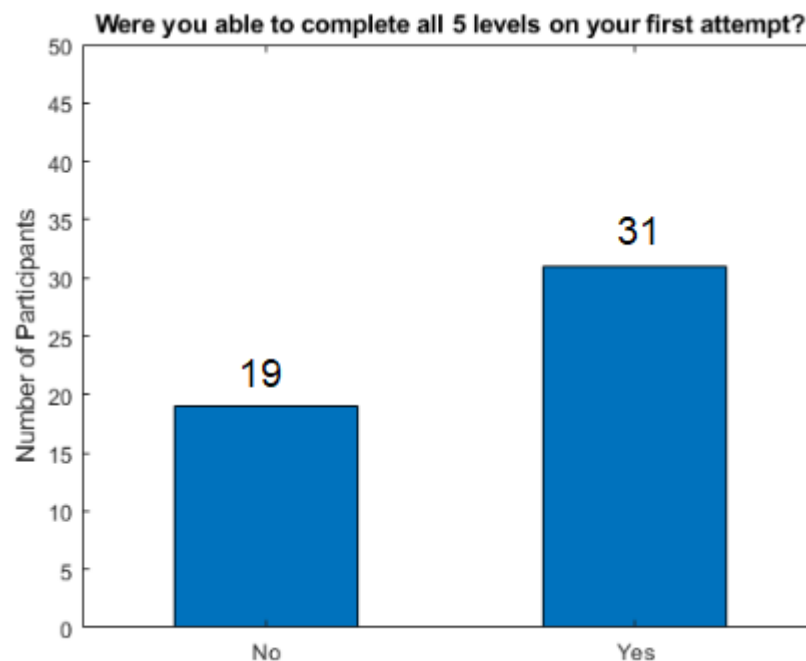


Figure 4.1: Bar chart of results from question one

As you can see from the chart above, more than half the people (62%) that took part in the survey said that they completed it on the first attempt. This is interesting because it shows us that a considerable number of participants must have struggled on some of the levels as there was not a landslide majority. This directly leads into question two which only had to be answered by participants that failed a level or multiple.

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Question two asks “If no, which level/s did you fail?”, I asked this question because I wanted to see what levels people struggled on the most, the results of this question could help identify which variables when modified to make the zombies stronger have the most impact on the players experience.

If no, which level/s did you fail?

19 responses

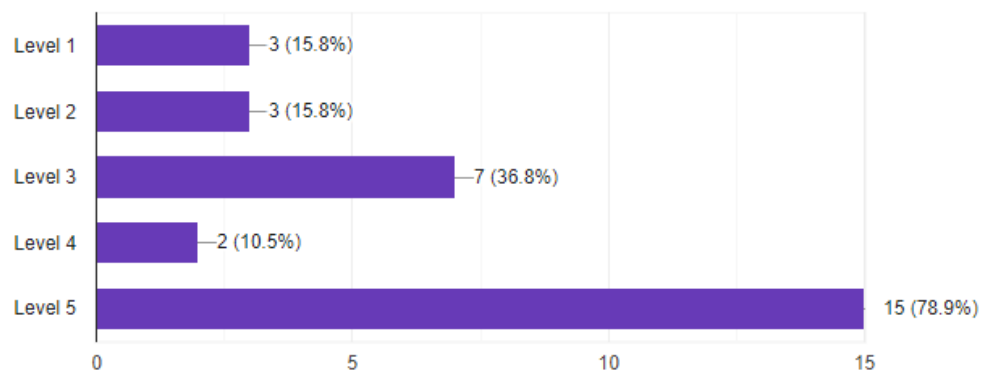


Figure 4.2: Bar chart of the results from question two (directly from google forms results)

The results from this chart show all the levels that the participants failed on, some participants failed a level more than once and/or multiple different levels but it is quite clear which levels had the biggest effect on the participants that took part in this project. From the results it is clear that level 5 was the level that people had the biggest difficulty with, which makes sense as this is the level where all three variables are modified to make the game more difficult. This is what I presumed the data would look like as this correlates with what you see in the game industry, the majority of games when manually increasing the difficulty will increase these same three components (enemy damage, enemy health and enemy movement speed) as well as other variables to make it more challenging to defeat the AI. Many people look for this challenge when playing games because generally people find it more entertaining if there is a bit of resistance from the AI as it makes it feel like you're going against an intelligent opponent.

What I also noticed from the results of this question is that it seems that people also tended to struggle with level three more than level two or four. This is very interesting because it visualizes that level three which had enemies with more health seemed to be more difficult for participants to complete than when the enemies damage or movement speed was increased.

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I believe this is very important information since it identifies that increasing the health variable of enemies seems to have a more of an effect on the players experience than the other two variables, this information will contribute when answering my main question.

The third question in my survey was “Did you feel a difference in difficulty between level 1 and level 5?” I wanted to ask this question so that I could see if the majority of the participants that took part felt the difference in difficulty that I implemented.

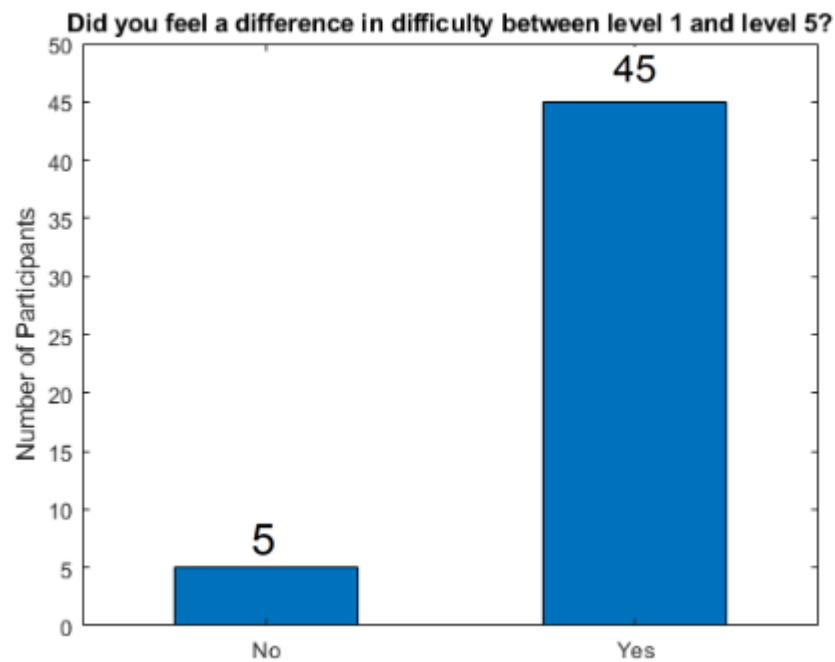


Figure 4.3: Bar chart of the results from question three

The bar chart shows that a considerable majority of the people that took part believed that they could feel the difference between the first level and the last. This was reassuring because it shows us that the three variables I modified had an impact on the players which was my intention. One of my biggest concerns when developing the project was that at points I felt like I did not make level 5 hard enough and I should have increased their attributes more, but in hindsight it's visible that I made the zombies strong enough for participants to feel a difference and their experiences effected.

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For question four I wanted to develop a question that would help back up the results that I received from question two and hopefully I would be able to see a correlation between the results of both questions. I also added an option for participants that didn't feel any difference in the zombie's attributes even after they were modified to be stronger, this was to see if the alterations I made to the AI were actually significant.

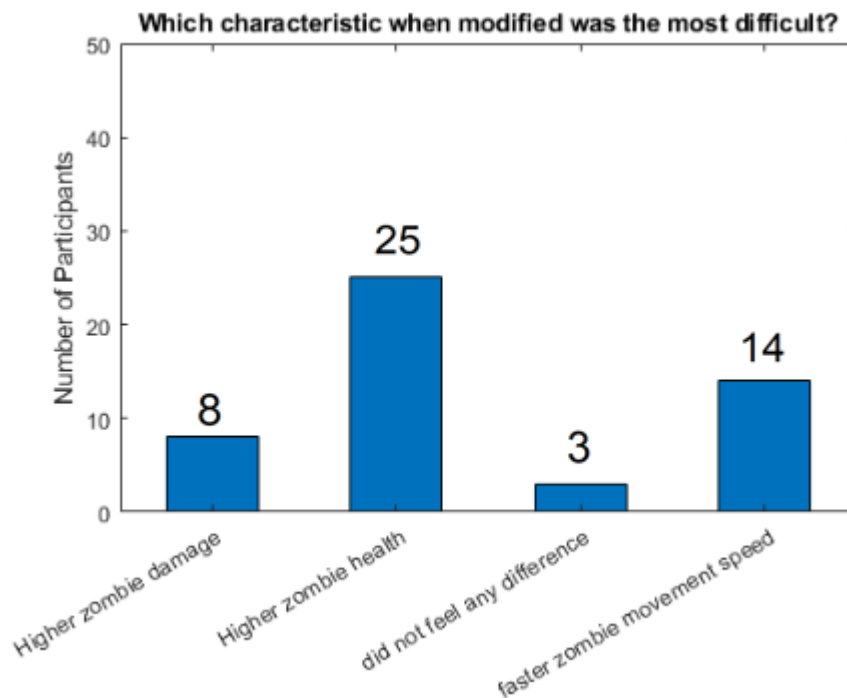


Figure 4.4: Bar chart of the results from question four

We can see from the bar chart above that the results from this question looked quite similar to the results from question two as the participants taking part seem to feel that the higher zombie health made levels in the simulation more difficult. The results from question 4 show that level 3 (zombie health variable is increased) is also the level that had the greatest number of failed attempts from the same group of participants. Due to these two tables having a strong correlation you could say that a pattern is starting to occur with the data gathered from this research, the further I analyse these findings it is clear that trends are starting to become visible and I may be able to produce a solid answer to the overall question to this project.

CHAPTER 4. FINDINGS AND DISCUSSION

For question five I wanted to see if participants gained a positive experience from playing the simulation when it was more difficult by giving the hypothetical “I enjoyed the game more when the zombies were more difficult” and allowing them to respond on a strongly agree to strongly disagree scale. The reason behind asking this question is because I wanted to identify how the difficulty of the zombie AI affected the players experience throughout the simulation.

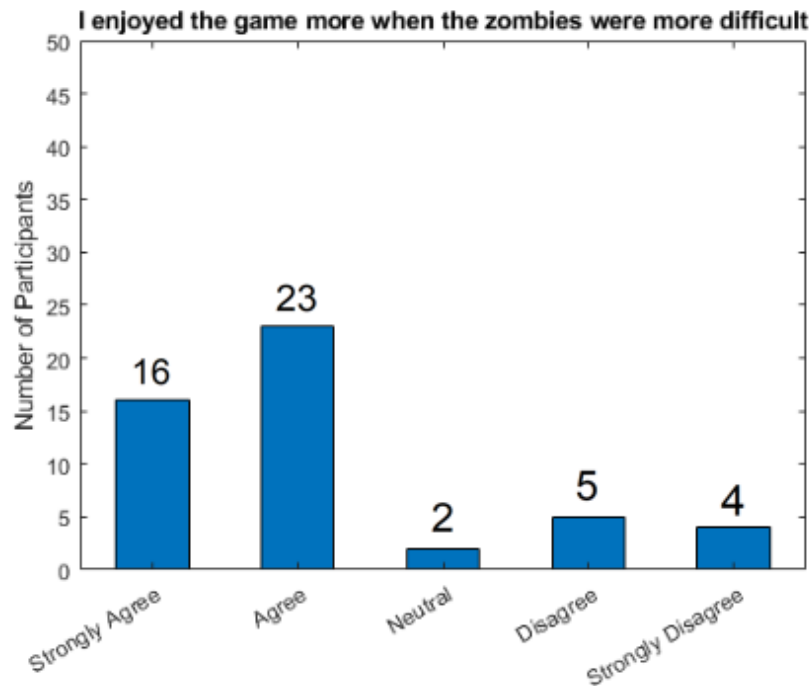


Figure 4.5: Bar chart of the results from question five

The results from this chart are quite significant, as you can see the overwhelming majority (78%) of people either agreed or strongly agreed with the statement I presented. This means that for most participants that took part enjoyed the simulation more when it was more challenging. This data is significant and will also contribute to the answering of my main question the fact that 78% of people that played this simulation agreed that it became more entertaining when the game was more difficult is notable because it shows us that changing the balance of the game can have a positive impact on the players experience. However, it should also be noted that not everyone will feel this way.

I wanted to identify which one of the components that I modified for the AI had the least effect on the participants experience so for question 6 I asked “Which aspect of the zombies did you feel had the least effect on their difficulty?” I felt like it was important to ask this question because with this information we know which variables in the AI should be prioritised to make the game appropriately more difficult.

CHAPTER 4. FINDINGS AND DISCUSSION

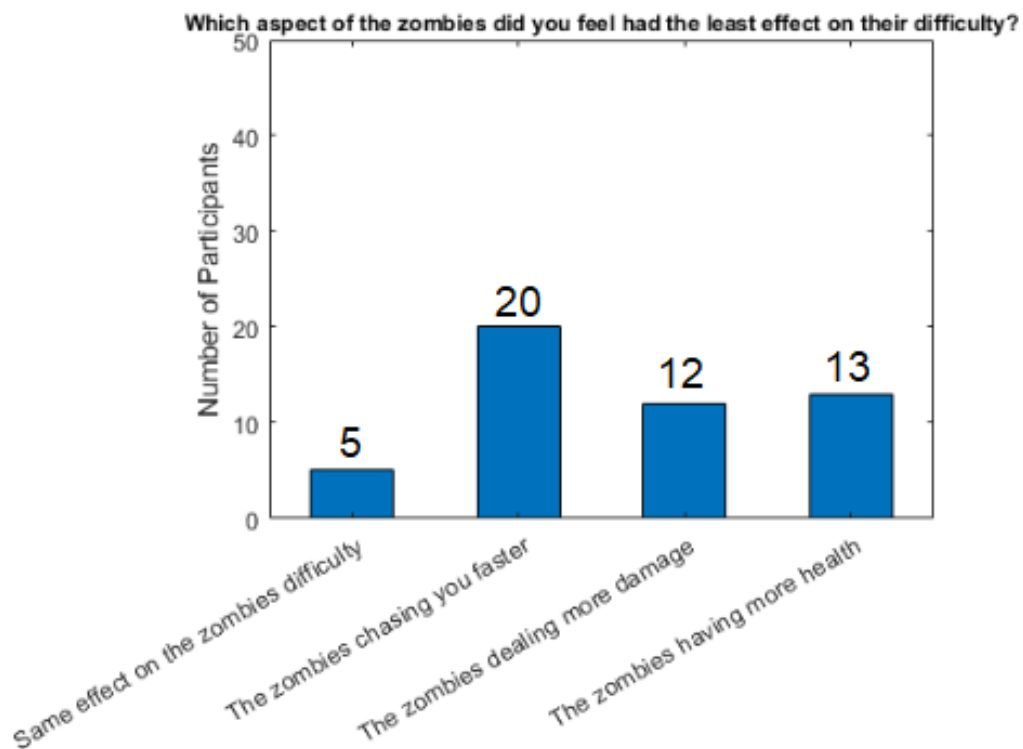


Figure 4.6: Bar chart of the results from question six

From the results above from question six you can see that there isn't any significant majority but the answer that was most popular by the participants was that they felt the zombies movement speed when chasing them had the least effect on the difficulty of the simulation meaning that maybe this variable shouldn't be a high priority when coming to modifying a games balance to effect it's difficulty.

For the last two questions I wanted to gather data on how the participants feel about the two main types of zombie AI you tend to see in the game industry. One type of AI you tend to see in zombie games is the so called "horde-like" zombies where they are quite weak but collect in masses like you see in games like Left 4 Dead and World War Z. The other type of zombie AI you see in the industry is the fewer in quantity but stronger AI, by stronger I mean their attributes (e.g., More Health, More Damage, etc) are increased to be made harder to eliminate therefore making the game more difficult, you can see this type in games like Resident Evil and Dayz. After taking these two types into consideration the last two questions I asked were, "What do you feel would make the simulation more challenging?" and finally "Which of these do you think would produce a more enjoyable experience?" and the options I gave the participants to choose from were the two main types of zombie AI you usually see within the industry.

CHAPTER 4. FINDINGS AND DISCUSSION

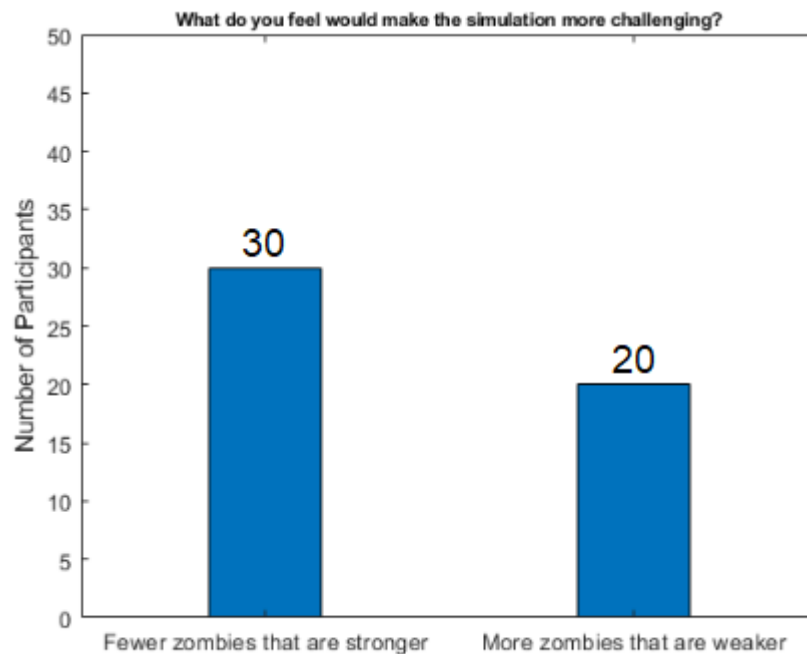


Figure 4.7: Bar chart of the results from question seven

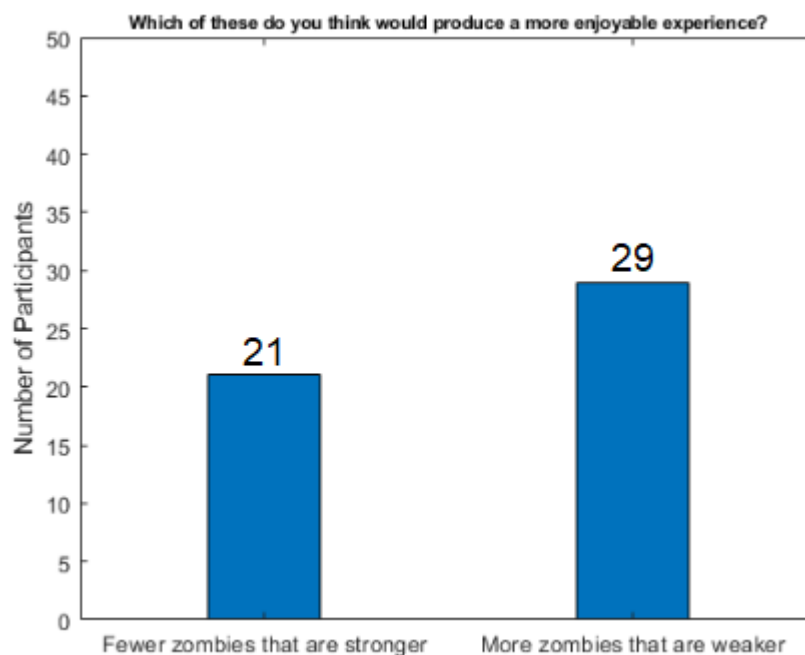


Figure 4.8: Bar chart of the results from question eight

As you can see from figure 3.7 and 3.8 the results split 60/40 and 58/42 respectively, these two sets of data when looked at together and compared are very significant. The bar charts results don't show any overwhelming majority which is understandable, because I believe that these results somewhat mirror what we see in the current industry, where usually the

CHAPTER 4. FINDINGS AND DISCUSSION

consumers lean towards one of these two types of AI. Another interesting point to identify when comparing these two data samples is that it seems that the participants believe that one type of opposition would make it more challenging, but the other type of opposition produces a more enjoyable experience. These results are not heavily one sided, but it was still a pattern that may have been identified and it was important that I developed the data more to gain a better understanding.

4.2 The implications of these results

I believe that these results provide a new insight into the symbiotic relationship between game balancing and the consumer's experience. I have proven that from the data I was able to gather, that modifying specific variables of the AI have an impact on the players experience of the game. It seems that from my group of participants that the vast majority of them enjoyed the game significantly more when it became more challenging. This is very useful data that could be used in the industry to improve the design and how they want to implement balancing into their new game titles. It is important that experiments like this take place so that when we are developing and improving new products, we are able to use the data to capitalize on as much profit within the market as possible. The more control a development company have over their consumers experience the more profit that can be made in the process. This can be seen within the wide range of successful titles that have been released since the beginning of this industry, the number one priority and goal has always been to keep people playing your product and if you understand how to balance a game appropriately for your target market then you are at a great advantage at reaching your goal.

My data shows that some variables of the AI I created had a larger impact than others on a players experience, from what I have interpreted it is clearly visible that the health of the AI seems to have the largest effect on a players experience by being the biggest factor on the difficulty of the game. This doesn't necessarily mean that the other two variables that I was also studying do not have an impact at all because that is not possible, every variable within the AI's programming has some effect on the experience of the participant no matter how small. This could also just mean that I did not increase the damage the AI deals and the movement speed when chasing enough, when I was modifying them to be more difficult. Maybe if I was to increase the variables further, I would have seen them have a larger impact on the games balance.

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I also feel that my work has some practical implications to it, from the sample size of participants data I was able to obtain, it was possible for me to see how the general populace felt towards the main two types of zombie AI in first person shooters. We can see that a small majority of the people that took part believed that fewer zombies that are stronger make the game more difficult but on the other side, playing against more zombies that are weaker lean towards having a more enjoyable experience. This can obviously vary depending on the target market you are focusing on but for my project I was not looking and directing my efforts towards any specific market of consumers.

4.3 Limitations of my project

Throughout my project I came across some relevant limitations. In every area of this project I found some limitations that I had to take into consideration and adapt my project around such limitations. The first limitation that I encountered with this project was the time constraints I was given to complete it, I had approximately a year to get this entire project completed. So, to deal with this limitation I set boundaries and goals for my project that I felt were feasible in the timeframes that I had. I also constructed a complete plan on how I wanted to manage my time on specific areas of the project, with this structure laid out in front of me I was able to use my time efficiently and reach my checkpoints every single time. 'The key to good time management is not to work more, but to work more efficiently. This means that you should structure your time so that you get more done in less time (without stress of course).' (*The Importance of Time Management (Aspects of Project Management Part 1)* - InLoox, 2020)

Another large limitation I came across was actually during the development of the game, what I noticed when developing the game was that it was not going to be feasible to learn and produce art assets for the project in the time frame I had. Another factor was that the aesthetic was not the focus of this project at all, so it does not really matter how visually pleasing it looks. I felt that it would be more practical to use free assets from the internet and then reference them appropriately as well as make sure that they got credit for their work. Due to this limitation some aspects of the game looked visually somewhat rough, but as I mentioned previously, aesthetics didn't really add any value to the aim of project so as long as the simulation was playable and did not have an impact on the results of my data there was no valid reason to waste time and resources on it.

CHAPTER 4. FINDINGS AND DISCUSSION

The final significant limitation I came across was during the planning of how I wanted to gather the data to answer my question. Originally, I wanted to reach a sample-size of approximately 100 participants, so that I could get a more precise set of data to interpret and analyse. Unfortunately, due to the recent global pandemic, I had to comprise with a smaller set of data because I was not able to get any more people to play through the simulation due to the government lockdown. I ended with receiving results from 50 participants, it was disappointing I was not able to reach the quantity I wanted but due to circumstances it was a limitation I would have to overcome.

Chapter 5

Conclusion

5.1 Answer the research question

The overall question for my project was “how does game balancing have an effect on the players experience?” I wanted to answer this question by gathering data from a survey that participants would fill out after playing the simulation that I created. After careful interpretation and analysing of the quantitative data set it is very clear that significant trends and patterns can be identified. These results have assisted considerably in producing an answer to my question as well as broadening my depth of knowledge in this field first-hand. In game balancing, the aim is to maintain the fairness of the game by changing its fundamental rules. It is essential that you try and make the game as fair as possible to make all players perceive the game as winnable even if the gameplay may seem complicated or unfair. ‘Gameplay is all about making choices and in a poorly balanced game, many of the choices available to the player are essentially rendered useless. And this, in a nutshell, is why game balance is so important it preserves your game elements from irrelevance.’ (*Gamasutra - Understanding Balance in Video Games, 2020*)

With this in mind we can generalize that my overall question was asking how specific areas of balancing a game would affect how fair the gameplay becomes for the player. From the broad picture of the results I got back from my simulation, it is visible that a relationship can be identified between increasing the difficulty using game balancing techniques and the

CHAPTER 5. CONCLUSION

increase in the enjoyability of the players experience. This meant that to a certain extent increasing the difficulty made the majority of players enjoy the game more. From data I collected I was also able to identify which of the variables I balanced in the game had the largest impact on the players experience. It seemed that the majority of participants believed that the oppositions health component when increased had the most significant effect on their experience. This was closely followed by the damage dealt by the AI and then their movement speed when chasing the player.

I felt like I did to some extent answer the overall question of this project and hopefully with the small game I produced and the data I gathered from the research I was able to construct a better image of the importance of game balancing in theory and practice. There is also no doubt that with more time I would have been able to significantly improve aspects as well as implement more into this project. Some of these implementations consisted of widening the field of factors that could be balanced in the game as I only worked in a very narrow field specifically on the balance of the AI. With more time I could have worked on showing some environmental balancing as well as resource management balancing. This could have aided in answering the question from different areas and points of view of game balancing not just specifically with the AI like I did. Another implementation that I would have incorporated was an options menu to allow for participants to modify bindings and controls as well as graphical and audio settings, unfortunately the lack of time made this not feasible.

5.2 Summarise and reflect on the project

This project has been a very interesting journey that morphed and evolved a lot throughout the year. Originally during my feasibility study my project was going to be an AI vs AI FPS simulation where I can test different game balancing modifications but I decided to change the direction of my project because I wanted to focus on the players experience and how it is effected by game balancing. The reason behind this change is because while researching, it became quite clear that game balancing is a fundamental pillar of game design and understanding the impact it has on consumers is very important to developing a successful product. 'Understanding customers is the key to giving them good service which in turn results into strong customer relationships and new sales through positive word-of-mouth recommendation.' (*Know the customer, The Importance Of Knowing Your Customer, 2020*)

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This project has also been a great learning experience, especially in understanding the enormous field of game balancing and how it influences game design on a fundamental level. This project was set into 3 areas, feasibility study, the product and the report. Personally, I enjoyed working on the simulation the most as I have always been interested in working in game design as well as the fact that I am a more confident programmer than a report writer. This doesn't mean that the other two areas had no value at all because I without a doubt did positively benefit from all aspects of this project. I also believed that this project would hopefully aid in laying down the fundamentals for me to start working on producing a career in the game industry.

The area I found the most challenging was interpreting the results I got from participants. I wanted to make sure that I interpreted the data I got in the most accurate and precise way possible. It was important that I did this to help validate the reasoning behind how I answered the overall question to my project. I also didn't feel that I got as much data as I originally wanted unfortunately due to unforeseen circumstances (Coronavirus pandemic), but I definitely feel that from the results I did receive I was able to construct a better understanding on how game balance can effect a players experience and how fundamentally crucial it is towards the development of any game.

Looking back on this project there are areas of this project I definitely could have improved with a bit more time. Firstly I would have implemented additional features into the game such as an options menu and I would have also worked on polishing and cleaning up the aesthetic of the game, there isn't much value in polishing up the simulation as it does not really effect the aim of the project but improving it visually never hurts. I would have also improved the research area of this project, I feel like if I was to produce one or two open questions I could have maybe used qualitative data as well to validate the conclusion I came to when answering the overall question of my project.

Overall, this project helped me pick up a lot of useful skills that I will be constantly using throughout my career. These skills consisted of better time management, stronger programming in C# and considerably more confidence in report writing. This will all be very beneficial in aiding my future career paths especially in the game industry.

CHAPTER 5. CONCLUSION

5.3 Possibilities for future work

Now that this project is concluding, there are some areas that I would love to come back to and keep improving on the simulation. In the future if I could improve the weaker areas of my project and make some significant improvements then I can see myself coming back to conduct stronger research with a considerably larger sample size to work with. I also feel that I could come back and work on testing completely different areas of game balancing and developing my understanding of those areas, such as further increasing my knowledge on balancing environments? As well as balancing resource management. These two areas can be just as significant if not more than AI depending on the genre and style of the game and it would be also great to see how it impacts the consumers experience.

I will also be uploading this work to Github so that I can come back at any time as well as to commit further improvements and modifications. This also means that it will be added to my Github portfolio so that that when applying for any future jobs I can present some of my past work as I feel that this project as well as other projects I have worked on could be especially interesting for employers in the game industry to look at when considering my application.

In the future I would also like to see more people take up researching and understanding game balancing as I believe more work in this field will have a positive benefit towards the industry. During the research stage of my project I did find a significant amount of resources to use and learn from online. However, I still felt that this overall area of games design is very unsaturated and could be improved upon a lot more. This would be especially useful towards novices trying to introduce themselves into the fundamentals of game design as currently it can be a bit daunting. It is my belief that in the near future if more beginner-friendly resources online were developed for game balancing it would have a net positive impact on the industry as a whole.

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Appendix A

MATLAB Plotting Data Source Code

Matlab code for making a table from .csv file and plotting question 1 and 3 data into charts.

```
% read some data from a spreadsheet:
t = readtable('Game Balancing Survey.csv');
t

% question 1 bar chart
q1_categorical = categorical(t{1:1:end,'WereYouAbleToCompleteAll5LevelsOnYourFirstAttempt_'});

q1_c = categorical({'Yes','No'});
q1_participants = [31 19];
q1_b = bar(q1_c, q1_participants,0.5);
title('Were you able to complete all 5 levels on your first attempt?')
ylabel('Number of Participants')
ylim([0 50])

% question 3 bar chart
q3_categorical = categorical(t{1:1:end,'DidYouFeelADifferenceInDifficultyBetweenLevel1AndLevel5_'});

q3_c = categorical({'Yes','No'});
q3_participants = [45 5];

q3_b = bar(q3_c, q3_participants,0.5);
title('Did you feel a difference in difficulty between level 1 and level 5?')
ylabel('Number of Participants')
ylim([0 50])
```

Matlab code for plotting question 4 and 5 data into charts.

```
% question 4 bar chart
q4_categorical = categorical(t{1:1:end,'WhichCharacteristicWhenModifiedWasTheMostDifficult_'});

q4_c = categorical({'Higher zombie health','Higher zombie damage', 'faster zombie movement speed', 'did not feel any diff
q4_participants = [25 8 14 3];

q4_b = bar(q4_c, q4_participants,0.5);
title('Which characteristic when modified was the most difficult?')
ylabel('Number of Participants')
ylim([0 50])

% question 5 bar chart
q5_categorical = categorical(t{1:1:end,'IEnjoyedTheGameMoreWhenTheZombiesWereMoreDifficult_'});

q5_c = categorical({'Strongly Agree','Agree', 'Neutral', 'Disagree','Strongly Disagree'});
q5_c = reordercats(q5_c,{'Strongly Agree','Agree', 'Neutral', 'Disagree','Strongly Disagree'});
q5_participants = [16 23 2 5 4];

q5_b = bar(q5_c, q5_participants,0.5);
title('I enjoyed the game more when the zombies were more difficult')
ylabel('Number of Participants')
ylim([0 50])
```

Matlab code for plotting question 6 and 7 data into charts.

```
% question 6 bar chart
q6_categorical = categorical(t{1:1:end,'WhichAspectOfTheZombiesDidYouFeelHadTheLeastEffectOnTheirDiffic'});

q6_c = categorical({'The zombies dealing more damage','The zombies having more health', 'The zombies chasing you faster',
q6_participants = [12 13 20 5];

q6_b = bar(q6_c, q6_participants,0.5);
title('Which aspect of the zombies did you feel had the least effect on their difficulty?', 'FontSize',9)
ylabel('Number of Participants')
ylim([0 50])

% question 7 bar chart
q7_categorical = categorical(t{1:1:end,'WhatDoYouFeelWouldMakeTheSimulationMoreChallenging_'});

q7_c = categorical({'Fewer zombies that are stronger','More zombies that are weaker'});
q7_participants = [30 20];

q7_b = bar(q7_c, q7_participants,0.3);
title('What do you feel would make the simulation more challenging?', 'FontSize',8)
ylabel('Number of Participants')
ylim([0 50])
```

Matlab code for plotting question 8 data into charts.

```
% question 8 bar chart
q8_categorical = categorical(t{1:1:end,'Finally_WhichOfTheseDoYouThinkWouldProduceAMoreEnjoyableExperie'});

q8_c = categorical({'Fewer zombies that are stronger','More zombies that are weaker'});
q8_participants = [21 29];

q8_b = bar(q8_c, q8_participants,0.3);
title('Which of these do you think would produce a more enjoyable experience?', 'FontSize',8)
ylabel('Number of Participants')
ylim([0 50])
```

Appendix B

Survey Questions

1. Were you able to complete all 5 levels on your first attempt?
2. If no, which level/s did you fail?
3. Did you feel a difference in difficulty between level 1 and level 5?
4. Which characteristic when modified was the most difficult?
5. I enjoyed the game more when the zombies were more difficult
6. Which aspect of the zombies did you feel had the least effect on their difficulty?
7. What do you feel would make the simulation more challenging?
8. Which of these do you think would produce a more enjoyable experience?

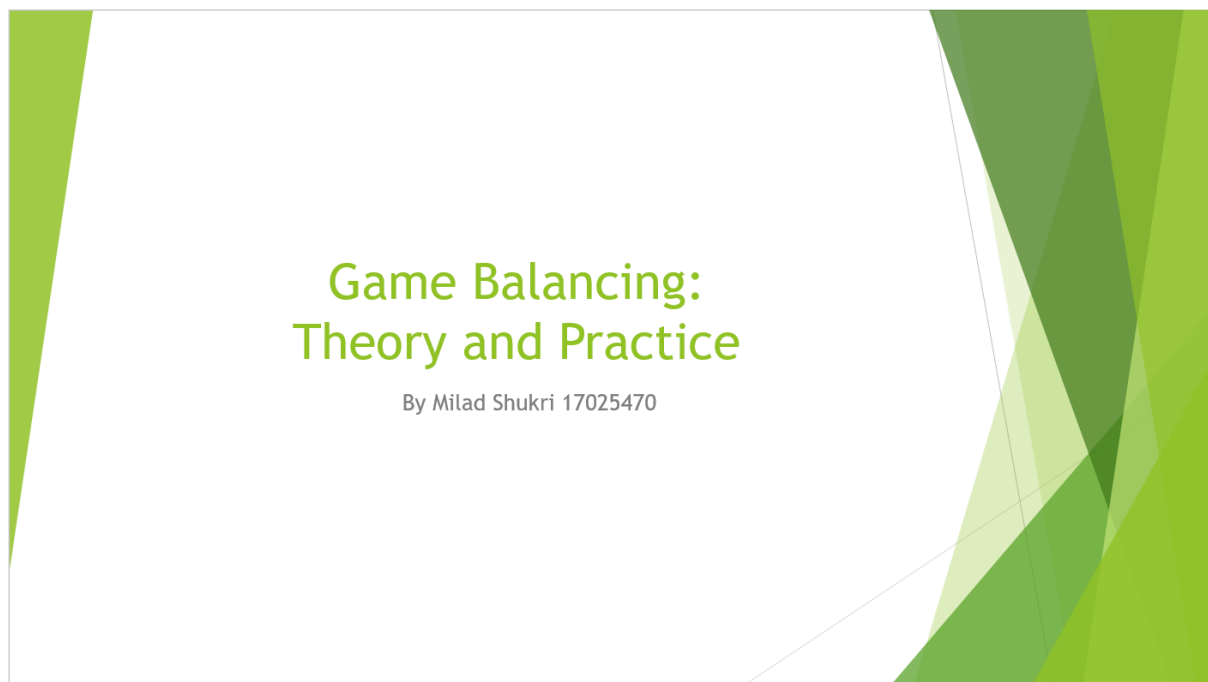
Appendix C

Showcase Slides and project one drive link

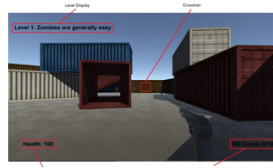
This link sends you to my completed project in a zip folder on the MMU OneDrive.

Milad Shukri
17025470

https://stummuac-my.sharepoint.com/:u:/g/personal/17025470_stu_mmu_ac_uk/EXk7NZtjZ-ZHsnO3L617NXcBgo9E8zndg0IuEyr_6al3hQ?e=Japc0o



What is my project about?



- For my project I wanted to represent how game balancing can have an impact on the consumer and their experiences.
- Game balancing is the concept of tuning the design of the game so that you can preserve the players choices and keep the game fair.
- The aims of this project
 1. Develop a FPS Simulation for participants to take part in.
 2. Gather and interpret data from a survey after the simulation.
 3. Present my results and answer the overall question of the project “How does game balancing have an impact on the players experience?”.

How I approached the project

```

// This function checks to see if the player is shooting at the enemy position
// enemy direction = player position - enemy position
// (vector).dot(player_position, this.transform.position) > 0
// direction = 0
// If the player is shooting at the enemy, it will be the same as the enemy
// this.transform.rotation = Quaternion.Euler(0, direction.rotation, Quaternion.LookRotation(direction));
// If the player is shooting at the enemy, it will be the same as the enemy
// direction.magnitude > 0
// This plays the audio when the player shoots at the enemy
// Audio.Play(AudioSource.Play("shoot"));
// This plays the audio when the player shoots at the enemy
// Audio.Play(AudioSource.Play("shoot"));

```

- I approached this project by constructing 5 levels.
 1. Level 1 (The opposition AI was generally quite weak).
 2. Level 2 (The damage the AI deals to the player is increased).
 3. Level 3 (The health of the AI is increased).
 4. Level 4 (The movement speed of the AI is increased).
 5. Level 5 (All three variables are increased to make the game more difficult).
- The survey takes place after you finish level 5 and asks questions about the game balancing variables I modified to test the fairness of the game. (No personal or private information is gathered)
- The results I got back helped me determine the answer to my overall question.

The results and the limitations

- ▶ Interesting results I got back from my survey
 - Participants struggled the most when the Ai's health was increased.
 - The majority of participants felt the contrast in difficulty between level 1 and 5.
 - A small majority of participants felt that stronger but fewer zombies would be more challenging.
 - A small majority of participants believe that weaker but more zombies would give a more enjoyable experience
- ▶ Limitations that I discovered in my project
 - Due to the coronavirus pandemic I was not able to gather as much data as I anticipated. (Obtained 50 I originally aimed for 100)
 - Due to time constraints aesthetics were limited, with more time I would have created my own assets instead of using free ones.
 - The simulation lacked a settings menu so it was limited on the graphical and audio modifications that could be made.



Conclusion



- ▶ What I learnt throughout my time on the project.
 1. How to program the fundamentals of a game using the Unity Engine.
 2. How to program and style charts in Matlab.
 3. How to plan, design, develop and manage a product until completion.
- ▶ What improvements I would have made a second time round.
 1. Experiment with environment and resource management game balancing.
 2. More complex game mechanics e.g., ammunition, score-system, time-trials, etc
 3. More time spent on testing and bug fixing as well as improving software robustness.