University of Glasgow | School of Computing Science

Honours Individual Project Dissertation

Virtual Reality as a Solution for Logistical and Mental Health Challenges in Student Support

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Abstract

This project explores the use of virtual reality technology for student support and advisor meetings. The report uses qualitative and quantitative data to evaluate the effectiveness of a VR app, analysing participants' experiences and opinions. The findings suggest that using VR technology for meetings with supervisors or advisors provides a middle ground between the convenience of phone and email and the personal touch of an in-person meeting. Participants generally had a positive experience using the VR app and expressed a likelihood to use it in future meetings. However, there were still areas where improvement could be made, such as addressing accessibility issues and making the VR environment more interactive. Future work could focus on improving accessibility options, creating more sophisticated virtual environments, and establishing guidelines for using VR technology in education. Overall, the report suggests that virtual reality technology has great potential to enhance student support and advisor meetings and revolutionise how educational institutions deliver their curriculum.

Education Use Consent

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1 Introduction

1.1 Overview

The COVID-19 pandemic has significantly changed how students access support services. With many universities and colleges transitioning to remote learning, students may face additional logistical and mental health challenges that can impact their academic success. Seeking therapy is often recommended to help manage these issues, but some individuals may hesitate. They may be uncomfortable discussing their emotions and problems with a therapist they don't know or may be prevented from attending in-person therapy sessions due to logistical or medical reasons.

Virtual reality (VR) technology offers a potential solution to these challenges. By using VR, individuals can access therapy and support from the comfort of their own homes without the need to travel to a therapist's office. However, using VR for medical purposes can raise logistical and ethical concerns. Thus, this project focuses on using VR in an educational setting to facilitate virtual supervision and student advisory meetings. This way, individuals can still benefit from VR technology without compromising ethical and logistical standards. Given more time, the project may still be able to be adapted to medical purposes, provided that ethical considerations can be met.

1.2 Aim

This project aims to develop a VR environment that offers an alternative platform for students to connect with their supervisors and advisors, especially in situations where traditional in-person meetings are not feasible due to various challenges. By developing an interactive and customisable virtual space, this project intends to provide a more flexible and convenient option for students to engage with their supervisors in an educational context.

The VR environment is designed to be interactive and customisable, allowing users to control the appearance of the virtual room, furniture, and other users' voices within the same virtual space. This level of customisation tailors the environment to each student's preferences and needs, creating a more comfortable and engaging experience.

Moreover, the ability to adjust the volume and pitch of other users' voices, in this case, the supervisors and advisors, can enhance the communication experience and create a safer and more comfortable experience.

A user study was conducted to measure the usability and user experience of the VR environment. Participants were asked to enter the virtual environment, and complete predefined tasks standardised for all users. Following this, participants were asked to provide feedback on their experience using the program, allowing them to evaluate it and suggest improvement areas. The user study aims to gather data on the effectiveness of the VR environment in facilitating student-supervisor interactions and to identify any areas of improvement for future development.

2 Background

This chapter provides a context for developing the VR application for student support. This chapter aims to review the existing literature on the use of VR technology in education and mental health and its relevance to the current project.

2.1 Virtual Reality

To explore the potential benefits of virtual reality (VR) for providing student support. VR is a three-dimensional computer-generated simulation environment, allowing human beings to interact with it using specialised head-mounted displays (HMDs), controllers, hand gestures or even eye movements tracked by multiple cameras attached to the headset or around the room. This technology provides users with a fully immersive experience that simulates real-world situations in a way that traditional screens cannot replicate.

This technology enables users to engage with digital environments in a way that enhances their understanding and retention of complex information and provides a "hands-on" experience that is difficult to replicate using traditional methods (7).

As VR technology becomes increasingly accessible, it has been simplified to the point where it can be used with just a smartphone and a few cardboard pieces. Google initially introduced this technology with their "Google Cardboard" product (Figure 2.2) (5). This alternative to a full-blown VR experience was groundbreaking, but it had limitations. The headsets were primarily made of cardboard and designed to be used with smartphones, which relied on the phone's accelerometer for motion sensing. Unfortunately, this was not advanced enough to keep up with quick head movements and tracking, resulting in users experiencing motion sickness and headaches.

Figure 2.1: Meta Quest 2 (10)

Figure 2.2: Google Cardboard (5)

Understanding both the opportunities and constraints of VR technology is critical to evaluating how it could provide students with flexible and supportive connections with advisors. By examining the potential benefits and limitations of current VR options for addressing diverse student needs, experiences, and goals, this literature review aims to assess the value of VR for supplementing traditional student support services, especially amid challenges from remote learning.

2.2 Virtual Reality and Cybersickness

Cybersickness, a type of motion sickness, occurs when electronic screens are used instead of actual movement (37). The symptoms are similar to motion sicknesses, such as dizziness and nausea, but cybersickness requires no physical motion. The brain receives conflicting messages from the eyes, inner ears, and body, causing disorientation. Like motion sickness, cybersickness can be caused by conflicting signals sent to the brain by the senses. Scrolling on a smartphone or computer, using multiple screens, or attending a virtual meeting where someone controls the screen can lead to cyber sickness. While some individuals experience cybersickness quickly, others may be unaffected (32).

For a VR program supporting students, cybersickness could pose challenges. Students who experience cybersickness may struggle to fully engage in virtual meetings with advisors, or find the interactions uncomfortable or overwhelming. The potential for cybersickness means VR student support programs must carefully consider how to design virtual interactions and environments to minimize discomfort for users with different sensitivity levels. Understanding and addressing cybersickness is critical to creating an accessible VR program that can benefit all students.

2.3 Virtual Reality in Meetings

VR technology could allow for more immersive and engaging virtual meetings between students and advisors. Rather than a standard video call, VR would allow students and advisors to feel present together in a shared virtual space. One of the main advantages of VR meetings is that they provide a more immersive and engaging experience, allowing users to feel as though they are in the same physical space even if they are located in different parts of the world(20); this will in turn help increase engagement and participation in meetings along all users.

There are various VR platforms for virtual meetings, offering options like customisable avatars and environments, such as MeetingVR, Spatial (11), Glue (19), and Future Visual (4). These platforms provide various features, such as customisable avatars representing the user, customisable virtual environments catering to the user's requirements, and the ability to view and share files with other users in the virtual room. However, for student support, it would be critical to choose or design a platform maximizing accessibility, comfort, and usability for all students and advisors. The value of VR meetings would depend on how well they can address students' and advisors' diverse needs, experiences, and goals. If VR could improve inclusiveness or focus for students who struggle with traditional meetings, it may be worthwhile, but it may not be suitable if it introduces barriers or discomfort.

Two articles explored the possibility of using VR for business meetings (15) (23). The articles explains the benefits of using VR technology for meetings, including increased collaboration, reduced travel costs, and improved engagement (39). The article closes by saying although VR for meetings has many potential benefits in the future, it is essential to consider the specific needs and goals of each meeting before deciding to use VR technology or any other method of communication. There are many positive aspects of using Virtual Reality for meetings. One key benefit is that it takes you completely out of your physical space, helping to minimise everyday interruptions and increase the effectiveness of the meeting (15) (23). This can improve meeting productivity by expanding the focus of attendees.

According to a Forbes article (22), virtual meetings can also be more inclusive by allowing people to participate from anywhere in the world. This means that people who may not have been able to attend a face-to-face meeting due to distance or other constraints can now participate fully in virtual discussions. Linking to the previous with reduced travel costs, the Forbes article explains it also makes users more environmentally friendly by reducing carbon emissions associated with travel. By using virtual reality technology to conduct meetings, businesses can reduce their carbon footprint and contribute to a more sustainable future.

2.4 Limitations of Using VR in Meetings

While VR could provide more engaging meetings, there are significant limitations to consider when evaluating if it would benefit student support. For example, large groups or complex discussions in VR may be more challenging than face-to-face, potentially making it less suitable for some student advisory meetings as it could lead to all attendees taking an active role (25). Another limitation is that virtual meetings rely on technology and internet connections, which can fail. This can disrupt the meeting flow and cause peer frustration. Another limitation is that some people may have low technological knowledge, which can prevent the broader adoption of virtual meetings. Some participants may not know how to use virtual technology effectively (26). Virtual meetings may also be less dynamic than face-to-face (20). Communicating feelings and emotions effectively during a virtual meeting may be more difficult.

Additionally, team members may be in different time zones, making scheduling virtual meetings more challenging. The same article(15) mentioned above also acknowledges some potential challenges, such as the need for high-quality VR technology and the potential for decreased human interaction. Overall, the limitations of VR mean it may not be helpful or comfortable for all students or meeting types.

VR technology and virtual meetings could also increase security and privacy risks. When sensitive topics regarding students' well-being are discussed, strict protections are essential. Since virtual meetings take place over the Internet, there is always a risk that unauthorised individuals may gain access to sensitive information being shared during the meeting. This can result in data breaches and loss of confidential information.

2.5 Virtual Reality in Education

Research shows VR can enhance learning outcomes, increasing student motivation, engagement, and retention. For example, a study by the University of Maryland found that students who learned through VR retained information for longer and performed better on exams than students who learned through traditional methods (28).

In addition, VR can also provide opportunities for collaborative learning, as it allows students to interact with each other and the environment in a shared digital space. This can be particularly useful for students who cannot attend physical classes or are in different parts of the world (18).

VR can transform how we approach education, making it more engaging, accessible, and effective. As technology becomes more widely available and affordable, we expect more educational institutions to integrate VR into their teaching practices.

By incorporating VR technology into this project, there is potential to enhance student engagement and academic success. As technology advances and becomes more accessible and affordable, we can anticipate an increase in educational institutions integrating VR into their teaching practices. VR technology integration can revolutionise students' learning, providing them with more immersive and interactive educational experiences. With the ability to simulate real-world situations and environments, students can engage with content more meaningful and memorable way. By leveraging the benefits of VR, educators can help students better retain information, promote critical thinking, and enhance problem-solving skills. As a result, we can expect to see VR technology become more widely used in the education sector in the coming years.

2.6 Virtual Reality in Healthcare

While VR research has focused on education and healthcare, its value for student support depends on how it may affect diverse students' experiences and goals. VR has been researched for healthcare as a potential alternative or equivalent tool for mental health therapy. One promising application of VR in healthcare is the use of cognitive-behavioural therapy (CBT) and virtual reality exposure therapy (VRET) for anxiety and post-traumatic stress disorder (PTSD) (17) (29).

CBT is a therapy that targets negative thought patterns and behaviours, while VRET uses VR to simulate anxiety-inducing situations in a controlled environment. VRET gradually exposes patients to these situations and provides coping strategies, helping them overcome their fears. VR technology holds potential for both education and mental health.

Studies have shown that VR-based therapies like VRET can be just as effective as traditional therapy in treating anxiety and PTSD, with some even showing better patient outcomes (24). For example, a study published by the American Psychological Association found that VRET was effective in reducing symptoms of PTSD in veterans (27). Another study by the University of Oxford found that VRET was more effective than traditional exposure therapy in treating social anxiety disorder(40).

Figure 2.3: VRET being used to reduce symptoms of PTSD in veterans (30)

Researchers at The University of Oxford and the Oxford Health NHS Foundation Trust discuss using VR to treat mental health problems, especially anxiety, among patients in Manchester, UK (1). The therapy involved exposing patients to virtual environments that triggered their anxiety, while the article does not say, this is a type of VRET. The study found that VR therapy effectively reduced anxiety symptoms, with patients reporting significant improvements in anxiety levels.

2.7 Limitations of Using VR in Education and Healthcare

Despite the advantages, there are limitations to using VR technology in education and mental health. One major limitation is the cost and accessibility of the technology. While VR technology is becoming more affordable and accessible, it requires specialised equipment such as head-mounted displays and controllers. This can limit the number of students who can access the technology and create a barrier to entry for institutions with limited resources.

Another limitation is the potential for adverse side effects such as motion sickness, eye strain, and headaches. Some users may also experience disorientation or vertigo when using VR systems for extended periods of time. This can be a particular concern in educational or healthcare settings, where users may be required to use VR for prolonged periods.

Developing high-quality VR content requires specialised knowledge and skills and can be time-consuming and expensive. This relates to the quality of VR content, as not all VR experiences are created equal. Low-quality VR experiences can be ineffective or counterproductive, leading to a poor user experience and potentially negative outcomes. It is vital to ensure that the VR content is relevant, accurate, and appropriate for the intended audience. This can limit the availability of quality educational or therapeutic content and may result in limited options for students or patients.

Moreover, there are concerns about the ethical implications of using VR technology in specific scenarios, such as exposing patients to traumatic events in virtual reality. This raises questions about informed consent, privacy, and potential emotional harm to users. Healthcare providers must ensure that they use VR technology responsibly and ethically. This was the reason that the project direction changed from medical to educational.

Finally, the effectiveness of VR technology in education and mental health is still being studied and validated. While many studies have shown positive outcomes like the ones mentioned above, more research is needed to determine the long-term impact of VR technology on education and mental health outcomes. It is important to ensure that VR technology is evidence-based and supported by research.

2.8 Future of Virtual Reality

The COVID-19 pandemic accelerated the adoption of VR and Augmented Reality (AR) for remote collaboration and work. While this shows promise for VR's potential to provide engaging experiences, effects on student support would depend on how VR impacts diverse students' experiences and goals. An article published by Forbes highlights the potential of VR in a post-pandemic world, with increased usage seen in remote work and collaboration. With many individuals working from home, VR can provide a more immersive and interactive way for teams to communicate and collaborate on projects, even simulating real-life work environments.

Significant investments in VR highlight interest in its potential. A report by Forbes explored the global spending on AR and VR headsets, software, and services, including purchases by consumers, and the report showed that there had been an increase of $12 billion in 2020, up 50% from 2019 (38). Furthermore, in 2020, 32% of consumers used AR for shopping, and the market growth rate for AR and VR is estimated to increase by 68.5% between 2020 and 2027, reaching a staggering $2094.08 Billion. This significant increase in spending highlights the growing importance and potential of VR and AR technologies in a world where remote work and collaboration have become increasingly widespread.

2.9 Summary

This chapter highlights that VR technology can be used to create immersive learning environments that enhance student engagement, motivation, and retention of information. VR technology also has the potential to facilitate collaborative learning and provide opportunities for students who are unable to attend physical classes.

Furthermore, the research suggests that VR-based therapies such as VRET can effectively treat anxiety and PTSD, which is relevant to the project for student support.

However, the research also acknowledges the limitations of using VR technology in education and mental health, such as the cost and accessibility of the technology, potentially negative side effects, and the need for high-quality VR content.

VR technology for meetings, including increased engagement and collaboration, reduced travel costs, and the need for high-quality VR technology. The chapter also discusses the future of VR in a post-pandemic world, with increased usage seen in remote work and collaboration and significant market growth projected.

Therefore, this chapter provides a valuable foundation for understanding the potential benefits and limitations of using VR technology in education and mental health, which can inform the development of your VR application for student support. It also highlights the importance of considering the accessibility and quality of the technology to ensure an effective and safe user experience. The research provides insights that can be applied to this project.

3 Requirements

3.1 Prioritisation Method

Different prioritisation methods and techniques are used at the beginning of a project to categorise specific requirements based on their importance to the project. For this project, the MoSCoW prioritisation technique was used. MoSCoW is a prioritisation technique that categorises requirements according to their importance to the application, such as "must have," "should have," "could have," and "Won't have(this time) (31)"

3.2 Functional Requirements

Functional requirements define the specific features that a software application must perform to meet the needs of its users and the end product. These requirements describe what the system should do and how it should behave to achieve its intended purpose. In the case of a virtual meeting application, some functional requirements using the MoSCoW prioritisation technique might include:

3.2.1 Must have

Multiplayer feature:
A multiplayer feature is an essential aspect of any online app. Multiplayer allows users to connect and collaborate with other users from around the world, providing an immersive experience. Without this feature, this app would be limited to the single-player mode, which would be useless, and students and supervisors/advisors would be unable to simultaneously be in the same virtual room.

Multiplayer speech feature:
The multiplayer speech feature enables users to communicate with each other through voice chat while using the app in real-time. This feature provides users with a more immersive, natural, interactive, and enjoyable experience. It is an essential user element and goes hand-in-hand with the multiplayer feature. This is particularly important as this allows students to connect with their advisors and supervisors.

Avatar creation:
Having an avatar creation feature allows users to create custom avatars that represent themselves, making the experience more personalised and engaging. It enhances the user's engagement with the application and makes it feel more like a personalised experience, which should also make the experience safer.

Customisable virtual space: The ability to customise the virtual space is a must-have feature for this project. This function allows users to design and adjust the virtual environment to their preferences and needs. It creates a more comfortable and engaging experience by allowing users to tailor the virtual space to their requirements.

3.2.2 Should have

Volume control:
In a multiplayer environment, it's essential to be able to adjust the volume of other users. This feature is particularly useful when there are multiple users in the virtual environment, and some may have louder voices or background noise that needs to be filtered out. This feature allows users to have more control over their experience.

Pitch control:
This provides users to control and adjust the pitch of other users. The feature provides users with more control over their experience and allows them to customise the audio to suit their preferences. The ability to adjust pitch can be helpful for users with hearing impairments, allowing them to adjust the audio to a pitch that is easier for them to hear.

Spawning objects:
The ability to spawn objects into the environment is an important feature that allows users to create an environment in which they feel comfortable and in control of what's happening around them. This feature also enhances user engagement and immersion in the application. This allows the users to create an environment that is unique to them and that makes them feel safe.

3.2.3 Could have

Multiple rooms:
Adding the feature of multiple rooms allows for multiple meetings with different users to take place simultaneously, which can enhance the virtual experience and the usability of the app. Users can join different rooms based on their requirements, making it easier to organise and manage meetings. This feature would improve the flexibility and scalability of the app, making it possible to accommodate a larger number of users and meetings at once.

Haptic feedback:
Haptic feedback could be a very useful feature. This would provide users with a more immersive and realistic experience in a virtual environment. By simulating physical sensations, users can better interact with virtual objects and feel a sense of realism.

Ability to interact with objects:
This feature enhances the user experience by allowing them to manipulate their surroundings and giving them a greater sense of control, immersion and personalisation.

3.2.4 Won't have

First person walking motion:
Initially, the idea of having a first-person walking motion seemed promising. However, after careful consideration, it was decided that this feature will not be included in the project. This is because it may cause motion sickness for some users, which could result in a negative experience.

Request object ownership:
While requesting ownership of objects in the environment to allow the initial user to give or deny permission for another user to spawn or move an object would have been beneficial in a collaborative environment. The idea was deemed too complex to implement effectively and also found to be unnecessary.

3.3 Non-Functional Requirements

Non-functional requirements describe how the software application behaves and how it performs. These requirements are not related to the specific features of the application but rather how the application operates as a whole. In the case of a virtual meeting application, some non-functional requirements using the MoSCoW prioritisation technique might include:

3.3.1 Must have

Security:
Security is a must-have non-functional requirement for this project. The app must keep user data and information secure and confidential. It is crucial to implement robust security measures to prevent unauthorised access and protect user privacy.

Performance:
As the virtual environment will be hosting multiple users and objects, it's important that the system can handle the load without lagging or crashing. This will ensure a smooth and enjoyable experience for all users. If this is not achieved, the use of this application could cause users to feel motion sick and nausea.

Reliability:
Reliability is another must-have non-functional requirement for this project. The app must be reliable and able to operate consistently without crashes or errors. This feature is essential as it ensures that users can connect with their supervisors and advisors without any technical difficulties.

3.3.2 Should have

Usability:
The virtual environment should be intuitive, easy to use, and have a user-friendly interface. This will help to minimise confusion and frustration for new users and allow them to focus on the content of the environment rather than on technical difficulties.

3.3.3 Could have

Performance:
Performance is a could-have non-functional requirement for this project. The app should perform well and operate at an acceptable speed. This feature is desirable as it ensures that the app can run smoothly without any lag or delays.

3.3.4 Won't have

Accessibility:
Although accessibility is desirable, it is a won't-have non-functional requirement for this project. Accessibility features such as text-to-speech, colour contrast, and screen readers require additional resources and will not be included in this project.

3.4 Chapter Summary

This Chapter discusses the functional requirements of the application, prioritised using the MoSCoW method. Must-haves include multiplayer and speech features, as well as avatar creation. Should-haves include volume and pitch control, as well as the ability to spawn objects. Could-haves include multiple rooms, haptic feedback, and the ability to interact with objects. First-person walking motion and request object ownership were deemed unnecessary. This chapter also discusses non-functional requirements, including the performance and usability of the application.

4 Design

Design is an essential aspect of any software engineering project. This chapter will outline the abstract design of the virtual meeting application. The design will cover the overall system architecture, user interface, multiplayer functionality, avatar creation process, and the data set design choices.

4.1 System Architecture

The overall architecture of the virtual meeting application will be divided into two main components: the client side and the server side. The client will handle the user interface, input, and output, while the server will handle the multiplayer functionality and client communication.

The client side will have three main components: the Unity engine, the Oculus Integration tool, and the Photon Unity Networking 2 (PUN 2) plugin(21). The Unity engine is the game engine that will be used to create the virtual environment. The Oculus Integration tool provides the necessary scripts and prefabs to enable the use of the Oculus Quest 2 headset and its controllers. PUN 2 is a plugin that offers multiplayer functionality by managing the network infrastructure and communication between players.

The server side will consist of the Photon Cloud, which is the backend service provided by Photon that handles the multiplayer functionality. The Photon Cloud will oversee the creation of rooms, synchronising game objects across the network, and communicating between clients.

4.2 User Interface

The user interface of the virtual meeting application will consist of several elements that allow the user to interact with the virtual environment and other users. The main components of the user interface will be the avatar, the virtual space, and the user interface menu.

The avatar will be a customisable user representation within the virtual environment. The avatar creation process will be discussed in more detail in the "Avatar Creation Process" section.

The virtual space will serve as the environment in which users can interact. It will include various objects such as furniture, pictures, and other interactive items. The virtual space will be designed to be highly customisable, allowing users to create their own virtual environment that is tailored to their needs. To enhance the user's experience, the virtual room will be surrounded by a forest. This will prevent the feeling of the room floating in a void and provide an immersive environment for the user.

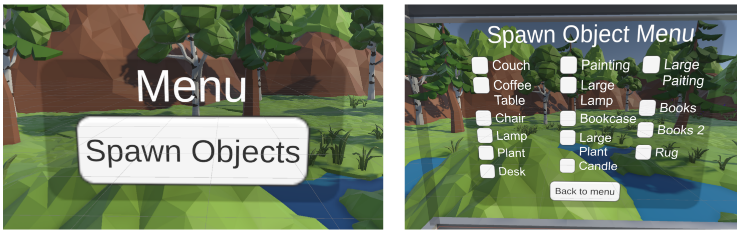


Figure 4.1: Spawn Object Menus

The user interface menu will be the interface the user can use to interact with the virtual environment and other users. The user interface menu buttons will provide options for customising the virtual space and controlling the audio settings, such as other users' volume and pitch controls. It will be designed to be simple and intuitive, allowing users to quickly and easily navigate the options.

The volume and pitch control slider will allow the user to adjust the pitch of the audio in real time. The slider will be designed to be easy to use, allowing the user to adjust the pitch quickly and accurately. The object spawning control will be a toggle, and this will activate and deactivate the objects in real time. The toggle buttons will be designed to be easy to use.

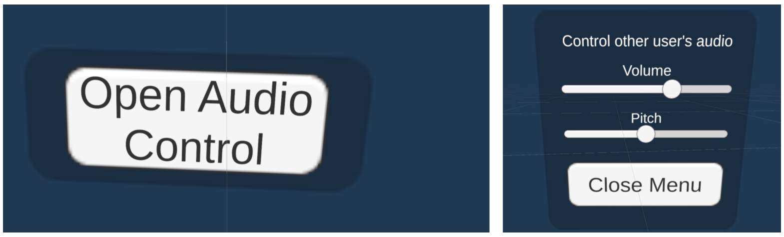


Figure 4.2: Audio control Menus

4.3 Volume and Pitch Control Algorithm

The volume and pitch control algorithms used in the system will be implemented using Unity's AudioSource class (35). The AudioSource class provides built-in functionality for controlling the volume and pitch of audio signals in real-time.

The volume and pitch control algorithms will be implemented on the client side using a programming language, in this case, it will be C#. The algorithms will work by accessing the AudioSource component of the audio signal and modifying its volume and pitch properties. The volume property is a floating-point value that represents the volume of the audio signal on a scale of 0.0 to 1.0. In contrast, the pitch property is a floating-point value that represents the pitch of the audio signal on a logarithmic scale.

The user interface of the system will include volume and pitch control sliders that will allow the user to adjust the volume and pitch of the audio signal in real-time. The volume and pitch control sliders will be integrated with the AudioSource component, allowing the user to adjust the volume and pitch of the audio signal by modifying its volume and pitch properties.

The volume and pitch control algorithms implemented using Unity's AudioSource class are designed to be fast and efficient, allowing real-time adjustment of the volume and pitch of audio signals. The algorithms are also easy to use and integrate seamlessly with the system's user interface.

4.4 Multiplayer Functionality

The multiplayer functionality of the virtual meeting application will be handled by the PUN 2 plugin and the Photon Cloud. PUN 2 will handle the creation of rooms, the synchronisation of game objects across the network, and the communication between clients. The Photon Cloud will handle the backend services required for the multiplayer functionality, including creating rooms, managing users, and communicating between clients.

When users connect to the application, they will be prompted to enter one of three rooms. Whichever room they join they can share the information with other users to allow them to join the same room. When the user enters a room, they will be connected to the room and added to the list of users in the room.

Once a user is connected to a room, they will be able to see and interact with other users in the same room. The avatars of other users will be visible in the virtual environment, and their movements and actions will be synchronised across the network. Users spawning in objects will also be synchronised across the network for every user.

4.5 Avatar Creation Process

The avatar creation process will be handled by the Meta Avatars SDK. The Meta Avatars SDK provides a range of technical features for creating and managing avatars, including animation control, networking capabilities, full-body tracking, lip sync, and facial expression support.

The avatar creation process will consist of several steps. First, the user will be able to choose a base model for their avatar from a selection of pre-made models. The user will then be able to customise the appearance of their avatar, including the clothing, accessories, and facial features. This will all be done before the user opens the applications. Once the user has finished customising their avatar, they will be able to save it and use it within the virtual environment.

4.6 Toggling Algorithm

The toggling algorithm in the virtual meeting application can be implemented using Unity's UI.Toggle class (34). The Toggle class is a user interface element that provides a simple way to enable or disable a specific feature or object within the virtual environment.

To implement the toggling algorithm using the Toggle class, each object that can be toggled will have a corresponding Toggle object. When the user clicks on the corresponding toggle button in the user interface menu, the associated object will be activated or deactivated based on the state of the Toggle object. In the application, the toggling feature will be used to toggle both objects and menus.

Using the toggling algorithm to toggle both objects and menus provides users with a simple and intuitive way to modify the virtual environment and the user interface. The algorithm is easy to use, and the visual representation of the toggles in the user interface menu provides users with a clear indication of which objects or menus are currently active or inactive.

4.7 Haptic feedback

The Unity XR Interaction Toolkit provides a range of tools and components for creating immersive haptic feedback experiences in virtual reality (36). These tools include support for custom haptic feedback sensations, as well as a range of pre-built haptic feedback options.

the Haptic Feedback component of the XR Interaction Toolkit can be used to provide haptic feedback to the user when interacting with virtual objects within the virtual meeting environment. This can help to simulate the feeling of touching and manipulating physical objects, enhancing the user's immersion and making the virtual environment feel more realistic. Haptic feedback can also be used to provide feedback to the user when interacting with the user interface. For example, when the user clicks on a button in the user interface menu, haptic feedback can be used to provide a tactile sensation, confirming the user's action.

4.8 Chapter Summary

In the Design chapter of the virtual meeting application, the abstract design of the application is outlined, covering the overall system architecture, user interface, multiplayer functionality, avatar creation process, and the data set design choices. The system architecture is divided into two main components: the client side and the server side. The user interface consists of several elements, including the avatar, virtual space, and user interface menu. The volume and pitch control algorithm is implemented using Unity's AudioSource class, while the toggling algorithm is implemented using Unity's UI.Toggle class. The multiplayer functionality is handled by the PUN 2 plugin and the Photon Cloud, and the avatar creation process is handled by the Meta Avatars SDK. Finally, the Unity XR Interaction Toolkit is utilised to provide haptic feedback to the user, enhancing the user's immersion in the virtual environment. Overall, the Design chapter provides a comprehensive overview of the application's design, highlighting the key features and technologies utilised in its development.

5 Setup for Implementation

5.1 Hardware Resources used

5.1.1 Headset

In this project, the Meta Quest 2 headset was selected as the primary device. The Meta Quest 2, previously known as the Oculus Quest 2, is a standalone VR headset, making it a highly versatile and accessible option for VR development.

The Meta Quest 2 headset was chosen for this project due to its technical capabilities and the ease of use it offers. Its wireless nature eliminates the need for additional cables or equipment, which simplifies the setup process and allows for greater mobility during use. Additionally, its advanced tracking and input systems enable a wider range of interactions, providing a more engaging and interactive experience for users.

The decision was also based on accessibility to the device. The university provided the headset, which was beneficial as it reduced the cost of the project and allowed me to work on the project outside the University hours.

5.2 Software Resources used

5.2.1 Game Engine

During the initial implementation of the project, one of the decisions was to choose a game engine to use. Game engines are software development environments designed specifically for creating video games. They provide a wide range of tools and resources that make game development more efficient, such as game physics, animation, graphics, and sound. The two most popular game engines used in the industry are Unity (33) and Unreal (13).

Unity is a cross-platform game engine that supports the creation of 2D, 3D, and VR games. One of its biggest advantages is its user-friendly interface, which makes it accessible to developers of all skill levels. Unity also has a vast asset store that provides pre-made resources, such as avatars, environments, and plugins, that can be used to speed up the game development process. Unity uses C# as its primary programming language, but developers can also use JavaScript, C, and C++.

On the other hand, Unreal Engine is a game engine developed by Epic Games and is best known for its advanced graphics capabilities. It is used to create high-end games for PC, consoles, and mobile devices. Unreal Engine also makes use of C,C# and C++ as its programming languages but it also has a visual scripting language called Blueprints that allows developers to create gameplay mechanics without writing any code (14).

Both Unity and Unreal Engine have large and active communities that provide extensive documentation and support. Choosing the right game engine for a project involves weighing the pros and cons of each engine based on the project's specific requirements. In this case, after evaluating the two engines, Unity was chosen as the game engine for the project due to its versatility, ease of use, the greater number of assets in its store, and mainly because it is a lighter program to run on the available machine to myself. Additionally, C# was chosen over the other available languages due to more resources and support available in Unity support forums.

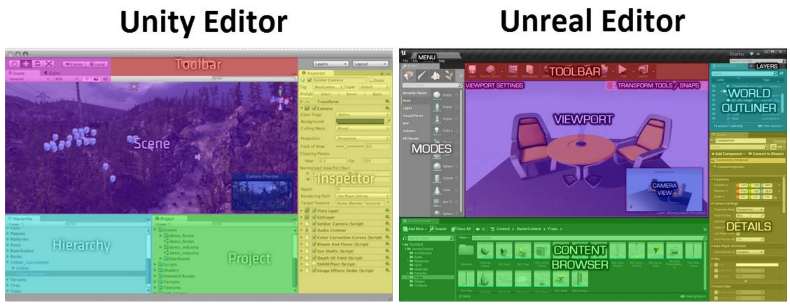


Figure 5.1: Comparison between Unity and Unreal editor user interface (14)

5.2.2 Assets and Plugins

As previously mentioned, Unity's asset store offers a variety of pre-made resources, including avatars, environments, and plugins. This project, several assets were used from the store for this project, including.

Oculus Integration: The main component needed for this project was the Oculus Integration tool. It provides a set of Unity scripts, prefabs (pre-made objects), and other resources that allow developers to easily integrate Oculus devices, such as the Quest 2 headset, into the Unity project.

The asset made it possible to use the Quest 2 headset's movement, camera and controller. This made it possible to interact with objects in the virtual environment. It also enabled the use of hand tracking and other features.

Plenty of documentation and support from the Unity forums to YouTube made it easy to troubleshoot any issues that arose during the development process. This asset allowed for seamless integration of the Oculus Quest 2 with the Unity engine.

PUN 2: To use the Photon engine, an account was needed to create an App ID. This was done on the Photon Dashboard, which was required for integrating the PUN 2 plugin into the Unity project. It was very straightforward to do so with the documents that come with assets. The App ID was then added to the Unity project, enabling communication between Unity and Photon.

Photon Unity Networking 2 (PUN 2) is the main asset that allowed to make the game multiplayer. It manages the network infrastructure and communication between players. PUN 2 includes features such as lobby creation and synchronisation of game objects across the network which were needed and implemented into this project. The asset was used to establish a network connection between players, synchronise their movements and actions, and project it to the other users in the same virtual room. PUN 2 asset provided a quick and easy way to implement multiplayer functionality without requiring extensive knowledge of network programming.

Photon Voice 2: The project needed a way to communicate with other users in the environment, the project needed a Voice over Internet Protocol (VoIP) and that's where Photon Voice 2 comes in. Photon Voice 2 is another asset from the same company, Photon, which provided a means for players to communicate with other users in the virtual world. It was a no-brainer to use PUN Voice due to the integration with PUN. To use this asset it was the same process as PUN 2 where a different voice App ID had to be created and then added to Unity for it to connect with Photon.

Meta Avatars SDK: The Meta Avatars SDK (Software Development Kit) is developed by Meta for use with their platform. The SDK allows for the creation of custom avatars that can be imported into projects. These avatars can be created using the Meta platform and can be edited within the VR headset itself or from any device with access to Facebook, Instagram, or Messenger. It is a Unity-based SDK which provides a range of technical features for creating and managing avatars, including animation control, networking capabilities, full body tracking, lip sync and facial expression support. It also includes appearance-changing features down to minor details, such as the ability to change the colour of clothing or add accessories.

Another reason to choose this particular SDK is its integration with the Photon Unity Networking (PUN) system. This integration enables the avatars to be used in multiplayer environments, with a smooth and reliable network. synchronisation.

Figure 5.3: Meta Avatars Menu with possible creations (41)

Environment Appearance To create the actual environment, the following assets were used: Free Low Poly Nature Forest by Pure Poly (3), HDRP Furniture Pack by Tridify (6), Wood Pattern Material by FrOzBi (16), Toon Furniture by Elcanetay (12), Classic Picture Frame by Vertex Studio (2), Lamp Model by HarpetStudio (9), HQ Modern Sofas Pack by Next Level 3D (8).

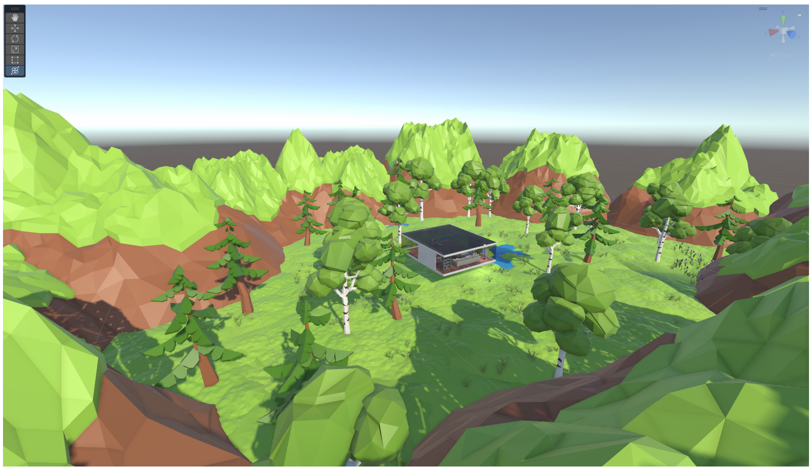


Figure 5.4: Picture of one of the Environments in the project

6 Implementation

Following the previous chapter, this chapter will explain how the game engine, assets and plugins were used to create the final product.

6.1 UI Menu

Implementing functional menus within the Unity game development platform proved relatively straightforward, given the pre-existing user interface assets readily available for customisation. The menus were designed using the world space render mode over the screen space render mode, ensuring the interfaces remained unobtrusive to the player's view and retained a fixed position relative to the virtual environment. A user interface layer was incorporated into the interface as a child component of a canvas, which served as the parent component, allowing menus to be locked within a designated space. Separate canvases were utilised for the distinct requirements:

Object Spawning To enable object spawning, a multi-step process was followed. First, two canvases were created: the "First menu" and the "Spawn object menu." The former contained a button labelled "Spawn Objects" while the latter was responsible for the actual object spawning. Within the Spawn object menu, UI toggles were used to activate and deactivate furniture objects placed around the room that had been disabled in the inspector tab, providing a blank slate for users to customize. To link the toggles to their respective objects, the On Value Changed (Boolean) option was selected in the toggle component in the inspector tab, with "runtime only" chosen. The relevant scene object was then added under Select-Object, and the Game Object was set to "SetActive" once selected. The Spawn object menu was linked to the First menu via the On Click option under the button component in the inspector tab. When the button was clicked, the Spawn object menu was activated, and the First menu was deactivated. The reverse process was followed to close the Spawn object menu and return to the initial menu: the Spawn object menu was deactivated, and the First menu was reactivated. Overall, these steps enabled object spawning and made it easy for users to customize their experience in the game.

Audio Control VolumeControl facilitates the manipulation of audio volume through a slider component. It declares a serialized Slider, volumeslider, representing the UI and attached to the AudioListener. VolumeControl's initialization logic restores the user's saved volume preference if detected. If not, it defaults to half volume. Load retrieves the preference from PlayerPrefs, applies it to the slider, and restores the user's input.

Interacting with the slider invokes ChangeVolume, which updates the AudioListener's volume to the slider's value and calls "Save" to serialize this preference, overwriting any previous value. Save persists the current slider value as the "musicVolume" key in PlayerPrefs. Load deserializes this key upon subsequent launches, restoring the user's volume.

```
public class VolumeControl : MonoBehaviour
{
   [SerializeField] Slider volumeslider;

   void Start()
   {
      if (!PlayerPrefs.HasKey("musicVolume"))
      {
         PlayerPrefs.SetFloat("musicVolume", 1);
      }
      else
      {
         Load();
      }
   }
   public void ChangeVolume()
   {
      AudioListener.volume = volumeslider.value;
      Save();
   }
   private void Load()
   {
      volumeslider.value = PlayerPrefs.GetFloat("musicVolume");
   }
   private void Save()
   {
      PlayerPrefs.SetFloat("musicVolume", volumeslider.value);
   }
}
```

PitchControl enables the modulation of an AudioSource's pitch through a slider interface. It declares a public AudioSource and Slider, pitchSlider, representing the audio element and visual component, respectively.

Continuous updating of the AudioSource's pitch based on the slider's value during runtime enables subtle control and corresponding audible feedback. The slider maintains a direct relationship with the pitch, reflecting the user's preference at any time.

```
public class PitchControl : MonoBehaviour
{
   public AudioSource audioSource;
   public Slider pitchSlider;
   void Start()
   {
      //Set the slider value to the current pitch of the audio source
      pitchSlider.value = audioSource.pitch;
   }
   void Update()
   {
      //Update the pitch of the audio source based on the slider value
      audioSource.pitch = pitchSlider.value;
```

```
    }
}
```

Room Choosing The NetworkManager class in the provided code is an essential component for implementing multiplayer functionality using Photon Unity Networking (PUN). It serves as a central hub for creating and managing rooms in the game, and its functionality is based on a list of DefaultRoom objects that store the room settings.

The InitiliazRoom method takes an integer index that corresponds to a specific DefaultRoom object from the list. It loads the specified scene using PhotonNetwork.LoadLevel, which instructs PUN to load the scene asynchronously and connect to the Photon servers. It then creates a room with the specified settings using PhotonNetwork.JoinOrCreateRoom, passing in the room name, RoomOptions object, and TypedLobby.Default.

The OnJoinedRoom method is a callback function that gets called when the local player successfully joins a room. It logs a message indicating that the player has joined the room.

The OnPlayerEnteredRoom method is a callback function that gets called when a new player enters the room. It logs a message indicating that a new player has joined the room.

The NetworkManager class provides a simple way to create and manage rooms in the game using PUN. It allows for the creation of multiple default rooms with different settings, and provides the necessary callbacks for handling network events.

```
public class DefaultRoom
{
   public string Name;
   public int sceneIndex;
   public int maxPlayer;
}

public class NetworkManager : MonoBehaviourPunCallbacks
{
   public List<DefaultRoom> defaultRooms;
   public GameObject roomUI;
   public void InitiliazRoom(int defaultRoomIndex)
   {
      DefaultRoom roomSettings = defaultRooms[defaultRoomIndex];

      //Load Scene
      PhotonNetwork.LoadLevel(roomSettings.sceneIndex);

      //Create room
      RoomOptions roomOptions = new RoomOptions();
      roomOptions.MaxPlayers = (byte)roomSettings.maxPlayer;
      roomOptions.IsVisible = true;
      roomOptions.IsOpen = true;

      PhotonNetwork.JoinOrCreateRoom(roomSettings.Name, roomOptions,
          TypedLobby.Default);
   }
   public override void OnJoinedRoom()
   {
      Debug.Log("Joined a Room");
      base.OnJoinedRoom();
   }
```

```
    public override void OnPlayerEnteredRoom(Player newPlayer)
    {
        Debug.Log("A new Player joined the room");
        base.OnPlayerEnteredRoom(newPlayer);
    }
}
```

Figure 6.1: Image of Room Choosing Menu

6.2 Multiplayer & Avatar

The OculusStuff class is responsible for integrating Photon PUN with Oculus Avatar and Oculus Platform SDKs. It includes various components that reference network connectivity, user ID, app ID, sample avatar, player prefab/spawn points, booleans for determining server ownership or exceeding spawn point capacity, and player count. To initialize the Oculus Platform, the StartOvrPlatform function is called. This function continues or logs errors and retrieves the user ID from Oculus Accounts, which is used to build a PUN room.

Once the player is connected through the ConnectToServer function, the OnConnectedToMaster function is called, which either joins an existing room or creates a new one with a maximum of two players. If more users need to be in a single room, this limit can be easily changed. When the server creates a new room, the OnCreatedRoom function is called, which sets a boolean confirming server ownership. When a player joins an existing room, the OnJoinedRoom function is called, which increments the player count and spawns the player using spawn points. Finally, the SpawnPlayer function instantiates the prefab at a spawn point, passing the user ID and disabling the spawn point. This system enables collaboration within Oculus systems using PUN and Oculus SDK integrations, allowing users to connect, join a shared room, and load as avatars.

```
public class StreamingAvatar : OvrAvatarEntity
{
    public OculusStuff networkCon;
    PhotonView view;
    // Start is called before the first frame update

    public bool startBool;
```

```
public GameObject mainCam;

WaitForSeconds waitTime= new WaitForSeconds(.08f);

public byte[] avatarBytes;

protected override void Awake()
{
   StartLoadingAvatar();
   base.Awake();
}

public void StartLoadingAvatar()
{

   PhotonView parentView = GetComponentInParent<PhotonView>();
   object[] args = parentView.InstantiationData;
   Int64 avatarId = (Int64)args[0];
   _userId = Convert.ToUInt64(avatarId);

   view = GetComponent<PhotonView>();

   if (view.IsMine)
   {
         SetIsLocal(true);
         _creationInfo.features =
             Oculus.Avatar2.CAPI.ovrAvatar2EntityFeatures.Preset_Default;
   }
   else
   {
         SetIsLocal(false);
         _creationInfo.features =
             Oculus.Avatar2.CAPI.ovrAvatar2EntityFeatures.Preset_Remote;
         mainCam.SetActive(false);
   }

   SetBodyTracking(FindObjectOfType<SampleInputManager>());
   SetLipSync(FindObjectOfType<OvrAvatarLipSyncContext>());

   StartCoroutine(LoadAvatarWithId());
}

IEnumerator LoadAvatarWithId()
{
      var hasAvatarRequest =
          OvrAvatarManager.Instance.UserHasAvatarAsync(_userId);
      while (!hasAvatarRequest.IsCompleted) { yield return null; }
      LoadUser();
}

public void AvatarCreated()
{
   if (view.IsMine)
   {
      StartCoroutine(StreamAvatarData());
   }
```

```
    }

    IEnumerator StreamAvatarData()
    {
        avatarBytes = RecordStreamData(activeStreamLod);
        view.RPC(nameof(RPC_PlayAvatarData), RpcTarget.Others, avatarBytes);
        yield return waitTime;
        StartCoroutine(StreamAvatarData());

    }

    [PunRPC]
    public void RPC_PlayAvatarData(byte[] aBytes)
    {
        avatarBytes = aBytes;

        ApplyStreamData(avatarBytes);
    }

}
```

The StreamingAvatar class is responsible for loading and streaming an Oculus Avatar for a networked player in a multiplayer scene using Photon PUN. To accomplish this, the class inherits from OvrAvatarEntity to interface with the Oculus Avatar SDK and stores reference to essential components such as the OculusStuff network script, Photon View component, and main camera. To track the loading status and view ownership, the class has two boolean variables that indicate whether the avatar has started loading and whether the view belongs to the local player. In the Awake method, the class calls StartLoadingAvatar to begin retrieving the avatar. This method takes the Photon View's instantiation data, which contains the user ID, and stores it locally as _userId. The avatar features are then set to either preset_default for the local player or preset_remote for remote players, and the main camera is enabled or disabled accordingly. The body and lip sync components are set, and a coroutine is started to load the avatar by ID. When the avatar is successfully created, the AvatarCreated method starts a coroutine to stream avatar data for the local player. The StreamAvatarData coroutine records stream data for the active Level of Detail (LOD), call Remote Procedure Call (RPC) to send it to other clients, yields a wait time, and repeats itself to continue streaming data. Lastly, the RPC_PlayAvatarData method receives the streamed data from other clients and applies it to the avatar. This way, all clients in the multiplayer scene can see the same avatar and its movements.

```
public class StreamingAvatar : OvrAvatarEntity
{
    public OculusStuff networkCon;
    PhotonView view;
    // Start is called before the first frame update

    public bool startBool;

    public GameObject mainCam;

    WaitForSeconds waitTime= new WaitForSeconds(.08f);

    public byte[] avatarBytes;

    protected override void Awake()
```

```
    {
        StartLoadingAvatar();
        base.Awake();
    }

    public void StartLoadingAvatar()
    {

        PhotonView parentView = GetComponentInParent<PhotonView>();
        object[] args = parentView.InstantiationData;
        Int64 avatarId = (Int64)args[0];
        _userId = Convert.ToUInt64(avatarId);

        view = GetComponent<PhotonView>();

        if (view.IsMine)
        {
              SetIsLocal(true);
              _creationInfo.features =
                  Oculus.Avatar2.CAPI.ovrAvatar2EntityFeatures.Preset_Default;
        }
        else
        {
              SetIsLocal(false);
              _creationInfo.features =
                  Oculus.Avatar2.CAPI.ovrAvatar2EntityFeatures.Preset_Remote;
              mainCam.SetActive(false);
        }

        SetBodyTracking(FindObjectOfType<SampleInputManager>());
        SetLipSync(FindObjectOfType<OvrAvatarLipSyncContext>());

        StartCoroutine(LoadAvatarWithId());
    }

    IEnumerator LoadAvatarWithId()
    {
          var hasAvatarRequest =
              OvrAvatarManager.Instance.UserHasAvatarAsync(_userId);
          while (!hasAvatarRequest.IsCompleted) { yield return null; }
          LoadUser();
    }

    public void AvatarCreated()
    {
        if (view.IsMine)
        {
           StartCoroutine(StreamAvatarData());
        }
    }

    IEnumerator StreamAvatarData()
    {
        avatarBytes = RecordStreamData(activeStreamLod);
        view.RPC(nameof(RPC_PlayAvatarData), RpcTarget.Others, avatarBytes);
        yield return waitTime;
        StartCoroutine(StreamAvatarData());
```

```
    }

    [PunRPC]
    public void RPC_PlayAvatarData(byte[] aBytes)
    {
        avatarBytes = aBytes;

        ApplyStreamData(avatarBytes);
    }

}
```

6.3 Voice Chat

To enable voice chat in the game, several components were added to the Avatar prefab. These components include PhotonView and PhotonVoiceView, which synchronize voice data across clients. By adding these components to the Avatar prefab, voice data is transferred to any instantiated Avatars. In addition, a speaker GameObject was added to the prefab with speaker and audio source components. These components manage spatial audio for voice chat and allow customization of the surround sound profile and proximity. By limiting voice chat to a set radius, voice data is segmented into groups based on proximity. To ensure that voice transmissions can be played back for new connections, a "Network voice" GameObject was added to each scene with the PunVoiceClient and recorder component. The recorder component records voice transmissions, allowing them to be played back for players who joined after they occurred. This preserves the audio narrative for new connections.

6.4 Challenges

6.4.1 Communication

During the final stages of testing and evaluation of the multiplayer system, an unexpected issue emerged whereby the voice chat between initiating players' functions stopped. As additional players were instantiated within the scene, voice transmissions between clients began distorting, clipping or cutting out entirely. Eventually, the original two players were unable to communicate vocally at all.

In order to remedy this issue, a temporary solution was implemented to echo the audio back to the user, thereby enabling them to experience the volume and pitch control of their voice. This workaround allowed each user to at least hear their own speech and adjust accordingly.

6.4.2 Avatar Rendering

Another issue faced was related to the rendering of avatars for players other than the user. Specifically, while the user's own avatar rendered correctly, any other avatar that was initiated was not rendering correctly. Instead, other avatars appeared as grey characters with no discernible emotions, movement or lip sync, resulting in a lack of immersion and limited interactivity between players. This issue was particularly frustrating because it hindered communication and social interaction between players, which is a key component of our multiplayer game. Unfortunately, this problem was not able to be fixed and the problem still persists in the project.

7 Evaluation

7.1 Pilot Evaluation

In order to identify areas for improvement prior to conducting broader user research, a pilot study was conducted to evaluate the functionality and usability of a virtual reality system. The study involved one participant, who provided valuable insights into navigating the challenges and limitations of the system from the perspective of a user with no prior experience in virtual reality.

During the study, the participant encountered difficulty in concurrently adjusting avatar controls, environmental attributes, and volume. This feedback led to the redevelopment of the interface, which included making the object spawn menu stationary. The modifications aim to provide users of all abilities with intuitive and seamless multifaceted control.

The pilot participant also expressed interest in enhanced customization potentials that would allow for greater personalization of the virtual space. Specifically, the participant requested options to reconfigure or retexture furnishings and environments. In response to this feedback, additional features were incorporated, including the ability to manipulate lighting, flooring, wall details, and other ambient elements. These modifications were designed to support an immersive personalized experience for users.

Although these modifications were not implemented before user testing due to time constraints, the feedback provided by the pilot participant will inform future development and improve the functionality and usability of the virtual reality system.

7.2 User Evaluation

7.2.1 Experiment

Every participant underwent the evaluation process in a consistent and uniform manner to ensure that the results and feedback collected were based solely on their experience with the application. The evaluation procedure was standardised for each individual.

At the beginning of the study, all participants were provided with a brief overview of the project and an explanation of what they could expect during the experiment. Following this, each participant was given a user study consent form that outlined the purpose of the study, the data that would be collected, and any potential risks associated with the experiment. Additionally, the participants were instructed on how to wear the headset and were reminded of potential risks such as discomfort and motion sickness. To minimise these risks, participants were instructed to perform the experiment while seated in a swivel chair, allowing them to easily view the room without rotating their heads and body. Participants were also informed that they could withdraw from the experiment at any time if they experienced any discomfort or symptoms. Finally, it was explained that the participants' experiences were being transmitted to a personal phone using the Meta Quest app.

Following the initial procedures and instructions, the users were directed to follow my commands as the experiment commenced. They were first instructed to navigate to the avatar edit menu and were given the freedom to take as much time as they needed to customise their avatar's appearance until they were satisfied. After completing the avatar customisation, the users were then instructed to open the application. Once they had done so, and the app has opened, they were then directed to join room 1. The user was then required to wait for the room to load and for their avatar to load. Once the user has fully loaded in, I would also enter room 1.

Following this, Users explored an empty room using the thumb sticks on the controller to familiarise themselves with the virtual environment. Then, they were directed to the spawn object menu button to spawn every object, with the freedom to remove any object they wished to customise the room according to their preferences.

After customising the room, the user was then asked to explore the room once again. This stage of the experiment allowed me to assess the user's level of comfort in the virtual environment and to gauge their reaction to the customised room. The user was then directed to open the audio control from their wrist menu. They were instructed to play with the volume and adjust the pitch. This stage of the experiment aimed to test the user's interaction with the virtual environment and assess their level of comfort in adjusting the audio settings.

In summary, the experiment began with the user being directed to the avatar creation menu and then being told to enter the virtual reality application and join room 1. They were then asked to explore the empty room before customising it to their liking. Following this, the user was asked to explore the room again before adjusting the audio settings. These stages of the experiment aimed to assess the user's level of comfort in the virtual environment and to gauge their reactions to customisation and interaction with the virtual world.

Figure 7.1: One of the participants testing the app

7.2.2 Online Questionnaire

After finishing the experiment, the participants were invited to share their feedback regarding their experience with the app through a Google form. The questionnaire aimed to gather quantitative data. The form started by asking participants to verify their consent and provide their names and email addresses. The form then presented the following questions in a five-point Likert scale format:

- How comfortable or uncomfortable were you while using VR?
- How easy or difficult was it to navigate and create your Avatar?
- How easy or difficult was it to navigate the virtual environment and interact with the objects?
- How satisfied or unsatisfied are you with the customisability?
- How was your overall experience using the virtual reality environment for meetings?
- How much did you enjoy or not enjoy the experience?
- How likely or unlikely are you to use the virtual reality environment for future meetings with your supervisor or advisor?
- Any General comments?

7.2.3 Verbal Interview

In addition to the Google form questionnaire, a verbal questionnaire was conducted to gather qualitative data about participants' experience using the app. The questions were open-ended, allowing participants to freely express their thoughts and opinions about their experiences. To ensure that accurate and complete responses were obtained, the questionnaire was recorded with the participants' permission. This also allowed me to review and analyse the responses later on, ensuring that no valuable information was missed during the interview. The interview question consisted of:

- How did you find the customisation options (e.g., virtual room appearance, furniture placement, own appearance) and did they make the experience more engaging/enjoyable or not?
- Did the virtual reality environment feel like a suitable alternative to current popular communication methods (e.g., Video and voice calls)? Why or why not?
- Did the ability to control the volume and pitch of the other user's voice enhance the communication experience? Why or why not?
- How did use the virtual reality environment compared to other methods of communication with supervisors and advisors (e.g., phone, email, in-person meetings)?
- Would the virtual reality environment affect your comfort level when it came to sharing personal information or discussing sensitive topics with your supervisor or advisor? Did the virtual reality environment positively or negatively impact in sharing of information?
- Did you feel that the virtual reality environment provided sufficient privacy for your meetings with your supervisor or advisor?
- What suggestions do you have for improving communication methods? If any?
- Any suggestions on how to make the experience more engaging and make you feel safer?
- If you were to add any feature big or small, what would it be?
- What would you change about the VR app?
- General comments on the experiment itself.

7.3 Chapter Summary

A pilot study was conducted to improve the system's functionality and usability based on valuable insights provided by one participant. Modifications were made to provide a seamless and immersive experience. Then, a user evaluation process was carried out to assess users' experience with the application. The process was standardised for each participant, who was directed to follow specific instructions during the experiment. The aim was to assess users' comfort level in the virtual environment and their reactions to customisation and interaction. Participants shared their feedback through a Google form questionnaire, which aimed to gather quantitative data on their experience. Additionally, a verbal questionnaire was conducted to gather qualitative data, allowing participants to express their thoughts and opinions freely. The questionnaire was recorded for accurate and complete responses.

8 Results

This chapter presents the findings from the data collected through an online questionnaire and a verbal interview. The online questionnaire aimed to gather quantitative data on participants' experience using the virtual reality environment for meetings. On the other hand, the verbal interview was conducted to gather qualitative data on participants' overall perceptions and thoughts on the virtual reality environment. The data collected through both methods provide valuable insights into participants' experiences and opinions, and these insights are discussed in detail in this chapter.

8.1 Quantitative Results

Based on the data gathered from the online questionnaire, it can be concluded that the participants generally had a positive experience using the VR app.

The first question aimed to gather information on the participant's level of comfort while using VR. The results show that the majority of participants felt very comfortable using VR, with nine out of the ten participants responding with a score of 4 or higher. With the rest of the responses combined the average comes out to 4.3 out of 5. From this, we can gather that the VR experience was generally well-received by participants and they found the experience to be comfortable.

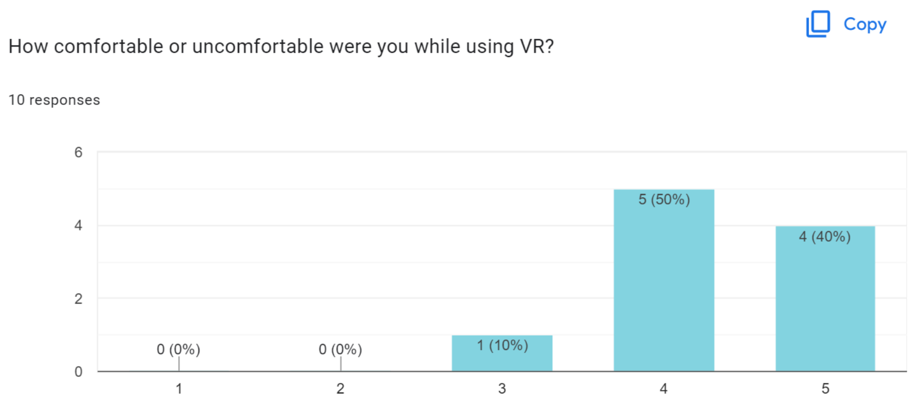


Figure 8.1: How comfortable or uncomfortable were you while using VR?

The second question aimed to understand how easy or difficult it was for participants to navigate and create their avatars in the VR environment. In terms of navigating and creating their avatars, the average score was 4.5 out of 5. The results show that most participants found it relatively easy to create and navigate their avatars, which suggests that the VR platform was user-friendly, intuitive and relatively easy to use.

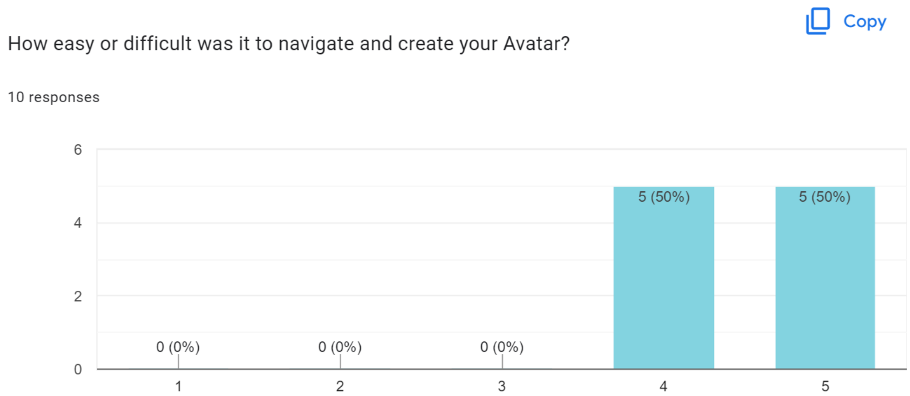


Figure 8.2: How easy or difficult was it to navigate and create your Avatar?

This question aimed to gather information on the ease of navigation and interaction with objects in the VR environment. The average score was 3.9 out of 5. The results show that most participants found it easy to navigate the virtual environment and interact with objects. This suggests that the VR environment was well-designed and easy to use. Although there is room for improvement as three out of the ten participants scored the ease of navigation a 3 out of 5, which tells us that there were still some areas where improvement could be made.

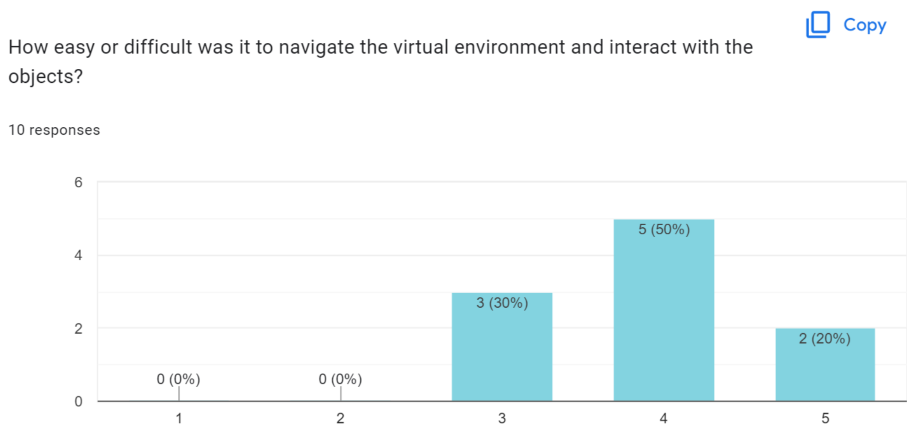


Figure 8.3: How easy or difficult was it to navigate the virtual environment and interact with the objects?

This question aimed to assess participants' satisfaction with the level of customisability in the VR environment. The average score was 4.4 out of 5, indicating that most participants were satisfied with the level of customisability. To meet the expectation of ten different participants and satisfy them, is a pretty good score, but as we can see from the graph there is still space to improve.

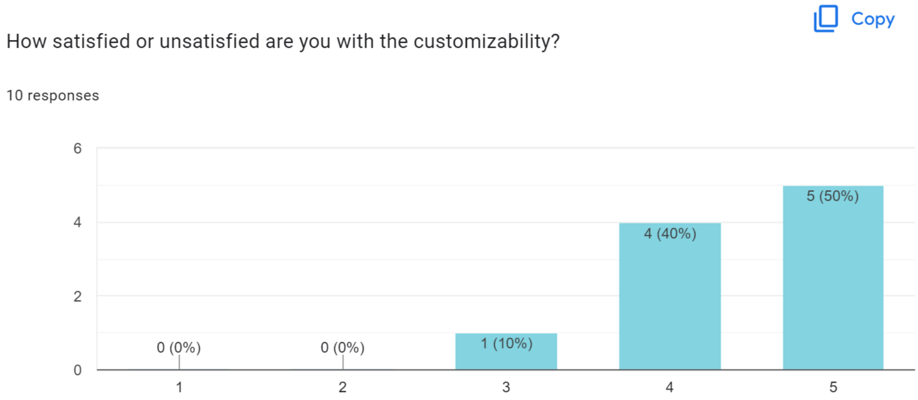


Figure 8.4: How satisfied or unsatisfied are you with the customizability?

The fifth question aimed to find the overall experience of the participants using the VR environment. The average score was 4.4 out of 5, indicating that most participants had a positive experience using the VR environment for meetings. This suggests that the VR environment was effective in facilitating virtual meetings. Although there was one user who was on the fence and scored the experience three out of five, this makes us believe that they may have been looking for something which was not found while using the app.

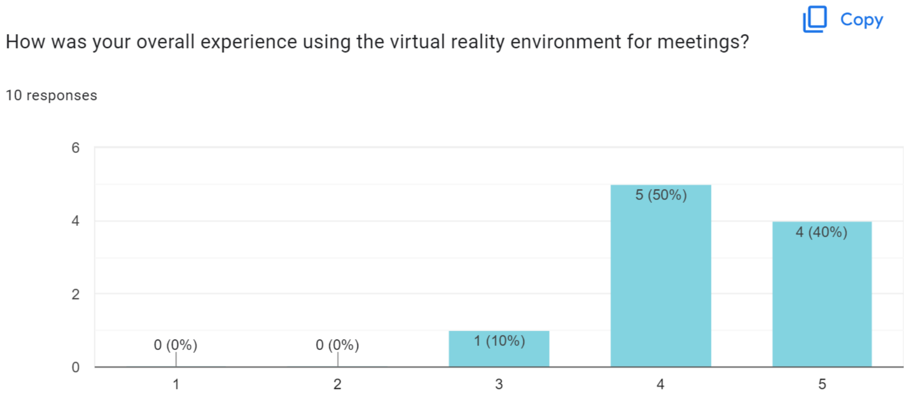


Figure 8.5: How was your overall experience using the virtual reality environment for meetings?

The aim of this question was to gather information on participants' enjoyment and how engaging the experience of the VR environment is. The average score was 4.7 out of 5, indicating that most participants enjoyed using the VR environment. This suggests that the VR environment was engaging and enjoyable to use.

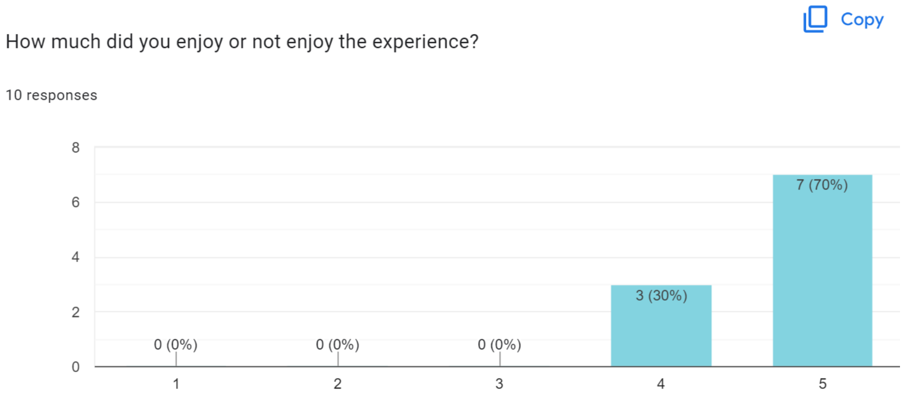


Figure 8.6: How much did you enjoy or not enjoy the experience?

The aim of this question was to assess participants' likelihood of using the VR environment for future meetings. The average score was 4.0 out of 5, indicating that most participants were likely to use the VR environment for future meetings with their supervisor or advisor. This suggests that the VR environment has potential in the future, due to its effectiveness in facilitating virtual meetings with supervisors and advisors.

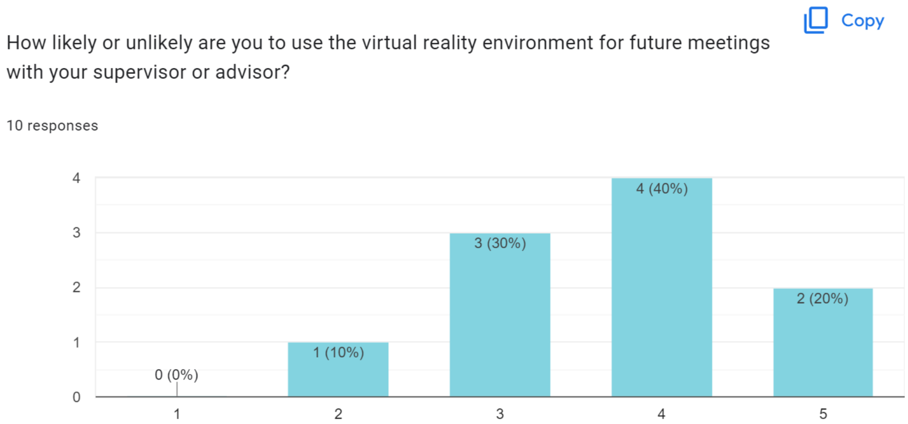


Figure 8.7: How likely or unlikely are you to use the virtual reality environment for future meetings with your supervisor or advisor?

To finish off the questionnaire, the participants were asked if they had any general comments. Overall, the general comments section of the questionnaire provided valuable insights into the strengths and weaknesses of the VR environment.

While most participants enjoyed the experience and found it to be an improvement over traditional video conferencing software, some users did experience motion sickness or found the app challenging to use due to visual impairments. These comments highlight the importance of considering the needs of all users, and the need to improve accessibility options in future iterations of the app.

Furthermore, the positive comments about the customisability of the VR environment suggest that this feature was well received and contributed to a more comfortable and engaging meeting space. One participant also mentioned that they could see how this technology could be useful for meetings with student advisors. This suggests that the app has potential applications in various educational settings. However, the comments about the lack of interaction with objects suggest that there is still room for improvement in terms of making the VR environment more interactive and engaging for users.

Overall, the general comments provided useful feedback for developers to consider in future iterations of the app and highlighted the potential applications of VR technology in various educational settings.

8.2 Qualitative Results

The qualitative results section provides a detailed analysis of the participants' responses from the verbal interview. Based on the interview there were a lot of positive things said, but also a lot of improvement and new ideas brought to life from every interview.

Participants found the customisation options to be a significant aspect of the virtual experience, particularly in creating their avatars and customising the virtual room appearance. The ability to create a personalised avatar was enjoyable and necessary and allowed participants to feel more connected to the virtual environment, which made the experience more engaging. Customising the virtual room was perceived to be a positive feature that enhanced the overall experience. Participants liked the variety of furniture options. Some described the experience to be somewhat realistic which made the experience more comforting. It gave the experience more of a creative aspect which let them immerse more into the app. However, some expressed a desire for greater interaction and placement control over furniture placement within the room.

Many participants mentioned that virtual reality could be a suitable alternative to current popular communication methods, such as video and voice calls, for particular situations. Participants reported feeling more engaged and more connected with other users while using virtual reality compared to video or voice calls, especially in one-on-one meetings such as therapy or advisor sessions—few of the participants mentioned using this over Zoom. However, accessibility concerns regarding hardware capability widespread availability were mentioned as potential barriers. Another problem could be the usability of users with visual or motor impairments, which could hold them back from being able to use the controller to point. Additionally, some participants expressed a preference for features such as screen sharing and drawing boards that are available in video and voice calls but may be harder to implement in virtual reality. During an advisor or supervisor meeting these features are very much necessary. While virtual reality may not completely replace traditional communication methods, it can be a valuable alternative for specific situations. It can provide a more engaging and lifelike experience for specific individuals.

The ability to control the volume and pitch of the other user's voice did enhance the communication experience to a certain extent. Volume control was deemed particularly useful as it allowed individuals to adjust the audio levels to their preference, especially in cases where someone's voice was too quiet or loud. Pitch control, while not as essential, still added another dimension to the experience and was found to be entertaining. Furthermore, there were suggestions that pitch control could be useful for individuals with different ranges of frequency, such as those with hearing loss or deafness. However, there were also concerns about the potential abuse of these controls, which could detract from the necessary formality of some meetings. The ability to control the volume and pitch of the other user's voice added a level of control and comfort to the communication experience, allowing individuals to tailor the audio to their preference and potentially accommodating those with different audio needs.

The participants explained that using a virtual reality environment for communication with supervisors and advisors is a unique experience compared to other methods such as phone, email, and in-person meetings. While emails and phone calls can be quick and efficient, they lack the personal touch and body language that can be seen in an in-person meeting or VR environment. All participants prefer in-person meetings, but scheduling can be difficult, and during the pandemic, it may not be possible at all. VR environments provide a middle ground between the convenience of phone and email and the personal touch of an in-person meeting.

From the response, it seems that the virtual reality environment could positively impact the comfort level of sharing personal information or discussing sensitive topics with a supervisor or advisor. Participants felt that the environment was more comfortable and like a real conversation than other forms of communication, such as email or Zoom. However, there were some concerns about privacy and the potential for others to access the information shared in the virtual environment by someone who could be in the same room as the participant with their knowledge. Some participants also felt uncomfortable due to a lack of familiarity with the technology. As a whole, it seems the impact of the virtual reality environment on sharing personal information would depend on the individual's comfort level and the nature of the information being shared.

According to most responses, using virtual reality technology for meetings with supervisors or advisors provides a sense of privacy and seclusion. It creates a feeling that it's just the two users in the room, removing the pressure and anxiety that comes with video conferencing. However, there are some concerns about the safety of the internet connection and the privacy of the physical environment. Some respondents mentioned that the virtual reality environment is less private regarding peripheral information than a video call, where they can see and hear what's happening around them. However, the convenience and ability to conduct meetings from home without facing other people or potential intruders, like in a therapist's office, make virtual reality a more private alternative. Overall, respondents felt that their information and privacy were not compromised within the virtual reality environment.

When asked for any suggestions that can be made to improve the communication method, the response varied among the participants. One suggested the addition of a mute button, allowing individuals to silence themselves in situations where they may be distracted temporarily. Another participant suggested incorporating a pass-through feature that allows users to see their surroundings without removing their VR headsets; this feature was brought up to improve privacy and comfort for new users. One participant suggested sharing screens or presentations within the VR environment.

The responses opened up some great ideas when asked how the experience could be made more engaging and feel safer. Firstly, having something to hold on to, such as a ball or a pen, can help fidgety people to engage with the environment better, the participant explained that users with Attention-deficit/hyperactivity disorder (ADHD) like themselves would benefit from some such features. Secondly, adding background noise like music, white noise, or nature sounds can enhance the immersive experience and make one feel less isolated and safer. Thirdly, having more customisation options to personalise the virtual room can help users feel safer and more engaged. This could include more furniture options and the ability to move furniture around and hide other users in the room. To improve safety, a pop-up could notify the user if someone enters the room (outside the VR), or there could be a half-vision feature to ensure awareness of one's surroundings. One user went as far as saying that this might be better to be an AR-based experience rather than a fully immersive VR for at least first-time users, as it can help ease them into the experience.

The participants explained that they would love more control over their surroundings to make them more interactive and personalised. Some suggested features include a mute button, background music or noise, adjustable lighting, and audio background transparency/filter mode. They also mentioned that having the ability to change the surrounding environment to something other than a forest would be a great addition. Some participants want more options for furniture and the ability to move it around, while others prefer the actual room design/structure. Additionally, having a board to write or draw on or a voice recorder to record meaningful conversations can be helpful. People want more customisation options to create the perfect environment that suits their preferences and needs.

Based on the feedback, it seems like the VR app is generally well-liked, but a few areas could be improved upon. One suggestion was to add more environmental options mentioned previously, such as a beach or space station. Another comment mentioned that the menu system is confusing, with one fixed menu on the wall and another non-fixed menu for audio control. One idea to improve this could be to have a consistent menu system that is easy to use and understand. Additionally, some users found the joystick intimidating initially, so it may be helpful to have a brief tutorial or explanation of the buttons when the app is opened. Lastly, some users mentioned that the menu on the hand can be distracting, and perhaps it could be adjusted only to appear when needed or when the hand is raised.

When asked for any general comments about the experiment, participants explained that the experience was very positive overall. They found it engaging and enjoyable, with a level of customisation that made them feel like they were in control of their environment. However, some participants noted that VR could be an issue for individuals who experience nausea or motion sickness. Overall, the experiment was well-run, and participants understood what was expected of them. The potential applications of VR for supervisors and advising experiences were also highlighted as exciting and could be a possibility in the future. While some suggestions were made for improvement, the overall feedback was positive, and participants enjoyed the immersive experience.

8.3 Result's Disscussion

The quantitative results section of the report presents the findings from the online questionnaire. The report outlines the results of each question, including the average score and any noteworthy comments or insights provided by the participants. The results suggest the participants had a positive experience using the VR app for virtual meetings. Most participants found the VR experience comfortable, user-friendly, and engaging. Additionally, most participants were satisfied with the level of customisability and expressed a likelihood to use the VR environment for future meetings.

The report also highlights areas where improvement could be made, such as improving accessibility options for users with visual impairments, making the VR environment more interactive, and addressing motion sickness experienced by some users. The general comments section of the questionnaire provided valuable insights into the strengths and weaknesses of the app. Some users found the app challenging due to visual impairments or lack of VR knowledge and suggested the need for more interactive features.

The qualitative results section of the report provides a more detailed analysis of the participants' responses from the verbal interview. The analysis highlights the importance of customisation options in the virtual experience, particularly in creating personalised avatars and customising the virtual room appearance. Participants found these features enjoyable and necessary, making the experience more engaging and immersive.

The report also notes the potential applications of VR technology in various educational settings, as suggested by some of the participants' comments. However, it also highlights the need to consider the needs of all users and improve accessibility options in future iterations of the app. The participants mentioned again making the app more interactable and giving users more options regarding the environment, room, and furniture. Overall, the report presents a comprehensive summary of the quantitative and qualitative results, providing insights into the participants' experiences using the VR app for virtual meetings and offering suggestions for improving the technology in future iterations.

9 Conclusion

9.1 Summary

This report presents a comprehensive analysis of the use of virtual reality technology for student support and advisor meetings. The report uses qualitative and quantitative data to evaluate the effectiveness of the VR app, analyzing the participants' experiences and opinions. The findings suggest that using VR technology for meetings with supervisors or advisors provides a middle ground between the convenience of phone and email and the personal touch of an in-person meeting.

The participants generally had a positive experience using the VR app, finding it comfortable, user-friendly, and engaging. They were satisfied with the level of customizability provided by the VR environment and expressed a likelihood of using it in future meetings. However, there were still areas where improvement could be made, such as addressing accessibility issues and making the VR environment more interactive.

Virtual reality technology has the potential to revolutionize the way education is delivered by creating immersive and interactive learning environments for students. By simulating real-world scenarios, students can gain hands-on experience that might not be possible in a traditional classroom setting. In addition, virtual reality technology can allow students to explore complex concepts and ideas in a safe and controlled environment, making it an effective tool for both practical and theoretical learning.

Furthermore, the report highlights the importance of customization options, particularly in creating personalized avatars and customizing the virtual room's appearance. Participants found these features enjoyable and necessary, making the experience more engaging and immersive. Additionally, the results indicate that the virtual reality environment could positively impact the comfort level of sharing personal information or discussing sensitive topics with a supervisor or advisor.

However, to fully realize the potential of virtual reality technology in education, much work still needs to be done. The report suggests that future iterations of the app should consider incorporating more advanced features, such as haptic feedback and real-time communication with other users. Developing such features could significantly enhance the immersive experience of using virtual reality technology and make it an even more effective tool for education.

Moreover, future work could focus on improving accessibility options for users with visual and motor impairments, making the VR environment more interactive, and addressing motion sickness experienced by some users. It is also beneficial to further explore the potential applications of VR technology in various educational settings, as suggested by some of the participants' comments.

The report also highlights the need to consider the needs of all users and improve accessibility options in future iterations of the app. Expanding customizability options could create a more personalized and engaging environment. Additionally, future iterations of the app could consider incorporating features such as a mute button, a pass-through feature, and the ability to share screens or presentations within the VR environment.

9.2 Future work

In future work, several areas could be explored to improve the virtual reality app for student support and advisor meetings. One important area is the development of more sophisticated virtual environments that facilitate learning and provide students with an even more immersive experience. This could involve incorporating more advanced features, such as haptic feedback and real-time communication with other users, which would enhance the user experience and make it an even more effective tool for education.

Another critical area to explore is the improvement of accessibility options for users with visual and motor impairments. This could involve incorporating more customization options to create a more personalized and engaging environment for all users. For example, the app could include more furniture options and the ability to move furniture around and hide other users in the room. Additionally, the app could consider incorporating features such as a mute button, a pass-through feature, and the ability to share screens or presentations within the VR environment.

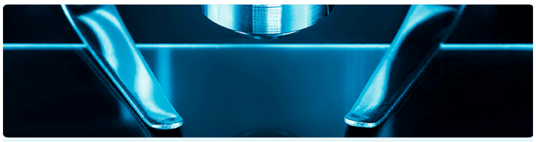
Standardization is also an important area of future work in virtual reality technology for education. The lack of standardization could lead to inconsistencies in the quality of the educational experience and hinder the widespread adoption of the technology. Therefore, it is essential to establish guidelines and best practices for using VR technology in education to ensure that all students can benefit from its potential.

Moreover, the app could work on addressing motion sickness experienced by some users. This could involve incorporating more interactive features to make the VR environment more engaging for users. For example, the app could consider adding background noise like music, white noise, or nature sounds to enhance the immersive experience and make users feel less isolated and more comfortable.

In conclusion, the results of this report suggest that virtual reality technology has great potential in enhancing student support and advisor meetings, as well as revolutionizing the way educational institutions deliver their curriculum. With further refinement and development, virtual reality technology could become a low-cost and low-risk method of conducting experiments, facilitating meetings, and delivering educational content in various settings. Future work could focus on further improving accessibility options, creating more sophisticated virtual environments, and establishing guidelines and best practices for using virtual reality technology in education.

A Appendices

A.1 Copy of Google forms



Section 1 of 2

VIRTUAL REALITY AS A SOLUTION FOR LOGISTICAL AND MENTAL HEALTH CHALLENGES IN STUDENT SUPPORT

User Study Consent Form
Project Title:
Virtual Reality as a Solution for Logistical and Mental Health Challenges in Student Support

Researcher:
Faraj Ahamed Monnapillai Ahamed Nagoor

Email:
2465104m@student.gla.ac.uk

Introduction:
You are being invited to take part in a research study. Before you decide, it is important for you to understand why the research is being done and what it will involve. Please take the time to read the following information carefully and feel free to ask any questions you may have before deciding whether or not to take part.

Purpose of the study:
The purpose of this study is to evaluate the usability and user experience of a virtual reality environment designed for supervisor and advisor meetings.

Procedures & Data Collection:
If you agree to participate in this study, you will be asked to use the virtual reality environment and complete a series of tasks while interacting with the environment. You will also be asked to answer a series of questions about your experience using the virtual reality environment. Your identity will be kept confidential throughout the study. Any information you provide will be used only for research purposes and will not be shared with anyone outside of the research team.

Exclusion Criteria:

- Under 18 years old
- History of epilepsy or seizures
- History of motion sickness or vestibular disorders
- Pregnant or breastfeeding

Risks:
There are no known risks associated with participating in this study. However, if you experience discomfort or motion sickness while using the virtual reality environment, you are free to discontinue your participation at any time.

Consent:
By signing below, you confirm that you have read and understood the information provided above, and that you agree to participate in this study. You understand that you are free to withdraw from the study at any time.

What's your name?

Short answer

Short-answer text

Required

Whats your email? *

Short-answer text

Section 2 of 2

User Feedback

Description (optional)

How comfortable or uncomfortable were you while using VR?

Extremely Uncomfortable 1 2 3 4 5 Extremely Comfortable

How easy or difficult was it to navigate and create your Avatar? *

Extremely Difficult 1 2 3 4 5 Extremely Easy

How easy or difficult was it to navigate the virtual environment and interact with the objects? *

Extremely Difficult 1 2 3 4 5 Extremely Easy

How satisfied or unsatisfied are you with the customizability? *

Extremely Unsatisfied 1 2 3 4 5 Extremely Satisfied

How was your overall experience using the virtual reality environment for meetings? *

Extremely Poor 1 2 3 4 5 Extremely Good

How much did you enjoy or not enjoy the experience? *

Extremely Boring 1 2 3 4 5 Extremely Enjoyable

How likely or unlikely are you to use the virtual reality environment for future meetings with your supervisor or advisor? *

Extremely Unlikely 1 2 3 4 5 Extremely Likely

Any General comments?

Long-answer text

A.2 Copies of ethics approvals

School of Computing Science
University of Glasgow

Ethics checklist form for 3rd/4th/5th year, and taught MSc projects

This form is only applicable for projects that use other people ('participants') for the collection of information, typically in getting comments about a system or a system design, getting information about how a system could be used, or evaluating a working system.

If no other people have been involved in the collection of information, then you do not need to complete this form.

If your evaluation does not comply with any one or more of the points below, please contact the Chair of the School of Computing Science Ethics Committee (matthew.chalmers@glasgow.ac.uk) for advice.

If your evaluation does comply with all the points below, please sign this form and submit it with your project.

---

1. Participants were not exposed to any risks greater than those encountered in their normal working life.

   Investigators have a responsibility to protect participants from physical and mental harm during the investigation. The risk of harm must be no greater than in ordinary life. Areas of potential risk that require ethical approval include, but are not limited to, investigations that occur outside usual laboratory areas, or that require participant mobility (e.g. walking, running, use of public transport), unusual or repetitive activity or movement, that use sensory deprivation (e.g. ear plugs or blindfolds), bright or flashing lights, loud or disorienting noises, smell, taste, vibration, or force feedback

2. The experimental materials were paper-based, or comprised software running on standard hardware.

   Participants should not be exposed to any risks associated with the use of non-standard equipment: anything other than pen-and-paper, standard PCs, laptops, iPads, mobile phones and common hand-held devices is considered non-standard.

3. All participants explicitly stated that they agreed to take part, and that their data could be used in the project.

   If the results of the evaluation are likely to be used beyond the term of the project (for example, the software is to be deployed, or the data is to be published), then signed consent is necessary. A separate consent form should be signed by each participant.

   Otherwise, verbal consent is sufficient, and should be explicitly requested in the introductory script.

4. No incentives were offered to the participants.

   The payment of participants must not be used to induce them to risk harm beyond that which they risk without payment in their normal lifestyle.

5. No information about the evaluation or materials was intentionally withheld from the participants.
   Withholding information or misleading participants is unacceptable if participants are likely to object or show unease when debriefed.

6. No participant was under the age of 16.
   Parental consent is required for participants under the age of 16.

7. No participant has an impairment that may limit their understanding or communication.
   Additional consent is required for participants with impairments.

8. Neither I nor my supervisor is in a position of authority or influence over any of the participants.
   A position of authority or influence over any participant must not be allowed to pressurise participants to take part in, or remain in, any experiment.

9. All participants were informed that they could withdraw at any time.
   All participants have the right to withdraw at any time during the investigation. They should be told this in the introductory script.

10. All participants have been informed of my contact details.
    All participants must be able to contact the investigator after the investigation. They should be given the details of both student and module co-ordinator or supervisor as part of the debriefing.

11. The evaluation was discussed with all the participants at the end of the session, and all participants had the opportunity to ask questions.
    The student must provide the participants with sufficient information in the debriefing to enable them to understand the nature of the investigation. In cases where remote participants may withdraw from the experiment early and it is not possible to debrief them, the fact that doing so will result in their not being debriefed should be mentioned in the introductory text.

12. All the data collected from the participants is stored in an anonymous form.
    All participant data (hard-copy and soft-copy) should be stored securely, and in anonymous form.

Project title: Virtual Reality as a Solution for Logistical and Mental Health Challenges in Student Support

Student's Name: Faraj Ahamed Monnapillai Ahamed Nagoor

Student Number: 2465104m

Student's Signature:

Supervisor's Signature __

Date: 20/02/23

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