# An Analysis of Immersion in Horror Games: a study of presence and usability


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# Abstract

This project is to determine the different levels of immersion that plyers feel when using Virtual reality compared to more traditional methods of play such as a keyboard and mouse. To research this, players will be testing a Horror game developed in Unreal Engine 5. The first group will use virtual reality to play and the second will use keyboard and mouse. Each player will then be asked to fill out surveys pertaining to what they experienced when playing the game. The aims of this project are to determine which method of play is more immersive and by how much. This will allow future game developers to better create immersive experiences for players.

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# Chapter 1

## Introduction

This project will be an analysis of immersion in video games. Immersion is defined as a "deep mental involvement in something". The research is exploring whether this involvement will deepen with VR compared to more traditional methods of play. Bjork and Holopainen (2005) described four types of immersion, Spatial, Emotional, Cognitive, and Sensory-Motoric. Spatial immersion is being focussed on as this is what occurs when manoeuvring a virtual environment. This happens when players experience what they feel as a "real" world (Rice, 2004). A horror game experience will be developed in which two groups of players will participate to play the game.

The first group of players will be playing the game using a VR headset and the second group using a monitor keyboard and mouse. Each group's levels of immersion will be measured using a range of methods. These will include post-game surveys where each participant will answer a range of questions to create a set of data for analysis. The system usability scale and the Witmer and Singer presence questionnaire will be used for these. Another technique I am using is thematic analysis where common themes, topics, ideas and patterns are identified. These two techniques will provide me with quantitative and qualitative data. The aim of the research is to investigate whether a VR experience is more immersive compared to that of one of a typical monitor.

There has been similar research completed in training employees using VR rather than basic methods to induce whether it was more effective or not. Borsci et al. (2016) conducted research using three methods of training: VR using a CAVE system, traditional video and 3D holographic. The research deduced that VR and 3D holographic produced better performance on the post training test. In order to complete the research; a horror game experience will be developed using Unreal Engine 5. The VR version and the Monitor version

will be identical games with the only difference being the controls, this way more accurate results will be obtained as all participants will experience the same stimulus. All participants will be kept separate and be asked to not talk about their experience with other participants as this will cause a bias in the results.

## 1.1 Figures and Tables

Figures and tables will be displayed as below with a short caption describing what is depicted and a title also for tables.

*Figure 1: A screenshot of the Horror Experience*

A table showing some data is displayed here (Table 1).

| **First name** | **Last name** | **Age** |
|---|---|---|
| Bob | Bobbington | 24 |
| Beth | Wavies | 49 |
| Joe | Bloggs | 37 |
| Billy | Bob | 10 |

*Table 1: A table holding data of some players.*

## 1.2 Referencing

It is worth noting that the standard for referencing is Harvard. An example is depicted below:

In text citation: Some information from a book by John Johnson written in 2023 on page 34 (Johnson, 2023, 34).

Reference List:

Johnson, J. (2023) Giving examples of Harvard referencing. Place of publication: Publisher

# Chapter 2

## Literature Review

This project is to create a horror game experience that can be played on VR or through traditional methods to determine which is more immersive and whether one stimulates stronger reactions than the other. The rationale for this project is that there are not many studies looking at this side of VR immersion. A lot of studies have been done for VR and immersive training experiences for jobs that are dangerous, or ones where stopping production to train new employees is inefficient like a car production line. For example, training medical professionals can be expensive and time consuming in the real world but using VR based technologies can significantly reduce training costs and improve performances. (Xie Biao, 2021). These immersive training programs were proved to make users more focused as a study conducted by PwC shows that VR learning participants were up to 4 times more focused than their e-learning peers. (PwC,2020). This means that they were also more immersed as it was harder to take them out of the experience. This aspect is what this research is looking to recreate with the game to gather the best results from the tests. The aim is to gather the most visceral responses to make the comparison between VR and traditional methods easier. When creating an immersive experience there are key factors that are involved to keep the player immersed and focused, especially in VR application (Bryan Wirtz, 2023):

- Fidelity and Coherence
- Sense of Embodiment and User Locomotion
- Flow
- Clear Goals

Fidelity is a measure to which the quality a VR experience reproduces a real-world experience. The main aspects that affect this experience includes Graphics and Audio, User Interface, and Interactions (Dickinson, 2022). The use of high-quality art assets and realistic textures will increase fidelity for players as its easier to become immersed in a believable environment. The same applies for Audio and non-evasive UI. UI is an especially hard aspect of VR game design to get right as UI can take a player out of the experience if it does not seem to fit in

properly with what the player is doing. A good technique to counter this is by using a form of UI called Diagetic UI. This means that the important UI aspects are built into objects in the game such as the maps in Minecraft (Microsoft, 2011) and Firewatch (Campo Santo, 2016).

A sense of embodiment is the players experience when controlling the digital avatar, they are playing. It is the sensation that a digital avatar, which represents your own body in VR, is somehow your own biological body (Dickinson, 2022). The sense of location, agency (control) and body ownership are three components that embodiment has been broken down into (Kilteni, 2012). For a player to stay immersed in an experience in VR they must feel like the avatar they are controlling is their own body, this means having well tracked hand and limb movements, failing this could cause the player to become unfocussed and fall out of immersion.

Flow is also an important aspect of immersion and can sometimes be critical to the experience. According to Weibel and Wissmath (2011), flow is the sensation of influencing the activity in the virtual world. This combined with a good feedback loop can create an immense state of flow. For example, Hi-Fi Rush (Tango Gameworks, Bethesda, 2023) is a game that has a cartoon look to it and unrealistic over dramatic audio, however the main mechanic of the game is that all the player and enemies attacks, dodges and movements are in sync with music and combinations can be created by following the beat perfectly. This creates a sense of flow that really immerses the player in the game.

Clear goals allow the player to have a definite idea of what they need to do and where they need to go, a game that doesn't have clear goals can cause players to come out of immersion as they can become unfocussed quickly as they are unsure of what they are supposed to do. These goals do not have to be as explicit as a mission log or waypoint like in Skyrim (Bethesda,2011). For example open world survival games like DayZ ( Bohemia Interactive, Dean Hall , 2013) do not have any clear set goals but the overarching goal of survive is enough for players to be immersed.

In conclusion the rationale of this project is to determine whether Virtual Reality is more immersive than traditional methods of play and how, if so, it does this. This will give developers a better understanding of the user experience and allows them to design and develop more intuitive and engaging interfaces. It will also help drive education and training as VR has already shown it can be a good tool to use for teaching, but understanding immersion levels for this will allow

the creation of better and more coherent training experiences that are closer the real life application of what is being trained.

## 2.1 Aims & Objectives

The aim of this project is to develop a horror game experience that can be played using both Virtual Reality hardware and traditional methods to determine which provides a more immersive experience.

1. Design a believable environment within the context for the game to be set in.
2. Write a convincing and immersive narrative for the participant to complete within a specified time.
3. Implement an enemy into the game which fits contextually and creates a sense of fear or unease.
4. Design accurate and effective sound effects to increase stimulation when playing the game.
5. Devise a character controller for the participant to be able to control the player in VR and using a keyboard and mouse.
6. Animate the enemy to a level which stimulates fear or anxiety.
7. Design and collect questions for three surveys which allow the player to detail their experience.
8. Collect each participants' answers to three surveys.
9. Present data in graph form to deduce which method of play is more immersive.

# Chapter 3

## Requirements Analysis

In order to achieve the aims and objects set out in the previous section there will have to be multiple requirements set out. The first is the development of a Horror experience. The game will be developed in Unreal Engine 5 as this engine is the best suited for creating realistic environments due to it's highly realistic lighting simulation named Lumen. This fact will ensure that objective 1 can be completed to a high standard and will also adhere to creating a high-fidelity experience which will, in turn, increase immersion. The hardware requirements for this game are also to be noted, players will need a Virtual Reality headset and a computer powerful enough to run a virtual reality experience on. For testing and research players will use the same computer and headset. This is not only practical, but it keeps results unbiased as different headsets have different resolutions and field of views and this will lead to a different experience of the game. The players that are using a keyboard and mouse can use their own devices to play the game as most computers will be able to achieve a steady framerate and the use of different keyboards and mice will not change the experience of the player. This way the game can be shared and a wider range of participants will be able to play and give feedback. The experience should also be a coherent and polished piece. This is to ensure that the immersion levels can be accurately measured between each play method. If the experience does not immerse players, then the outcome of determining which method is more immersive will be extremely difficult.

### 3.1 Risk Analysis

| Risk ID | Description | Consequence | Possibility | Severity | Precautions | Contingency Plan |
|---|---|---|---|---|---|---|
| R1 | Causing severe anxiety to participants | Could cause panic/anxiety attacks | Low | High | Ask participants to disclose any history of mental illness | Call 999 |
| R2 | Bumping into objects during VR testing | Could cause bruises or abrasions | Medium | Low/ Medium | Remove all objects within the close vicinity of the participant | Seek medical advice |

| | | | | | | |
|---|---|---|---|---|---|---|
| R3 | Tripping during VR testing | Could trip into something and cause injury | Medium | Medium/High | Ask participant to wear sensible shoes | Seek medical advice |
| R4 | Repetitive Strain injury when conducting tests | Could cause participants to have RSI | Low | High | Ask each participant to make sure they are well stretched and there aren't any pre-existing injuries | Seek medical advice |
| R5 | Causing injury due to improper posture when conducting tests | Could cause back or muscle strains or pains | High | Low | Ensure all participants adhere to posture guidelines | Seek medical advice |
| R6 | Eye strain due to improper screen brightness | Could cause eye pain or even longer lasting damage | Medium | Low | Ensure screen is at an appropriate brightness for the participant | Seek opticians' advice |
| R7 | Epilepsy | Could cause an epileptic fit | Low | High | Ask participants to disclose any history of epilepsy | Call 999 |
| R8 | Players aren't properly immersed in the game | Data results could be skewed as raw emotions aren't experienced | Medium | High | Create as immersive experience as possible using all methods | Attempt to add more immersive elements and re test participants |

## 3.2 Testing and evaluation

To test and evaluate the game, players will be asked to complete three surveys on completion of the game. These three surveys each have a different purpose. The first two surveys are validated questionnaires, meaning there is already a standardized way of measuring the data. The first questionnaire is the system usability scale or SUS. This questionnaire determines the usability of the game. It consists of 10 questions that can be answered with 5 responses from strongly agree to strongly disagree. Each response is then converted to a number and multiplied by 2.5 and a final score can be worked out from here. Based on previous research the average score is 68.

The next validated questionnaire is the Witmer and Singer Presence Questionnaire. This questionnaire is split into separate categories where the scores

are summed up to achieve a score for that category. For example the realism category is calculated by summing answers form questions 3 to 7, 10 and 13.

The last survey the participants will fill out is an open-ended questionnaire. This allows for thematic analysis to be conducted. Thematic analysis is where the answers are analysed for common themes, topics, ideas and patterns that can create a general consensus for how the participants experienced the game.

# Chapter 4

## Design & Methodology

The question being answered in this research project is whether Virtual Reality is more immersive than more traditional methods of play. In order to answer this question, a way of measuring immersion levels in both play types is needed. The experience needed to be the exact same between Virtual reality and more traditional methods as the immersion being studied has to come from how the user is playing and perceiving the game not what they are playing and perceiving. For there to be no bias in results each participant in the study may only play using one method as their second method would have skewed results as they would be bias as to what is happening.

## 4.1 Software development projects

The methodology used to conduct this research was the waterfall method. As this research was conducted by only one student it was found to be easier to fully finish one stage before moving onto the next. All the requirements were written out such as: environment, sounds, player controller, etc. After this step each requirement was designed and prototyped to finalise what the game would be like. After this the designs were implemented into the game using Unreal Engine 5 and then finally tested to insure there were no bugs before the participants could take part in the research.

The tools used the complete the project were mainly that of Unreal Engine 5 for the main game mechanics. The Epic Games store provided a lot of the models used to build out the environments and turbosquid.com for the enemy and player models. Audacity was used to record and edit the sounds that were implemented into the game. The hardware used to develop the game was all done on a personal computer at the lead researching student's home which is more than sufficient to run and develop the Virtual Reality side of the project. The headset used was a Oculus Rift S released in 2019. This headset has two displays: 2560x1440 (1280x1440 per eye) running at 80Hz. The headset also uses 2$^{nd}$ Generation Oculus touch motion tracked controllers and has a mass of 500g. The choice to use this headset was purely since the lead student had one at his disposal, and although newer headsets like the meta quest 2 are available the Rift S was adequate for this project.

Unit tests were carried out for the game after it had all its components implemented, this also included stress testing. The unit tests are quick and low-level tests to ensure that individual components of the game are working correctly and give the desired result. Stress testing was also carried out to ensure that the system could handle different scenarios that were thrown at it. Stress testing consists of effectively trying to break the game and fixing any issues that may arise from this. Examples of this are repeatedly trying as many

inputs as possible to test if the system can handle it, or purposely running into seams in walls to test collision.

## 4.2 Research involving human participants

This research task requires the use of human participants to test the game and to be able to give the feedback required to answer the question of whether the use of VR is more immersive than the traditional methods. The hypothesis this research is looking to answer is: "Is virtual reality a more or less immersive experience than traditional methods of play?".

Gathering participants for this survey will be completed using a direct approach, private and secure social media accounts will be used to reach out to participants in order to conform to privacy standards. The aim is to gather 20 participants however this may be a little ambitious for the project, so a more likely number is 10.

Ethics must be considered when completing a project where human participants are to be used. All the appropriate ethics forms have been submitted and approved. All the participants in this project are to remain anonymous as this way no personal data needs to be stored about them. Before any research takes place, all participants will need to fill out a consent form shown here below.

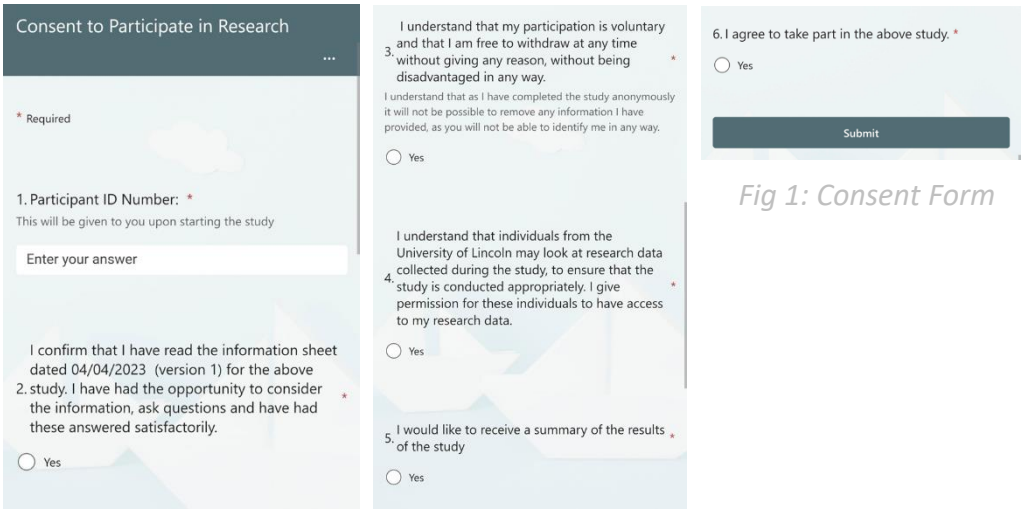


*Fig 1: Consent Form*

Each participant can choose to leave the study whenever they want to however any information that they have already given will not be able to be destroyed as it will be impossible to link back to who has given what answers. This is outlined in the consent form above.

Once the participants have filled out the questionnaires shown below the raw data will need to be analysed.


*Fig 2: Presence questionnaire*

## SUS questionnaire

System Usability Scale, used to determine the usability of a system.

1. I think that I would like to use this system frequently
   - Strongly Agree
   - Agree
   - Neither agree or disagree
   - Disagree
   - Strongly Disagree

2. I found the system unnecessarily complex
   - Strongly Agree
   - Agree
   - Neither agree or disagree
   - Disagree
   - Strongly Disagree

3. I thought the system was easy to use
   - Strongly Agree
   - Agree
   - Neither agree or disagree
   - Disagree
   - Strongly Disagree

4. I think that I would need the support of a technical person to be able to use this system
   - Strongly Agree
   - Agree
   - Neither agree or disagree
   - Disagree
   - Strongly Disagree

5. I found various functions in this system well integrated
   - Strongly Agree
   - Agree
   - Neither agree or disagree
   - Disagree
   - Strongly Disagree

6. I thought there was too much inconsistency in this sytem
   - Strongly Agree
   - Agree
   - Neither agree or disagree
   - Disagree
   - Strongly Disagree

7. I would imagine that most people would learn to use this system very quickly
   - Strongly Agree
   - Agree
   - Neither agree or disagree
   - Disagree
   - Strongly Disagree

8. I found the system very cumbersome to use
   - Strongly Agree
   - Agree
   - Neither agree or disagree
   - Disagree
   - Strongly Disagree

9. I felt very confident using the system
   - Strongly Agree
   - Agree
   - Neither agree or disagree
   - Disagree
   - Strongly Disagree

10. I needed to learn a lot of things before I could get going with this system
    - Strongly Agree
    - Agree
    - Neither agree or disagree
    - Disagree
    - Strongly Disagree

*Fig 3: System Usability Scale Questionnaire*

## Thematic Response Questionnaire

1. How would you describe your experience?

   Enter your answer

2. How did the environment make you feel?

   Enter your answer

3. How did the sounds make you feel?

   Enter your answer

4. How did the enemy make you feel?

   Enter your answer

5. What made you feel the most uneasy and why?

   Enter your answer

*Fig 4: Thematic response questionnaire*

The presence questionnaire was first devised by Witmer and Singer to measure a participant's presence in a virtual environment (Witmer and Singer, 1998). Witmer and Singer defined presence as "the subjective experience of being in one place or environment, even when one is physically situated in another". This questionnaire is useful as if the participants feel present in the environment, that in turn will make them feel immersed. There is similar reasoning to the System Usability Scale (Brooke, 1995). If the system used to control the environment is intuitive and easy to understand, this then leads to being more immersive.

Measuring the raw data from these two quantitative questionnaires can be a little confusing. The presence questionnaire is divided into 6 categories: Realism, Possibility to Act, Quality of Interface, Possibility to examine, Self-evaluation of performance, and sounds. These different categories all have different questions that apply to them, some questions applying to more than one category. Below is a table depicting the categories and their questions.

| **Category** | **Questions** |
|---|---|
| Realism | 3,4,5,6,7,10,13 |
| Possibility to Interact | 1,2,8,9 |
| Quality of interface | 14,17,18 (scores reversed) |
| Possibility to examine | 11,12,19 |
| Self-Evaluation of performance | 15,16 |
| Sounds | 20,21 |

*Fig 5: Presence questionnaire categories and their questions*

The answers from each question then get changed into a number from 1 to 7 depending on the answer given. These numbers then get summed with the other questions from that category and a final score for that category is obtained. These sums can be summed to give an overall score however the individual category scores give a more in-depth review. The system usability scale scoring can also be quite complex. Each question's answer will also be converted to a number in a similar way to the presence questionnaire however these only range from 1 to 4. This score is then multiplied by 2.5 to get a score from 0-100 rather than 0-40. These scores are not percentages though and can be misconstrued as that as they are from 0-100. Based on previous research a score of 68 or above is deemed average (usability.gov, 2013).

# Chapter 5

## Implementation

The first requirement of the game was to create a believable environment for the participant to play in. An island was created in Unity using the landscape system however it was not as realistic as it needed to be. After a re-think Unreal Engine 5 was deemed the better choice due to its more realistic lighting system and a better stocked marketplace for prebuilt assets. Below are the comparisons from the islands and the Unreal Engine Island is a lot more realistic.

*Fig 6: Unity Island*

*Fig 7: Unreal Island*

Due to the nature of a Virtual Reality game and the idea of being present in a virtual world the graphics need to portray that of the real world and so Unreal Engine 5 is the obvious choice. Next the cave system was first sketched out to get the layout sorted out and then created in Unreal. A group of assets was collated from the Unreal Store to create the cave environment, reference images were looked at to try and create a more realistic cave however it had to be kept simple enough for a coherent play experience.

Next was the creation of a player controller, the project started off by just creating the controller for the keyboard and mouse to test further developments

like enemies and triggers. It was decided a first-person controller was best as it would be as close to the VR version as possible, an arms and gun model was sourced to act as the viewport for the player controller, as seen here below.

*Fig 8: Player Controller Viewport*

The controller is relatively simple with the movement input mapped to the classic FPS WASD keys, aiming with the mouse and clicking to shoot. All inputs are controlled using the enhanced action input system. Players are meant to focus more on the surroundings than the FPS aspects of the experience which is why this was kept so simple. The shooting mechanics are carried out by using a line trace. When the player clicks a line is drawn from the centre of the screen outwards and if it intersects anything, this object will take damage. This is shown below.

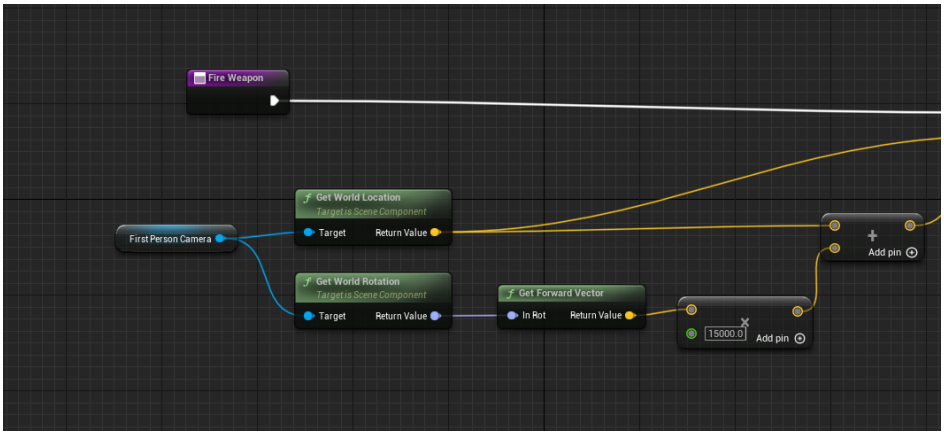


*Fig 9: Shooting mechanics*

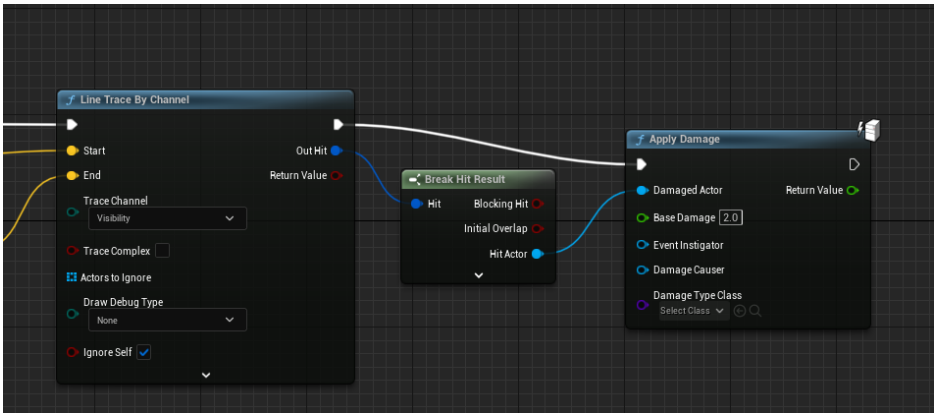


*Fig 9.1: Shooting mechanics*

The next aspect of the game to be completed was the enemy. The enemy needed to be scary and still fit in with the idea of a cave, reference images of cave fish were studied, and it was noted that they were very pale and didn't have eyes; this was recreated as best as possible with the enemy as seen below.

*Fig 10: Cave Fish*

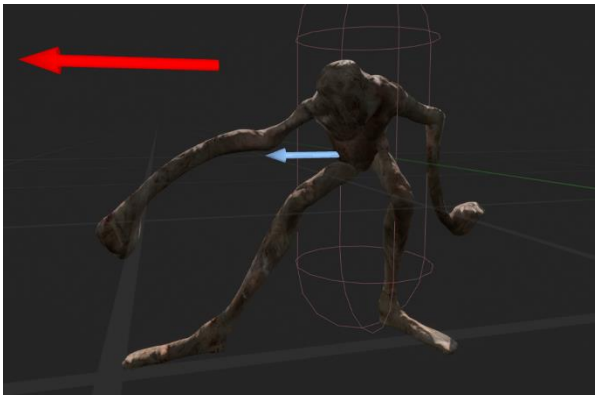

*Fig 11: Enemy*

The enemy movement was very simply done, if the enemy saw the player, it would simply move towards them and, when close enough, will attack. The enemy also has a set of animations that it cycles through depending on the sate of the enemy. The states are Locomotion, Attacking and Damaged. Each state has a separate animation and are controlled using a state machine shown here. The animation helps towards a more polished look and gives the enemy a scarier feel when in the game. The smoothness of its

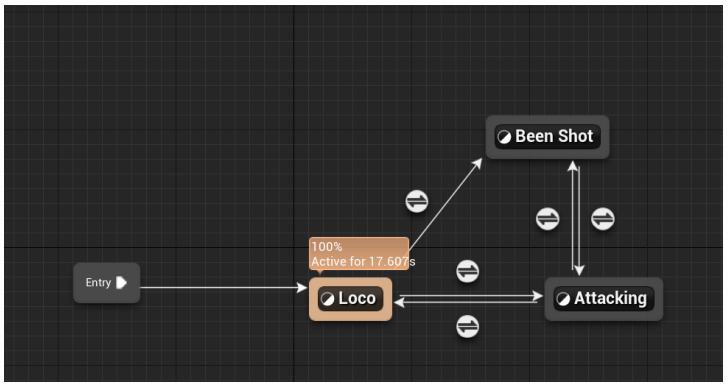


*Fig 12: Animation State Machine*

movements also lends to keeping present in the environment as it moves how it would in the real world.

After the enemy had been properly implemented and tested the next requirement was the sound design. The project needed to have good sound design as sound is a big part of being present and immersed. All the sounds for the project were edited and exported using Audacity, this program was used to add reverb to each sound to make it sound like it was in a cave and the sound was echoing and bouncing off the walls. The enemy sounds were all recorded using a microphone. The gun sounds were sourced from a package that included the arm and gun models and the sounds for the ambience were taken from a YouTube video. The sounds were mostly implemented suing Unreal Engines metasounds library which allows the sounds to be changed and altered in order for them to sound more appealing. For example, the enemy's footstep was just one soundbite. It was randomly pitched up or down every time it was played creating the illusion of variance.

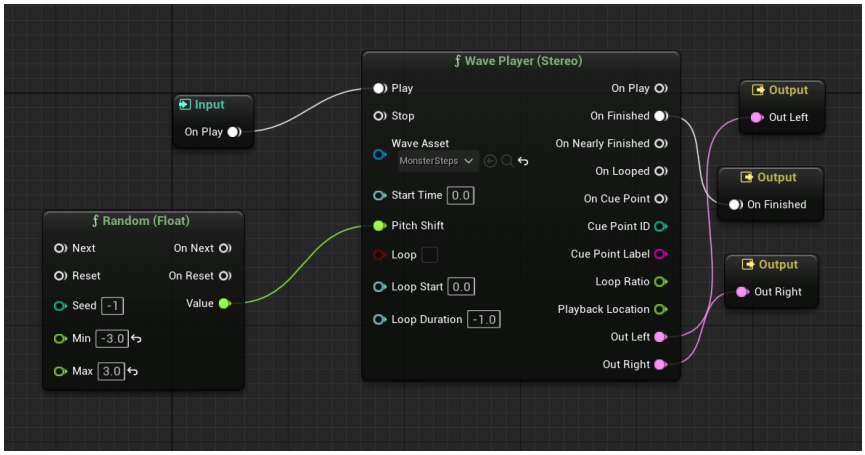


*Fig 13: Monster Steps Metasounds*

The footsteps and gunshot sounds are then linked to the animations using a notify track, this way they will stay synced up with their animations and always play at the correct time. This will further increase the immersion levels as the sounds are playing exactly corresponding to the object making them and at the correct time.

Lastly cutscenes and some triggers were added to the level to give it a more polished feel. An opening cutscene and a ending cutscene were added using

Unreal Engine 5's timeline feature. This feature allows the user to control events in the scene using keyframes to edit their position scale and rotation. For these cutscenes the keyframes were used to edit the position and rotation of a camera to create a first-person type of look to them. After some development testing of the cutscenes in VR it was decided that they should only be used for the keyboard and mouse version of the game as they were extremely disorienting when using a Head Mounted Display and they greatly took away from the immersion of the experience.

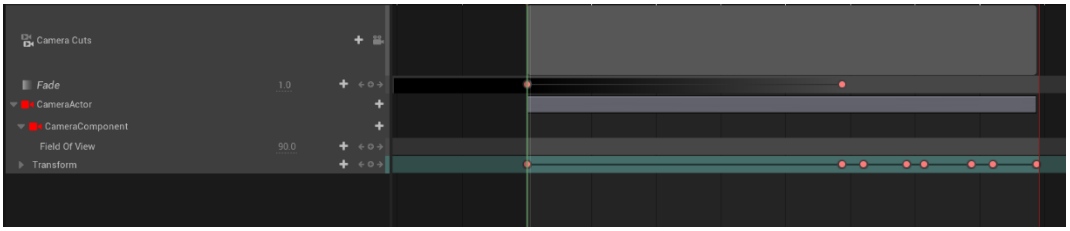


*Fig 14: Timeline of opening cutscene*

Trigger boxes were used throughout the landscape of the cave to plan out when some of the story actions took place. For example, a trigger box is placed near the start of the cave so that as the payer walks through it a scream of an enemy is played using the Metasounds to set the scene and foreshadow the enemy's existence. These boxes were implemented using Unreal Engines blueprint system, as the player capsule collides with the trigger box on entry, the sound is played then the trigger box is destroyed to stop any repeat sounds playing. This is repeated at a few other points within the cave to build up tension and suspense. Another use of the trigger boxes was to stop and start the ambient sound of the cave. There is a section in the level when the player must scale a cliff after emerging from the cave, at the point the player leaves the cave the ambient noises are turned off and as they complete the cliff section and re-enter a different section of the cave a different trigger box restarts them.

Lastly the Virtual Reality controller was implemented, this was built off the Virtual Reality template in Unreal Engine 5. The template used a teleportation method for locomotion however this was deemed not realistic and would take away from the immersion levels. The head rotation was also snap movement meaning the camera would rotate in 45-degree intervals. These methods were both changed to become a lot smoother. The left thumb stick of the touch controls was mapped to control the movement of the player using a vertical and horizontal enhanced input actions. This movement was a lot smoother and more realistic and suited the project a lot better as it also doesn't require a UI element to decipher where the player will move. The snap movement of the rotation was also changed to a smoother method as again it was seen as more realistic.

# Chapter 6

## Results & Discussion

In this section the results of the questionnaires and analysis of such will be discussed. Each participant was asked to read the Participant Information Sheet and sign the consent form. From here they each went in one at a time to play through the game, each participant was asked not to discuss their experience with another as this may cause bias between the participants. After each participant has completed their turn, they were then asked to fill out the forms so their results could all be compiled in one place. The first group to test was the Virtual Reality group.

### 6.1 Presence Questionnaire

The presence questionnaire comprises of 21 questions and each fit into a category describing specific areas of presence. The first category is realism and questions 3,4,5,6,7,10 and 13 are considered when calculating the score. Taking the average score of these questions, an average realism score can be calculated. For the Virtual Reality side of the study the average scores were 4.71, 4.86, 4.29, 5.57, 4, 5.29, 6.14. This creates an average realism score of 34.86. The same process can be completed for the other 5 categories. The questions pertaining to them have been detailed in Chapter 4.2 Fig 5. The average scores for each of these categories is shown in the graph below with the total score shown at the bottom.

| **Categories** | **Score** |
|---|---|
| Realism | 34.86 |
| Possibility to Interact | 21.43 |
| Quality of interface | 13.28 |
| Possibility to examine | 16.29 |
| Self evaluation of performance | 10 |
| Sounds | 11.15 |

| | |
|---|---|
| **Total** | **107.01** |

*Table 1: Presence questionnaire average score for VR*

As virtual reality aims to try and recreate what it feels like to move in real life in a virtual environment, the Virtual Reality score is expected to be higher than the keyboard and mouse score. Below are the scores for the keyboard and mouse section of the study.

| **Categories** | **Score** |
|---|---|
| Realism | 32.54 |
| Possibility to Interact | 18.76 |
| Quality of interface | 12.84 |
| Possibility to examine | 10.12 |
| Self evaluation of performance | 7.4 |
| Sounds | 11.86 |
| **Total** | **93.52** |

*Table 2: Presence questionnaire average score for keyboard and mouse*

As expected, there is a difference between the scores with virtual reality coming out on top. The difference in score is not as much as expected and some of the categories have very similar results. For example, the sound category has only a change of 0.71 between the two, this however is to be expected as the sounds for the game are the exact same and are both outputted to the participant the same way through headphones or a speaker. The difference in score is shown below with all the Virtual Reality scores being higher but the sound.

| **Categories** | **Difference** |
|---|---|
| Realism | 2.32 |
| Possibility to Interact | 2.67 |
| Quality of interface | 0.44 |
| Possibility to examine | 6.17 |
| Self evaluation of performance | 2.6 |
| Sounds | 0.71 |

*Table 3: Presence questionnaire average score difference*

The smallest differences were the sound and the quality of interface. The quality of interface judges the User interface and delay in outcomes. This is another section that didn't change much between the versions as there is minimal UI in

both and the movement and shooting controls are controlled in a similar way. The highest difference is the Possibility to Examine category with a difference of 6.17, this is especially large as this is over a third lower in the keyboard and mouse section. Questions 11 and 12 are about the possibility to examine object closely and at different angles and this can be completed at a much higher capacity than using a traditional keyboard and mouse as the participant can physically get their eyes and head closer to what they want to look at being able to examine object at all angles, especially ones they can pick up, like the gun. The differences where the VR method was higher are highlighted blue and where it was lower are highlighted in pink.

## 6.2 System Usability Scale Questionnaire

The SUS questionnaire comprises of 10 questions with a 5-point scale ranging from strongly disagree to strongly agree. The answers, like the Presence questionnaire, are then converted into numbers and the summed score in then multiplied by 2.5 to get a score out of 100. To convert the positions into numbers the odd number questions are their scale position minus one and the even numbered questions are 5 minus the scale position. These scores, however, are not percentages and an average score is one above 68 (usability.gov, 2013). Below are the average scores for each question for the Virtual Reality portion of the study.

| **Question Number** | **Average Score** |
|---|---|
| 1 | 2.5 |
| 2 | 2.875 |
| 3 | 3.25 |
| 4 | 2.875 |
| 5 | 3.25 |
| 6 | 2.875 |
| 7 | 3.375 |
| 8 | 2.375 |
| 9 | 3.25 |
| 10 | 3.5 |

*Table 4: SUS average scores per question VR*

After summing up the scores and multiply by 2.5 the total score for the Virtual Reality side of the study is 75.3125. This is above the average of 68 and therefore a good score for a system to achieve. The Highest scoring question was “I would imagine that most people would learn to use this system very quickly”. This shows that the system is very intuitive and can be learned in a short space of time. This leads to the system being immersive as the controls to use the VR are quick to use and do simulate that of how we use our hands in real life. Below are the results for the keyboard and mouse side of the study.

| **Question Number** | **Average Score** |
|---|---|
| 1 | 2.875 |
| 2 | 3.25 |
| 3 | 3.375 |
| 4 | 2.5 |
| 5 | 3.25 |
| 6 | 2.375 |
| 7 | 3.25 |
| 8 | 2.25 |
| 9 | 2.875 |
| 10 | 3.375 |

*Table 5: SUS average scores per question Keyboard and Mouse*

After summing the scores for the keyboard and mouse side of the study and multiply by 2.5 the score comes out to be 73.4375. This very close to the score of the VR side of the study and the average question scores haven’t got much difference in them between the two methods of play.

| **Question Number** | **Difference** |
|---|---|
| 1 | 0.375 |
| 2 | 0.375 |
| 3 | 0.125 |
| 4 | 0.375 |
| *5* | *0* |
| *6* | *0.5* |
| *7* | *0.125* |
| *8* | *0.125* |
| *9* | *0.375* |
| *10* | *0.125* |

*Table 6: SUS average score differences*

The differences between the two methods are actually very small and in some cases like question 5 they are the same. The differences, in the cases of questions 3,5,7,8,10 , are small enough to be margins of error and can be disregarded during the analysis process. The biggest difference is that of question 6 with 0.5. Question 6 states that the players thought there was too much inconsistency in the system. The Virtual Reality method scored a 2.875 whereas the keyboard and mouse scored a 2.375. On first glance it may seem that the VR method was then therefore more inconsistent but due to how the SUS scale converts its numbers and works out scores (5-the scale position for even numbered questions). The reality is in fact the opposite with the VR system being less inconsistent than the keyboard and mouse. This is somewhat unexpected as Virtual Reality is a newer technology and due to that there are more likely to be inconsistencies with how it operates.

The SUS questionnaire has shown that there is only a very small difference between the two systems and how much usability they have with the difference in total score only 1.875. This shows that the two systems seem to be equally as usable as each other and in terms of control and usability do not affect the immersion levels greatly.

## 6.3 Thematic Response Questionnaire

The last questionnaire the participants were asked to fill out was the thematic response open ended questionnaire. The purpose of these answers is to identify any common themes, ideas, patterns, or words that appear. The first analysis is on the VR methods of play. The first step is to carry out the initial coding of the answers, this is where key words and phrases are identified that capture the essence of the experience. This coding and analysis are carried out for the first question, “How would you describe your experience”.

- Positive Experiences: “Fun” “enjoyable” “immersive experience”
- Negative Experiences: “nauseous” “took a minute to learn/memorise controls”
- Ambivalent Experiences: “Different” “weird”

After the initial coding, themes can start to be developed about what those initial codes mean.

- Enjoyment: “Fun” “Enjoyable” “positive” “Good game”
- Immersion: “Immersive” “very immersive” “positive and immersive”
- Unfamiliarity: “very different” “weird” “Nauseous”

Finally, the themes can be expanded upon to gather a better understanding of how the participants experienced the game.

- Enjoyment: Most participants found the game enjoyable and had positive responses to the experience using words such as “fun” and one described the experience as a “good game”. This does leave some questions as the experience is a Horror game and whether a participant is meant to “enjoy” it or be scared by it is a difficult analysis.
- Immersion: Several participants noted the “immersive” nature of the experience with one describing the experience as “positive and immersive”. This gives a strong argument for Virtual Reality being an immersive method of play and improving the experience for the participant.
- Unfamiliarity: There are many reasons that VR may seem unfamiliar to many people, some may have not had much experience and others may find the change in resolution and field of view distracting or “weird”. This fact could take people out of the experience and make them not feel as immersed as they are focussing on the fact they are in VR too much and not what they are actually doing within the experience.

Using all the questions from the thematic analysis questionnaire gives us an idea of the experience as a whole and how the participants viewed their time playing the game. The questions consider specific feelings about each aspect of the game such as the environments, sounds, and enemy. The coding is as seen below.

- Positive Experience: “Fun” “Immersive” “good ambient noise” “involved” “educational”
- Negative experience: “nausea” “disoriented” “bored” “stressed” “unsteady” “dizzy”
- Ambivalent experience: “weird” “different” inconsistent”

- Immersive: “Ambient Noise” “immersive” “involved” “like real life”
- Disoriented: “nausea” “stressed” “unsteady” “disoriented” “dizzy”
- Scared: “spooky” “creepy” “unsteady” “menacingly” “nervous”

- Immersive: There was a lot of words appearing around immersion and how it felt “like real-life”. This is an excellent support for the argument that VR is more immersive than more traditional methods. One participant said the experience made them feel “involved” and other described the sounds as “perfect”.
- Disoriented: The theme of being disoriented cropped up a few times in the analysis from different participants. This was mostly in answering the question “How did the environment make you feel”. This would suggest that the environment was not as polished and immersive as first intended as there was a few mentions of “gaps in cave walls” which seemed to pull participants out of the experience.
- Scared: The last theme for the thematic analysis is that of being scared. This was expected to appear as the participants were testing a horror game. Some participants described the enemy as making them feel “uneasy” “on edge” and “stressed”. This would imply that they were fully immersed in the experience as an object in a virtual world made the participants feel strong feelings of anxiety and uncomfortableness.

The thematic response for the traditional methods of play was extremely similar to the Virtual Reality thematic response analysis. All of the themes and ideas present in the VR TA were also present in the keyboard and mouse TA. However the keyboard and mouse groups feelings were not quite as strong as the Virtual Reality groups. For example, where one participant in the VR group described the enemy as “creepy” and “scary” the other described them as “weird and funny looking”. These words present the same themes of being scared by the enemy however the VR study experienced these reactions a lot stronger than the keyboard and mouse group. Another example of this is when the VR group became “disoriented” by the gaps in the cave walls the keyboard and mouse group described the environment as “a little confusing at points” and “kinda buggy but nothing huge”. This again shows the VR group having the same thoughts. This pattern between the groups could be explained by the fact that the VR headset takes up the whole view of a participant whereas a monitor does not and is therefore easier to spot issues and details within the experience. Another take away would be that the VR headset was more immersive and therefore the participants experienced a stronger reaction to the enemies and environment.

# Chapter 7

## Conclusion

In this section the project will be reflected on as a whole. The limitations and successes of the project will be discussed, and future work opportunities will also be highlighted. The aim of the project was to answer the question of whether Virtual Reality is a more immersive experience than traditional methods of play. The project has delved into immersion, presence, and usability; in conclusion the immersion levels of Virtual Reality and traditional methods are too similar to be able to definitively state that one is more immersive than the other. In some cases, it would seem VR is the clear winner however in other is has been its own downfall.

When talking about the idea of presence and feeling like the participant was in the space they occupied in the a virtual world the VR was a clear winner with a higher Witmer and Singer presence overall score and winning in all the categories but one. However the SUS questionnaire was so close in score that its not possible to be able to sate which was a better system. The thematic analysis is where this becomes most apparent. Though VR is immersive as a technology, as it puts the participants eyes in the virtual world and no where else, this then causes some issues with immersion. As discussed in Chapter 6.3 in the thematic analysis section, VR participants perceived their experience a lot stronger than the keyboard and mouse group. This means that they also experience the small bugs and glitches that may appear a lot more than a

monitor would and for this reason can be pulled out of a state of immersion easier.

It could be argued that if participants were tested on a perfect game with no bugs or glitches then the VR group would experience a lot higher immersion levels than the keyboard and mouse group. This way the participants wouldn't be pulled out of immersion, and they would experience everything at a greater level. This however was not the case, and this is the first limitation of the project.

## 7.1 Limitations

The first limitation of the project was the inexperience with Unreal Engine 5. The technology, especially lumen, is relatively new and this is the first project that I had completed in UE5 meaning that there was not as much documentation as was needed. The decision to use UE5 could have been changed and using as more familiar game engine like Unity may have been preferable. However, the main reason for using UE5 was the graphics and realism that Lumen can give, and this was overruled by the unfamiliarity of the engine. This fact meant that there was a learning curve to the development of the game, and this slowed down the project significantly.

Another limitation of the project was that this was also the first project I had developed using a VR headset, this was another learning curve that had to be overcome and I also encountered a lot of issues with compatibility with Unreal Engine and DirectX 12. This led to a big delay in the project as each time the editor launched it would crash. The inexperience with VR development was a big limitation as I was not aware that when using VR DirectX 12 and Lumen aren't compatible and DirectX 11 must be used.

## 7.2 Successes

Though there were a lot of limitations to the project there were also a lot of successes. The horror game experience was completed well and can be played on both VR and with a keyboard and mouse. The aims and objectives were all completed fully expect number 9. “Present data in table form to deduce which method of play is more immersive”. Though all the data was presented and analysed a solid outcome could not be decided on however this leaves a gap for future research. Another success of the project was the new skills that I have learnt as a student. I am now proficient in UE5 and have some experience in developing games with a VR headset which can be very useful in the future.

Another success was being able to expose more people to Virtual Reality. Most of the participants in the research I conducted have said that they have only used Virtual Reality once or twice and would like to use more of it. Virtual Reality is an amazing piece of hardware and there are many applications for it apart from games. It can be used to train workers and teach children in a much more engaging way and there will be a lot more of this in the future so being able to expose people to it now is a big success.

## 7.3 Future Work

There is a lot of room for future work to be completed on this subject. Research into flow states and VR and just how immersive VR can be, are interesting approaches to different studies that can be done. In terms of presence and determining the question that was set out to be answered in this project, there is more work that can be completed, and the question can be answered in more depth. A fully polished game with minimal bugs and issues, tested the same

way that this project has been, could output some interesting conclusions and answer the question that was set out here in the first place.

The method of testing two groups of participants, one with VR and one without, can be applied to many applications and can give some interesting insight to different areas of life. Studies about training and simulation have been completed using VR and this structure but VR has a lot of uses elsewhere. For example a primary school class could have a lesson with a VR headset and another without being taught the same material. They could then be tested to see which class retained the information better.

## 7.4 Final Words

In conclusion, VR has not been proved to be more or less immersive than more traditional methods, however it has proved itself to be a valuable resource and the groundwork for future studies has been laid.

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