MiTeachVR: A Novel Virtual Reality Classroom for Developing Pre-service Teacher Communication Skills

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Thesis Declaration

I hereby certify that this material, which I now submit for assessment on the programme of study leading to the award of Doctor of Education is entirely my own work, and that I have exercised reasonable care to ensure that the work is original and have conformed to the regulations on the use and declaration of Generative AI, and does not to the best of my knowledge breach any law of copyright, and has not been taken from the work of others save and to the extent that such work has been cited and acknowledged within the text of my work. I hereby certify that no Generative Artificial Intelligence (Gen AI) tools have been used in the creation of the thesis.

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Contents

List of Abbreviations

AR	Augmented Reality
DCU	Dublin City University
CPD	Continued Professional Development
HE	Higher Education
HEI	Higher Institute of Education
HMD	Head Mounted Display -(Virtual Reality Headset)
IoE	Institute of Education
ITE	Initial Teacher Education
IVE	Immersive Virtual Environment
IVR	Immersive Virtual Reality
MiTeachVR	Microteaching in Virtual Reality System – IVR Prototype
MR	Mixed Reality
PC	Personal Computer
PLS	Plain Language Statement
PST	Pre-service Teacher
VE	Virtual Environment
VR	Virtual Reality
VRLE	Virtual Reality Learning Environment
XR	Extended Reality
3D	Three-dimensional

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Conference Publications

Boylan, P. 2024. Microteaching in Virtual Reality: The Design, Development and Implementation of a Custom-built Immersive Environment for trainee teachers to practice and develop their Microteaching Skills. *Uconference*, Dublin City University, Ireland, 23 May.

Boylan, P. and Tiernan, P. 2025. MiTeachVR: A virtual reality classroom for teachers to practice their communication skills. *Virtual Immersive Blended Education Symposium (VIBES)*, Dublin City University, Ireland, 10 January.

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Abstract

MiTeachVR: A Novel Virtual Reality Classroom for Developing Pre-service Teacher Communication Skills

Patrick Boylan

Microteaching is a well-studied and widely practiced area of teacher education. Pre-service teachers (PST) often take part in microteaching long before they begin teaching, with limited opportunity to re-engage with skills practice. This thesis investigates lecturers' and PSTs' experiences of using a prototype Immersive Virtual Reality (IVR) Microteaching system designed to allow PSTs to practice and develop their communication and microteaching skills. IVR has the potential to improve learning outcomes. Through repeated training and practice, PSTs have the opportunity to practice their teaching in a safe virtual environment. The skills practiced in the virtual classroom may translate to real-world teaching environments, helping to bridge the gap between theory and practice. The developed IVR prototype has the potential to form a new paradigm in teacher training as an alternative, safe method that will allow PSTs to learn through repeated practice and self-reflection.

By adopting a case-study approach, this study collects qualitative data from multiple sources, including interviews, questionnaires, and observations, to explore and understand the lived experiences of lecturers and PSTs in using the system. Examining the two groups may help discover how such a tool can be adopted if we address the unique needs and concerns of lecturers and PSTs.

The preliminary findings indicate that lecturers and PSTs have a positive attitude towards utilising IVR as a tool within traditional microteaching in ITE. The results suggest that IVR should be strategically employed to complement ITE programmes, rather than serving as a direct replacement for authentic, real-world classroom experiences. Therefore, ITE programmes should consider leveraging IVR as a supplementary tool for refining specific teaching communication techniques, while incorporating structured reflection to enable PSTs to effectively transfer the skills developed in their IVR practice to their real-world classroom teaching experiences and contexts.

Chapter 01: Introduction

1.0 Introduction

Positioned within a constructivist-interpretivist paradigm, this research investigates the use of Immersive Virtual Reality (IVR) using a novel prototype system, "MiTeachVR", a life-sized IVR classroom for practicing microteaching and communication skills. In particular, the study examines the experiences of lecturers and pre-service teachers (PSTs) as part of initial teacher education (ITE). The study was conducted within the Institute of Education (IoE) at Dublin City University (DCU). This chapter introduces the research topic. It provides the professional context of the researcher. It presents a justification for the current study and describes the aims and objectives of the research. Finally, it sets out a description of each chapter.

1.1 Overview of the Research Topic

The training of skilled teachers is of societal importance nationally and internationally (Bakır, 2014; Report on the 2022 Transforming Education Summit, 2023), as is the development of PSTs professional competence (Depaepe & König, 2018; Fitzsimons et al., 2024), before they embark on their teaching career. Having classrooms with qualified and experienced teachers is deemed to be a high priority in any society (Alonso et al., 2021). A report on "School Placement in Initial Teacher Education" in the Irish education system recognises the importance of School Placement for PSTs professional learning, as it provides "diverse and extensive opportunities to learn the art, craft and science of teaching" (Hall et al., 2018, p. 12). The report indicates the requirement to have partnerships between Schools and Higher Education Institutes (HEI) to enable the integration of skills practice and theory. However, it highlights the challenges in securing school placements for both PSTs and HEI's (Hall et al., 2018). Microteaching and skills practice in IVR may be a way for PSTs to develop the art, craft and science of teaching (Ledger & Fischetti, 2019; S. M. Lee & Wu, 2024).

In this research, four broad areas converge as the foundation of the research: (**1**) Virtual Reality, (**2**) Effective teaching, (**3**) Microteaching, and (**4**) Microteaching 2.0. Virtual reality (VR) is a technology generated three-dimensional (3D) simulated interactive environment that can be an imagery world or a representation of a real-world scene, allowing users to interact within a digital virtual environment (VE) (Hoffman, 2004; Kuleto et al., 2021; Makransky & Lilleholt, 2018). VR use in education is growing (Häfner et al., 2018; Radianti et al., 2020), however, its use as a student learning tool in HE has been limited (Radianti et al., 2020). Effective teaching is the art and science required to guide students in their learning experiences to achieve meaningful outcomes. In doing so, PSTs use a mixture of teaching theory and skills developed as part of ITE (The Teaching Council, 2020). The development of PSTs' effective teaching skills is of importance to ensure high standards in the profession (The Teaching Council, 2020). Microteaching is a well-established and commonly used teacher training technique that involves the delivery of short, scaled-down teaching sessions. These scaled-down teaching experiences combine theory and practice and are designed to enable PSTs practice and refine their teaching skills in a controlled and safe environment (Allen & Ryan, 1969; Singh, 2010). Combining VR simulation and microteaching has created opportunities for PSTs' to practice their teaching in a VE (e.g., Delamarre et al., 2021; Ferguson & Sutphin, 2022; Ledger & Fischetti, 2019; Mariana et al., 2023), and has been termed Microteaching 2.0 where technology becomes the classroom, utilising VR simulations to represent the classroom, with avatars as students (Ledger & Fischetti, 2019). The MiTeachVR system is a fully immersive, innovative, novel prototype IVR classroom designed for microteaching as part of ITE. It uses the Oculus Quest 2 head mounted display (HDM), and the MiTeachVR classroom software. The MiTeachVR system, unlike some other IVR or VR simulations, requires no direct connection to a personal computer (PC) because the VE and data collected are stored inside the HMD, enabling users to move freely within the physical space.

Set in an Irish context within the DCU IoE, the research sets out to explore the lived experiences of lecturers and PSTs in their engagement with the MiTeachVR system. It investigates the potential of the MiTeachVR system by examining how PSTs can utilise this immersive virtual environment (IVE) to practice and refine their microteaching and communication skills in a virtual microteaching setting before they enter a live classroom. It further gives voice to PSTs and lecturers about their views regarding the usefulness of the MiTeachVR system as a tool for microteaching and their willingness to adopt it within the IoE. The MiTeachVR system may be a tool to help address the challenges faced by HEI's and PSTs concerning the securing of school placements, by providing further practicum opportunities for PSTs.

1.2 Aims and Objectives of the Research

Aim: The overall aim of the study is to better understand the usefulness of a prototype IVR system, MiTeachVR, a platform designed to support PSTs' to practice and develop their microteaching and communication skills in an IVR classroom. It also sets out to:

Objectives:

1. To understand both lecturer and student experiences, perceptions, and acceptance of IVR as a tool for PSTs to practice microteaching communication skills using the MiTeachVR system
2. To investigate what support (technical or otherwise) would be needed to support the MiTeachVR system's introduction into ITE in the IoE.

1.3 Significance of the Study

Research into combining VR simulation with microteaching continues to advance, accompanied by a growing body of literature. Perspectives based on both new and prior studies continue to emerge within this evolving field (e.g., Ga et al., 2025; Ogegbo et al., 2024; Zhang et al., 2024). Some studies used 2D mixed reality simulation (e.g., Ersozlu et al., 2021; Larson et al., 2020; Ledger et al., 2018; Ledger & Fischetti, 2019), accompanied by the emergence of research using IVR (e.g., S. M. Lee & Wu, 2024; Rodríguez Gil et al., 2024).

The significance and contribution can be summarised as follows.

- Firstly, the study adds to the growing body of literature using IVR in combination with microteaching for practicum in ITE.
- Secondly, the study provides evidence of the usefulness for PSTs to practice communications skills in IVR.
- Thirdly, the study provides evidence of the support (technical and non-technical) required if the MiTeachVR system is to be introduced into the IoE as part of microteaching in ITE.
- Fourthly, the study provides evidence that may be useful to inform policy and practice relating to the future development of technology-enhanced microteaching within the IoE.

The findings from the study may be useful to inform other policy development beyond the IoE.

1.4 Professional and Personal Context (Positionality Statement)

Researchers must reflect on their own experience and how they might impact the interpretations of the participant's lived experiences while conducting research (Creswell, 2014; Denzin & Lincoln, 1994), especially if they are considered an insider researcher (Braun & Clarke, 2022). At the time of this research, I am employed as a Senior Technical Officer within the DCU School of Psychology. Prior to this I worked in private industry in technical roles and computer management. In my current position, I am responsible for a wide variety of technical equipment, including the School of Psychology VR lab, for which I was instrumental in establishing. A large part of my role is to provide advice and support to staff, students and researchers pertaining to many aspects of technology for research. I work with undergraduate and post-graduate students advising on technical equipment as part of their final year projects, while also working with doctoral students, researchers, and staff advising on some of the technical aspects of their research projects. I hold several academic qualifications, including a BSc. in Education and Training, a Graduate Diploma in Information Technology, and an MSc in Cyberpsychology. I have been involved in previous research projects, including VR research. Drawing upon the combination of my employment, academic qualifications, and research experience was invaluable in conducting this research, as it gave me a holistic view of the research process.

This research's rationale is grounded in two key perspectives. Firstly, my active contribution to the development of the MiTeachVR system prompted a deeper interest in exploring its potential, as I aim to understand its usefulness and possibilities as a tool for PSTs to practice their microteaching communication skills. Secondly, my technical role supporting staff, researchers, and students with various technologies, including VR, motivated me to explore the MiTeachVR system, as I wanted to understand the opportunities, challenges, and technical supports needed to use this technology for microteaching within and beyond the IoE.

1.5 Chapter Organisation and Outline

This thesis is divided into five chapters, Introduction and Context, Literature Review, Methodology, Findings and Discussion, and Conclusion and Recommendations. Each chapter has its own unique purpose as outlined below.

Chapter 01 Introduction and Context

This chapter introduces the research by providing an overview outlining the four key areas explored, which together underpin this research study. It provides the aims and objectives of the research and the significance of the study. A Positionality Statement is presented, and finally, an overview of the chapters.

Chapter 02 Literature Review

This chapter reviews the literature around VR, Effective Teaching, Microteaching, and Microteaching 2.0. Firstly, it describes VR and, its place in society, followed by VR's use in higher education (HE). Secondly, it looks at effective teaching as part of ITE. Thirdly, it explores traditional in-person microteaching. Fourthly, it explores Microteaching 2.0, the convergence of microteaching and VR simulation. Finally, it provides a summary.

Chapter 03 Methodology

This chapter gives an overview of the MiTeachVR system. It then deals specifically with the qualitative methodological framework that underpins the research design. It outlines and justifies the use of a qualitative methodology. It describes the data collection methods and the analysis process. It presents the researcher's constructivist-interpretivist paradigm and the philosophical, epistemological and ontological underpinnings of the research. It considers the strengths and limitations of the research methods. The chapter also addresses the ethical challenges of the researcher as an insider researcher.

Chapter 04 Findings and Discussion

This chapter presents the findings of this research under four main themes. Firstly, it outlines the demographic data of the participants. Secondly, it presents the findings from the qualitative interviews, including participant extracts, where relevant. Thirdly, it weaves findings from the questionnaires and the observations into the interview data to give a richer context and understanding of the findings. The findings are discussed in relation to the literature to provide context and establish their relevance and meaning by connecting them to previous work.

Chapter 05 Conclusions and Recommendations

This chapter draws together the themes of the study to provide insights into the views of lecturers and PSTs as to the usefulness of the MiTeachVR system under a number of headings. It also provides an indication of the intention to adopt the MiTeachVR system. It outlines the technical support required by both lecturers and PSTs, and proposes recommendations for the implementation of MiTeachVR. The chapter provides an overall summary of the research findings, and their implications in the event that the MiTeachVR system is introduced into microteaching as part of ITE within the IoE. Finally, from these findings, the chapter acknowledges the strengths and limitations of the research and concludes by making recommendations for future research.

The thesis concludes with a personal reflection by the researcher.

Chapter 02: Reviewing the Literature

2.1 Introduction

In the context of teacher education, reviewing the literature is essential to understanding how educational theories, practices, and technologies evolve and interact. Research into the future of ITE has highlighted two significant areas requiring further exploration: the evolving landscape of professional knowledge and the growing potential of digital technologies (Burden et al., 2016). Among these emerging technologies, VR is gaining prominence for its potential to transform teaching and learning practices (Farrell et al., 2022; Fischetti et al., 2022; Taggart et al., 2023; Van Der Want & Visscher, 2024). To ground this study and understand how the MiTeachVR system may be useful for PSTs to practice their communication skills in an IVR VE, five interrelated areas were explored: Virtual Reality, Effective Teaching, Microteaching, Technology-Enhanced Microteaching, and Microteaching 2.0. I examined VR to understand its capabilities, Effective Teaching to understand the skills and professional competencies required by teachers, Microteaching to understand the underlying principles and processes of traditional microteaching, and Technology Enhanced Microteaching to understand the utilisation of technology as part of traditional microteaching. Additionally, I explored Microteaching 2.0 to examine how VR and simulation converge with traditional microteaching, communication and teaching skills.

2.2 Defining Virtual Reality

There is no single definition of VR, as the technology is ever-changing (Hamilton et al., 2020). VR can be defined as a computer-generated simulation of a three-dimensional (3D) virtual world that users perceive as comparable to the real-world (Hoffman, 2004; Kuleto et al., 2021; Radianti et al., 2020). Other researchers understand VR to be a technology that generates virtual immersion in an artificial digital environment through computer-graphic simulation, immersing users in 3D worlds where the users' actions provide sensory and emotional feedback experiences (e.g., Coban et al., 2022; Makransky & Lilleholt, 2018; Smutny, 2022; Villena-Taranilla et al., 2022). For clarity, I offer the following definition: VR is a simulated experience that utilises digital technologies to create a simulated 3D immersive, interactive environment that users perceive as real.

2.2.1 Development of Virtual Reality, History and Timeline

The term "Virtual Reality" was popularised in the 1980s and is credited to Jaron Lanier, a computer scientist, while conducting research in immersive technologies (Virtual Reality Society, 2022). VR's origins can be traced back to 1838 when Charles Wheatstone devised the stereoscopic viewer, where two identical offset images are viewed side by side, creating the illusion of 3D depth in the combined image (Kings College London, 2016; Wade, 2012). In 1957, Morton Heilig created the Sensorama (**Figure 2.1**) an arcade-style cabinet featuring a stereoscopic 3D display, audio output, fans, olfactory smells and a vibrating chair; the purpose was to stimulate the senses while immersing the user in specially created 3D films (Basso, 2017; Gigante, 1993; Smutny, 2022; USC, 2025).

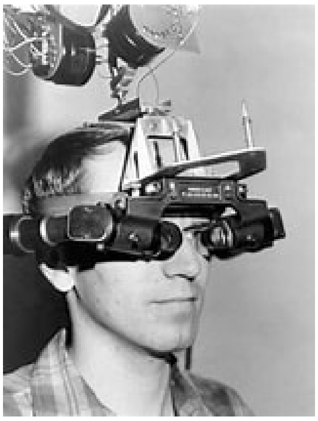
Figure 2.1 Sensorama created by Morton Heilig in 1950s. Source: USC

Later in the 1960s, Heilig developed the Telesphere Mask (**Figure 2.2**), a HMD that presented stereoscopic 3D films with stereo sound, but lacked motion tracking or any user interactivity (Gigante, 1993; Martirosov & Kopecek, 2017).

Figure2.2 Telesphere Mask created by Morton Heilig in 1962. Source: USC

In 1968, computer scientist Ivan Sutherland and his student Robert Sproull created the "Sword of Damocles" (**Figure 2.3**), a computer-connecter HDM that showed wire-frame 3D stereoscopic computer graphics and featured head tracking (Basso, 2017; Gigante, 1993; Martirosov & Kopecek, 2017).

Figure 2.3 The Sword of Damocles created by Sutherland and Sproull 1968. Source: USC



The Telesphere Mask and the Sword of Damocles were precursors to modern VR HMDs. Throughout the 1970s and 1980s, VR development continued, but was mainly confined to academic research and public sector institutions, advances in of flight simulators, with NASA influencing the evolution of VR technology (Basso, 2017; Gigante, 1993; Kavanagh et al., 2017). In the 1990s, technological developments enabled VR systems to become available to the public, however, some systems were not commercially successful and were eventually discontinued (Kavanagh et al., 2017; Martirosov & Kopecek, 2017). From 2010 on, technical advances, cost reduction and a growing consumer interest led to the development of viable VR HMDs (Cipresso et al., 2018; Kavanagh et al., 2017). In 2013, Oculus introduced the Oculus Rift DK1 prototype VR HMD, followed by devices from manufacturers (Cipresso et al., 2018; Kavanagh et al., 2017; Merchant et al., 2014). Over the past 10 years, advancements in VR technology have increased the functional capabilities of VR HMDs, associated hardware, and systems. Standalone headsets such as the Oculus Quest 2 (used in this research); operate without direct connections to external computers, enabling greater freedom of movement within the physical environment. However, battery life remains a constraint. Some VR systems continue to depend on PC connectivity for graphical processing, with images rendered within a HMD or on a conventional 2-D screen.

2.3 Overview of Virtual Reality

IVR is an interactive computer-generated simulation of a 3D virtual environment (VE) displayed inside a HMD (Villena-Taranilla et al., 2022). Handheld controllers enable users to navigate within the VE mimicking a sense of walking, using thumb-sticks and buttons to point and click allows users to teleport around the VE (Coban et al., 2022; Riecke & Zielasko, 2021; Smutny, 2022; Villena-Taranilla et al., 2022). A VE is an immersive multimedia imaginary world or a computer simulation of an element of the real-world that approximates reality, allowing users to explore, interact, and receive sensory feedback from within that world (Huang et al., 2010; M. Slater, 2018). Some IVR environments allow users to navigate the VE by walking in the physical real world, which is translated into movement in the VE, however walking in the real-world has limitations, as VEs can be larger than the physical real-world space available. Additionally, head tracking enables the user to look around the VE, with some HMDs incorporating eye-tracking to monitor eye movement. Voice recognition allows for voice commands or the recording of the user’s voice. These VR features provide users with a sense of immersion.

Immersion is the user's perception of being present or part of the VE, as opposed to the real world (Slater, 2018; Meyer, Omdahl and Makransky, 2019; Mystakidis, 2022).

2.3.1 Levels of Immersion and Extended Technologies

There are three levels of immersion – ranging from non-immersive (2-D computer-screen) and semi-immersive (combination of real-world and virtual content) to fully-immersive (where the real-world is blocked out) utilising HMDs (Blascovich & Bailenson, 2011; Stracke et al., 2025).

Non-immersive VR systems are effectively 2D desktop computer-generated environments using conventional computer displays that allow the user to interact and navigate within that environment using keyboards, mice, joysticks and controllers while still being aware of their physical real-world environment (E. A. L. Lee & Wong, 2014; Meyer et al., 2019; Stracke et al., 2025). Non-immersive VR is often overlooked because of its familiarity; however, it is the easiest, relatively inexpensive and most common way to access VR (E. A. L. Lee & Wong, 2014).

Semi-immersive VR blends digital environments with real-world elements, providing users with a partial VE in which to interact. Typically, semi-immersive VR doesn't require HMDs. Users experience a partial sense of immersion while remaining aware of their physical real world surroundings. They can still interact with the real world, which creates the perception of being in an alternative reality (Di Natale et al., 2020; Stracke et al., 2025; Villena-Taranilla et al., 2022). Examples include modern flight and driving simulators.

Fully-immersive VR represents the highest level of immersion. It uses HMD's with high-definition stereoscopic 3D imagery, positional tracking, high-quality audio, and hand controllers with haptic feedback, creating artificial environments that users perceive as real (Blascovich & Bailenson, 2011; Sousa Santos et al., 2009; Stracke et al., 2025). IVR is experiencing an upsurge in the entertainment sector (Wohlgenannt et al., 2020), and its use in HE is increasing (Stracke et al., 2025).

In addition to VR exists Extended Reality (XR) an umbrella term incorporating VR, Augmented Reality (AR) and Mixed Reality (MR). Both AR and MR are immersive technologies that blend digital content with the real world. AR overlays digital elements (3D models, graphics, and text) onto the real world. This enhances the user's perception of the real world without replacing it. Users can see and interact with the real world, but the digital content does not respond or interact with the real world. Whereas MR extends AR by overlaying digital content, but also integrates it so the digital content can interact in real-time with the real-world, and allows the user to interact with the digital objects (Carter, 2021; Kaplan et al; Marr, 2021). XR refers to all combinations of real and VEs incorporating human-machine interactions generated by computer-based technologies (Doolani *et al.*, 2020).

2.3.2 Summary

VR is a computer-generated simulation that creates an immersive, interactive VE that can mimic the real world or create an imaginary world that users perceive as real. Immersion is the perception of how much a user feels they are present in a VE. VR systems can be classified as non-immersive, semi-immersive or fully immersive. Users typically experience VR through a HMD, which tracks head and body movements, and hand controllers for navigation, allowing users to interact with the VE in real-time. Adding further dimensions to VR are AR and MR technologies that allow the overlaying of graphics and other content onto the real world. MR allows users to interact with both the real world and the added content. Its application is increasingly expanding into other sectors, including education, suggesting a broader shift in its usage (Chang & Lai, 2021; Davila Delgado et al., 2020; Dhanalakshmi et al., 2021; European Commission, 2021; Guo et al., 2020; Nicolaidou et al., 2023; Stracke et al., 2025; Villena-Taranilla et al., 2022).

2.4 Virtual Reality in other Sectors

Before we consider VR in education and HE, it is important to note its penetration into other areas of society. Some prominent sectors include Manufacturing, Engineering, Architecture and Construction, Health Care, Business, and Retail, many of which demonstrate strong alignment with tertiary education pathways. The cross-sectorial nature of VR/AR is often misunderstood or overlooked by consumers, industry actors and policymakers, who perceive VR/AR as exclusively related to the video-gaming and entertainment industry (European Commission, 2021). However VR/AR's prevalence and potential beyond video-gaming and entertainment is also growing with VR/AR expected to flourish in a variety of sectors and industries (Davila Delgado et al., 2020; Dhanalakshmi et al., 2021; European Commission, 2021; Guo et al., 2020; Thompson, 2024). While the popularity and growth of VR continue, it is still viewed as a niche technology (Lege & Bonner, 2020). There are numerous scenarios where, when it is expensive, impractical or impossible to do something in the real world, VR or AR can provide an alternative credible solution (Blascovich & Bailenson, 2011). The following section explores the usage of VR in HE.

2.5 Virtual Reality in Higher Education

VR has existed in the education arena for more than half a century, although not widespread or mainstream (Kavanagh et al., 2017). It has become increasingly important in education research, transitioning from a tool of interest to a tool of pedagogical practice (A. Wang et al., 2021). The potential for IVR in education is growing due to the increased quality and availability of affordable devices (Stracke et al., 2025). Its adoption as a pedagogical method has challenged the conceptual meaning of what constitutes a learning environment (Hamilton et al., 2020).

While VR studies conducted in education have shown positive results, its adoption in HE as a student learning tool has not been extensive (Hamilton et al., 2020; Kavanagh et al., 2017; Stracke et al., 2025), but it is widely used as a research tool, including simulations in HEIs (Sümer & Vaněček, 2025). However, the use of VR in education and its potential to enhance learning in HE is growing (e.g., Cowan & Farrell, 2023a; Häfner et al., 2018; Hamilton et al., 2020; Kuleto et al., 2021; Radianti et al., 2020; Stracke et al., 2025; Van Der Want & Visscher, 2024). Cost (equipment, maintenance, training, etc.) is considered as one of the challenges associated with introducing VR into educational institutions (Kavanagh et al., 2017). The continued reduction in cost of ownership of VR equipment has permitted educational institutions to incorporate VR into their teaching (Hamilton et al., 2020; Seufert et al., 2022; Stracke et al., 2025), and the potential for VR in education is growing (Kuleto et al., 2021; Stracke et al., 2025). Marks and Thomas (2021) assert that adoption rates of the technology are linked to educators' ability to experiment with VR content. Cowan and Farrell (2023b) explored the attitudes of 50 ITE subject methods tutors across Ireland towards using VR in education. Respondents showed openness and optimism about VR's potential to enhance learning, with 92% indicating that VR has a place in ITE subject methods modules. They indicate that a gradual approach, starting with non-immersive experiences, moving towards a wider use of IVR. However, they identified limited technical skills, access to equipment, and availability of curriculum-aligned resources as barriers. They put forward a possible solution to overcome these barriers is adoption through "reverse mentoring", whereby ITE students as 'change agents' lead the transition on how to embed VR into classroom teaching. The findings reveal a cautious but optimistic approach to VRs adoption, and advocate for professional development and collaboration to integrate VR into ITE programmes effectively.

Kavanagh et al. (2017) conducted a systematic review of VR used in education, covering the period 2010 to 2017. The selected papers covered a wide range of educational institutions and VR applications, with 51% focused on HEI's, 9% Second level, 6% Primary, 4% Early Childhood, and the remaining 30% representing a mixture of the private sector and other areas. The review analysed 99 papers implementing VR, with a thematic analysis identifying the broad areas of application: Health (35), General Education (28), Engineering (19), Science (16) and other (27). The review concludes that VR is predominantly used in specialised areas requiring realistic simulation.

Another systematic review by Hamilton et al. (2020) examined the impact of IVR as a pedagogical tool in education. Most of the studies focused on science (45%), Engineering (24%), Medicine (14%) and limited representation in arts and humanities. The key findings reported that the majority of studies reviewed reported significant benefits of IVR, including knowledge retention and improved engagement. However, some of the studies indicated no significant differences between IVR and non-IVR methods. Procedural tasks demonstrated significant advantages, with evidence of skill transfer to real-world scenarios. Many of the studies reported brief single interventions, limiting the understanding of IVR. In addition to the short interventions and exposure times, many of the studies did not complement IVR with additional methods of teaching or self-learning. The authors also indicate that the novelty of IVR may hinder learning outcomes as users may require time to adapt to the technology, explaining that it is prudent to factor in some time for familiarity. Extending the insight of Hamilton et al. (2020) relating to skills transfer to the real-world, Farrell et al. (2022) concluded from their study investigating a model for reverse mentoring for professional learning that PSTs are also likely to transfer VR skills acquired in HE to the school setting.

A review by Xiaoning et al. (2024), examining the utilisation of VR technology in HE from 2014 to 2023, highlighted the benefits of VR in HE through applications such as virtual laboratories, digital environments, and simulation-based training. The main findings reveal significant benefits of using VR in HE, categorised into three main areas: (1) Immersion, the sensation of being fully absorbed in a realistic and engaging VE, which can enhance user motivation. (2) Interaction, enabling active user participation in a natural and multisensory environment using HMDs and haptic devices. (3) Conceptualisation, supporting the transformation of abstract ideas into concrete virtual representations, improving learning outcomes. However, they indicate some challenges, including (1) Limited space for practical training. (2) The cost of VR equipment. (3) The constant speed at which VR technology changes. (4) Insufficient investment in experimental teaching. They conclude by indicating that there are opportunities for the application of VR in HE.

A more recent systematic review, conducted by Stracke et al. (2025), examined the use of IVR in HE, highlighting the opportunities and challenges for its integration. The discipline areas of the 50 articles covered are broken down, Medicine (13), Computer Science (6), Biology (5), Education (4), Engineering (4), Geography (2), Physics (2), and Others (8). Some of the key points include: (1) most studies focused on learners as the primary target group, followed by teachers. (2) The majority of IVR studies are conducted in specialised laboratories without the integration into regular programmes of study. (3) Research outcomes are diverse and often contradictory due to specific isolated applications. (4) The implementation of IVR does not automatically result in enhanced learning outcomes, as several studies in their review show no substantial difference in learning outcomes. (5) The majority of the studies reviewed lacked standardised research methodology and lacked evidence-based results. (6) IVR in HE is in its infancy and lacks standardised research frameworks for comparative validation. The authors indicate that the design, implementation and use of IVR in HE requires careful consideration and conclude by advocating for the development of a comprehensive development, deployment and evaluation framework for IVR applications in HE.

These insights offer an overview of the current state of VR in HE. The literature indicates that VR is a promising tool within many subject domains in HE. However, the uptake of VR has been led by science, technology, engineering and mathematics (STEM) disciplines (Hernandez-de-Menendez et al., 2020). The following sections present an overview of the application and use of VR in the disciplines of Engineering, Nursing Education, and Language learning.

2.5.1 Engineering

In their systematic review of VR applications in HE, Radianti, et al. (2020) identified engineering as a domain frequently associated with multiple learning approaches, including problem solving, analytical skills, collaboration, procedural and practical knowledge. The traditional approach to teaching engineering is delivered through classroom-based lecturers, with instruction and explanation of materials using whiteboards and projectors to display digital content, multimedia or PowerPoint slides (Soliman et al., 2021). In terms of VR integration, the following studies illustrate VR's application in engineering in HE.

AlAwadhi, et al. (2017) developed an interactive VR digital application, for students to perform hazardous experiments in the fields of engineering and science in a virtual lab. It allowed students to practice and perform experiments in a safe environment where mistakes did not cause harm. The application facilitated learning by increasing students' understanding and attention, reducing risks associated with dangerous experiments, and was used as a supplement to traditional classroom based teaching. Integrated quizzes were used to test student understanding and performance, which helped to increase their attention and engagement during lessons. The authors concluded that practicing dangerous experiments in VR improved student learning by facilitating easier comprehension of concepts through visual explanations and immersive VR scenarios.

Ingale et al. (2023) explored the use of VR as a method to enhance learning experiences for engineering students, in particular architecture, mechanical, civil, and automobile engineering. They developed a VR platform that allows students to interact with 3D movable models. Architecture students can interact with the building to change building materials, while automobile students can pick up automobile parts to view them as part of a larger automobile or as an individual part. The VR platform supported multiuser functionality, enabling students to collaborate, and lecturers monitor and guide student interactions. The results indicated that 90% of students had a positive learning experience and understood the concepts better. Overall, the study highlighted the effectiveness of using high end technologies like VR to improve student learning.

In another study, Ghazali et al. (2024) explored the use of VR to teach engineering students about the abstract concepts of magnetostatics (magnetic fields), which the authors indicate is a challenging subject as the concepts can't be visualised in the physical world. The study utilised a bespoke VR laboratory, “Merlin's Playground”, which allowed students to engage in immersive and interactive learning. Students first learned the theoretical concepts of magnetostatics in a traditional lesson. Students completed five activities in the VR laboratory, followed by completing quizzes within the VR environment based on the virtual activities and classroom knowledge. The authors concluded that integrating VR into engineering education had a positive impact on students' learning experience and learning outcomes.

These studies demonstrate that VR labs, through immersive simulation and active engagement, enhance engineering students' learning by integrating practical application with declarative knowledge.

2.5.2 Nursing Education

Nursing skills play a vital role in nurse education by refining core competencies essential for clinical practice. Traditional nursing skills education used anatomical models as patients, where qualified, trained skills nurses would explain the skill, followed by demonstrating the skill to students and in turn student nurses would practice and be assessed (Chang & Lai, 2021), essentially a microteaching session. Chang and Lai (2021) investigated nursing students' perceptions of engagement in learning nursing skills in VR. They set out to understand students' experiences of learning the skills of nasogastric tube care. Students learned the skill with traditional practice equipment and also experienced the VR simulation of the same procedure, see (**Figure 2.4**). The students reported positive results, indicating that VR required a small space, there was no need for consumables or other equipment, and students could repeat the skill to perfect it. Not having to rely on consumables eliminates the recurring expenses of physical resources, increasing flexibility. Despite the positivity towards VR, students also felt conventional teaching methods gave a greater sense of reality because VR did not give a sense of touch or the warmth of patient-nurse interactions.

Figure 2.4 Student engaging in in nasogastric tube care skills (Chang and Lai, 2021).

As part of midwifery education, Ryan et al. (2022) used a virtual reality learning environment (VRLE) to assess learning and understanding of the topic of foetal lie, position, and presentation during pregnancy. A VRLE is a VE where students are actively engaged with simulated scenarios. Participants took part in a fact-finding exercise, locating learning objects and answering practice questions designed to correlate displayed images with clinical knowledge. Pre and post multiple-choice questionnaires were used to evaluate knowledge before, immediately after and one-week after the intervention. The study found that the VRLE had no impact on knowledge gain. However, satisfaction and self-confidence levels showed positivity towards the VRLE, with the researchers indicating that VRLEs are a potential learning tool to increase engagement, satisfaction and self-confidence while enhancing the student learning experience.

A study by Lee and Baek (2023) investigated VR simulation on clinical practice in nursing education. Nursing students (n=44) were divided in two groups, an experimental group experiencing VR simulation combined with clinical practice and a control group partaking in clinical practice only. The results showed that VR was effective in improving nursing students' performance confidence and clinical decision-making ability. A meta-analysis conducted by Chen et al. (2020) reviewed 12 studies, concluded that VR can effectively improve knowledge in nursing education, but it was no more effective than other teaching methods in the areas of skills, performance time, confidence and satisfaction. A systematic review of 22 studies of VR simulations in nurse education by Plotzky et al. (2021) concluded that IVR simulations have the potential to immerse students in scenarios that otherwise may be difficult to create and could make nurse education more efficient. It would appear that VR enables nurse students to engage through experiential and kinaesthetic learning (hands-on-learning by doing) with positive outcomes

2.5.3 Language Learning

Language learning is the acquisition or development of language skills, usually as a second or subsequent language (Ortega, 2014). Collaborative learning in VR is showing promise; and the most effective way to learn a language is to participate in the community in which the target language is used (Shih & Yang, 2008). VR is recognised as a tool for language learning, because of its ability to create “authentic and immersive environments” enabling learners to interact and converse with native speakers (Lin & Lin, 2015, p. 486). Research suggests that VR enhances learners’ independence, increases self-efficacy, reduces learning anxiety, and can foster creativity (Lin & Lin, 2015). Nicolaidou et al. (2023) investigated the use of IVR in comparison to mobile applications for language learning in HE. Although they did not find a significant difference between the two conditions, higher scores were found for engagement, engrossment and immersion in the VR condition. The study reveals that while VR was effective and engaging for language learning, it was not found to be superior to mobile applications. Similar results were found in a study where Irish and German students collaborated in VR, using an equal mix of English and German, to ‘escape from a room’ (Senkbeil et al., 2022). The results of these studies indicate that the VR has the potential to enhance the learning outcomes for language students in HEIs.

2.5.4 General VR Commonalities in Education

Many of the findings in the literature relating to teaching and learning with VR as a learning tool have commonalities across the subject disciplines. Affordance is a frequently used term in educational technology. It is a theoretical construct that represents the potential for an action to occur between an agent and an environment; it is the relationship between the properties of the environment and the agent who perceives them (Nye & Silverman, 2012; Shin, 2017). Essentially, it is what an object affords an agent to do with it. VR as the object gives potential to the user (agent) to engage (action) with the VE. Soliman et al. (2021) suggest that VR is an excellent tool for blended learning in comparison to traditional education, because of its learning and cognitive benefits, including enhanced understanding of complex concepts, problem solving and experiencing a task in VR as they would in real-life.

While VR may have potential in teaching declarative knowledge (Webster, 2016). From the exemplar learning disciplines presented here, it appears that the potential of VR is not only in teaching declarative knowledge, but in the praxis of these domains. While learning-by-doing may be possible in the real world, VR may be an alternative with an advantage. The multi-user shared space afforded by some VRLEs enables users to be aware of each other in a common learning environment, encouraging peer interaction, which stimulates a user's motivation towards collaborative learning (Huang et al., 2010). Student knowledge retention has been found to improve in a VE classroom compared to a traditional classroom, with students reporting a more enjoyable learning experience (Laseinde et al., 2015).

Radianti et al. (2020) observed from their review of the literature that engineering and computer science regularly used certain VR applications to teach skills that required both declarative and procedural-practical knowledge. However, the authors indicate that in most domains, VR is still experimental and usage is not methodical or based on best practice. They indicate that "the true potential of VR lies not in better teaching of declarative knowledge, but in offering opportunities to "learn by doing" which is often very difficult to implement in traditional lecturers" (2020, p. 23). The adoption of VR for teaching purposes may give universities an advantage with the possibility of widening the student base in terms of international offerings; and integrating VR into the curriculum has potential benefits pedagogically and economically for the university and the students (Soliman *et al.*, 2021).

2.5.5 The Future Directions of VR in Education

The Metaverse is a complex concept, it is a convergence of technologies that support the merging of physical reality with digital VR to enable multisensory interactive VR, AR and XR environments (Smart et al., 2009). Drawing parallels to the internet, where users move and switch between numerous web pages, the Metaverse is a multiuser interconnected web of social, networked environments, each its own ecosystem merging physical and virtual worlds, where users can teleport their avatars between collaborative spaces (Chamola et al., 2025; Mystakidis, 2022). From an education perspective, the Metaverse is not a new concept, with researchers and educators long considering its implications for learning (Tlili et al., 2022). Some researchers purport that the Metaverse is the next space where individuals can meet, interact and learn (Chamola et al., 2025; Collins, 2008), with Onu et al. (2024) indicating it "holds the power to revolutionize teaching and learning" (p.1).

According to Tlili et al. (2022), one of the advantages of the Metaverse is enabling students to attend their classes virtually while combining elements of a physical classroom. This affords students the opportunity to interact with peers and teachers, creating immersive learning opportunities that may enhance their motivation. An example of this is an innovative classroom experience conducted by Jeremy Bailenson at Stanford University, where the course "*Virtual People"* is one of the first and largest courses to be delivered almost entirely through remote VR (Hadhazy, 2021). With multi-campus universities and the global connectivity of HEIs, distance learning can benefit through VR, by helping remote students feel more connected to the HEI, lecturers and their peers (Healy, 2024).

Online education is growing, and the COVID-19 pandemic, through remote emergency teaching, has accelerated this trend by disrupting attendance-based activities across all levels of education (Tlili et al., 2022). The Metaverse has the potential to transform online education (Chamola et al., 2025), but a number of questions remain to determine if it can become mainstream. Questions concerning privacy (Casey et al., 2021; Tlili et al., 2022), especially at third level where HEIs are bound by legal requirements such as accessibility, accreditation and student privacy requirements (Collins, 2008). Uncertainties and usability challenges still exist (Han et al., 2022), and according to Onu et al. (2024) several barriers to the Metaverse still remain to ensure the successful integration in education. If these challenges can be addressed and implemented correctly, the Metaverse has enormous potential and may provide a set of possibilities to realise learning scenarios (Hirsh-Pasek et al., 2022), including within HEIs. VR and the Metaverse may be a transformative force in education, blending technological innovation with instructional advancement (Chamola et al., 2025). Initial Teacher Education (ITE) is a field in which VR is still in the early phases of adoption and integration. However, it may prove beneficial as a PST learning tool and for competence development. Therefore, understanding the evolving role of educational technologies (including VR) is crucial to informing ITE in the digital age (Burden et al., 2016).

2.5.6 Summary

VR is a computer-generated simulation that allows users to interact with immersive 3-D environments that the user perceives as real. VR can be non-immersive, semi-immersive and fully immersive, each with a deeper level of presence. VR in education is not new, and its potential as a learning tool continues to grow in HE. VR studies conducted in education have shown positive results, with a large uptake in STEM subjects, while also finding usage in other areas, including engineering, nursing and language learning. Commonalities exist within the affordances offered by VR across disciplines. Its growth and expansion into the Metaverse may see opportunities for student education, including ITE and HEIs. The reviewed literature collectively explores the role of VR in HE. The consensus among the studies indicates that VR enhances learning outcomes, potentially improving knowledge retention, student engagement, and active learning. However, the adoption of VR is viewed with cautious optimism, leading to the recommendation for developing a formal, comprehensive framework for IVR applications in HE.

2.6 Effective Teaching and Professional Competence

Teaching is one of the most important activities that occurs in schools, and it is the most important thing that teachers do (Muijs & Reynolds, 2018). Teaching does not merely involve the simple transfer of knowledge from teacher to learner; teaching and learning are relational processes (The Teaching Council, 2020). Effective teaching behaviour is essential for students' academic outcomes (Decuyper et al., 2025). A teacher's influence on their students is powerful and long-lasting, directly affecting how, what, and how much they learn (Stronge, 2018). "Teaching is a skilled job" (Patil &

Bhuiyan, 2015, p. 236), and the training of skilled teachers is of societal importance nationally and internationally (Bakır, 2014), as too is the development of PSTs' professional competence (Depaepe & König, 2018), before they embark on their teaching career. In the Irish context, the training of skilled PSTs is of significant importance and is the statutory responsibility of The Teaching Council of Ireland. ITE is provided by third-level institutions, with The Teaching Council prescribing criteria and setting graduate standards for ITE education providers (The Teaching Council, 2020). This combination of prescribed criteria embedded in third-level curricula prepares student teachers for active engagement in teaching and life within a school environment. Among an array of criteria (learning outcomes) expected of student teachers, The Teaching Council (2020) requires that student teachers of ITE programmes should understand the theory, concepts and methods pertaining to effective teaching and professional competence. The section briefly outlines effective teaching and teacher effectiveness as a prelude to a more specific exploration of microteaching and microteaching 2.0.

2.6.1 Effective Teaching

There is no universally accepted definition of teaching (Otsupius, 2014) and the research literature pertaining to effective teaching is vast and complex (Harris, 1998). 'Effectiveness' is a contested term arousing strong emotions because of its perceived links with notions of professional competency, which makes defining effective teaching, teaching effectiveness and the effective teacher complicated and controversial (Ko et al., 2013). Stronge (2018) elaborates that "effectiveness is an elusive concept when we consider the complex task of teaching" (p.4), as some researchers define effectiveness in terms of student achievement, others in terms of high performance ratings, or based on comments from students and other stakeholders. While cognisant of the width, depth and complexity of the subject, within this section, the term 'effective teaching' focuses on a narrow aspect of professional competency that relates specifically to the professional competence, skills and experience required by PSTs to teach students in a classroom environment.

Effective teaching is the process of trying to teach in a way that reinforces how people learn naturally (Muijs & Reynolds, 2018), delivering information, developing skills, and values in a way that maximises student learning and retention of the subject material. It comprises of and utilises various instructional strategies tailored to meet the needs and abilities of individual students, which align with specific learning objectives (Melara-Gutiérrez & Gonzalez-López, 2021; Paolini, 2015). Supplementary instructional materials, including interactive digital tools and technologies, may be employed to enhance student engagement (Paolini, 2015).

An effective teacher has the skills, competence and ability to create a positive learning environment that encourages active participation, fosters critical thinking, and promotes student engagement (Muijs & Reynolds, 2018). Learning environments differ in terms of the physical environment and the type of learning activity that occurs there. Teachers are the key agents in creating influential learning environments through design instruction and class delivery (Baier et al., 2019). A key aspect of classroom management is creating a safe, supportive, and positive learning environment where students feel comfortable, “which increases the likelihood that learners will choose to actively engage” (Banks, 2014, p. 523). Effective teaching requires three main types of knowledge: Subject, pedagogical, and domain knowledge (Muijs & Reynolds, 2011), developed through formal and informal learning experiences; which requires conscious practice in the real-world classroom (Lecat et al., 2019). In essence, effective teaching uses strategies to inspire and motivate students in the learning process while creating learning environments that support and promote their learning.

A review of the literature conducted by Harris (1998) informs that early studies circa 1960’s and 1970’s of teacher effectiveness focused on the personality of the teacher, with later studies concentrating on the behaviour of the effective teacher in the classroom in a paradigm termed ‘process-product’ (p. 171). Slater et al. (2012), investigated the effect of individual teachers on student test score outcomes, found considerable variability in teacher effectiveness, which impacted student outcomes. However, they note that the data required in estimating teacher effectiveness is complex. They caution that other research has found that individual teacher effectiveness does not produce lasting impacts on their students' achievements. They also corroborate other researchers' findings that observed teachers' characteristics explain very little of the differences in estimated teacher effectiveness. Baier et al. (2019) indicate that the empirical evidence on the "relationship between teacher characteristics and instructional quality is not yet conclusive" (p.769). In contrast, Engida et al, (2024), note that studies with students who have access to highly qualified teachers tend to have higher achievement rates. However, they also note that teacher quality has not been adequately established in these studies. They further indicate that "the quality of teachers is not easily measurable" (p. 7). Baier et al. (2019) suggest that differences in personality traits of teachers may make them more suited and/or better able to cope with the dynamics and rigours of teaching.

In summary, many factors contribute to effective teaching and to becoming an effective teacher. Essentially, effective teaching refers to the pedagogical and methodological elements of teaching. It requires that the effective teacher is prepared with mastery of the subject being taught, the appropriate skills, techniques, and competencies to deliver teaching to their students. Consequently, PSTs need to be equipped with both professional knowledge and personal skills.

2.6.2 What are the skills and competencies needed to be an effective teacher?

"Teacher effectiveness is generally referred to in terms of the focus on student outcomes and the teacher behaviours and classroom processes that promote better student outcomes" (Ko et al., 2013, p. 6). Harris (1998) indicates that defining the effective skills required by teachers is not straightforward, as many studies reveal a number of different perspectives. Nevertheless, three important competencies are apparent: **Knowledge** (*pedagogical and subject*), **Decision making** (*thinking before, during and after a lesson in how best to achieve the intended educational outcomes*) and **Action** (*overt teacher behaviour to nurture student learning*). Professional teaching skills are acquired with study and attentive practice as part of ITE engagement (Perrott, 1982; The Teaching Council, 2020). Baier et al. (2019) further elaborate that effective teaching relies on specific knowledge acquired through formal and informal learning that must be intentionally practiced through practical application in the classroom. Along with this, individuals may exhibit personality traits that help them navigate the demands of the job more effectively, even if some of these traits are not unique to the teaching profession. Some associated traits include motivation, enthusiasm, cognitive ability, and gravitation towards the performance of teaching.

The development of competence and professional skills are central to the heart of teacher education programmes (Fitzsimons et al., 2024; O'Flaherty et al., 2023; Singh, 2010). Institutions tasked with ITE are responsible for developing teachers with the competencies needed in this increasingly digital era (Azrai et al., 2020; The Teaching Council, 2020). Microteaching is a teaching method for student teachers to practice and refine their teaching skills and competencies (Allen, 1967; Remesh, 2013; Singh, 2010). Microteaching is discussed in the next section. In Ireland, the Teaching Council sets out a range of learning outcomes for PSTs under three broad domains: Professional Values, Professional Skills and Practice, and Professional Knowledge and Understanding (The Teaching Council, 2020). The three domains are inherently symbiotic and inter-connected which enables the development and professionalism of the graduate teacher. These attributes recognise ITE as the beginning of the life-long journey of the newly qualified graduate teacher. Each domain can be subdivided into a number of dimensions. '**Professional Values**' are concerned with ethical standards and professional behaviour, and professional and ethical teaching. '**Professional Skills and Practice**' pertains to areas of classroom management, organisational skills, communications, relationship-building, critical thinking and problem solving, reflection and evaluation, and the integration and application of knowledge for planning, teaching and learning. '**Professional Knowledge and Understanding**' relates to subject and curriculum knowledge, principles of planning, teaching, learning, assessment, reflection and evaluation, and an understanding of education and the education system, with further reference to communication and relationship-building (The Teaching Council, 2020). These subdivisions provide a more granular view of the day-to-day values, skills, practices, knowledge and understanding required by teachers within the education ecosystem.

In the context of this study, the area of communication skills is particularly important. The following section briefly outlines some of the skills and competencies associated with the effective teacher, however this is not an exhaustive or prioritised list, but drawn from broad headings within the literature.

Communication Skills: Communication is a fundamental component in classroom interactions and develops over time (Fitzsimons et al., 2024). Teachers must have excellent communication skills to effectively convey information and ideas to students within the classroom (Paolini, 2015). The teacher needs to understand how learner diversity can affect communication and know how to communicate effectively in differing environments (Cooper, 2012). Developing the PST's ability to actively listen, ask questions, and provide feedback that is clear and constructive is essential to meet the learning goals (J. R. Davis, 2018; Perrott, 1982).

Presentation Skills: These are the skills of describing, narrating and making the topic interesting to the audience, using a high degree of clarity (Muijs & Reynolds, 2018; Patil & Bhuiyan, 2015).

Verbal Skills: A teacher's language fluency is paramount in effectively communicating with students in a clear and compelling manner (Allen & Cooper, 1972a; Patil & Bhuiyan, 2015; Stronge, 2018).

Organisational and Planning Skills: Lesson planning does not occur in a vacuum; usually, it is based on a course syllabus laid down by the school or by an external body (Perrott, 1982). Teachers must be highly organised and able to manage their time effectively. Planning lessons and activities is essential to keep track of student progress and maintain accurate records and documentation (Cooper, 2012).

Subject Knowledge: "Good subject knowledge is an essential prerequisite for good teaching" (Ko et al., 2016, p. 19). There is a positive association between a teacher's content knowledge and student learning (Stronge, 2018). Teachers must possess an in-depth understanding of the subject matter they are teaching (Depaepe & König, 2018), and use it to decide what is the essential knowledge, understanding and skills necessary for individual learners to progress in the subject (Cooper, 2012). Having a high degree of content and subject knowledge assists teachers in arranging and planning their lessons in a sequential and interactive way, applied through pedagogical knowledge (Stronge, 2018).

Pedagogical Knowledge: Pedagogical knowledge refers to knowledge and insights about how to teach a particular subject, accounting for students' conceptions, levels and learning difficulties (Shulman, 1997, as cited in Depaepe & König, 2018). Teachers must have a deep understanding of the principles and practices of teaching and learning, including instructional strategies, assessment techniques, classroom management, and subject content (Stronge, 2018). To be effective, teachers need a combination of overlapping subjects and pedagogical knowledge (Stronge, 2018).

Technology Skills: The majority of teachers have generic digital competence extrinsic to their professional requirements that could potentially be applied to develop learning resources. In addition to generic digital competence, teachers should also be proficient in the use of technology, including digital tools and resources, to enhance teaching and learning (Starkey, 2020). They should be able to identify and use technology to create engaging digital resources and interactive lessons to engage students and provide feedback (Starkey & Yates, 2022).

Classroom Organisation and Management: Classroom management is an essential element in effective teaching. It is important that PSTs develop their understanding of classroom management and associated skills through theoretical and practical hands-on experiences (Christofferson & Sullivan, 2015; Gokalp & Can, 2022). Classroom environments vary and include open-plan, formal, and informal, requiring the teacher to be aware of the physical space and plan accordingly to accommodate students' learning needs (Perrott, 1982). Theachers must use proactive and reactive strategies to encourage learning and influence appropriate behaviour in the classroom (Little & Akin-

Little, 2008). Christofferson and Sullivan (2015) explain that teachers' confidence and competence in classroom management practices are linked to formal training in classroom management. However, they also inform that many teachers report that their pre-service training was inadequate in relation to classroom management. J. R. Davis (2018) explains that for all the classroom skills attributed to teachers, they become moot if they are unable to maintain order in the classroom. In addition to creating a positive learning environment, classroom management is indispensable to enable learning in the classroom.

The quality of the education is connected to the quality of teachers (Singh, 2010), which is underpinned by the quality of pre-service preparation they receive through teacher training (O'Flaherty et al., 2023). The Teaching Council (2020) emphasises that as part of ITE, school placement is the fulcrum of the continuum of PST education in developing their understanding and experience of the complexity of teaching, with Donlon (2019) indicating that, in general, school placement is considered essential to the development of PST professional competence. Teacher education is seen as both a theoretical and practical discipline, with a shifting emphasis on developing reflective practitioners (Coolahan, 2004). For Remesh, "the classrooms cannot be used as a learning platform for acquiring primary teaching skills" (2013, p. 158). As an intermediate "Microteaching has been suggested as a partial answer to the question 'What is teacher effectiveness?', particularly in the context of teacher education" (Spelman & St John-Brooks, 1972, p. 73). Microteaching is a significantly helpful technique to connect theory to practice (Hama & Osam, 2021; O'Flaherty et al., 2023), and can act as a prelude bridging the school placement gap (Griffiths, 2016) in preparation for practicum experiences (O'Flaherty et al., 2023). According to Remesh, "microteaching works as a focused instrument which helps to practice essential teaching skills safely and effectively" (2013, p. 162). In their study, Fitzsimons et al. (2024) indicate that PSTs do not progress at the same rate across all competencies. Improvements in professional practice vary among different skill sets, and the development of competencies does not necessarily follow a linear trajectory. They noted significant improvements in PST performance were observed in some areas, such as Professionalism, Communication Skills, Classroom and Lesson Management, from year three to four of their ITE. Microteaching in VR may be an appropriate precursor for PSTs to practice in the early stages of their ITE before moving to a live classroom environment in the final years of their study.

2.6.3 Summary

Teaching is an important activity that takes place in schools. Effective teaching is the practice of applying professional knowledge and personal skills that lead to positive student outcomes. Learning environments are diverse in terms of classroom layout and students. Effective teaching involves creating engaging learning experiences, nurturing a supportive environment, and adapting teaching methods to meet students' needs. PSTs need to have strong teaching abilities to create engaging, inclusive, and impactful lessons that lead to successful student learning.

2.7 Microteaching

Experimental teaching and learning methods have demonstrated positive outcomes over traditional lecture-based techniques (Mahmud & Rawshon, 2013). Microteaching is one of the few experimental techniques that combines theory and practice, research and training, and innovation and implementation (Allen & Eve, 1968). It is a teacher training technique that provides opportunities for teachers to build and improve their teaching skills (Kroeger et al., 2024; O'Flaherty et al., 2023; Remesh, 2013; Singh, 2010), and is practiced worldwide (Bakır, 2014; Remesh, 2013). As a concept, microteaching is not new. The term was first attributed to Dwight W. Allen of Stanford University in 1963, emanating from a desire to find new, more effective methods of training pre-service secondary school teachers that improved upon the observable demonstration lesson (Allen & Cooper, 1972a; Turney, 1970). It subsequently appeared regularly in literature, including works by (Allen & Ryan, 1969; Kelly & Brown, 1976; McKnight & Bush, 1977; Paintal, 1980; Spelman & St John-Brooks, 1972; Turney, 1970), and continues to appear in modernity. Although initially lacking in direction and without a domain focused on teaching techniques, at the time it represented a significant departure from traditional forms of teacher training and research (McKnight & Bush, 1977). Subsequent evolutions have introduced the practice of the technical teaching skill, focusing on and teaching one skill at a time, which proved successful, and concentrating on one skill at a time enabled the PST to build a repertoire of teaching skills (Allen & Cooper, 1972a). Its usage and application now extend beyond traditional teacher education, and is used in several settings where teachers teach, including in medical settings, as evidenced in the work of (Dutt et al., 2023; Ort et al., 1991; Patil & Bhuiyan, 2015; Reddy, 2019; Remesh, 2013).

2.7.1 Defining Microteaching

To move beyond artificial situations, 'microteaching' was developed, where the PST conducted a short cut-down lesson with real students. It is a carefully planned teaching session, scaled down in terms of class size, task, time, and skill; in effect "microteaching is contrived, but nevertheless real teaching" (Turney, 1970, p. 1). In essence, microteaching is a truncated teacher training technique that involves a small-scale simulation of a teaching session where PSTs practice and refine their teaching skills in a controlled, safe, and supportive environment (Hama & Osam, 2021; Kokkinos, 2022; O'Flaherty et al., 2023; Remesh, 2013; Singh, 2010). It is a scaled-down teaching encounter to develop teaching skills, while providing a method of feedback to the PST about their teaching (O'Flaherty et al., 2023; Patil & Bhuiyan, 2015). Allen and Cooper; succinctly define microteaching as:

> A teaching situation which is scaled down in terms of time and number of students. Usually, this has meant a 4 to 20 minute lesson involving 3 to 10 students. The lesson is scaled down to reduce some of the complexities of the art, thus allowing the teacher to focus on selected aspects of teaching (1972a, p. 1).

One key argument in favour of microteaching is that it can contribute to bridging the gap between theory and practice in teacher education, and serves as a valuable practice ground for PSTs (Asregid et al., 2023). It focuses on building knowledge, understanding and skills that can be applied in a professional setting (Allen & Ryan, 1969; O'Flaherty et al., 2023).

2.7.2 Rationale and Organisation of Microteaching

The initial concept and rationale behind microteaching was to move away from having PSTs familiarise themselves with the classroom environment over a long period of student teacher observation (typically six to 24 months). This extended time period could be shortened through microteaching clinics, allowing student teachers to acclimatise to the classroom environment in a much shorter time-period (typically three months) (McKnight & Bush, 1977). Considered by (Patil & Bhuiyan, 2015) as a quick, efficient and proven method providing students with a strong start.

Microteaching involves teaching a small group of students, for a short time period (5 to 15 minutes), with shortened lesson plans (Allen & Cooper, 1972a; Allen & Ryan, 1969; Hama & Osam, 2021; Kokkinos, 2022; Singh, 2010). It breaks down the complexities of teaching into smaller, manageable parts, and thereby allowing the PST to practice each part separately. This way the PST can focus on specific teaching skills and methodologies, such as questioning techniques, classroom management, or feedback provision (Allen & Ryan, 1969; Patil & Bhuiyan, 2015; Remesh, 2013). Though a scaled-down teaching encounter, microteaching is not simulated teaching, as the teachers are teaching, not role-playing (McKnight & Bush, 1977). It is teaching that focuses on developing teaching skills and competencies (O'Flaherty et al., 2023; Singh, 2010). Microteaching enables the conversion of difficult topics into smaller learning units, considered to be an advantage (Remesh, 2013), through expert modelling; impacting on PST learning (O'Flaherty et al., 2023). From a training perspective, the goal of microteaching is to allow PSTs to try out their theoretical knowledge, by letting them gain confidence while trying out among peers what they plan to do in a live classroom (O'Flaherty et al., 2023; Patil & Bhuiyan, 2015).

Allen and Cooper consider that "Microteaching is not synonymous with simulated teaching", instead, in a microteaching session "the teacher is a real teacher, the students are real students, and learning does occur in these short lessons" (1972a, p. 1). They indicate that learning does not occur because the students are role-playing and acting as they think a student would behave. They are critical of how the term microteaching is portrayed in practice, as it has been used to describe peers role-playing as students for the practicing PST during a microteaching session. Peers are in effect acting as they think real students would behave, but peers are not part of the population PSTs are preparing to teach. The authors point to the value of peer teaching, but believe it should not be equated with microteaching, in which "the students are real" students (Allen & Cooper, 1972a, p. 1).

Despite the authors' reservations about using peers as students, they also noted that many institutions used peers due to the difficulty of accessing real students during the day, because they would be in school and therefore unavailable. Out of hours, access to students could be difficult and costly. Indeed, it is evidenced in the literature that many studies include peers acting as students in microteaching sessions (e.g. Allen & Cooper, 1972a; Bakır, 2014; de Lange & Nerland, 2018; Fischetti et al., 2022; Hama & Osam, 2021; Kokkinos, 2022; Ledger & Fischetti, 2019; Remesh, 2013; Triastuti, 2020; Zalavra & Makri, 2022). As a consequence, "the utilization of peers as students, at least at the secondary level, far outnumbers the use of actual students for the microteaching process at pre-service level" (Allen & Cooper, 1972b, pp. 6–7). This type of learning exercise, where student-peers act as students, has been referred to by Farris (1991) as micro-peer teaching. A full exploration of this subset of microteaching is outside the scope of this thesis.

2.7.3 Conceptual Models Underling Microteaching

Microteaching from the perspective of the PST is a training technique as opposed to a teaching technique. It focuses on the training of a particular skill in a structured way (O'Flaherty et al., 2023; Remesh, 2013; Singh, 2010). Microteaching does not focus on the subject or the syllabus being taught; instead, it emphasises the behavioural aspect of teaching as opposed to lesson content (Ferguson & Sutphin, 2022; O'Flaherty et al., 2023; Remesh, 2013; Spelman & St John-Brooks, 1972;

Zalavra & Makri, 2022). Emphasis is placed "on 'how' to teach rather than 'what' to teach" (Patil & Bhuiyan, 2015, p. 237).

2.7.4 Teaching Skills with Microteaching

In the context of learning how to teach, microteaching is used for developing and practicing specific teaching skills. These skills are defined as teacher behaviours that are effective in creating desired changes in student teachers (Singh, 2010). The literature indicates the importance and range of teaching skills (Cooper, 2012; Muijs & Reynolds, 2018; Patil & Bhuiyan, 2015; Singh, 2010; The Teaching Council, 2020). Depending on the contextual setting, '*education, medical, etc.*', different researchers and authors describe and list the associated microteaching skills differently. From the perspective of teaching medical professionals, Patil and Bhuiyan (2015) describe nine specific teaching skills utilised in their education programme, which are (1) Lesson Planning, (2) Set induction, (3) Presentation, (4) Questioning, (5) Reinforcement of Student Participation, (6) Stimulus variation, (7) Use of Audio-visual Aids, (8) Non-verbal Cues, and (9) Closure.

Within the context of education of trainee teachers, the early works of Allen (1967), and Allen and Ryan (1969), suggest a core set of fourteen skills suitable for learning through microteaching, listed in (**Table 2.1**) and briefly described in the following section.

Table 2.1 Fourteen Microteaching Skills

1. Stimulus Variation	8. Divergent Questions
2. Set Induction	9. Attending Behaviour
3. Closure	10. Illustrating
4. Silence and Non-verbal Cues	11. Lecturing
5. Reinforcement of Student Participation	12. Higher Order Questions
6. Asking Questions	13. Planned Repetition
7. Probing Questions	14. Communication Completeness

<u>Stimulus Variation</u>: Psychological research shows that deviations from standard, habitual teacher behaviour elicit increased pupil attention. This skill relies on the teacher constantly and deliberately changing various stimuli to keep pupils' attention (Singh, 2010), it is important to avoid boredom among students during class (Patil & Bhuiyan, 2015). Securing and sustaining learner attention through gestures, speech modulation and interaction style is imperative for a good teacher (Remesh, 2013).

Set Induction: This skill creates a cognitive connection between the teacher and the pupils (Allen, 1967; Fatinah et al., 2022; Narayanan et al., 2019). It refers to the initial steps the teacher takes to capture pupils' attention to obtain immediate involvement in the lesson, and it encourages pupils to focus attention ready for learning. It involves creating a connection between previous knowledge and a new topic to be introduced (Patil & Bhuiyan, 2015). Creating carefully planned knowledge-based questions can initiate pupil discussion (Majola & Mollo, 2024; NCCA, 2015; Shanmugavelu et al., 2020).

Closure: Complementary to Set Induction, Closure is a method of recapping on a previous lesson and introducing students to new knowledge connecting to previous learning. Extending beyond the quick summary of the material covered in a lesson, closure draws together the major points as a cognitive link between past and new knowledge, providing the pupil with a feeling of achievement (Allen, 1967; Filiz et al., 2024; Patil & Bhuiyan, 2015).

Silence and Non-verbal Cues: By using moments of silence and non-verbal cues (hand gestures, facial expressions, etc.) the teacher can encourage pupils to participate. This can have a significant impact on how questions are perceived and answered. It allows pupils time to formulate an answer, although the interval should not be too long or student attention will fade and they will lose interest (NCCA, 2015; Patil & Bhuiyan, 2015; Shanmugavelu et al., 2020).

Reinforcement of Student Participation: This skill encourages pupil participation through the use of questions, verbal praise, accepting their responses or providing non-verbal cues (smiles and facial expressions); students learn better when actively involved (Patil & Bhuiyan, 2015). The use of open-ended questions can motivate pupils and probe their understanding (NCCA, 2015), where diverse answers are welcomed.

Asking Questions: This skill involves the teacher asking many questions smoothly and continuously within a limited time frame (Allen, 1967). Questioning is not only used to assess pupils, it can also be used to scaffold learners towards understanding. The types of questions vary and can include open-ended questions to allow pupils to express their ideas, with generative questions to encourage meaningful discussion (Muijs & Reynolds, 2018; Pylman & Ward, 2020).

Probing Questions: This is a questioning skill designed to move pupil responses beyond superficial answers. It allows the teacher to ask open-ended questions that probe and encourage the pupil towards revealing more information on the topic, open-ended questions can encourage meaningful discussion (Patil & Bhuiyan, 2015; Pylman & Ward, 2020).

Divergent Questions: This skill encourages higher-order thinking and creative thinking, as the teacher encourages students to explore multiple divergent possibilities, while expanding their range of thinking. Teachers engage and guide students in discussion to infer meaning or predict outcomes from a given learning situation (NCCA, 2015; Shanmugavelu et al., 2020).

Attending Behaviour: The PST must recognise and become sensitive to pupil behaviour. By attending to pupil behaviour and recognising verbal and non-verbal cues, the PST can quickly gauge pupil attention and engagement, allowing the PST to change the pace or dynamics of the classroom to improve the quality of teaching and learning (Allen, 1967; Dai, 2024; Opdenakker, 2023).

Illustrating: The trainee teacher should be able to explain the concepts they are teaching to pupils using simple, interesting, and relevant examples, thereby increasing pupils' understanding and enabling them to develop higher-order thinking (Remesh, 2013; Shanmugavelu et al., 2020).

Lecturing: Lecturing may be a presentation of content or a conversation with an audience (Patil & Bhuiyan, 2015), it requires effective presentation of learning material using appropriate teaching techniques and or devices to aid teaching (projector, interactive boards, etc.). Delivery techniques such as pacing, closure and repetition, combined with other skills, are a feature of lecturing (Allen, 1967; Allen & Cooper, 1972a; Loughlin & Lindberg-Sand, 2023).

Higher Order Questions: The teacher uses open-ended questions that elicit responses from pupils that go beyond simple language (yes or no answers). They require pupils to actively engage, assessing their abilities and knowledge. They use "How, Why, Would, and Could" questions that help students to apply information, encourage deeper thinking and understanding with higher levels of complexity through critical thinking (Muijs & Reynolds, 2018; NCCA, 2015; Shanmugavelu et al., 2020).

Planned Repetition: This is an important skill used to highlight previous key points. By intentionally revisiting core concepts, teachers support students to consolidate understanding and improve long-term retention learning (Muijs & Reynolds, 2018; Remesh, 2013).

Communication Completeness: Although the importance of clear communication is obvious, this skill focuses on training aimed at increasing the teacher's awareness of their own biases, emotions and behaviours to promote respect, empathy and effective communication (Allen, 1967; Allen & Cooper, 1972a; Burke, 2004; Loughlin & Lindberg-Sand, 2023; Singh, 2010).

Awareness of these 14 core skills contributes to improving teaching style and effectiveness (Allen, 1967; Patil & Bhuiyan, 2015). By including the individual skills in a microteaching cycle, they can be practiced and re-practiced at each phase as necessary (Allen, 1967; Blegur et al., 2024; O'Flaherty et al., 2023; Patil & Bhuiyan, 2015; Remesh, 2013).

2.7.5 Phases of Microteaching

From a purely descriptive perspective, microteaching appears quite simple. Its basic elements are the teacher, a micro class consisting of four or five students, a condensed lesson (5 to 20 minutes) and predetermined resources; however, these limited components can be applied to "purposes ranging from training, to diagnostic evaluation, to experiment with innovation" (Allen & Eve, 1968, p. 181).

The phases of microteaching as explained by Remesh (2013) can be grouped under three headings: Knowledge Acquisition, Skill Acquisition and Transfer, as detailed here.

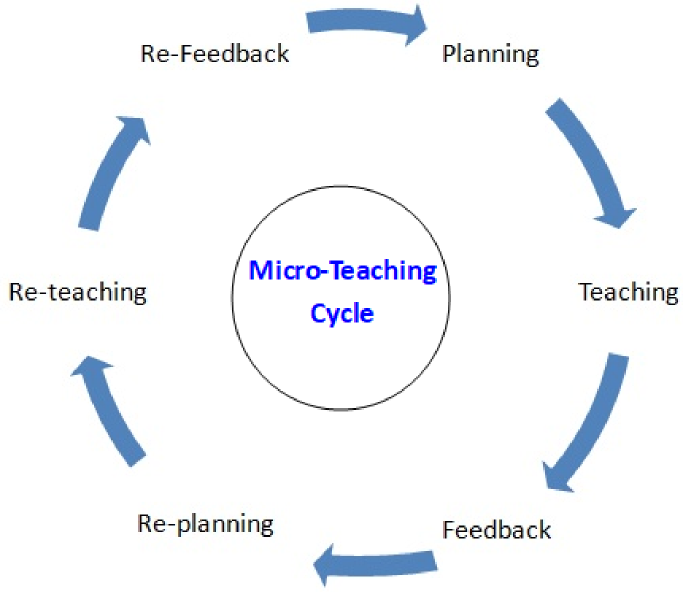
Phase 1 – Knowledge Acquisition: (Theory of how to teach – gained from classroom-based lecturers/learning): This is the preparatory, pre-active phase where the trainee teacher learns about various skills and components. This occurs through classroom discussion, assigned readings and their own self-directed learning.

Phase 2 – Skill Acquisition: (Application of theory to practice – the act of microteaching in a reduced classroom): This is an interactive phase where the trainee teacher plans a micro-lesson for practicing the demonstrated skills. Through practice, the trainee teacher gradually acquires and builds a level of mastery in various teaching skills through the microteaching cycle. Two approaches are available: the Perceptual model and the Symbolic model. In the *perceptual model*, the instructor acts as a model and presents a teaching episode in person that exemplifies the intended teaching behaviour. It may also be presented in video format. In the *symbolic model*, a detailed written description of the specific skill/behaviour to be attained by the student teacher is provided to them.

Phase 3 – Transfer: (Combination of knowledge and skills in a live classroom environment): In this phase, the student teacher takes the skills learned through practice and feedback and transfers it to a real teaching session.

Microteaching is conducted sequentially. From the literature, it appears that various authors and researchers (e.g., Patil & Bhuiyan, 2015; Remesh, 2013; Singh, 2010) describe the stages associated with microteaching slightly differently from each other. Nevertheless, they display and follow a similar trajectory. The cycle (**Figure 2.5**) developed by Allen and Ryan (1969) followed seven steps, focusing on skills mastery in scaled-down teaching sessions.

Figure 2.5 Microteaching Cycle (Allen and Ryan, 1969).



Step 1 - Planning – The student teacher plans a class with the intent of focusing on one skill (*micro-skill*) they intend to master during this session.

Step 2 - Teaching – Using the *micro-skill,* the student teacher teaches for five to ten minutes, termed a (*micro-lesson*), to the audience in a (*micro-class*), consisting usually of three or four peers and a qualified observer.

Step 3 - Feedback – The feedback for the completed *micro-lesson* is given by the *micro-class*. Feedback usually follows a pre-validated checklist or is given in response to a video recording (if one is available). The student can self-evaluate from the recording or from feedback from the audience in the *micro-class*.

Step 4 - Re-plan – Considering the received feedback and comments relating to the *micro-skill* and *micro-lesson*, the student re-plans the *micro-lesson,* incorporating modifications (if any).

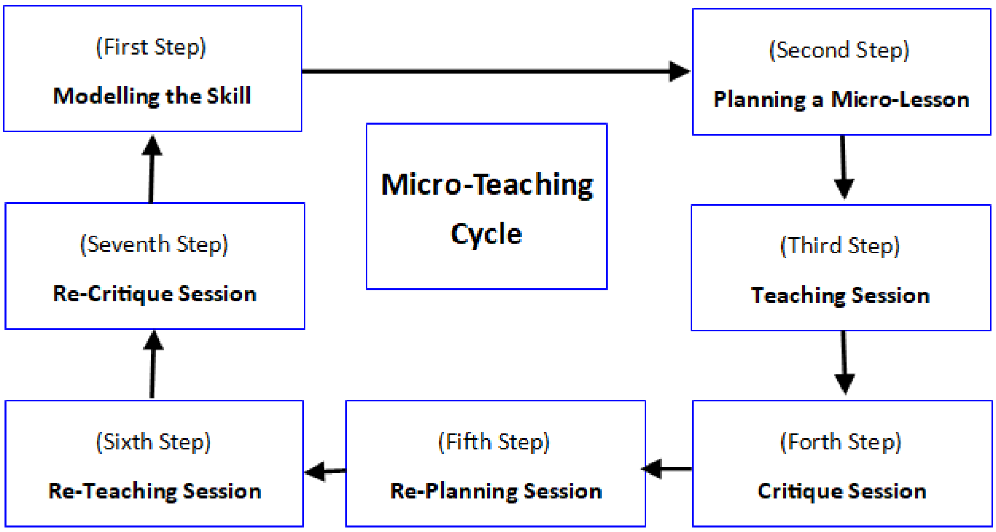
Step 5 - Re-teach – The re-planned *micro-lesson* is delivered again with the intent of improving performance.

<u>Step 6 - Re-use feedback data</u> – The feedback re-teach *micro-class* is evaluated by the student teacher.

<u>Step 7 - Classroom teaching</u> – The feedback is evaluated.

By following the cycle of the microteaching session, trainee teachers are able to practice a skill or set of skills through multiple microteaching sessions. This allows them the opportunity of practice under the close supervision of an experienced supervisor while providing feedback (Allen, 1967; Asregid et al., 2023). Singh (2010) uses a similar cyclical 7-step model (**Figure 2.6**). Although the steps are slightly out of step with those of Allen and Ryan (1969), they are essentially the same. Singh (2010) includes 'Modelling the skill', which the author indicates is essential to orientate the student teacher with both a perceptual and conceptual model, indicating that microteaching usually uses the perceptual model. A perceptual model is one, which is presented by way of demonstration and observed by the trainee. The conceptual model is usually presented in written form and conceptualised.

Figure 2.6 Microteaching Cycle (Singh, 2010).



Remesh (2013) uses a similar cyclical model, but with the addition of a linear trajectory including the three phases of the microteaching process, 'Knowledge Acquisition', 'Skill Acquisition' and 'Transfer'.

It also emphasises reflection at skills acquisition phase, as depicted in (**Figure 2.7**). This model is clear and would appear to portray a more holistic pictorial representation of the microteaching process. A comparison of the three models showing the central areas of commonality across the models is presented in (**Table 2.2**) below.

Figure 2.7 Microteaching Cycle (Remesh, 2013).

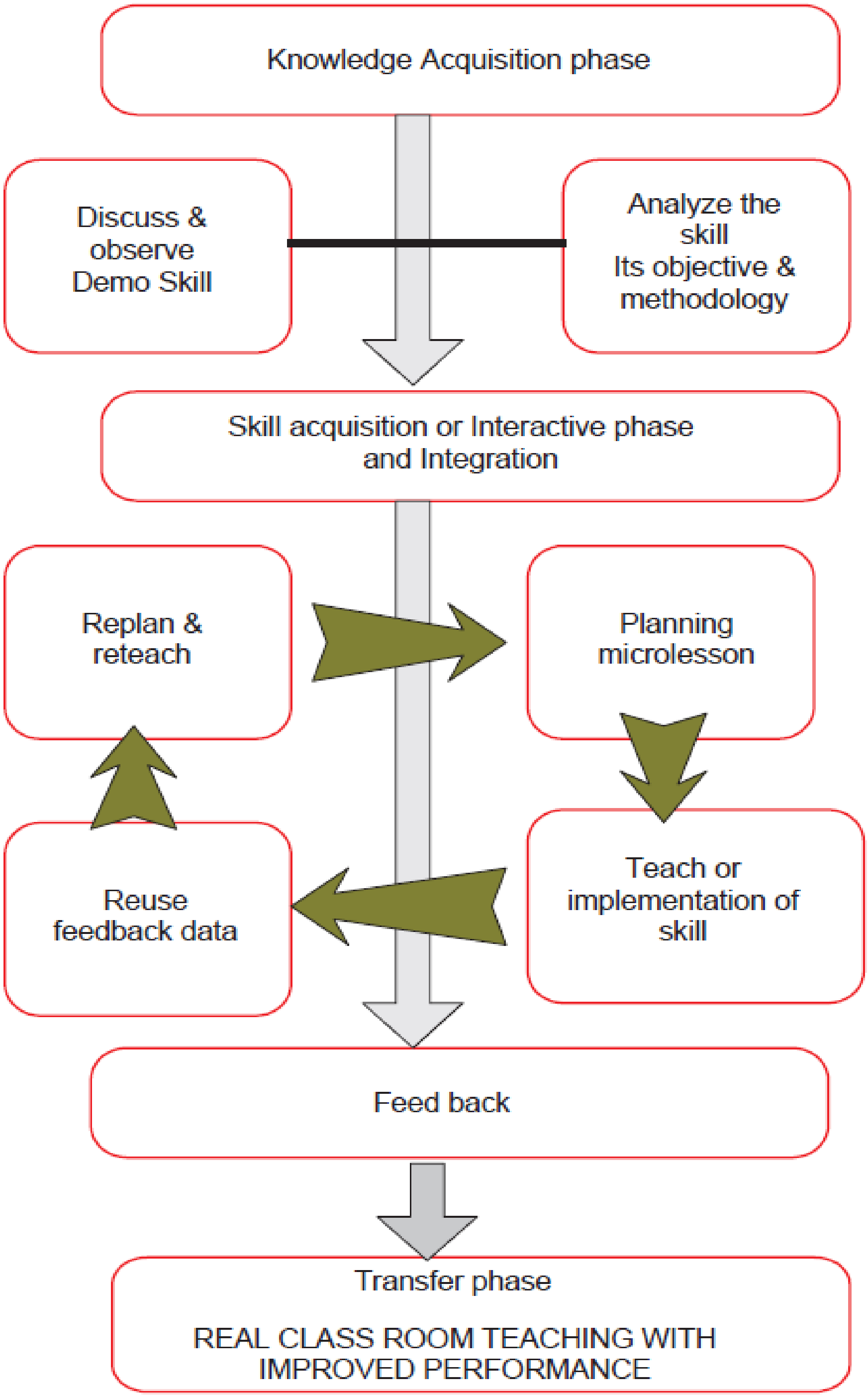


Table 2.2 Comparison of the three models showing the central areas of commonality.

Step	Allen and Ryan (1969)	Singh (2010)	Remesh (2013)
			Knowledge Acquisition Phase
		Modelling the skill	Skill Acquisition Phase
1	Planning	Planning a micro-lesson	Planning Micro-session
2	Teaching	The teaching session	Teach or Skill Implementation
3	Feedback	The critique session	Reuse Feedback Data
4	Re-plan	The re-planning session	Re-plan and Re-teach
5	Re-teach	The re-teach session	
6	Re-use feedback Data	The re-critique session	Feedback
7	Classroom teaching		Transfer Phase to Real Classroom

The microteaching cycle is the foundational framework introduced by Allen and Ryan (1969). It focuses on practice, feedback and re-teaching. It supports immediate feedback and the use of video for skills mastery. Singh (2010) builds upon the original model by formalising the phases, emphasising skills analysis and reflection through critique. It also integrates video to enhance cyclical learning. Remesh (2013) further builds on the previous models, emphasising reflective practice in parallel with feedback. It also encourages PSTs to critically evaluate their teaching by "reusing feedback" from lecturers or peers, followed by "re-teaching". The three models share the core principles of microteaching. Differences exist mainly in the degree of formalisation, and the incorporation of video and reflection.

A foundational understanding of the core principles of microteaching skills and the cyclical phases of the microteaching process was essential for mapping which skills and competencies could be effectively integrated into the MiTeachVR environment. This is explained in greater detail in sections 3.1 – 3.2.1. The research concentrated on key communication techniques, including eye contact, voice modulation, stimulus variation, and classroom circulation and movement. Therefore, mapping these specific skills to an IVR environment can effectively scaffold PSTs, maximise their acquisition of microteaching communication skills and their possible transferability to authentic classroom contexts.

2.7.6 Impact and Merits of Microteaching

Recognised for its structured approach to developing teaching skills, microteaching resides between the theoretical knowledge of teaching and classroom practice (Asregid et al., 2023; Fernández, 2005; Griffiths, 1977, 2016; Ledger & Fischetti, 2019; Remesh, 2013; Simamora et al., 2024; Singh, 2010). Since its inception, microteaching has been widely acclaimed as an effective means of introducing practical teaching experiences in PST education (McKnight & Bush, 1977). Microteaching is a well-established practice recognised in teacher education as a learning-to-teach experience (Ferguson & Sutphin, 2022; Ledger & Fischetti, 2019; O'Flaherty et al., 2023; Zalavra & Makri, 2022). It plays an essential role in ITE training programmes and contributes to a greater understanding of the teaching process and the associated complexities (Ferguson & Sutphin, 2022; Remesh, 2013; Singh, 2010). By focusing on one skill at a time, microteaching simplifies the complexities of teaching by reducing student numbers, content, and time-duration (Ferguson & Sutphin, 2022; Griffiths, 2016; Singh, 2010), into a "controlled and monitored training environment" (de Lange & Nerland, 2018, p. 172). Enabling PSTs to concentrate on a specific skill to attain a level of mastery, which may require repeated practice (Celik, 2019; Ledger & Fischetti, 2019; Pagarra & Syamsiah, 2019). PSTs develop from novice to mastery level at different rates and varies greatly across individual teachers (Fitzsimons et al., 2024; Stronge, 2018). By repeating opportunities for practice and formative assessment, microteaching may be a way to help rebalance and move trainee teachers forward at similar rates.

Immediate diagnostic evaluation and correction of practiced skills through a formative feedback mechanism may contribute to improved performance of PSTs (Arsal, 2015; Turney, 1970). Depending on the microteaching setup, the PST can learn from their own performance and by observing the performance of their peers (Arsal, 2015; Donnelly & Fitzmaurice, 2011). Recorded microteaching sessions provide an opportunity for the PST to self-evaluate and self-assess their performance by reviewing the video recording (Arsal, 2015; Brent et al., 1996; de Lange & Nerland, 2018; Donnelly & Fitzmaurice, 2011; Shaw, 2022; Spelman & St John-Brooks, 1972). Donnelly and Fitzmaurice (2011), exploring reflective practice in microteaching, found that it afforded participants opportunities to observe and learn from their peers. They could recognise an array of teaching styles and approaches, discover ideas for self-improvement in their own practice, understand the importance of planning, structure, and learning strategies to engage students. The authors indicate that microteaching provided an opportunity for participants to think critically about their classroom activities.

While examining the effect of microteaching on the teaching skills of pre-service science teachers, Bakir (2014) concluded that microteaching had a significant positive effect on the teaching skills of PSTs. Revealing significant improvement in lesson introduction, classroom and time management, lesson planning, effective communication, and self-confidence. It also reduced PST fear, anxiety and nervousness. Arsal (2015) explored the effects of microteaching on PST critical thinking. They reported that participants critical thinking skills increased, indicating that microteaching might affect the critical thinking dispositions of PSTs. Özonur and Kamışlı (2019), evaluated PSTs views related to microteaching practice. They determined that PSTs felt that microteaching practice had a positive impact on their lesson preparation and planning, self-development, presentation skills, and classroom management. It also helped reduce anxiety and stress. The reported positive outcomes from these studies indicate the impact microteaching may have on PSTs' professional development and preparations for teaching in real-world classrooms.

2.7.7 Limitations and Critiques associated with Microteaching

Despite its popularity and pedagogical merits as an effective method of teaching practice, microteaching has attracted criticism. Azrai et al. (2020) indicate that microteaching fails to capture effectively the complexities and dynamics of real-life teaching, reducing its overall relevance for

PSTs. Microteaching is limited in scope because it’s a reduced form of teaching that focuses only on a small part of the lesson and a limited number of skills. This is mainly because teaching cannot be broken down into subcomponents, as their meaning is lost in isolation, and teaching is not a simple combination of isolated elements (Singh, 2010). In their study Özonur and Kamışlı (2019) indicated some positive elements relating to microteaching as indicated earlier. However, they also highlighted some limitations. PSTs were fearful of making mistakes and being criticised, which adds to stress and anxiety. They also indicate that PSTs reported microteaching to be ineffective in areas of class management, presentation and communication with students, leading to a reduction in self-confidence. Consequently, it may not provide PSTs with the self-confidence or skills required for the full scope of teaching, including classroom management, presentation and communication skills. Bakir (2014) explains that the artificial nature of microteaching sessions, while beneficial for developing specific pedagogical skills, can result in a disconnect between the experiences they facilitate because the microteaching environment is part of the microteaching exercise. Therefore, how can educators develop the integration of core practices that reflect the demands of actual practice (O’Flaherty et al., 2023). The feedback received during microteaching is often limited to a small group of observers or peers (Bakır, 2014; McKnight & Bush, 1977), which may not represent the broader views of the teaching community. The feedback may be vague or not actionable (Otsupius, 2014; Singh, 2010), which may hinder a teacher's ability to improve. Feedback and critique from peers can cause tensions among PSTs (Bakır, 2014).

Microteaching emphasises the importance of techniques and technical aspects of teaching, such as classroom management, presentation skills, adjusting tone of voice, and questioning techniques (Kokkinos, 2022). While these skills are important, they may be insufficient to ensure effective teaching (Otsupius, 2014), which also requires content knowledge, creativity, critical thinking, adaptability, and empathy (Depaepe & König, 2018; Stronge, 2018). Microteaching is also considered to be time-consuming, requiring significant investment of time and resources to prepare (Bakır, 2014; Otsupius, 2014). Creating opportunities for repeated practice and assessment when resources are limited is challenging, particularly if student-teacher ratios are high or teachers have additional responsibilities (Patil & Bhuiyan, 2015).

In their study of reflective practice in microteaching, Donnelly and Fitzmaurice (2011) reported some of the negative experiences conveyed by participants, specifically an indication that microteaching was artificial, unrepresentative and subjective, as teaching is generally a "solitary pursuit, but microteaching treats teaching as a collaborative, communal activity" (p. 324). Participants reported that microteaching was stressful, giving rise to increased anxieties resulting from performing in front of peers and trying to compress a lesson into the short time frame used in microteaching. Participants felt it was a daunting, intimidating, and nerve-racking experience in front of peers while being recorded (Donnelly & Fitzmaurice, 2011). These findings are similar to those of Mahmud and Rawshon (2013) who explained that student teachers reported feelings of anxiety as they were observed.

It would appear microteaching is a valuable tool for developing teaching skills. However, it is important to recognise its limitations and complement it with other forms of PST training and professional development from experienced teachers. Microteaching should not be considered a substitute for other teaching methods, but as a supplement (Dhimolea et al., 2022; T. G. Ryan & Ryan, 2025; Singh, 2010). There are calls for the enhancement of microteaching programmes to incorporate more authentic experiences and feedback mechanisms that reflect actual real-world teaching experiences as opposed to relying predominantly on theoretical pedagogical constructs (Ledger & Fischetti, 2019; O'Flaherty et al., 2023).

2.7.8 Summary

Microteaching is a widely utilised teacher training technique that integrates theory, practice, research, and innovation, providing PSTs with valuable opportunities to practice and enhance their teaching skills. It focuses on a set of fourteen skills, allowing PSTs to focus on refining a single skill at a time in a safe environment. It promotes PST development through practice, constructive feedback and self–reflection. Ultimately, microteaching strengthens confidence and competence by providing an opportunity for PSTs to understand the complexities of teaching in a classroom environment (real-world or virtual). Despite its merits, microteaching has limitations and critiques, with some researchers indicating that the setting is artificial, including PST peers as pupils limits authentic pupil-teacher interactions, reducing its practical relevance. It is considered time-consuming and resource-intensive. PST personal development is also often overlooked in favour of a narrow technique refinement, as microteaching often focuses on isolated skills that may not fully prepare PSTs for the complexities of real-classroom environments.

2.8 Technology Enhanced Microteaching

Since its inception, microteaching has advanced with the trends in educational theory and technology (Cavanaugh, 2022) to incorporate technological components to enhance elements of reflective practice, feedback, and self-reflection (Diana, 2013; Ledger & Fischetti, 2019; Mariana et al., 2023; Shaw, 2022; Tripp & Rich, 2012). While microteaching is fundamentally associated with face-to-face interactions (Hama & Osam, 2021), the introduction and advancements in technologies, such as video recording and analysis, online collaboration, digital tools, simulations and VEs, have contributed to a technological shift in the development of microteaching (Ledger & Fischetti, 2019; Mariana et al., 2023; Zalavra & Makri, 2022).

2.8.1 Combining Technology with and into Microteaching

There is a large repertoire of research discussing the utilisation and integration of various technologies into microteaching, with some researchers using generic descriptions depending on the research context and focus, while others use specific terms including “Technology Assisted Micro Teaching” (Akman, 2018), and “Technology-Enhanced Microteaching” (Zalavra et al., 2020). These terms have emerged in the literature in recent years, describing variations within or extensions to the traditional concepts of microteaching, as researchers explore novel approaches within teacher education to take advantage of technology, including the works of (Akman, 2018; Diana, 2013; Ledger & Fischetti, 2019; Mariana et al., 2023; Tochon, 2013; Zalavra & Makri, 2022). In their respective works, the authors refer to the integration and utilisation of modern technologies, such as video-recording, online platforms, digital tools and simulated environments, into traditional microteaching to supplement and enhance the teaching and learning experience. The following section explores video-recorded microteaching to capture simulated classroom activity and on-line environments to replicate teaching experiences.

2.8.1.1Video Recorded Microteaching

Video-recorded microteaching sessions and feedback are an important aspect of PST learning (Holstein et al., 2022; Kpanja, 2001; Shaw, 2022). The use of video-recordings in microteaching dates back to the 1960's and has been discussed in the work of various researchers at the time including (Cotrell & Doty, 1971; Klingstedt, 1976; McDonald, 1973; Perlberg & O'Bryant, 1968). Since the early microteaching work of Allen and Eve (1968), video technology has made considerable improvements, not only in terms of the technology itself, but also in terms of user friendliness and cost of implementation, making it an acceptable tool in teacher training, including microteaching (Tochon, 2013). Over the last two decades, there has been a growing body of literature exploring the use of video-recording technologies to support teacher education (e.g., Kpanja, 2001; Shaw, 2022; Tochon, 2013; Tripp & Rich, 2012; Walshe & Driver, 2019; Zalavra et al., 2020). The importance of video in microteaching was noted in a review of literature spanning 25 years by Tochon (2013), indicating that video was a valid method for teacher improvement.

Current and early literature present a variety of descriptions as to what constitutes video-recorded microteaching, and in general, they offer similar descriptions within varying contexts (e.g., Diana, 2013; Holstein et al., 2022; Klingstedt, 1976; Kpanja, 2001; Ostrosky et al., 2013; Shaw, 2022; Tripp & Rich, 2012). Drawing the literature together, video-recorded microteaching is the use of video cameras and or digital-video recording devices to capture visual, audio and classroom events during the PSTs' microteaching sessions. Video plays an important role in teacher education, including microteaching, because of its ability to capture the complexity of instruction and the dynamics of the classroom climate (Kokkinos, 2022). I understand video-recorded microteaching in the context of this research to be the capture of the PSTs' microteaching session in VR, providing a visual and audio record of events inside the HMD.

2.8.1.2 Recorded-Video, Analysis and Feedback

Video-recorded Microteaching offers several benefits, which make it a useful tool in supporting teacher and PST learning (Kpanja, 2001). Firstly, it allows for the recorded-video to be reviewed multiple times, by the student independently, with their peers, and or with their tutor (Shaw, 2022). According to Jordan (2012), recorded video frees students from the restraints of time and location by providing flexibility for feedback. This can allow PSTs to step back from classroom events and objectively examine their classroom performance, which is considered an important aspect of PST learning (Kokkinos, 2022). Defis et al. (2022) indicate that there are benefits for students being recorded as part of the microteaching session, which include increased attention to the process, both during and after the recording, and watching the recordings of themselves back can increase their self-confidence.

2.8.1.3 Feedback

Holstein et al. (2022) inform that feedback on task level provides information on task accuracy, but the provision of simple binary feedback, indicating if the task is right or wrong, has little effect on learning outcomes. Feedback from lecturers and peers explaining areas that need improvement contributes to the PSTs' analysis and self-reflection (Diana, 2013). Feedback of this nature appears to enhance learning efficiency (Holstein et al., 2022). The video-recording of a microteaching session facilitates the capture in detail (task and process) of the actions and interactions between the PST and their peers and can be used in peer-feedback (Shaw, 2022). Video-recorded microteaching has also been shown to positively impact PSTs' reflective practices (Diana, 2013; Jordan, 2012; Shaw, 2022).

2.8.1.4 Self-Reflection

Video footage enables PSTs to review their own teaching practices, examine their instructional techniques, and identify areas for potential improvement (Diana, 2013; Kpanja, 2001; Shaw, 2022). According to Osterman (1990), "Reflective practice is a dialectic process in which thought is integrally linked with action" (p.134). Through self-reflection and further analysis of their teaching performance from reviewing the video-recordings, PSTs can identify strengths and weaknesses, and plan to make targeted improvements (Diana, 2013; Ostrosky et al., 2013). Video-recordings of microteaching sessions afforded PSTs opportunities to think about their teaching session and analyse both the positive and the negative, concentrating on areas that need improvement (Diana, 2013). Having the ability to critically reflect on their teaching performance ultimately creates a positive learning environment in their own classroom (Tripp & Rich, 2012).

2.8.2 Microteaching Online

Online microteaching is the digital adaptation of traditional microteaching to online platforms, including general-purpose tools such as Zoom, Microsoft Teams, and Second Life, and purposeful platforms including SimSchool, ClassSim and Sim:Classroom.

Zalavra and Makri (2022) utilised Microsoft Teams to switch from face-to-face to online microteaching during the COVID-19 pandemic restrictions. Student teachers were assigned to small collaborative groups of three or four, and tasked to create a learning material (a course design). Later, each group had to "teach" the material in a simulated online microteaching session to the peers in their group, followed by reflection and peer feedback. The observations from this study showed similar levels of engagement in "teacher and Peer" role-playing in the online activity as had previously been observed in the face-to-face microteaching sessions. However, they noted that students were less enthusiastic in whole-class discussions online and were less likely to ask questions or "raise their hand" in MS Teams. Although researchers also reported some challenges in organising technology-enhanced microteaching, they concluded that overall it was a rich experience for instructors and students.

Ersin et al (2020) during COVID-19 moved PST face-to-face education to online using Zoom. They reported that PSTs experiences were positive in the online e-classroom, indicating that they felt as if they were in a real classroom. However, PSTs stated that they preferred having their practicum in a physical classroom (face-to-face), but highlighted the importance of e-practicum and e-mentoring.

Online microteaching offers a range of benefits, including (**1**) Safe environment for students to practice, (**2**) Immediate feedback, (**3**) Promotion of active learning, (**4**) removal of geographical distance as a limitation, and (**5**) cost effectiveness. There are disadvantages also including, (**1**) Reduced non-verbal communication, where body language is absent, (**2**) Reduced spontaneity, where there is less natural interactions, (**3**) Limited real-world interaction, where physical presence is absent, (**4**), Technical challenges, including poor connectivity and digital tools can fail, and (**5**) potential limitation of some skills that can be practiced in traditional microteaching classroom (Ersin et al., 2020; Kokkinos, 2022; Zalavra & Makri, 2022).

2.8.3 Summary

Traditional microteaching has embraced trends in educational theory and technology to incorporate technological components to enhance student practice and learning. The literature suggests video recording is a highly useful tool in PST training for a variety of reasons. This includes the ability for PSTs to watch their body movement and their movement around the classroom, as well as listen to their speech. It further allows PSTs to engage in feedback with their peers and lecturers, with the intention of developing and refining their teaching skills. Microteaching online offers another way to re-imagine microteaching. The following section discusses a relatively recent addition to the microteaching ecosystem, termed as Microteaching 2.0.

2.9 Microteaching 2.0

Ledger and Fischetti (2019) recently presented the concept of Microteaching 2.0 as a transformative shift in ITE, blending proven pedagogical methods with simulation technologies including VR. It retains the core principles of traditional microteaching practice-based strategies while incorporating interactive feedback loops through Human-in-the-Loop (HITL) simulation technologies. They indicate that Microteaching 2.0:

> Differs from previous combinations of microteaching and technologies in that traditionally technology was used to video or capture the simulated experience (recordings) or replicate the experience within an online environment (Second Life, simSchool). Microteaching 2.0 adopts technology as the classroom rather than in the classroom (Ledger & Fischetti, 2019, p. 42)

Microteaching 2.0 is grounded in the established pedagogical principles of practicum, which includes, teaching, feedback, and re-teaching. It utilises technology to overcome some of the logistical constraints of traditional microteaching. At the same time, it preserves the principles of situated learning and reflective practice within a safe learning space (Ledger & Fischetti, 2019). Using VR to emulate a realistic classroom environment aligns with the concept of situated learning, where PSTs can engage in an authentic digital teaching experience (Ledger & Fischetti, 2019).

The term HITL simulation can be used in different contexts. It may refer to systems that do not require human intervention, but it can also describe scenarios where a certain degree of human intervention is necessary (Insights, 2021; Mosqueira-Rey et al., 2023). Ledger & Fischetti (2019) describe HITL as a technology in which a human actor operates behind the scenes to control avatars in real-time, enabling synchronous voice and body responses. Integrating HITL technologies into Microteaching 2.0 removes the requirement for peers to physically role-play during microteaching sessions by using avatars. Mochizuki et al. (2022) indicate that using puppets as part of role-playing in microteaching creates psychological distance from the role-players' actual identity, which reduced PSTs fear and anxiety. Using avatars may elicit the same effect. Ledger & Fischetti (2019) used the

SimLab HITL simulation system, and noted VRs ability to reduce the variability associated with real-life practicum contexts.

Delamarre et al. (2021) discuss the development and evaluation of a 3D Interactive Virtual Training system for teachers to refine their classroom management skills. The system provides realistic classroom scenarios with virtual students, with utterances displayed as text. Teachers can interact with virtual students, receive feedback and reflect on their decisions.

A further study by Ferguson & Sutphin (2022) examined the impact of using Mursion™, a mixed-reality simulation, as a risk-free microteaching experience for PSTs participating in an introductory teaching course. Mursion™ provides a virtual classroom where PSTs interact with students (avatars) controlled by actors. PSTs can practice their teaching techniques, classroom management, and lesson delivery in a low-risk environment. The researchers reported that participation significantly contributed to PSTs' confidence, preparedness, and teaching skills, concluding that simulation was a useful tool in ITE.

In their systematic review, Erosozlu et al. (2021) combined research over a decade using TeachLive™, a mixed reality VE for PST skills practice. It found that the majority of the studies reviewed focused on using qualitative single-subject experimental designs for PSTs' instructional skills development. The studies predominantly focused on the integration of the system into ITE. The authors conclude that TeachLive™ is a suitable alternative for preparing PSTs for real world classroom contexts.

Luke et al. (2023) in an online study examined the impact of using TeachLive™ to investigate PSTs, peers', and instructor's perceptions of PSTs' teaching performance in foundational teaching practices. After their simulation experience, conducted in groups of three to five, each participant completed a Self-Assessment, completed by the PST and an Observer-Assessment, completed by peers and instructor. The calculated results were compared against focus group data exploring their perceptions of their teaching performance. The study found that PSTs struggled to accurately assess their own and their peers' instructional practices. Even though PSTs were familiar with teaching practices, they were not used to conducting them in an online platform. However, the authors conclude that using virtual simulation in PST 'field experience' provides PSTs with opportunities to learn and rehearse foundational teaching practices rather than just observe other teachers enacting them.

A study by Freeman & Lee (2024), explored PST perceptions of mix-reality simulations (MRS) as a tool for teacher training. MSR provides a combination of real-world and virtual classroom experiences, allowing PSTs to interact with digital objects to practice teaching, classroom management and communication skills. However one of the challenges is for the PST to believe they are interacting with real students. The participants indicated that the simulation experience was realistic and engaging. The findings revealed that MSR was an effective tool to build pedagogical skills, self-efficacy and confidence. According to the authors practicing teaching and communication skills in a simulated environment can enhance learning outcomes. Overall, simulation was found to be a promising tool in preparing PSTs for real-world classroom contexts.

Mariana et al. (2023), used SimLab™ to enhance the teaching skills of prospective elementary teachers. They focused on eight areas, including: asking questions, reinforcement, varying methods, explaining concepts, opening and closing lessons, guiding small group discussions, classroom management, teaching small groups and individuals. The researchers reported improvements across all teaching skills, indicating a significant enhancement in opening and closing lessons and teaching small groups and individuals. They conclude that Microteaching 2.0 technologies are valuable tools for developing essential teaching skills.

The following is a synthesis of the benefits and challenges associated with practicing microteaching skills in VR simulations, as identified by researchers including Delamarre et al. (2021), Erosozlu et al.

(2021), Freeman & Lee (2024), Ferguson & Sutphin (2022), Ledger et al. (2018), Ledger & Fischetti (2019), Luke et al. (2023), and Mariana et al. (2023).

Identified benefits: (**1**) VR provides a safe learning environment for PSTs to practice, allowing them to make mistakes without real-world consequences. (**2**) VR can enable situated and contextualised learning by creating realistic classroom settings that allow PSTs to engage with diverse environments and student behaviours, while applying their prior knowledge and experiences to make learning more meaningful. (**3**) Simulations often provide immediate responses through real-time interactions with virtual students, along with instructor feedback delivered at the point of need. (**4**) VR simulations offer repeatable and customisable scenarios, enabling PSTs to reflect on and revisit specific parts of their teaching, make appropriate adjustments, and track their progress over time. (**5**) The immersive nature of VR helps keep PSTs focused, interested, and engaged in the learning experience. (**6**) The VR sessions can be recorded for self-reflection and feedback.

Identified challenges: (**1**) Simulation can limit human interaction, reducing the nuanced and spontaneous exchanges typical of real-classroom environments. (**2**) There may be a lack of immediate feedback from experts, which may allow PSTs to continue without timely guidance or clarification. (**3**) VR technology has limitations, as current simulation systems are often unable to create fully authentic and contextually appropriate environments. (**4**) Some VR systems have a steep learning curve, requiring considerable time to master due to their complexity.

Depending on the researcher and context, two elements were perceived as both a benefit and a challenge. Firstly, realistic classroom environments enhance learning by fostering emotional connection, improving information retention, and increasing engagement. They also allow for complex scenarios that support deeper understanding and skill development. However, creating such environments requires advanced technologies, involves higher costs, and may overwhelm users, potentially reducing the effectiveness of learning. Secondly, VR simulations often depend on human presence. Having tutors involved in VR training can enhance authenticity, enable dynamic interaction, and foster emotional connection. They can also provide immediate feedback and personalised responses. However, this requires the availability of subject-knowledgeable tutors, which may not always be possible.

In summary, research evidence suggests that simulation systems for microteaching are promising tools for enhancing teacher preparation (Freeman & Lee, 2024; Ledger et al., 2018) as they provide a safe environment for PSTs to practice microteaching skills (Delamarre et al., 2021; Ledger & Fischetti, 2019; Luke et al., 2023). However, these systems are not without challenges, as the technology cannot fully replace the complexity and interpersonal dynamics of real-world teaching (Delamarre et al., 2021). Nevertheless, the benefits of simulation in “Microteaching 2.0” outweigh the challenges, making it a valuable preparatory tool for ITE programmes (Ledger & Fischetti, 2019).

Simulations are ambiguous or open-ended and designed to emulate real-world classrooms, engaging PSTs and encouraging them to contemplate the implications of the teaching session, thereby promoting higher-order learning, critical thinking and self-directed learning (Freeman & Lee, 2024). A distinguishing feature of HITL technologies is the inclusion of real human interaction and decision-making within a simulated or VE, where a human actor controls the responses of avatars. Shifting from fully automated simulations to HITL technologies adds authenticity and realism to the learning experience. Simulation allows PSTs to practice their skills in a safe environment, make mistakes, engage in feedback (peer and tutor), and reflect on their performance to develop and refine their teaching skills (Freeman & Lee, 2024; Ledger & Fischetti, 2019; Mariana et al., 2023).

2.10 Chapter Conclusion

This chapter presented a review of the relevant literature that underpinned the core areas relevant to this thesis. Each section highlighted critical factors shaping my perceptions and understanding of the MiTeachVR prototype’s effectiveness as a tool for PSTs to practice and develop their microteaching and communication skills and competencies within ITE. Through the synthesis of these areas, several conclusions can be drawn from the literature. The popularity of VR is evident in several sectors, including entertainment, engineering, nurse training, medical training and education. Its use in education spans more than half a century, adoption has been gradual and remains limited in scope, however its use as a pedagogical tool is gaining traction. The literature on VR has demonstrated its educational value, particularly its potential as a tool to support PSTs to practice and develop their microteaching and communication skills within ITE, extending our conceptual understanding of microteaching and technology-enhanced microteaching. Research also highlighted the wider capabilities of VR technology and its application across a range of educational contexts within HEIs, including ITE. To fully understand the benefits of using VR, and particularly, the MiTeachVR system for PSTs to practice their communication skills as part of microteaching, consideration must be given to the technology's ability to meet the learning requirements of PSTs as part of ITE. The convergence of the literature on VR, effective teaching and microteaching aligns closely with discussions and research insights on digitally enhanced microteaching 2.0, where VR becomes the classroom, a space for PSTs to develop their communication skills and competencies in a VE. Drawing on this literature was essential to understanding VR's ability to create realistic learning scenarios that actively engage students, while also exploring its perceived usefulness as a teaching tool from the lecturer's perspective. The literature on effective teaching emphasised key skills and competencies essential for PSTs, underscoring their significance within the classroom and broader teaching. This was particularly valuable for my research, as it facilitated my understanding of how these elements could be incorporated into the MiTeachVR System. The microteaching literature highlights its usage beyond conventional teacher education, demonstrating how its iterative cycles help connect theoretical knowledge with practical applications in other teaching settings. Understanding the constituent parts of the microteaching cycle informed me how the testing within this research could be conducted. Building on these insights, the study progressed to designing suitable testing procedures and a range of appropriate testing materials to evaluate the usefulness of the MiTeachVR system and its potential as a learning tool for PSTS to practice their microteaching and communication skills as part of ITE, detailed in chapter 3.

Chapter 03: Research Design (Methodology)

3.0 Introduction

The previous chapters provided an overview of microteaching as a teacher training method in ITE, and a synopsis of VR in HE, including ITE using VR for classroom simulation. This chapter presents an overview of the VR system (MiTeachVR) used in this research. This is followed by the research paradigm framing this study, including an outline of the research setting, focus and field of study. It outlines the methodological approach utilised in this thesis and the philosophy behind the chosen method. Firstly, it discusses the theoretical framework and approach that guided this study before offering a justification of the chosen methods. Secondly, a discussion of the study design, sample and procedures is presented, followed by the data collection methods and management used in this study. Thirdly, it explains the rationale behind a qualitative methodology and approach utilised in this study and in particular, reflective thematic analysis. Finally, it discusses research quality and ethical considerations before concluding with a summary of strengths and limitations.

3.1 MiTeachVR System Introduction

The MiTeachVR project set out to design and implement a purpose-built immersive virtual classroom environment. This initiative arose from a cross-disciplinary collaboration between the Faculty of Education and the Faculty of Computing and Engineering at the authors' university. The project involved an iterative process of translating real classroom scenarios into an interactive VR experience.

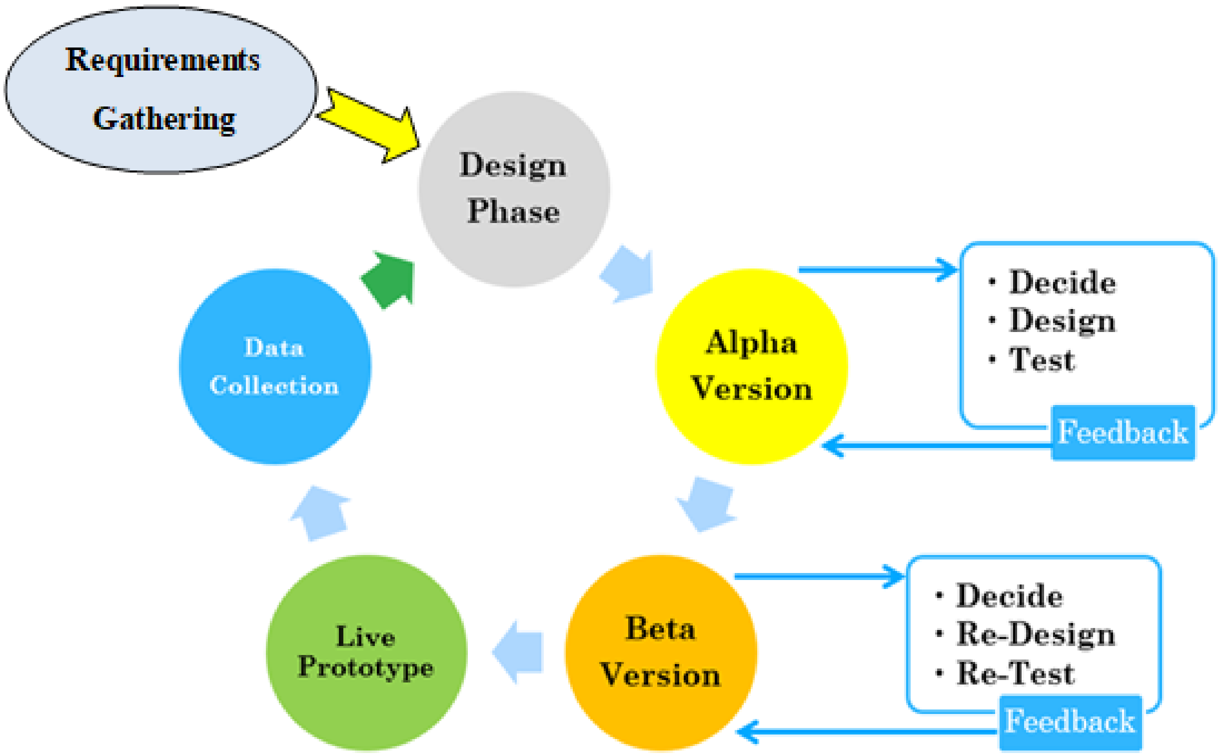
This section describes the MiTeachVR system. While the development of the MiTeachVR System is not the central focus of this research, it was instrumental to the study. MiTeachVR is a bespoke prototype with no independent descriptions available; therefore, it is essential to provide a detailed description of the software to ensure contextual understanding, transparency and reproducibility. By describing the MiTeachVR system, it helps readers understand "why" and "how" it was used in this research. The inclusion of images enhances understanding, clarity and serves as illustrative evidence. Understanding the MiTeachVR System provides context in relation to other IVR and VR simulation systems currently in use, under development and described within the research literature.

MiTeachVR is an abbreviation for '**Mi**cro**teach**ing in **V**irtual **R**eality'. The MiTeachVR system is a purpose-built contextualised prototype virtual classroom that helps bridge the gap between theory and practice in PST education. It allows PSTs to practice their fundamental communication skills in a life-size virtual classroom, record their sessions, and reflect on their performance through a playback option. The system captures the PSTs' voice, hand and head movements, and simulates various teaching activities such as using a PowerPoint presentation, writing on a whiteboard, distributing teaching material in class, and monitoring student (avatar) attention. The MiTeachVR system provides a safe space for PSTs to practice their skills and behaviours in an IVE and may be particularly beneficial for those who have not yet taught in a live classroom. While not a replacement for school placements, MiTeachVR complements microteaching and offers an opportunity for independent practicum before PSTs embark on a school placement. The following section briefly outlines the development and testing of the MiTeachVR system with stakeholders.

3.2 MiTeachVR System Development

The MiTeachVR system was co-designed with stakeholders, including lecturers and PSTs. Co-Design involves the active participation of various stakeholders, including end-users in the design process, with the intention that it will lead to improvements and innovation (Burkett, 2012; Dollinger & D'Angelo, 2020), to create software that meets the needs and expectations of lecturers and PSTs as potential users. The development comprised of five key phases: (**1**) Requirements gathering, (**2**) Design, (**3**) Alpha testing, (**4**) Beta testing, and (**5**) Live prototype - for data collection, as presented in (**Figure 3.1**). Each stage was crucial to ensure the system was functional and reliable while providing insights and improvements along the development trajectory.

Figure 3.1. MiTeachVR Design Process Cycle



3.2.1 Requirements Gathering

The initial stage involved requirements gathering and mapping of microteaching skills that could be enacted in a virtual classroom. This involved reviewing existing microteaching modules across ITE at Primary, Post-Primary, and Further Education levels. This exercise identified the common fundamental teaching approaches within these microteaching modules and allowed the team to map these features in the MiTeachVR classroom environment. The features were developed to help PSTs track and improve their skills in each of the specific areas, detailed in (**Table 3.1**).

Table 3.1. Mapping Microteaching Skills to Virtual Reality Features

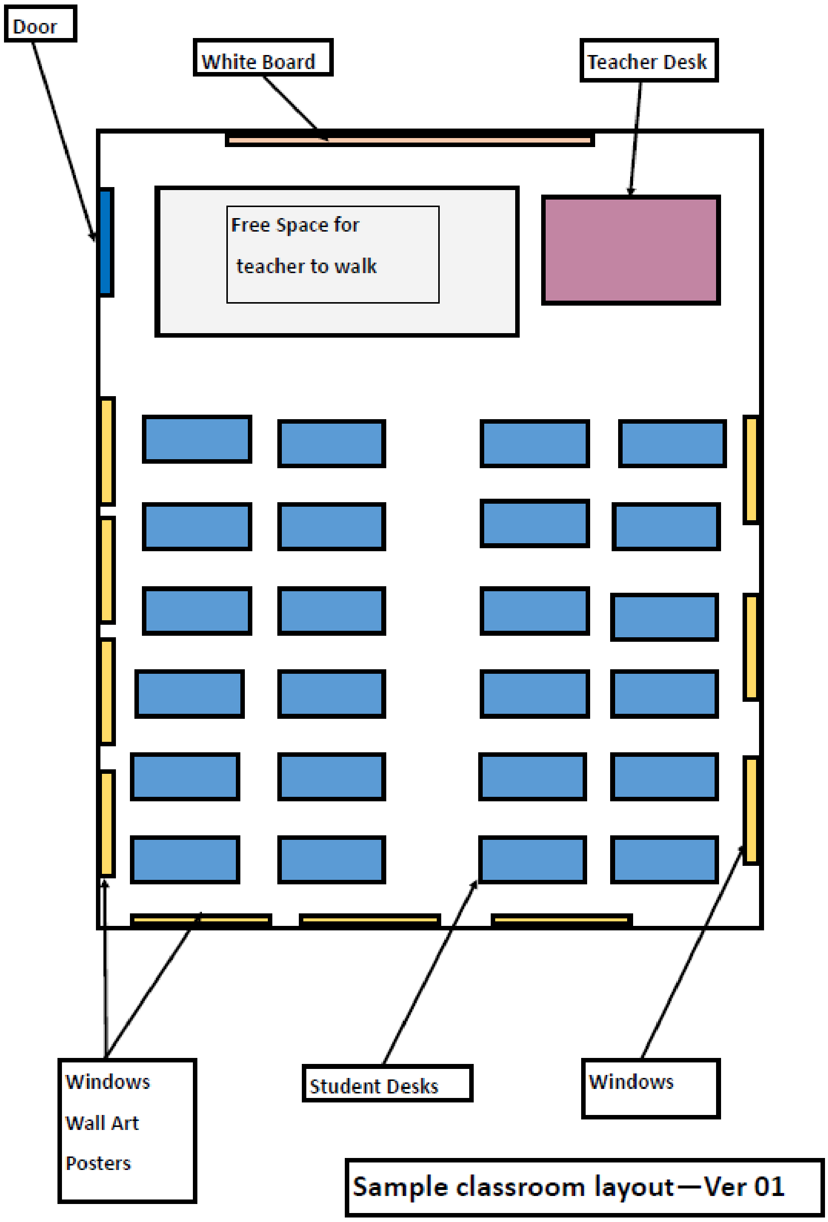
Mapping Microteaching Skills to Virtual Reality Features	
Microteaching Skill	**VR Feature**
Eye Contact	Head tracking / Eye Tracking PST focuses on different virtual students (Avatars) Avatars behaviour state - indicating raising hand
Hand Gestures	Hand – controller tracking
Classroom Circulation and Movement	PST movement around the VE is mapped
Using Voice	Audio recording and playback
Varying the stimuli	PST presentation, use of whiteboard, use of 'hand-outs'
Teacher confidence / fluidity	Overall use of VR system / Repeated Practice
Technology Acceptance / Familiarity	Overall use of VR system / Practice
Reflection	Using the playback function to review their recorded session

The system design was created by defining which microteaching skills could be incorporated into the MiTeachVR system based on the capabilities and limitations of the software and hardware.

3.2.2 Design

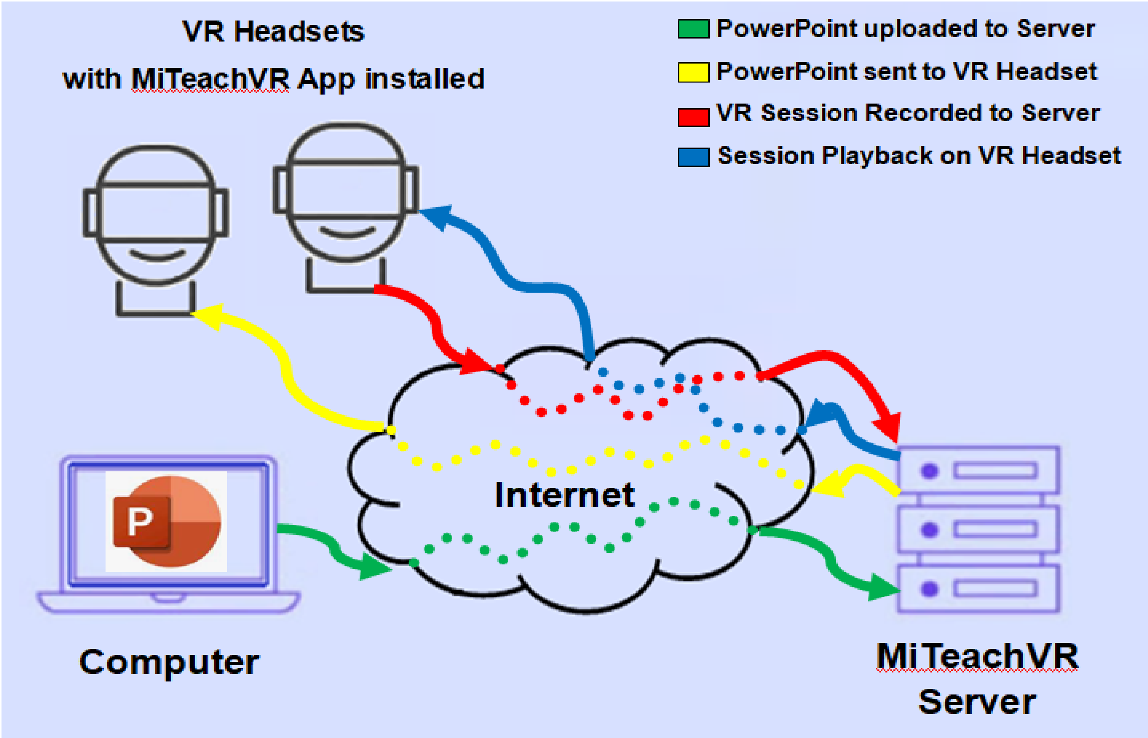
The design phase focused on creating the initial classroom layouts, configuring the system infrastructure, and embedding the functionality outlined in (**Table 3.1**). The MiTeachVR system is designed as a full-scale classroom environment with a diverse mix of avatars, allowing PSTs to experience standing in a full-size classroom in front of students (avatars). To provide PSTs with a diverse virtual microteaching experience, the project team created multiple classroom layouts for practice (see **Figure 3.2** below and **Appendix A**). Each layout included a teacher's desk, whiteboard, projector screen, and various classroom artefacts to create a realistic and natural environment.

Figure 3.2. MiTeachVR sample classroom layout – Standard Rows



The system infrastructure consisted of a laptop and individual VR HMDs with cloud connectivity to a secure online server that allowed the data to be sent to and from the HMDs. The base classroom design is stored in the HMD and classroom layout and environment data, including the PowerPoint, were transferred from the server to each headset. Individual VR session data (head tracking, teacher movement, audio recording) was transferred from the VR HMD to the server, as detailed in (**Figure 3.3**). The development platform used was Unity™, and the hardware was the commercially available consumer version of the Meta™ Oculus Quest 2.

Figure 3.3 MiTeachVR HMD and Server Connectivity

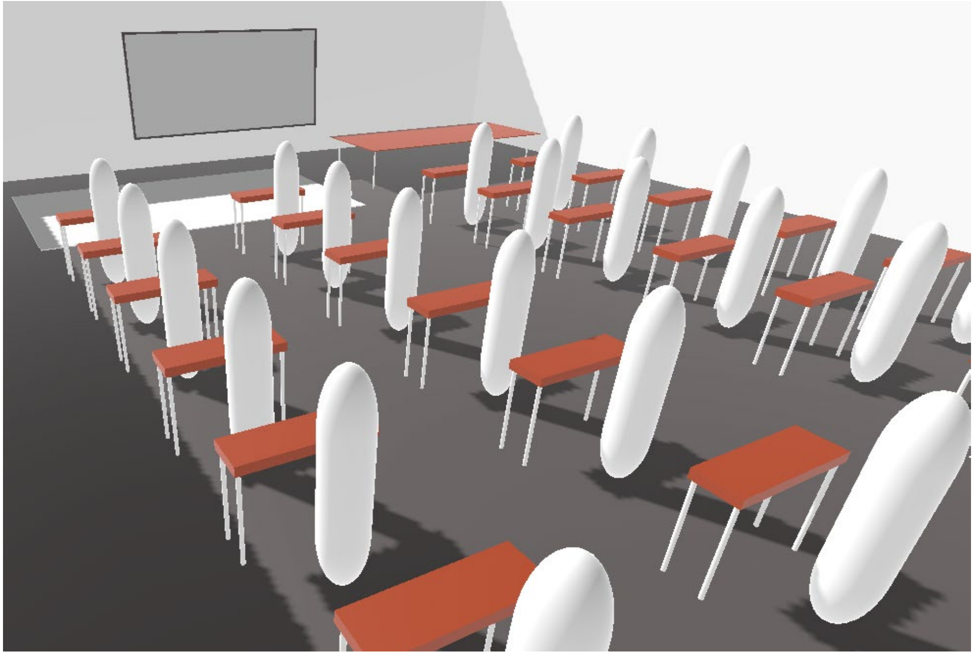


Once the initial classroom design had been created, system infrastructure had been implemented, and functionality created, the project team progressed to the alpha testing phase.

3.2.3 Alpha Version

The alpha phase focused on testing the features and functionality identified in the design phase. This version incorporated a low-fidelity simple design with rudimentary features and functionality, as shown in (**Figure 3.4**), to facilitate system testing with the project team, PSTs and lecturers. Throughout this phase, the team confirmed design decisions including classroom scaling, room layouts, and positioning of artefacts. Additionally, the system architecture, recording functionality for users' voice, position within the virtual space, head tracking and hand movements, as well as system technical features and usability, were tested.

Figure 3.4 MiTeachVR Alpha Version Classroom Design



Testing identified some bugs and areas for improvement, which were fixed and incorporated into the system, leading to the development of the beta version.

3.2.4 Beta Version

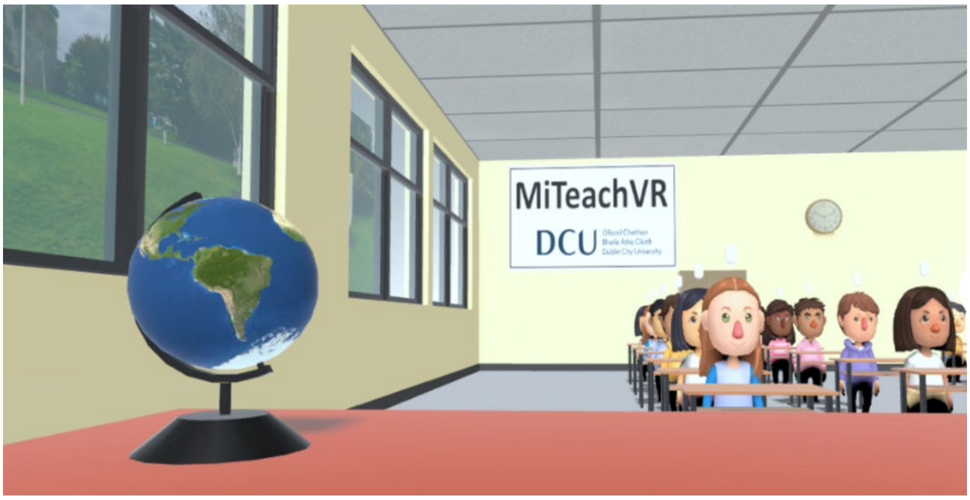
The changes included a more realistic classroom layout, with the addition of avatars, re-designed classroom layout, the incorporation of various artefacts (desks, furniture, clock, wall art, etc.), and photo-realistic external classroom views. This iterative development helped identify and resolve issues early by adapting changes and requirements, and ensuring that the final system closely aligned with the end users (PSTs) needs (Lewrick et al., 2020). After additional testing by the project team, PSTs and lecturers, the system was released as the live prototype version.

3.2.5 Live Prototype

The incorporation of recommended changes and further testing resulted in a stable system. The live prototype version as illustrated in (**Figure 3.5** and **Figure 3.6**), included the functional and aesthetic improvements, creating a VR classroom suitable for practicing communications skills as part of microteaching.

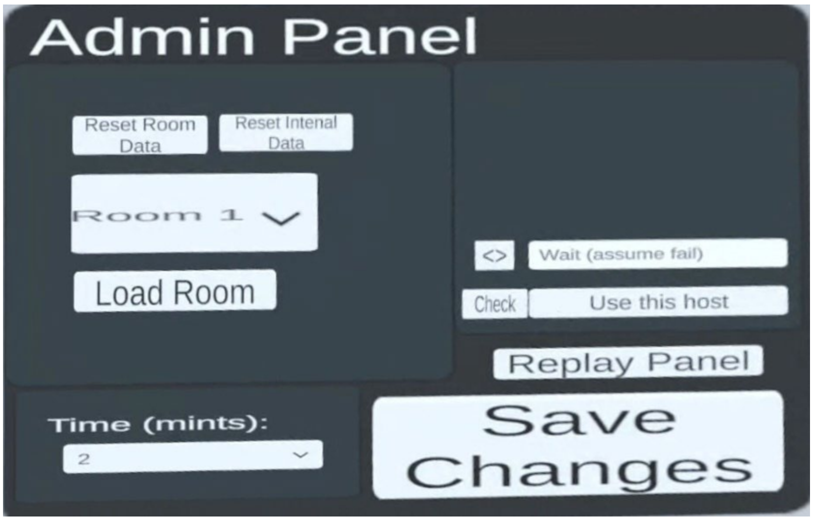
Figure 3.5 MiTeachVR Live Version Classroom Design

Figure 3.6 MiTeachVR Live Version Classroom Design



The live prototype version of the MiTeachVR system incorporated some user and administration panels, as illustrated in (**Figure 3.7**). The panels allowed users to control user functionality, such as recording and playback of the microteaching sessions. Other functions included selecting the recording length (2, 5, 10, and 15 minutes), and an option to select the room layout from a selection of four, (**1**) Standard Rows, (**2**) 'U' Shape, (**3**) Group work, and (**4**) User Design – where desks could be moved to create a bespoke room layout, see (**Appendix A**).

Figure 3.7 MiTeachVR Live Version Admin Panel

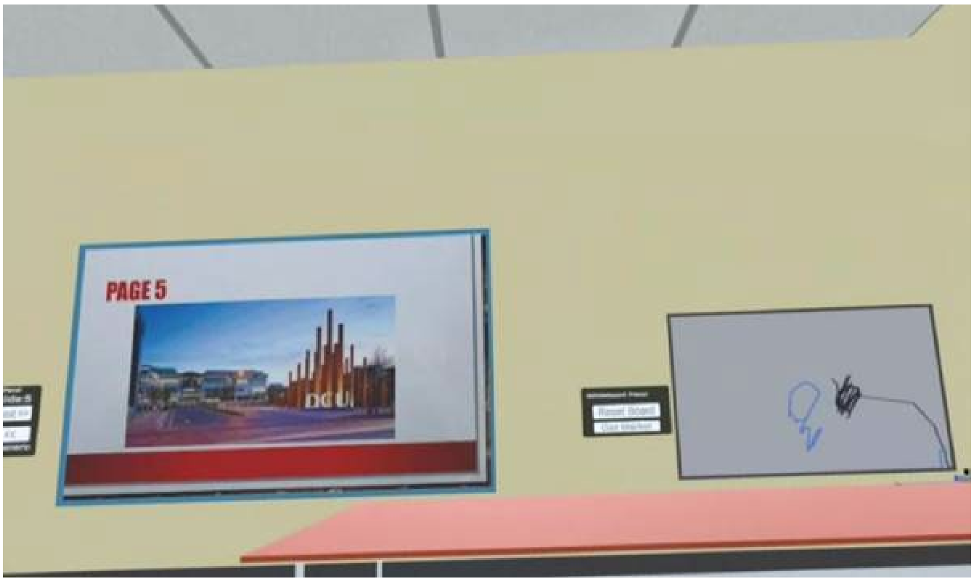


3.2.6 Live Prototype Key Functions and Constraints

The final live prototype used in this study included a number of functions and features mapped from those identified in the requirements gathering phase, detailed in (**Table 3.1**) above. The system can capture verbal and some non-verbal communications. It records the user's voice as PSTs deliver their lesson, and tracks their position, head and hand movements as they navigate around the classroom using handheld controllers or by walking in the real-world. Through the playback function, users can reflect on their communication skills, including how they presented their lesson, considering timing, flow, progression, clarity of voice and appropriate language used. By critically evaluating and self-reflecting on their communication and teaching performance, PSTs can identify strengths and areas for improvement. In consultation with their lecturers, the recording can be reviewed to obtain further feedback. Other functions allow PSTs to upload a PowerPoint that they can use while delivering their microteaching lesson, as illustrated in (**Figure 3.8**). A virtual whiteboard allows users to select a pen and write on the board in a similar way to real-world teaching, as illustrated in

(**Figure 3.8**). Another function mimics the distribution of class materials to students, with a further function recognising if PSTs are aware of avatar interactions during a lesson. The MiTeachVR system uses a small bubble above the avatars to indicate if they are asking a question, requesting attention, etc. As the bubble changes colour on an avatar, the PST needs to respond. Their reaction is recorded, and they can see at a later stage if the responded in time.

Figure 3.8 MiTeachVR Live Version – PowerPoint and Whiteboard



The MiTeachVR system prototype is constrained, as avatars do not have the ability to speak. Therefore, it is not possible for PST's to have a two-way conversation with the avatars. This limits the PST's ability to ask questions and receive meaningful answers from the avatars, limiting the PSTs opportunity to practice questioning techniques. Another constraint relates to the type of teaching and skills practice that can be enacted in the MiTeachVR VE, for example, it is not possible to conduct practical show and tell classes. While the MiTeachVR classroom has a whiteboard and markers, it is rudimentary and a little awkward to hold and use the markers in a natural way. To use the admin and control panels to record the session or move the PowerPoint, the user needs to point and click on the options, this can be a little cumbersome while using the controllers to point and click on the options, which can be difficult to see from a distance, as illustrated in (**Figure 3.9**). It is not possible to play sound or video as part of the PowerPoint presentation within the VR HMD, which may limit the type of presenting PSTs can use within the MiTeachVR classroom. Finally, because MiTeachVR is a prototype and the limited availability of avatars and time constraints during its development, the selected avatars stand behind their desks, as illustrated in (**Figure 3.10**). While it does not affect the functionality of the system, it could be a little off-putting to some users.

Figure 3.9 MiTeachVR Live Version – Showing Pointers and Admin and Control Panels

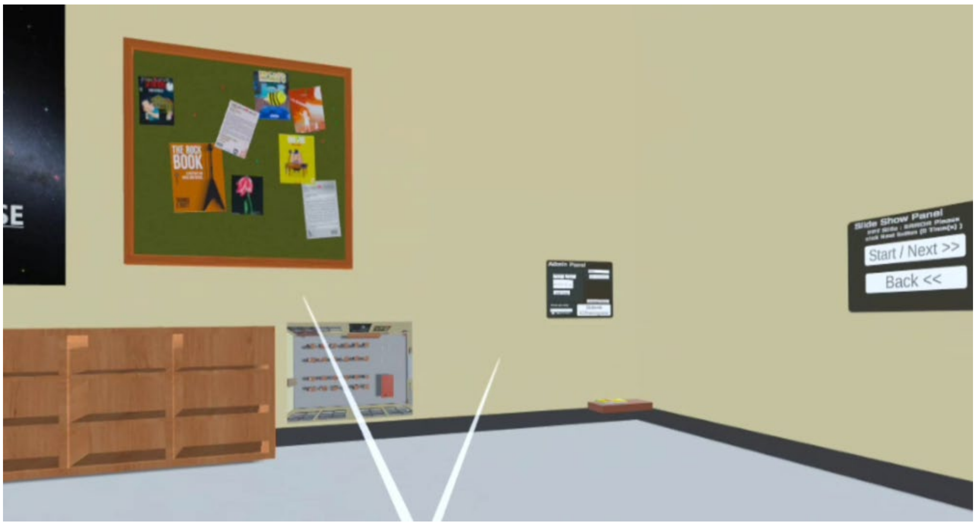
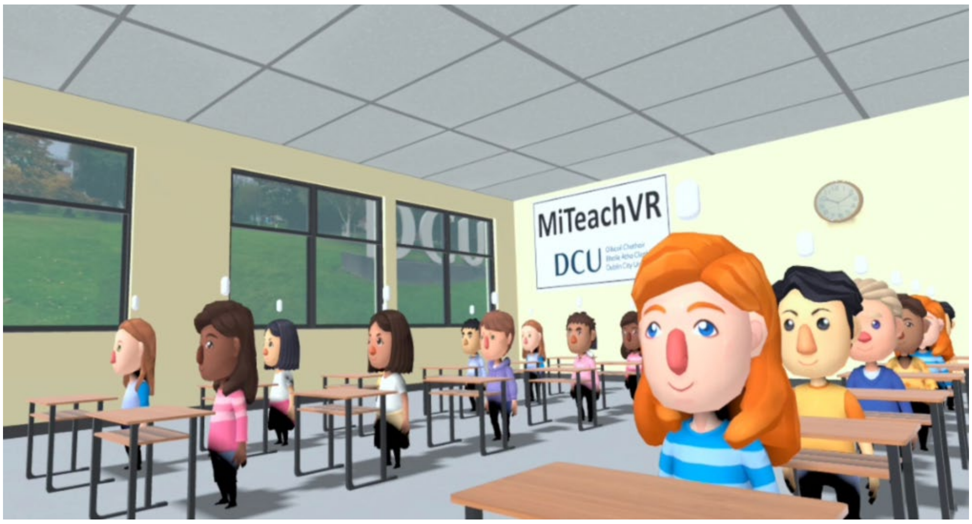


Figure 3.10 MiTeachVR Live Version – Showing Avatars Standing behind their Desks



3.2.7 Conceptualisation of Virtual Reality as it Relates to MiTeachVR

VR, as it relates to the MiTeachVR system, is understood to be a computer-generated digital environment that allows users to interact within a 3D world (MiTeachVR Classroom) in which they encounter different types of emotional and sensory experiences, through sight, sound, touch and movement (Coban et al., 2022). There are two key concepts, immersion and presence, that are considered important in our understanding of how users experience VR. IVR systems using HMDs similar to the MiTeachVR system represent the highest levels of immersion (Coban et al., 2022; Stracke et al., 2025; Villena-Taranilla et al., 2022). Immersion determines how effectively a VR technology can replace the perception of the real-world (M. Slater et al., 2009), as VR submerges the user's senses as they feel a sense of presence or a feeling of 'being there' in the VE, removed from the real-world (Riva & Waterworth, 2013). Immersion and presence are important in this study as they create a connection for PSTs to a 'realistic virtual classroom', where they may feel a connection to a teaching environment (MiTeachVR Classroom) and a readiness towards teaching and skills practice.

3.3 My Role in the Design and Development of MiTeachVR

As a project team member, I contributed towards the requirements gathering and mapping in the early stage of the design and development. Following the requirements gathering phase, I took a lead role in managing aspects of the project, working in collaborative partnership with lead project investigators (PIs) to oversee the research activities, design, planning and project timelines. A key aspect involved working closely with the developer to convey the design requirements, including essential functions and features to be incorporated into MiTeachVR. I designed and illustrated the virtual classroom layouts (for example, see **Figure 3.2** above) to allow the developer to translate them into the VE. These design decisions involved calculating the classroom scale, the position of artefacts, user panels, avatar selection, etc., while at times problem-solving to address design challenges that arose during the project. The avatars were selected to ensure that there was diversity represented in the VR classroom.

I tested various iterations of the designs before they were tested with lecturers and PST's. This testing was essential to understand user needs while balancing hardware and software limitations to create a VR system to meet PSTs needs. It also allowed me to oversee the alpha and beta testing phases, as I had a unique insight into the system design, features and functions, and understood how the system functioned. During the testing phases, I gained insight into the testers' experiences and challenges, and I was readily available to assist them with any technical issues they encountered while using the system. Throughout the system development and testing, I created PowerPoint slides to explain the system to users and I created a 'Protocol and Operational Instructions' manual for lecturers, available in (**Appendix B**).

I recognise that I was one member of the project team. However, my role was significant in many aspects of the design, development and implementation of the MiTeachVR system. My experience, qualifications and skills allowed me to bridge the gap between team members, user needs and technical implementation to deliver a functional, efficient, and usable solution mapping back to the original requirements (**Table 3.1**) for PSTs to practice their communication microteaching skills.

Reflecting on the design and development stages of the MiTeachVR system, I was aware that my personal beliefs, assumptions and preferences could have potentially influenced the system design and functionality. These beliefs, assumptions and preferences, conscious or unconscious had the possibility to skew the design outcomes, leading to a system that was either narrow in scope or engineered to meet a specific purpose of particular interest to me, as I wished to use the MiTeachVR system in this research. I believe that I mitigated against any such bias by staying close to the original design and functional requirements decided upon by the research team. My creative or design features and suggestions were presented to the project team for consideration, while some suggestions were accepted, others were not. This process acted as an audit to ensure the

MiTeachVR system was built to reflect the original vision of the design team. It is clear from the thesis that the MiTeachVR system is functional, but it has some constraints as a prototype VR system.

3.4 Background to the Research – Setting and Focus

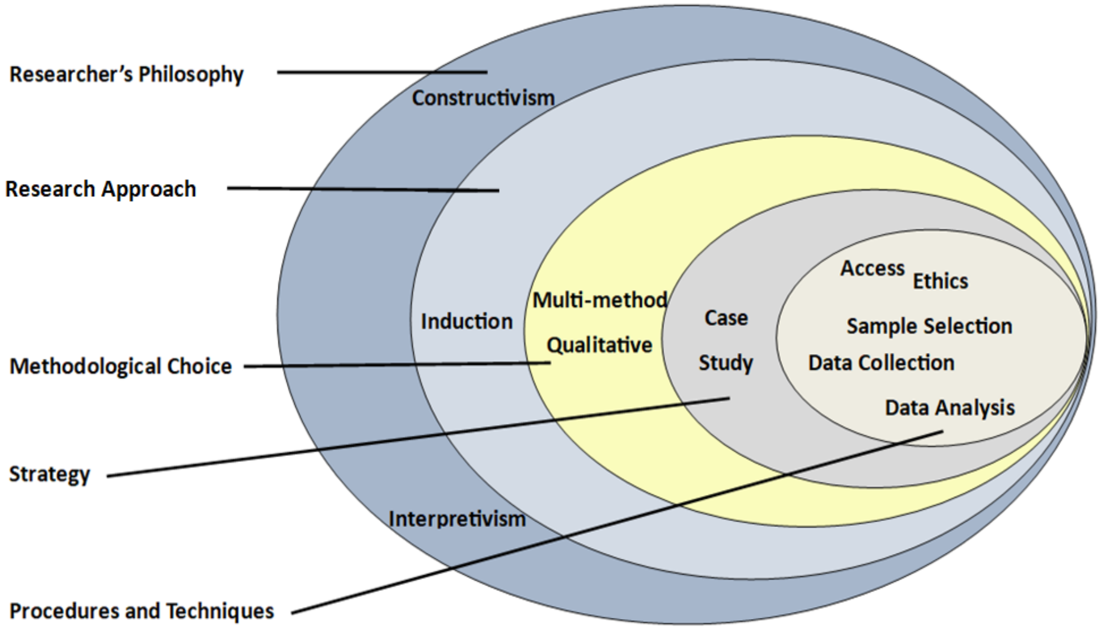
This qualitative research inquiry is an exploration of HE teaching and learning using MiTeachVR in ITE. This research employed a single-site case study methodology, utilising multiple methods of data collection to explore the research question. The use of triangulation and the combination of multiple data sources to examine a phenomenon enhances the research by improving validity and reliability, allowing the researcher to "delve deeper" than would be possible using a single data source approach (Walliman, 2018, p. 168).

This case study set out to: (**1**) explore the experiences of two groups of participants (lecturers and students) by understanding their engagement and usage of the MiTeachVR System. (**2**) Establish the participants' perceptions of the MiTeachVR system as a useful tool for PSTs to practice their communications and microteaching skills. (**3**) Examine participants' perceptions, attitudes and feelings regarding the adoption of IVR as a teaching and learning approach. (**4**) Establish what supports, technical or otherwise, would be required to support its introduction for microteaching in ITE within the IoE.

3.5 Research Methodological Approach

To guide and understand the research process, I used the Research Onion (Saunders et al., 2023) (**Figure 3.11**), which depicts the research process similar to peeling the layers of an onion, where each layer requires a decision by the researcher. In turn, each decision influences the research design.

Figure 3.11: Research Onion Methodological Design Process



***Note*.** Adapted from (Saunders et al., 2023)

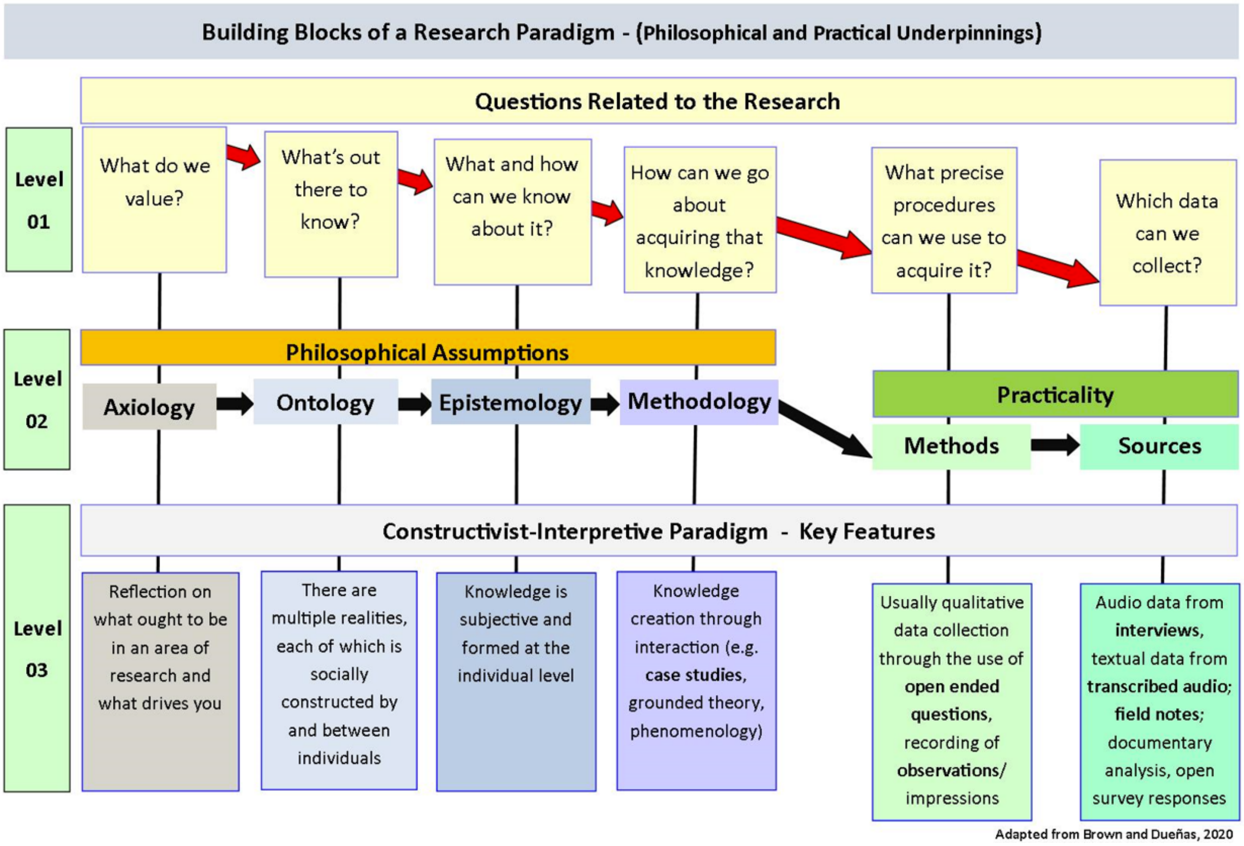
In the following sections, I present the research design of the Constructivist-Interpretive paradigm employed in the research, outlining the philosophical assumptions, axiological, ontological, epistemological, methodological and analytical underpinnings.

3.5.1 Philosophical Assumptions and Research Paradigms

"Philosophy" quite literally means, "love of wisdom"; but in a broader academic understanding, according to Craig (2020) and Sefotho (2015); philosophy is the study or pursuit to understand general and fundamental truths, wisdoms and beliefs about the world. For Walliman, "All philosophical positions and their attendant methodologies, explicitly or implicitly, hold a view about reality" (2018, p. 16). According to Chamberlain (2015, p. 10), the most fundamental assumptions for research are those made about the nature of the world (ontology) and how we can successfully investigate it (epistemology). These worldviews or belief systems are defined as *paradigms* (Guba & Lincoln, 1994; Tashakkori & Teddlie, 1998), with Sefotho (2015) and (Guba & Lincoln, 1982) highlighting the existence of multiple and diverse paradigms. Fundamentally, paradigms can be viewed as value systems encompassing assumptions and principles that guide our actions about valid, invalid and ideal research practice (Guba & Lincoln, 1982). Creswell & Creswell (2018) purport a paradigm to be an essential collection of beliefs shared by scientific researchers. Essentially, I recognise paradigms as basic belief systems “based on Ontological, Epistemological and Methodological Assumptions” (Guba & Lincoln, 1994, p. 107). This traditional view was extended in their later work to include Axiology, or “the role of values in human inquiry” (Lincoln & Guba, 2013, p. 11). In essence, I understand philosophy is the pursuit of truth, wisdom and beliefs about the nature of the world and how it can be investigated, understanding that no one view exists.

Hence, it is important that the education researcher understands that their assumptions, associated ideologies and values are highly influential in shaping what they do and the knowledge produced. Brown and Dueñas emphasise that “a paradigm does no good if it only exists in the mind of the researcher and is not clearly communicated” (2020, p. 549). It is therefore important that the researcher prospectively selects and understands their research paradigm in advance of starting the research. Figure 3.12 presents the building block of the research paradigm adopted in this thesis.

Figure 3.12: Building Blocks of a Constructivist-Interpretive Research Paradigm and Philosophical Underpinnings of this Study.



Note. Adapted from (Brown and Dueñas, 2020)

Level 01 of (**Figure 3.12)** presents questions relating to research and the linear path they follow, Level 02 portrays the philosophical assumptions (Axiology, Ontology, Epistemology and Methodology), followed by the practicalities of research about the selected research *'methods'* and the possible data *'sources'*. Level 03 represents the adapted research paradigm through a Constructivist-Interpretive lens and introduces the key features of this approach. The foundational philosophical concepts that shape this research are presented in the following sections.

3.5.2 Axiology

I understand axiology is concerned with the study of the nature of values and value judgements or worth. It questions what is valuable, what constitutes goodness, what is ethical, and what assign worth to in society and our lives (Biedenbach & Jacobsson, 2016). Values influence our decisions, priorities, and the way we perceive the world, as well as playing a significant role in "shaping what we do and the knowledge that we produce" (Chamberlain, 2015, p. 11). Research cannot be value-free or neutral (Bordens & Abbott, 1996; Braun & Clarke, 2022). Researchers need to remain aware of their values and positionality because "Axiological change is a constant feature of human history" and "Human values seem to vary across time and space" (Danaher, 2021, p. 1), which shape our knowledge, perspectives, identities, and how we engage with the world. This is something I was aware of in this research, as "different kinds of knowledge embody different kinds of value" (McNamee, 1998, p. 8).

Central to axiological value is the distinction between intrinsic and extrinsic value. Intrinsic value is associated with something that has value "in itself or good in its own right", and can be a person, an experience, an act, or nature. Whereas extrinsic value is associated with 'things' that are valuable as a means to something else, the value is not "in itself", but in its function (Biedenbach & Jacobsson, 2016, p. 141). It is of extensional value and "connected to the functionality it has in a specific context" (Biedenbach & Jacobsson, 2016, p. 141). This holds particular significance, given my involvement in the development of the MiTeachVR system. During its development, I felt MiTeachVR had intrinsic value in its own right (in-itself) as a learning tool for PSTs, and the design and functions were in part a reflection of my values and judgement. Coupled with this, I was conscious of its extrinsic value, as an artefact within this research, hence it was also valuable to me for the purposes of this research. I had to be aware of my domain knowledge, biases, intentions and influencing decisions, as they had an influence on the design and development of the MiTeachVR system. It is difficult to bracket off who we are from this type of research. We can only mitigate potential issues, as further discussed in section 3.12.1 "Insider Researcher".

3.5.3 Ontology

I recognise ontology to be a branch of philosophy that focuses on the nature of the world, existence, and being (Willig, 2013). I realise it endeavours to understand the essential categories and structures that constitute the world and the relationship between them. From my perspective as a researcher, ontology's driving question is "What is there to know?" (Willig, 2013, p. 12). In essence, I understand that ontology explores questions about what exists, what is real, and how things are fundamentally connected. Therefore, ontology asks "What is there that can be known?" or, to rephrase the question, "What is the nature of reality?" (Lincoln & Guba, 2013, p. 37). I recognise my contribution to the development of the MiTeachVR system as an independent tool and singular reality. However, in this research, it is also a tool to support microteaching and PST experiential learning. My interest is in the intersection of where this technology meets students' learning, and what I, as a researcher, can learn and understand. What can I discover and learn from the participants' lived experiences of engaging with the MiTeachVR system, in essence, is the purpose of this research.

3.5.4 Epistemology

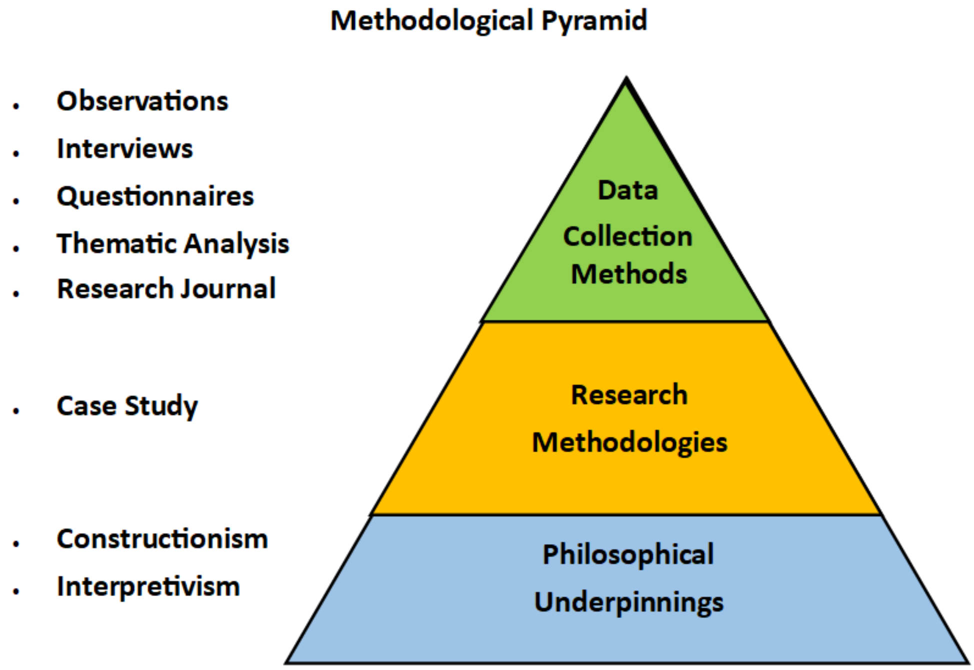
Epistemology is the study of the nature, scope and production of human knowledge (Brancati, 2018) especially regarding its validation and the methods used (Walliman, 2018). A positivist researchers' epistemological view upholds that an objective reality or truth exists in the world independent of the observer, and reality can be understood using the scientific method. Positivists embrace the scientific method, a set of procedures used to test hypotheses and adopt qualitative and quantitative methodologies in analysing numerous phenomena (observation, interaction or experimentation) (Brancati, 2018; Queirós et al., 2017). An alternative view according to Walliman (2018) is relativism, also known as interpretivism or constructivism. The relativist researcher takes an opposing view to 'objective reality' and is based on the philosophical doctrines of idealism and humanism. It upholds that the "view of the world we see around us is the creation of the mind" (p. 23), something Guba and Lincoln refer to as "intangible mental constructions" (1994, p. 111). This is not to say the world is not real, but rather:

> We can only experience it personally through our perceptions which are influenced by our preconceptions, beliefs and values; we are not neutral, disembodied observers but part of society (Walliman, 2018, p. 23).

I consider these theoretical views to be relevant in this research, where a 'virtual world' is generated for the participants to engage in and for me as the researcher to understand through data collection and analysis. Unlike the external view perspective of the natural sciences, the relativist researcher is not observing phenomena from outside the system, but is inextricably embedded in the human context that is being researched (Walliman, 2018).

I understand epistemology is a field of inquiry that investigates how humans come to know and understand the world; it helps to provide insights into the nature of truth, belief, and the processes of knowledge acquisition. In this research, it provides a way for me to investigate the production of knowledge from the participants' engagement with the MiTeachVR system. It further allowed me to explore and try to understand the 'individual and personal realities' as perceived by the participants. The intertwining and my understanding of the three pillars (axiology, ontology and epistemology) helped me to create a holistic view of my research worldview or paradigm presented in (**Figure 3.13**) based on the 'Methodological Pyramid' adapted from Quinlan (2011).

Figure 3.13: The Methodological Pyramid helping to understand the key concepts of this Study.



***Note*.** Adapted from (Quinlan, 2011)

The elements of each layer will be explored, from the bottom up, in the following sections, starting from the pyramid base with 'Philosophical Underpinnings', followed by the 'Research Methodologies', concluding with the 'Data Collection Methods'.

3.6 Philosophical Underpinnings

I understand that the philosophical underpinnings within any research endeavour helps to regulate the researchers expectations, values, principles, and worldviews. These combine to create a view about reality. "This view, in turn, will determine what can be regarded as legitimate knowledge" (Walliman, 2018, p. 16). In deciding the underpinning paradigm, I considered my current and previous research experience, intrinsic beliefs, values and their potential to influence the research direction and outcomes, especially my involvement as a team member in the conceptualisation and creation of the MiTeachVR System.

Qualitative research is a search for understanding and meaning rather than an absolute truth, as there is no single 'truth' to be discovered (Creswell, 2014; Flick, 2023). Rather, we live in a pluralistic world with many realities and lived experiences (Cohen et al., 2011; King et al., 2019). I believe there are multiple realities experienced by individuals, which aligns with this research investigating the experiences of multiple participants using the MiTeachVR system. Participants reported their own 'unique' experience or reality, leading to 'multiple' realities, a view held by constructivist and interpretive researchers. Constructivism is often combined with interpretivism as an effective way to explore the complexities of human experiences and is typically seen as an approach to qualitative research in the social sciences (Creswell, 2014; Mills et al., 2010).

3.6.1 Constructivism

Constructivism is a psychological and educational theory suggesting individuals actively construct personal meanings of the world from their experiences and interactions with the world. These meanings are diverse and multiple, directing the "researcher to look for the complexity of views rather than narrowing meanings" (Creswell, 2014, p. 8). Constructivism emphasises the individuals' active role in constructing their understanding of the world (Lincoln & Guba, 2013). I consider knowledge is not passively received; it is constructed through individual experiences and mental processes (Lincoln & Guba, 2013).

3.6.2 Interpretivism

Interpretivism has a 'relativist' perspective approach to social science, predicated on the existence of multiple realities rather than a single reality (Walliman, 2018). Relativists suggest that reality is only knowable through socially constructed means, and acknowledge the complexity of human behaviour, which cannot be predicted (G. Ryan, 2018). Interpretivists argue that humans behave in part because of their environment and are also influenced by their subjective perception of their environment (Willis, 2007, p. 7). Interpretivism takes a more inductive approach, using data collection to explore the phenomenon, identify themes and patterns, and move from data collection to theory or concept development (Saunders et al., 2023). I consider knowledge, immaterial from where it is created or derived, needs to be interpreted to discover the underlying meaning of an individual's 'unique' experiences. In this research, the experiences of participants were interpreted to understand their 'unique' lived experience or 'reality' using the MiTeachVR system.

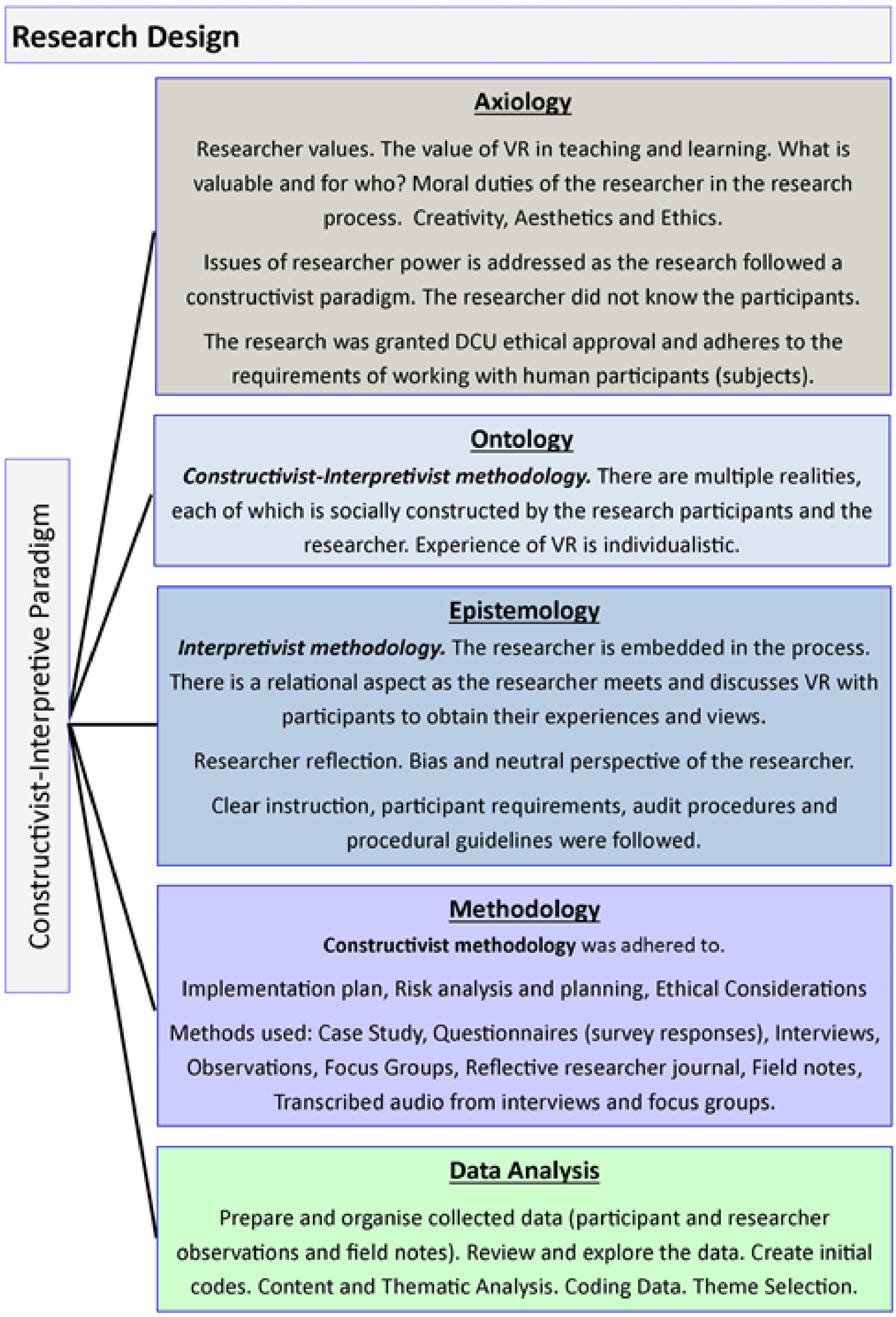
3.6.3 Constructivist-Interpretivism Approach to this Research

Epistemologically, constructivism and interpretivism differ, as constructivists are interested in how the realities of individuals are constructed (versions of the World), while Interpretivists are interested in how realities are experienced (understanding ascription of meaning) (Flick, 2006, p. 85). Constructivist and interpretivist researchers hold a similar view from an ontological perspective that people can experience the same event differently based on their own reality, consequently multiple realities exist (Creswell, 2014). Creswell further expands and suggests:

> These meanings are varied and multiple, leading the researcher to look for the complexity of views rather than narrowing meanings into a few categories or ideas. The goal of the research is to rely as much as possible on the participants' views of the situation being studied (Creswell, 2014, p. 8)

Constructivist and interpretivist researchers place importance on reflexivity. Constructivism co-constructs meaning to understand how an individual's experience is constructed within the "specific context in which people live and work" (Creswell, 2014, p. 8), in order to understand the setting of the participant. Interpretivists "describe specific social settings, processes or relationships" focusing on feelings, perceptions and experiences of the individuals' reality as they consider people are the experts of their own experiences (King & Horrocks, 2010, p. 11). Hence, they hold important the participant voice, and focus on understanding people's social worlds without changing them (King et al., 2019). In this study, participants constructed and interpreted their experiences engaging with the MiTeachVR system. While individual participants constructed and reported on their own 'unique' reality, I acknowledge that by comparing these multiple realities, we see what is 'reported as real' from a variety of perspectives. A constructivist-Interpretivist approach acknowledges multiple perspectives with a tendency to employ qualitative methods such as case studies, interviews, and observations (Cohen et al., 2011). Figure 3.14 details the research design of the constructivist-Interpretive paradigm employed in the research, outlining the axiological, ontological, epistemological, methodological and analytical underpinnings.

Figure 3.14: Research Framework (Research Design)



This research is underpinned by a case study utilising observations, questionnaires and interviews, which are described later in this chapter. I deemed this combination appropriate within the context of this study because it allowed for an in-depth, detailed exploration of the phenomenon, as the instruments offer a pragmatic method of collecting the diverse research data emanating from the multiple realities of the participants in this study.

3.7 Methodological Approach

It is important to distinguish between research methods and research methodology, as to use them interchangeably would be inaccurate. Research methodology refers to the overarching philosophical framework and the theoretical underpinnings that guide the entire research process. It broadly encompasses the principles, concepts and approaches that guide how research is conducted, while justifying the selected research methods (Clough & Nutbrown, 2012; Flick, 2023; Hennink et al., 2020).

Research methods refer to the specific techniques, procedures and tools that researchers utilise to conduct their research. This involves outlining the practical steps they follow to collect data, create information, and draw conclusions. Depending on the research questions, aims, and objectives, and the data the researcher is aiming to collect, numerous techniques such as case studies, observations, interviews, questionnaires, content and statistical analysis can be employed (Flick, 2023; Hennink et al., 2020; Quinlan, 2011).

In the following sections, I provide a rationale for choosing the case study as the research methodology, along with an outline of the case study approach. I further explain the associated procedures, data collection methods and research instruments.

3.7.1 Rational for selecting a Case Study Design

A case study is an empirical method of inquiry commonly used in qualitative research (Flick, 2023; Silverman, 2016; Yin, 2018). It can be described as a strategy for doing research that involves an in-depth and comprehensive exploration of a specific instance, phenomenon, or individual within its real-life context (Blackwell, 1993; Creswell, 2014; Flick, 2023; Ledford & Gast, 2024; Tomaszewski et al., 2020). The case(s) are "bound by time and activity, and researchers collect detailed information using a variety of data collection procedures over a sustained period of time" (Creswell, 2014, p. 241). I considered other methodological approaches, including action research and phenomenology, but deemed both unsuitable. Action research combines research and action to solve a problem through iterative cycles of planning, acting, observing and reflecting, usually in the researcher's own practice, where they "are able to take action to improve it" (McNiff, 2013, p. 23). The purpose of this research was not to solve a problem, and hence I deemed action research inappropriate. While phenomenology might have been useful, it relies primarily on in-depth interviews with individuals about their experiences and the meaning of those experiences (Flick, 2023; Tomaszewski et al., 2020). However, I felt that phenomenology lacked the ability to understand the complexities and context of a case in a real-life natural setting, bounded by time and place, specifically one semester in the IoE, in a way that a case study would allow. I therefore concluded phenomenology not to be suitable in this research context. Hancock and Algozzine (2017), provide a checklist of planning questions (T**able 3.2**) for researchers when considering conducting case study research, by answering '**Yes**' or 'No', the researcher can determine the suitability of case study research. By completing the checklist (**Table 3.2**) with additional notes, I determined that a case study was a suitable choice.

Table 3.2: Checklist – When to Do Case Study Research

Checklist: When to Do Case Study Research			
	Planning Question	**Yes**	**No**
Q01	Does the research topic address a question or questions that focus on describing, documenting, or discovering characteristics of an individual, group of individuals, an organisation, or a phenomenon?	Yes	
Q02	Does previous research literature support using case study methods to address similar questions?	Yes	
Q03	Do the context and time frame for the research support case study methods?	Yes	
Q04	Are data available to answer questions that focus on describing, documenting, or discovering characteristics of the individual, the group of individuals, the organisation, or the phenomenon under investigation?	Yes	
Q05	Are data collection procedures feasible and clearly described in the research plan?	Yes	
Q06	Is the Potential for researcher bias controllable?	Yes	
Q07	Are case study collection strategies (e.g., participant observations, interviews, field notes, ongoing reanalysis) appropriate for and consistent with the purpose of the research?	Yes	
Q08	Are technical adequacy expectations related to validity, reliability, and generalisability manageable?	Yes	
Q09	Are case study data analysis strategies (e.g., categorising, recombining, cross-checking) appropriate for and consistent with the purpose of the research?	Yes	
Q10	Will answers to research questions and conclusions derived from the data support theory expansion and improve practice?	Yes	

Researcher Notes:
Q01 – Yes - The research focuses on two groups (pre-service teachers and lecturers).
Q02 – Yes –
Q03 – Yes - The context is a HEI, exploring ITE, IVR and MT with a defined timeframe for this study.
Q04 – Yes – The data is generated from participant engagement in IVR (MiTeachVR), with interviews, observations and questionnaires.
Q05 – Yes – The data collection is feasible and data collection methods are clearly described.
Q06 – Yes - The researcher will follow a research protocol and predefined interview schedule.
Q07 – Yes - Observations are used to understand participant movement and engagement with the VR equipment and MiTeachVR system. Interviews are designed to explore and gather the participants' views. Questionnaires are designed to gather participant views and comments.
Q08 – Yes - Validity and reliability are accounted for in the triangulation and procedures. The study does not set out to generalise the findings. Most of the requirements are met and answered 'Yes'.
Q09 – Yes - This is a qualitative study, utilising qualitative findings analysed using thematic analysis.
Q10 – Yes - The findings will contribute to existing theory and may be useful to understand how a system like MiTeachVR may be used in ITE in the IoE.

Note. Adapted from (Hancock and Algozzine, 2017, p6). Researcher notes section is an addition.

Yin (2018) asserts that there is no exact formula to determine if a case study is the correct choice; the author maintains that the choice is driven largely by the research question(s). Especially if the question(s) seek the '**how**' or '**why**' of some social phenomenon and require no control over behavioural events, where variables are observed in a natural setting rather than manipulated. I wished to examine and understand:

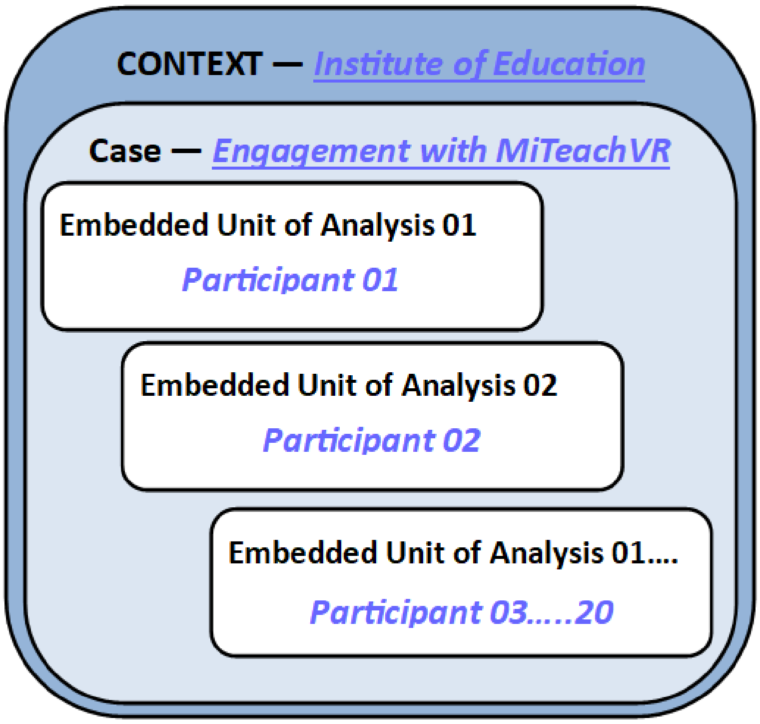
1. How do lecturers and students experience and perceive their engagement with MiTeachVR as a tool for microteaching within initial teacher education?
2. How can lectures and students be supported in the introduction of the MiTeachVR system into microteaching practice in the Institute of education?
3. Based on their experiences, why would lectures and students choose to adopt or reject the MiTeachVR system?

Case study research is a powerful method used by researchers to realise both practical and theoretical aims and is viewed by experienced qualitative researchers as a stand-alone qualitative approach offering a level of flexibility that is not readily available in other qualitative approaches (Ebneyamini & Sadeghi Moghadam, 2018; Yin, 2018). Rather than presenting abstract principles or theories, a case study can provide a distinctive example of people (PTSs and lecturers) in real-world situations, allowing readers to understand the phenomenon more clearly, especially if the phenomenon under investigation is not always susceptible to numerical analysis (Cohen et al., 2011).

3.7.2 Single-Site Case Study Rational

A single-site case study with embedded units (multiple units of analysis) was chosen for this research (**Figure 3.15**), as it was able to provide an in-depth understanding of the experiences of PSTs' and lecturers' engagement with MiTeachVR for microteaching practice in ITE. The context is the broader setting/environment (IoE) in which the single-site case exists. The case is the phenomenon being studied (Experiences with MiTeachVR) and the embedded units are the participants (PST and lecturers) taken part in the study (Cohen et al., 2011; Yin, 2018). Because this research was conducted as part of a doctor of education, the data collection time frame is limited. Hence, the single-site case study is "bound by time and activity, and researchers collect detailed information using a variety of data collection procedures over a sustained period of time" (Creswell, 2014, p. 241), specifically one semester in the IoE.

Figure 3.15: Single-site Case Study Design



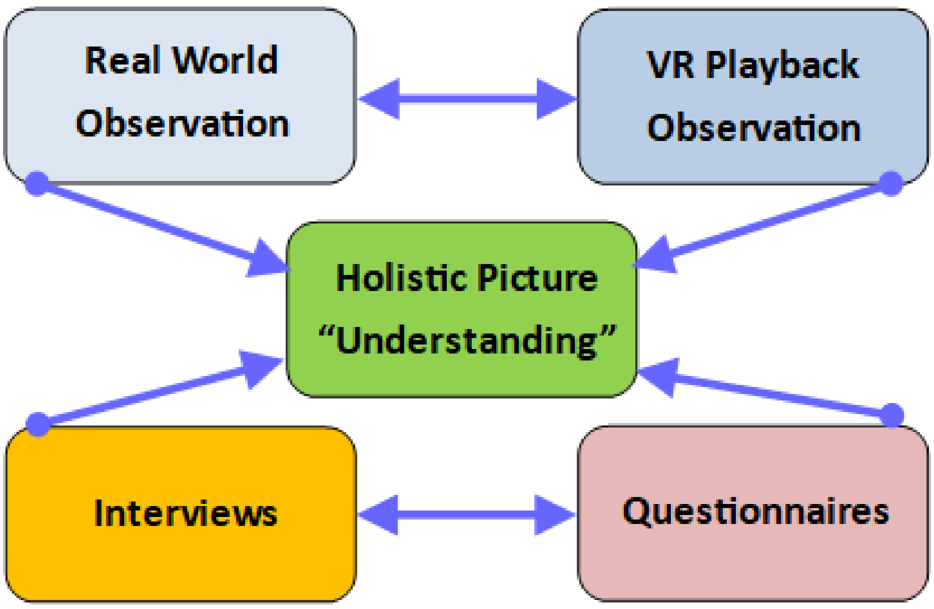
***Note*.** Based on the design of Case Studies (Yin, 2018, p. 48)

Yin (2018) provides a range of reasons for employing a single-site case study with embedded units, including: (**1**) it allows for a deep exploration of the phenomenon within its real-world context, ensuring a thorough examination of all aspects of the case - the MiTeachVR system was tested in the IoE, with PSTs in its real-world context. (**2**) When the case consists of multiple interconnected embedded units (PSTs and lecturers) that contribute to a comprehensive understanding of the research. (**3**) Embedded units allow for a more detailed and multi-perspective analysis – testing the MiTeachVR system with multiple PSTs and lecturers allowed for a deeper understanding of the phenomenon, and (**4**) by including multiple embedded units can help enhance validity and reliability by minimising errors and biases.

3.7.3 Data Source Integration

Case studies are a design of inquiry that can employ any of the qualitative methods, observations, interviews and document analysis, etc. (Ebneyamini & Sadeghi Moghadam, 2018; Mills et al., 2010; Yin, 2018). Yin (2018) stresses, "a major strength of case study data collection is the opportunity to use many different sources of evidence" (p. 126), as illustrated in (**Figure 3.16**). A similar view held by other authors/researchers including Creswell, (2014) and Cohen et al. (2011) where they refer to triangulation as a method to strengthen research. (Triangulation is discussed later in this section). However, the term triangulation is somewhat contested by Braun and Clarke (2022).

Figure 3.16: Integration of the Data Sources



The data sources employed in this single-site case study are interviews, questionnaires, observations and a research journal, which are further described in the following sections. The methods are not mutually exclusive, as they represent the participants' views, action and explanations from different perspectives, leading to a greater understanding of the phenomenon as depicted in (**Figure 3.16**). The research used a non-experimental observational single-site case study. Rather than manipulating an independent variable, I as the researcher, simply measured/recorded variables as they naturally occurred, in a natural setting (Robson, 2009). In this research, the setting is the 'real-world' space and the 'virtual classroom' generated by the MiTeachVR system. Interviews were used as the prime source of data and were supplemented by data from the questionnaires and observations. During the coding and analysis of the interview data, coded data from the questionnaires and observations were used to gain a further understanding or clarification of the participant experience by comparing and contrasting the data. A similar procedure was carried out for the observation data. In some instances, the data confirmed the interview data, and in a small number of instances, it conflicted.

3.7.4 Case Study Strengths and Limitations

Cohen et al. (2011) inform us of the possible advantages of case studies that make them attractive to the education researcher, including their recognition of the complexity and embedded nature of social truths; they may provide rich descriptive material to allow subsequent reinterpretation; they are a step to action for formative evaluation and in education policymaking (p. 292). I understand that a key strength of case study methodology and methods is that researchers can obtain a rich, in-depth examination and detailed contextual understanding of a particular subject (situation, individual, and phenomenon) and its complexities by producing thick descriptive qualitative data (Blackwell, 1993; Brancati, 2018; Creswell, 2014; Wisker, 2003). A further strength of case studies is that "they observe effects in real contexts, recognising that the context is a powerful determination of both cause and effect" (Cohen et al., 2011, p. 289). Within this research, I was able to administer questionnaires, interview and observe participants using MiTeachVR in a natural setting to understand their unique lived experience of the real-world environment.

Yin (2018) highlights some concerns associated with case study research including, the need for greater rigour because too often systematic procedures are not followed, or the inclusion of equivocal evidence to influence the direction of the findings and conclusions. Generalisability may not be possible, especially in a single-case study, because they can potentially take too long and can require a large amount of effort. Their comparative advantage is unclear in contrast to other research methods. Wisker (2003) indicates case studies are not easily generalised from one case, which is considered a limitation. Single case studies need to be "contextualized and carefully described and then others can consider its usefulness in other contexts" (Wisker, 2003, p. 190). To mitigate against these concerns, I have described the case and research context, and I have identified and provided a clear methodological approach, methodological procedures and audit trail information at various points in this thesis.

Case study design offers a good choice within this research as I seek a deep understanding and detailed insights about a complex social phenomenon of PSTs' and lecturers' experiences while using the MiTeachVR system, in a real-world context situated in its natural setting, that of a classroom within a University setting. As a methodological approach, a case study aligns with my beliefs and values as discussed earlier in this chapter. In addition, while I conducted earlier fieldwork during the creation and testing of the MiTeachVR system, it became clear that a case study was a logical choice based on the context, methods and aims of the research. The rational to use single-site case study design was based on the above reasons and my concern about the feasibility and practicality of conducting the research in a limited timeframe. I also felt that this case study design would allow sufficient data to be collected without compromising the depth and breadth of the research.

3.8 Data Collection

I recognise that Braun and Clarke (2024) prefer 'data generation' as opposed to 'data collection', as they argue that researchers do not merely collect ready-to-hand data. Instead, through qualitative methods, researchers generate data that can be analysed to understand the experiences, perspectives, or phenomena. However, I have decided to use 'data collection' in this thesis, not to confuse the reader, but because many qualitative scholars use the term 'data collection, as it is an established term for how researchers obtain data in the empirical field (Bryman, 2016). Data collection is the process of systematically collecting information from multiple sources to build a picture of the phenomenon under investigation (Flick, 2023; Hennink et al., 2020). Data sources can include observation, questionnaires, interviews and focus groups (Hennink et al., 2020; Quinlan, 2011; Silverman, 2016). In this section, I present how I collected the data, participant selection, including access and recruitment, followed by detailing the process in the data collection sessions.

3.8.1 Research Sample – Selection Criteria

Convenience sampling, employed in this research, is a non-probability sampling method where the researcher selects participants based on their availability and willingness to take part in the study (Brancati, 2018; Flick, 2023; Quinlan, 2011). It involves choosing individuals to participate, and recruitment continues until the required sample size is obtained. Convenience sampling does not represent any group apart from itself, meaning it is not generalisable. Captive audiences such as students and teachers often serve as respondents (Cohen et al., 2011). As this research took place in a HE setting, the sample comprises of PST and lecturers.

To be eligible, PSTs had to be 18 years and above, registered on either the BSc in Education and Training (BET) or the BEd in Gaeilge and French, German or Spanish (BEDLAN) programme, and participating in, or having recently participated in, a microteaching module. Lecturers were recruited if they were teaching on a microteaching module. 16 PSTs and six lecturers were recruited, with two PSTs withdrawing. The final PST sample consisted of nine identifying as female and five identifying as male, with 10 from (BET) and four from (BEDLAN). The lecturer sample consisted of three identifying as female and three as male. PSTs were recruited through an in-class presentation and the distribution of a recruitment flyer (**Appendix C**). Lecturers were invited to participate in the research by email. Further details of the recruitment process are available in (**Appendix D**).

3.8.2 Session Outlines

All sessions were carried out in the IoE using two classrooms that were similar in size and design, to maintain consistency in the physical environment. PSTs had two sessions conducted at two time points. For practical and scheduling constraints, and participant availability, lecturers had one combined session. However, both groups experienced the same tasks in order, as detailed in (**Figure 3.17**). Students had two sessions: a VR familiarisation session, followed a few days later with the MiTeachVR session. Lecturers had both the familiarisation and MiTeachVR sessions together. The following section gives a brief outline of the sessions, with the full protocols available in (**Appendix E**). The procedures of each session are detailed in (**Figure 3.17**).

<u>Meta First Steps</u>

The Meta 'First Steps' app is a brief VR tutorial that introduces new users to the Meta Quest system, teaching basic controller functions, object interaction, and navigation within the virtual environment.

<u>PSTs Session 01</u>

In this session, PSTs were asked to read a Plain Language Statement (PLS) and complete a Consent Form, available in (**Appendix F**). Participants were informed of their right to withdraw from the study at any stage, with no consequences. Upon consenting, they then used the Meta 'First Steps' app to become familiar with the VR equipment. This was followed by a short break before they were introduced to the MiTeachVR classroom. On completion, there was a short debriefing session with an outline of session two. Session time was approximately 30 minutes.

<u>PSTs Session 02</u>

In this session, PSTs were asked to reconfirm their consent and informed of their right to withdraw from the study at any stage, with no consequences. Upon reconfirming their consent, they delivered their microteaching session. Their primary task was to deliver a pre-prepared lesson using an accompanying PowerPoint presentation. PSTs were asked to focus on several teaching behaviours during the session as detailed in (**Table 3.3**).

Table 3.3: Teaching Behaviours to be practiced in the microteaching session

Teaching Behaviours to be practiced in the microteaching session	
Non-Verbal Communication	Be conscious of eye contact with the avatars and noticing when an avatar reacted (as per the indicator above their heads).
Paralanguage	Varying the tone, pitch, and volume of their speech appropriately throughout the session.
Classroom Circulation, Movement and Gestures	Use appropriate hand gestures, moving around the virtual classroom space and consider various positions in the classroom to connect with students.
Varying Stimuli	Utilising the PowerPoint, whiteboard, and distributing virtual materials.
Timing	Timing of the session to structure their delivery of material. Using time and pauses between questions.
Session Structure	Paying specific attention to the opening and closing of the microteaching (MT) session.

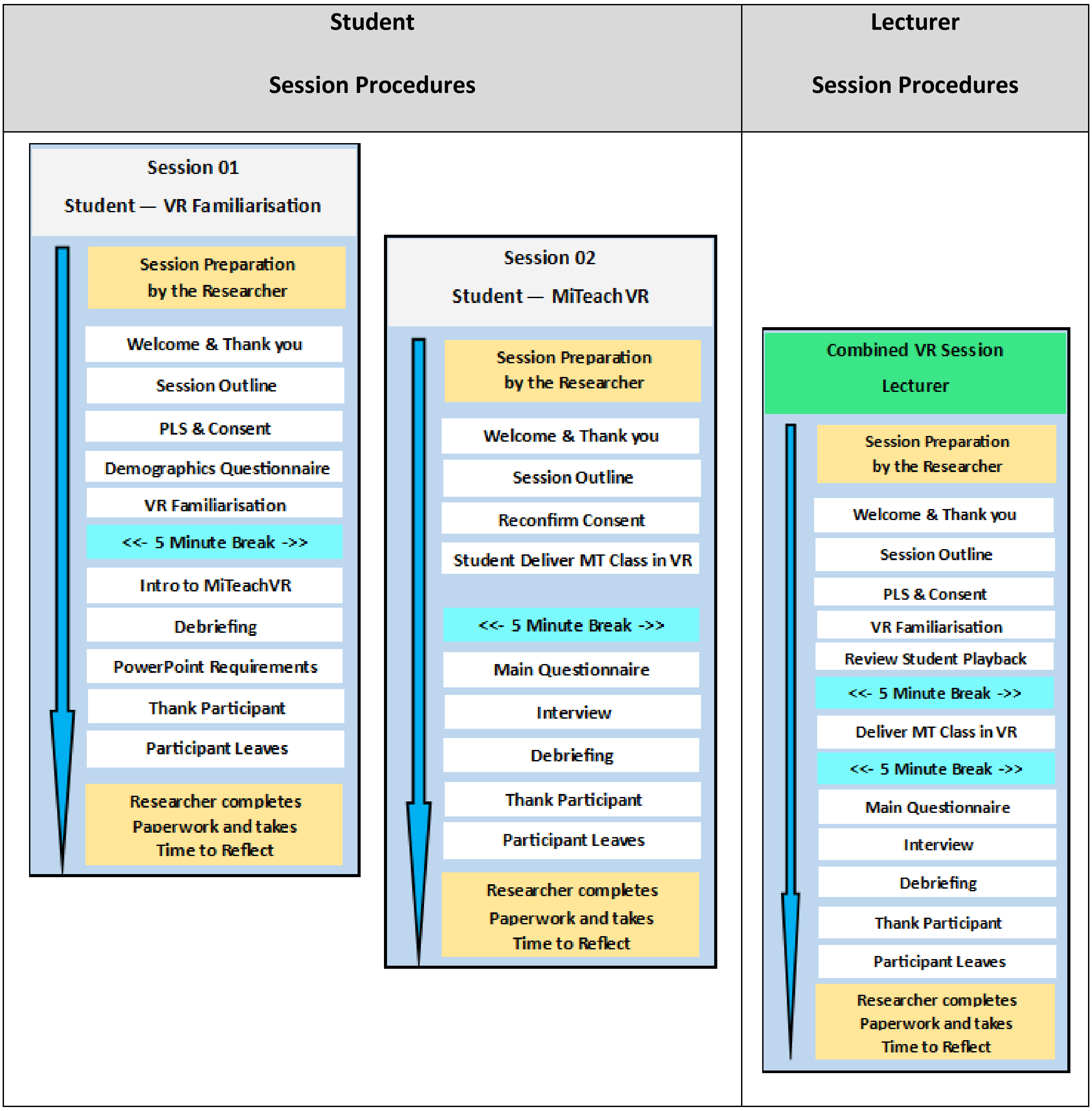
On completion, they were asked to review the recorded session and reflect on their performance. While PSTs were delivering their teaching session, I recorded my observations using an observation sheet (**Appendix G**). After a short break, PSTs completed the questionnaire before participating in the audio-recorded interview, using a semi-structured interview schedule (**Appendix H**). On completion, there was a short debriefing session. Session time was approximately 65 minutes.

Lecturers Combined Session

In this combined session, lecturers were asked to read the PLS and complete a Consent Form, available in (**Appendix F**). Participants were informed of their right to withdraw from the study at any stage, with no consequences. They then used the Meta 'First Steps' app to become familiar with the VR equipment. This was followed by a short break before they were introduced to the MiTeachVR classroom. They were first asked to review a pre-recorded student teaching session. This session was a recording of the researcher delivering a short session. The purpose was for them to think about the content delivered and how they would provide feedback based on the recorded performance. Following this, lecturers were asked to deliver their pre-prepared microteaching lesson using an accompanying PowerPoint presentation. Lecturers were asked to focus on the teaching behaviours detailed in (**Table 3.3**) during the session. At the end of the session, they were invited to review their own session and how it could be used for reflection.

Throughout the MiTeachVR session, I recorded my observations. After a short break, lecturers completed the questionnaire before participating in the audio-recorded interview, using a semi-structured interview schedule (**Appendix H**). On completion, there was a short debriefing session. Session time was approximately 75 minutes.

Figure 3.17: Student and Lecturer Session Running Order



Note. PST and lecturer running order follow a similar sequence.

At the end of the session, I completed the relevant paperwork and send follow up thank you emails to the participants. I also took the time to reflect on the session, as I tidied up the VR equipment, etc. In the following section, I describe the research methods and outline the procedures for each.

3.9 Research Methods

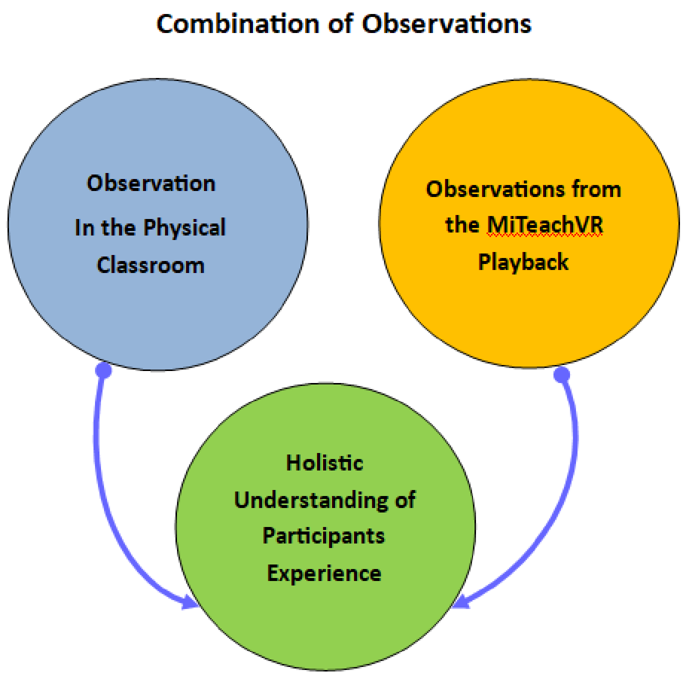
I understand that research methods are the tools and procedures used to collect data as part of a research project. By increasing the quantity and quality of the data will allow a richer picture of the phenomenon to emerge. The more methods and variety of sources and perspectives that can be utilised will lend to comparisons to build a richer view of the phenomenon (Brancati, 2018; Flick, 2023; Quinlan, 2011). In this section, I present the methods used in this research, namely Observations, Questionnaires, Interviews, my Research Journal, and the rationale for their selection, while outlining the administration procedures for each.

3.9.1 Observations

Observation is a data collection method where the researcher takes field notes and systematically watches, listens to, and records behaviours, events, or conditions in their natural setting (Brancati, 2018; Hennink et al., 2020; Quinlan, 2011). Field notes can be unstructured or semi-structured, using some prior questions that the researcher wants to know (Creswell, 2014). Observation is a useful method to explore a new topic or provide context to a study by observing the social setting, and can help understand how people utilise spaces (Flick, 2023; Hennink et al., 2020). This study involved two types of observations: firstly, in the "real-world" where I observed participants as they used the MiTeachVR system and secondly, my observations viewing the playback data from the MiTeachVR recordings, as illustrated in (**Figure 3.18**). I deemed observation to be a valuable method, as I wanted to record the experience of the participants as they used the MiTeachVR system in a natural space. I also wanted to understand if there would be a disjunction or conjunction between the "real-world" and "virtual-world".

In earlier development testing of the MiTeachVR system, I noticed that while participants used the MiTeachVR system, some had difficulties, while others seemed very much at ease. I designed the observation sheet with 12 predefined observation codes and some open text boxes for notes (**Appendix G**). I was a non-participant observer, which allowed me to collect real-time, context-rich data in a natural setting, offering a deeper understanding of the phenomenon under study.

Figure 3.18 Combinations of Observations



Note. Holistic understanding of the "real-world" physical observation and the "playback" data from the MiTeachVR recording.

The physical 'real-world' observations allowed me to see what is happening in the 'real-world' while the 'playback' data allowed me to interpret what occurred in the 'virtual world'. Combining data in this manner allows the researcher to capture detail and depth of complex phenomena (Vogt et al., 2012).

3.9.1.1 Observation Procedure

At the start of the VR session, I informed participants that I would be observing them as they engaged and delivered their MT session, explaining that I wanted to understand their movement around the room and monitor them from a health and safety perspective. I used the observation sheet (**Appendix G**) to record my observations, noting how the participants moved in the physical space, their interactions with the VR equipment and their voice, tone and fluidity. This data was later used in conjunction with the recorded VR session.

3.9.2 Questionnaires

Questionnaires are an efficient way to collect data, and are suitable for both quantitative and qualitative research. Each participant gets the same set of questions, and they are allowed to answer with no personal influence from the researcher (Walliman, 2018). This research is predominantly a qualitative study, but the limited amount of quantitative data is included to add context. This data provides demographic clarity and measurable support to understand the participants' previous engagement and usage of VR and gaming technologies. I deemed that questionnaires were suitable to efficiently collect the necessary demographic information and technology usage. The instrument was designed to immediately follow the MiTeachVR exposure. It consisted of a range of open-ended and Likert scale questions to capture participants' initial thoughts and feelings regarding their MiTeachVR experience, providing measurable and contextual insights to support the main qualitative data. Questionnaires were created by (**1**) identifying areas of interest to be measured, (**2**) translating concepts to build questions, (**3**) choice operationalisation, followed by testing for quality and clarity (Saris & Gallhofer, 2014). (**Table 3.4**) presents a selection of the questions, with the full range available in (**Appendix I**).

Table 3.4: Sample questions from the Demographic Questionnaire

Sample questions from the Lecturer and Student Demographic Questionnaire

3. Have you used Virtual Reality before today's research session? **Yes** ☐ **No** ☐

3a. If Yes, how often have you used it?

One time only ☐ Two to five times ☐ Six time or more ☐

6. Did you feel comfortable using the VR technologies today? **Yes** ☐ **No** ☐

Can you explain why: ____

____

9. Would you describe the MiTeachVR as a negative or positive experience?

Negative Experience	0	1	2	3	4	5	6	7	8	9	10	Positive Experience

12. To what extent do you believe the MiTeachVR is a practical tool in microteaching?

Not Practical	0	1	2	3	4	5	6	7	8	9	10	Extremely Practical

The demographic data was reported numerically. However, I reported on the Likert scales using numeric and descriptive narrative.

3.9.2.1 Questionnaire Procedure

After the VR session, to build a rapport with the participant, I started by thanking them and continued with a general conversation to ensure they were comfortable and alleviate any anxiety they may have experienced. I explained the purpose of the questionnaire. Participants were asked to complete a self-administered questionnaire, see (**Appendix J**). Participants completed the questionnaire in an area of the room away from the researcher, to ensure they could answer independently and without influence.

3.9.3 Interviews

Interviews are a common source of data collection in qualitative research (Flick, 2023; King et al., 2019). Flexibility is a key requirement of qualitative interviewing. The qualitative research interviewer must be able to respond to issues that emerge in the course of the interview to redirect, guide or explore the perspective of the participant on the topics under investigation (Flick, 2023; King et al., 2019). Semi-structured interviews were employed, as they allow the same set of questions to be asked of each participant, while allowing for some divergence, with the interviewer controlling the interview by returning to the set of predetermined questions (Flick, 2023; Silverman, 2016; Wisker, 2003). Open-ended questions allowed for rich insights. In developing the questions, I was guided by Patton (1990) who indicates six types of questions can be asked in qualitative interviews, including (**1**) Background/Demographic, (**2**) Experience/Behaviour, (**3**) Opinion/Values, (**4**) Feeling Questions, (**5**) Knowledge Questions, and (**6**) Sensory Questions, a full description is available in (**Appendix H**).

A range of questions, including sub-questions were developed to guide the participant interviews. (**Table 3.5**) presents the main themes and a small sample of the questions used in the interview schedule. See (**Appendix H**) for the interview schedule. King et al. (2019), indicate that the space where the interview takes place can have a bearing on the interview outcomes; the location should be quiet and familiar to the participants. Hence, the interviews were conducted in the same space as the VR session.

Table 3.5: Sample questions from the Participant Interview Schedule

Main Interview Themes and Sample Questions from the Interview Schedule
The main themes of the interviews included: • The users experience of using the MiTeachVR System • How the MiTeachVR system compared to Real-world classroom microteaching session • Was the MiTeachVR system Useful as a tool for practicing Microteaching • Strengths and Weakness of the MiTeachVR System • Feasibility, Supports and Barriers to using the MiTeachVR system for Microteaching • Participants Future Recommendations and Expectations for the MiTeachVR System
Sample Questions from the Interview Schedule: • How would you describe your experience of using the MiTeachVR System? • How would you compare the MiTeachVR environment to the physical classroom? • In what ways do you think the MiTeachVR System is useful for Microteaching Practice? • What resources or support would facilitate your use of the MiTeachVR System? • Are there any barriers that might prevent you from using the MiTeachVR System? • If the MiTeachVR System was fully available to you now would you use it?

3.9.3.1 Interview Procedure

I explained the purpose of the interview, to ensure the participant was clear about what type of information I was seeking. Participants were informed and asked to consent to the interview being recorded. I restated this at the start of the recording. The interview started by asking the participants to describe their experience of using the MiTeachVR system, which allowed participants to share their experiences in their own words. I listened attentively and used verbal and non-verbal cues to progress through the questions or probe further. The final question asked participants if they would like to share their comments on any part of the research. On completion of the interview, I again thanked the participant and stated that the recording was stopped. The interview was followed by a short debriefing session.

3.9.3.2 Debriefing Procedure

In general, debriefing sessions inform participants about the true nature of the study. However, in this study, participants were fully informed of the true nature of the study and no deception was involved. This session was useful because during the pilot study and earlier development stages, participants asked questions about the MiTeachVR environment design. I determined that answering these questions might unduly influence participant responses in the subsequent questionnaire and interview. After the final session, I answered their questions and explained the rationale behind some of the MiTeachVR design decisions.

3.9.4 Research Reflective Journal

As a data collection method, a research journal serves several important purposes for the researcher, it's more than just a log of activities, it is a written record of the research, a tool for reflection, and a method to document the key events and decisions throughout the process (Braun & Clarke, 2022; N. Brown, 2021; Quinlan, 2011). Journals provide a first-hand account of the researcher's experience, as it is written close to the time the events occurred, "it conveys immediate experiences undistorted by memory" (Frankfort-Nachmias & Nachmias, 2008, p. 323). While separate from the main research instruments, their content forms part of the collected research data (Flick, 2023). Consistency can be an issue, they are time-consuming, they are subjective, which can introduce biases, and perceived to lack rigour (Pezzato et al., 2024).

My research journal served multiple roles: as a method of reflection, recording research experiences or events, recording my observations and to provide research transparency. I used a simple structured journal template created in MS Word (**Appendix K**), which allowed me to record decisions, milestones, and key events throughout the research. I also included a reflection section on the participant observation sheets (**Appendix G**) that allowed me to think about the research session for the particular individual participant.

3.9.5 Triangulation (Crystallisation)

Triangulation has two broad meanings. Firstly, in the context of mixed methods, it refers to the combination of quantitative and qualitative methods to validate results from other methods. Secondly, it also refers to the use of different data sources, approaches or methods to corroborate other data, approaches or methods (Brancati, 2018). Data in social science are obtained in formal or informal settings involving verbal (oral or written) or non-verbal (responses, acts or observation); these combinations allow for various data collection instruments to be employed, including interviews, questionnaires, and observations (Yin, 2018). Each has advantages and inherent limitations; however combining two or more can be used to measure variables (Frankfort-Nachmias & Nachmias, 2008). The constructivist paradigm acknowledges that multiple realities can exist, and these realities may be divergent. Triangulation goes beyond the limitations of a single method by combining several methods, and assigning them equal relevance (Walliman, 2018). In essence, triangulation is the convergence of, or consistency, among evidence from multiple varied data sources (Ledford & Gast, 2024).

Braun and Clarke consider the term triangulation as put forward by some scholars as rigid and not universally applicable in the context of qualitative research, as it omits:

> the range and diversity of qualitative research, and the various (and sometime antithetical) theoretical assumptions embedded in the field (2022, p. 278).

Richardson and St. Pierre (2005), put forward an alternative term, 'Crystallization', embracing the complexity of the world and indicating there is no single objective reality as "there are far more than three sides by which to approach the world" (p. 963). Triangulation within a case study is used to determine the:

> convergence of the data collected from different sources of evidence, to assess the strength of the case study finding and also to boost the *constructive validity* of measures used in the case study (Yin, 2018, p. 288).

The data collection methods in this study were compared against each other in different ways and at different points. It was possible to compare some interview data with questionnaire data or observation data. By comparing the 'real-world' observation and 'virtual-world' playback, I was able to understand the holistic use of the MiTeachVR system by each participant. For example, while a participant was observed standing in the same small area in physical 'real-world' space, was this mimicked in the virtual space, or did the participant use the hand controllers to navigate the virtual space as opposed to walking in the physical 'real-world' space? Similarly, participant questionnaire data and interview data were compared to check for consistency in some areas.

3.10 Data Management

It takes considerable time and effort to gather research data in a professional and scholarly manner (Flick, 2023; Hennink et al., 2020). Data are the evidence gathered by the researcher, and therefore, it is "important that the data gathered be properly managed when it has been gathered" (Quinlan, 2011, p. 352). Within this research, I amassed a large amount of data. The data was securely stored to ensure the protection of personal data, used for legitimate purposes only and securely stored to maintain confidentiality. Physical forms, including consent forms, questionnaires, observation sheets and participant record forms, were stored in a physical folder during the sessions and later stored in a locked file cabinet in the researcher's office. A Participant Record Sheet was used as a master list linking a three-digit ID between the participants and their sources of data; this was stored separately in the researcher's office. Electronic data, including, recorded audio interviews, typed transcripts, and the researcher's journal, were stored on a secure Google Drive and an encrypted laptop. The VR data from the MiTeachVR sessions was stored on a secure server.

3.10.1 Qualitative Data Analysis Software (QDAS)

Qualitative data analysis requires effectively managing large amounts of data (Hennink et al., 2020). Interview transcripts accounted for the majority of the data. I had considered using a manual method (pencil, paper and highlighters), however, according to Quinlan:

> When analysing large quantities of qualitative data by hand, it is too easy to make mistakes, to overlook data, and miss relevant issues or even critical issues within the data (2011, p. 435).

I used NVivo, a qualitative data analysis software (QDAS) tool. Such tools are not methodology-specific and can be utilised in many types of qualitative studies. QDAS tools can make data management more efficient as data can be organised in one place, which helps manage ideas, conduct simple and complex queries, and data visualisation and reporting on the development of the data is possible (Hennink et al., 2020; Jackson & Bazeley, 2019). Woods et al. (2016) inform that QDAS allows for more efficient and accurate retrieval of the coded data, while also handling different types of data, including interviews, field notes, and open-ended surveys.

However, QDAS systems have limitations, as they might lead to a less critical engagement with the data, as the software might influence how the data is analysed and interpreted (Jackson & Bazeley, 2019; Woods et al., 2016). QDAS inherently embeds certain methodological assumptions, which can influence the research process and outcome (Zhao et al., 2016). This is something, Braun and Clark (2022) indicate is at odds with engaging in deep questioning, allowing time for reflection and understanding to develop, something the researcher needs to be aware of. Notwithstanding the learning curve and knowing the advantages and limitations of using a QDAS tool, I decided to use NVivo, as I felt it would be more efficient for me as a researcher. I was also aware that there was a high volume of interview data, and manual processing would become messy and frustrating. The data analysis procedures for the dataset are presented in the following section, including the method choice.

3.11 Data Analysis and Method Choice

Qualitative analysis is not mathematical and involves identifying, classifying and describing different types of behaviours, outcomes or characteristics (Passer, 2017). Unlike quantitative analysis, there are no clearly agreed procedures or rules for qualitative data analysis; various approaches exist and vary in their approach based on epistemological assumptions (Cohen et al., 2011). For example, **Content analysis** - quantifies the presence of certain words, themes or concepts; **Grounded Theory** - develops theories through systematic data collection; **Ethnographic Analysis** – attempts to understand social practices and interactions in a particular culture/community (Flick, 2023; Quinlan, 2011; Silverman, 2016). As this research was not attempting to quantify, develop theories or understand cultural complexities, I deemed them unsuitable. The next section presents the method choice of Reflective Thematic Analysis (RTA) and details the data analysis procedures.

3.11.1 Reflective Thematic Analysis

I selected Braun and Clarke's (2022) RTA, as it is a powerful tool for qualitative research, offering a balanced approach to capturing the complexity of participants' experiences while providing a clear framework for analysis. It "is a method for developing, analysing and interpreting patterns across a qualitative dataset, which involves a systematic process of data coding to develop themes" (Braun & Clarke, 2022). RTA was suitable in this context because the research set out to generate data using multiple sources while trying to understand the complexities of participants' engagement, thoughts and feelings of using the MiTeachVR system for microteaching and communication skills practice. RTA's approach highlights the importance of the researcher's reflexivity and subjectivity in the analysis process. I acknowledge the active role I played as a researcher in generating codes and themes and their development. Here, I expand on the six phases of RTA as indicated by Braun and Clark (2022), by briefly outlining the process I used to explore the interview data.

Phase 1: Familiarising yourself with the dataset - I familiarised myself with the data by listening to the audio recordings, taking notes I felt were key points for consideration. I opted to transcribe the data "verbatim" as it is the most detailed method to capture the uttered words of the interviewer and interviewee, including any of the non-verbal communications in the spoken discourse, pauses, filler words, tones, laugh, etc.

Phase 2: Coding – I used open coding. Creating codes based on the sentiments of the sections of text and applying the codes to the sections of text that represented the same meaning. Examining and reflecting on the codes and the content over a number of iterations led to the merging of some codes, deletion of redundant codes, and the creation of new codes.

Phase 3: Generating Initial Themes – I compiled clusters of codes to form tentative themes by considering what the codes had in common. This generated an initial theme for consideration.

Phase 4: Developing and reviewing themes – I considered how the tentative themes related to the codes and their extracts, and in relation to the entire dataset. Some tentative themes did not align with the core concepts and were set aside.

Phase 5: Refining, defining and naming the themes – The theme names were refined, ensuring there was a strong concept. I endeavoured to create themes that Braun and Clarke (2022) indicate should be concise, punchy and informative. I created a thematic table/map (**Appendix L**).

Phase 6: Writing up – I started the write-up with the findings from the interviews first, followed by the questionnaire and then the observation data, and matching similar themes together across the different data sources.

The dataset consisted of two distinct groups (PSTs and lecturers), and each group was analysed and coded separately. Because of my familiarity with the lecturers' dataset (coded first), certain code labels filtered into the student codes as the sentiments and content were of a similar nature. Some code labels were similar but not identical. Upon completion of the coding and theme creation, I renamed the overarching themes to match between the two groups. This allowed for meaningful analysis by exploring each group, and comparing and contrasting between the groups. Mirroring the theme names across the groups allowed for a clearer analysis between the two groups. While the themes and sub-themes have some mirroring in the labelling (**Table 3.6**), the content and sentiments from the participants did not change and are applicable under the relevant theme.

Table 3.6: Linking of a theme, showing the mirrored and unique sub-themes

Themes and Sub-Themes	
03 - Bridging the Gap between Theory and Practice	
Participant	**Sub-Themes**
L&S	01 - Linking Theory and Practice
L&S	02 - Confidence Building in Microteaching
L&S	03 - Enhancing Teaching Skills through Repeated Practice
L&S	04 - MT Complement or Alternative
L&S	05 - MiTeachVR vs Face-to-Face MT
L	06 - Unpredictability of Classroom Dynamics
L	07 - Creative Space for Freedom of Expression
L	08 - In the Moment Multitasking
S	01 - Safe Environment to Practice MT
S	02 - MT that is Similar but Different
S	03 - Strength - Translate Skills to a Live MT class

For example, the theme name is "Bridging the Gap between Theory and Practice", the first five sub-themes (**L&S**) are duplicated across lecturers (**L**) and students (**S**), the next three (L) relate to lecturers only, and the remaining three (**S**) relate to students only. Some of the codes were not large enough to report. After further iteration of reviewing and refining the themes the final themes, and sub-themes were decided upon as per the example in (**Table 3.7**).

Table 3.7: Final themes and sub-themes for Theme 01

Theme 01 – Bridging the Gap Between Theory and Practice
Sub-Themes 01 – Linking Theory and Practice 02 – Skills Development and Opportunities to Practice - The Skill of Public Speaking - Movement and Classroom Circulation - Avatars possibly are easier to teach than Peers - Safe Supportive Practice for Building Confidence 03 – Is MiTeachVR Complementary or an Alternative to Traditional Microteaching

Analysing and reflecting on the data as described here offers insights into the data itself, but it also evidences my interpretive lens in this qualitative inquiry.

3.11.2 Pencil, Paper and Sticky-Notes

Earlier, I presented my rationale for using NVivo to explore the interview data. However, the questionnaires and observations, which accounted for a small portion of the dataset, were analysed manually using pencil, paper and colour highlighters, and sticky notes. I also used MS Excel to quantify the demographics and MS Word to take notes and report on the data. According to Braun and Clarke (2022), the way you code depends on a number of factors, including researcher ability and circumstances. I felt, that because of the format of the data (paper sheets and forms) manual analysis was more appropriate. Although this process was very time-intensive, I also felt less removed from the dataset.

3.12 Research Quality

Research quality refers to the standards set by the researcher that determine the reliability and ensures credibility in the research process. Researchers are responsible and accountable for the standards of their own work (Brancati, 2018; Flick, 2023). In the following sections, I discuss my position as an insider researcher, address Validity and Reliability, and Reflexivity, concluding by detailing quality using a pilot study.

3.12.1 Insider Researcher

I regarded my role as an insider-researcher as one of privilege. An insider researcher is someone who conducts research within the group, community or organisation in which they are a participant member (Braun & Clarke, 2022). Insider membership can provide advantages and challenges. Advantages can include (**1**) trust and easier access to the research participants. (**2**) Contextual understanding of the organisation. (**3**) Familiarity and rapport with the participants (Aburn et al., 2021). Potential challenges may include (**1**) power imbalances between the researcher and participants. (**2**) The possibility of bias as the researcher may struggle to maintain objectivity. (**3**) If the researcher is familiar with and understands some of the participants' experiences related to the research. Braun and Clarke (2022) caution about the importance of good reflexive practice by the researcher. I recognise my position as an insider researcher, because of my position as a DCU staff member, albeit in another school on a different campus, and fully aware of my position as a doctoral student of the IoE. To eliminate or at least reduce potential challenges that I faced as an insider researcher, I was ethical, objective and rigorous in interacting with and collecting data from the participants. For example, I only communicated with participants using my student email address, I was transparent about my dual position, I followed the research protocols, and I did not break any confidence inside or outside the research, reporting only on data pertaining to the research.

However, regardless of my values, as an insider researcher, I had to be reflexive and at all times impartial and non-influential at every stage of the research, including the preparation of the research instruments, and especially during data generation and analysis phases of this research. The following two sections explain how this was achieved.

3.12.2 Validity and Reliability

Reliability relates to the consistency of the research (procedures and instruments) and the degree to which it can be replicated by other researchers (Denscombe, 2003; Frankfort-Nachmias & Nachmias, 2008). Within qualitative research, reliability can be a challenge as human behaviour is subject to change (Willis, 2007). At various points in the research, I reflected on what I was doing and why, carefully considering if the decisions I made would introduce biases, intentional or unintentional. Validity within a qualitative research study is the procedures and means to assess that the data and methods are correct, does the data reflect the "accuracy of the findings" (Creswell, 2014, p. 201) . In this research, I have presented how multiple sources through triangulation (crystallisation) can contribute to research validity. Validity, in terms of the methods used to collect the data, asks "Are we measuring suitable indicators of the concept and are we getting accurate results?" (Denscombe, 2003, p. 301). Constructive validity refers to "the accuracy with which a case study's measures reflect the concepts being studied" (Yin, 2018, p. 286). Considering this research was exploring participants engaging with a VR system, I argue that observation was a suitable method in combination with interviews to explore the participants' lived experience. Qualitative research discusses the credibility of the findings, referring to the confidence that the data and its analysis are valid and reliable (Creswell, 2014; Creswell & Creswell, 2018). I have provided clear evidence within this research to enable the procedures to be reproduced, by being clear and transparent about how the data was collected and analysed, and the instruments and procedures are readily available in the appendices. Effectively, an audit trail exists that can be scrutinised by other researchers.

3.12.3 Reflexivity

It is not easy to focus attention on our role in the research process, especially if we have been trained in a way that places the researcher as detached, neutral and unbiased, "more of an instrument than a person" (Willig, 2013, p. 25). Reflexivity suggests that there can be no objective position for the social researcher to study the social world. What we know about the social world can never be entirely objective, furthermore a

> researcher can never stand outside the social world he or she is studying in order to gain some vantage point…which is not contaminated by contact with the social world (Denscombe, 2003, p. 300).

For Creswell (2014), reflexivity concerns the relationship between the researcher and the social world in which they are conducting research, as social world influences can shape the researcher's perspective, including interpretations they ascribe to the data. This was an important consideration, from the perspective of how I am influenced by my previous experiences, personal, social and my previous research undertakings, as they all had the potential to shape my interpretations of the methods and the data. Unlike quantitative data, the researchers' comments in qualitative research are considered an explicit part of the gathered data. My field observations, feelings, impressions, irritations and reflections on my actions became data in their own right, "forming part of the interpretation and are documented in research diaries or context protocols" (Flick, 2023, p. 8).

For the social qualitative researcher, to be neutral in the data collection and analysis would appear to be unattainable (Given, 2008). From my position as a researcher, reflexivity is important because it has made me think about the research and its findings, and its implications. Reflexivity acknowledges my role as researcher, to mitigate bias, enhance credibility and allow for transparency in this research study, I utilised field notes, a reflective journal as an audit trail of decisions as referenced earlier.

Throughout the research, I embraced opportunities to be reflexive by presenting early work in both formal and informal settings, thereby integrating the constructive feedback of experienced educational researchers and subject experts. I presented the work through two conference presentations, thereby moving the research beyond the findings detailed in this thesis and gaining valuable insight from audience interaction and external viewpoints. A further conscious decision was the submission of the work for publication, with the feedback and commentary from the peer review process significantly contributing to my reflexivity and affirming the work's validity by providing external scrutiny.

3.12.4 Pilot Study

A pilot study is a small-scale preliminary investigation conducted before a full-scale research project to aid and improve the rigour and validity of the research (Hennink et al., 2020; Quinlan, 2011). It is designed to test various elements of the research methodological procedures, instruments, equipment or any of the tools used as part of the research (Hennink et al., 2020). Its purpose was to help identify and address potential errors or problems before a full-scale research project goes live (Bordens & Abbott, 1996, 2018).

During the system development stage 01 (Alpha and Beta), a number of problems arose with the technology and the procedures, which were resolved as part of the development processes. However, to be prudent, I conducted a pilot study to check that the equipment and live version of the MiTeachVR system were working as expected, before data collection began with recruited participants. Research materials (PLS, Consent Form, Questionnaire, Interview Schedule, Instructions) and Protocols were also checked. As the researcher, with the help of three students, I worked through all the documentation, checking for errors and suitability. I observed the students using MiTeachVR and noted any difficulties they had. I had open conversations with the students and noted their feedback. Based on the feedback and my observations, some amendments and procedural and documentation changes were introduced. The piloting sessions were useful as I built my confidence in using MiTeachVR and my understanding of the difficulties participants may experience.

In summary, I recognise the influential position that an insider researcher may hold. The recognition of the importance of validity, reliability, reflexivity, and the conducting of the pilot study demonstrate how research quality was achieved in a transparent way. In the following section, I further demonstrate quality through the ethical considerations within this research.

3.13 Ethical Considerations

I agree with Walker (2010) that the main principle that should underpin our research is that participants should come to no harm as a result of participation and they should exit the research in the same condition they entered. “Ethics are the principles of what is, and what is not, acceptable behaviour when carrying out research” (Walker, 2010, p. 247). Ethical issues in research command increased attention (Behr et al., 2005), and applies equally to quantitative, qualitative, and mixed approaches, and at all stages of the research process (Creswell, 2014). I am aware that my ethical views and beliefs (alluded to earlier in the chapter) are interspersed throughout the research by the nature of the methodological approach, procedures and methods employed to conduct this research. To reduce the risk of ethical issues, I used Creswell’s matrix pertaining to ‘Ethical Issues in Qualitative, Quantitative and Mixed Methods Research’ as a guide (**Appendix M**). I found them useful at particular points when I was designing and developing the research. The key ethical points relating to participants are briefly detailed in (Appendix O). The study received research ethics approval from Dublin City University (DCU) Research Ethics Committee, DCU REC Reference (**DCUREC/2023/006**), available in (**Appendix N**).

Beyond the traditional ethical issues faced by researchers, VR technologies can add to the complexity (Skulmowski, 2023; Spiegel, 2018). In their paper, Behr et al. (2005) highlight some specific issues of concern relating to "entering and exiting VR", "exposure time in VR", and "motion sickness". I addressed these concerns by explaining what should occur when putting on and removing the VR HMD, I explained the navigation functions indicating moving slowly using the controller in the VE would help reduce the likelihood of motion sickness. I also limited the maximum VR session exposure time 15 minutes as per the research protocols, available in (**Appendix E**).

3.14 Methodological Limitations and Strengths of the Research

There are a number of limitations and strengths associated with this research, summarised here.

Limitations

The sample size is relatively small (N = 6 lecturers and N = 14 students), however it is similar to sample sizes used in other VR research. Increasing the sample size may have deepened the current insights and contributed to further understanding.

Considering that, the MiTeachVR is a prototype system and the focus on understanding PSTs' communication skills in microteaching, some features associated with other microteaching systems were missing from the study. For example, the study may have benefited from the inclusion of two-way communication between the avatars and the participants (PSTs and lecturers).

A further limitation was located in the resource and time intensity of the study, including interviewing, resource planning, especially when dealing with complex technologies, which were a challenge for a single researcher. While the insights from the data may contribute to current knowledge and understanding, they are not generalisable.

Strengths

Notwithstanding some limitations, the design and functions of the MiTeachVR classroom are strength as it created a replica classroom that participants were familiar with, and provided a safe and engaging space for PSTs to practice their microteaching communication skills.

The interviews allowed for an in-depth, detailed exploration and understanding of participants' experiences using the MiTeachVR classroom. Interviews, combined with the other data collection methods, including the observations and playback functions, allowed for a wider understanding of their experiences.

Further strengths of this research are in its well-planed design, providing a clear framework to steer the objectives. Clarity and transparency contribute to the rigour, reducing bias, and the possibility for other researchers to reproduce it. The inclusion of good ethical procedures to protect participants at various points in the study is also a strength.

3.15 Chapter Conclusion

Selecting the right methodological approach along with suitable research methods is crucial for the success of any study. This chapter provided an overview of the methodological approach employed in this study. The philosophical assumptions and principles underpinning the research design, and the rationale for the adoption of the interpretivist-constructivist paradigm were portrayed. Detailed descriptions of the qualitative data collection methods and instruments were provided, including the data analysis procedures, and the data were managed. The chapter also outlined the considerations pertaining to the research quality by discussing insider research, validity, reliability, and reflexivity. It further highlighted the importance of reflective journaling, the significance of conducting a pilot study, and addressed ethical considerations. Finally, it detailed the methodological limitations and strengths of the research.

Chapter 04: Findings and Discussion

4.1 Introduction

In Chapter Three, I outlined the data-gathering methods employed in this research, including data exploration, code generation, and the development of themes and subthemes. This chapter presents and analyses the study findings, gathered through interviews, observations, and questionnaires. The research aims to contribute to the existing body of knowledge by exploring lecturers' and PSTs' views on integrating the MiTeachVR system into microteaching as part of ITE within the IoE.

The research question provided a framework for the research:

> What are the experiences and perceptions among lectures and students when using a novel prototype immersive virtual reality system (MiTeachVR) for microteaching practice in initial teacher education in the institute of education?

To answer the research question and develop a deep understanding of lecturers' and PSTs' perspectives on microteaching in IVR, three secondary questions were developed:

1. How do lecturers and students experience and perceive their engagement with MiTeachVR as a tool for microteaching within initial teacher education?

2. How can lectures and students be supported in the introduction of the MiTeachVR system into microteaching practice in the Institute of education?

3. Based on their experiences, why would lectures and students choose to adopt or reject the MiTeachVR system?

The following sections present the demographic data, and the key findings under four main themes and subthemes that emerged from the analysis.

4.2 Participant Demographics

This section presents the essential demographic and contextual data for the participants, establishing the study's participant cohort before presenting the main qualitative analyses. The data collected via the initial questionnaire provides a basis to understand the participants' years of professional experience, traditional microteaching exposure, and VR and technical exposure. These metrics help understand the qualitative analyses based on the participants' reported experiences with MiTeachVR.

Lecturers: The group consisted of six individuals, identifying as female (3) and male (3), with an average of 11 years' experience involved in traditional microteaching, two had 20 yeas' plus experience and one was new to microteaching with one years' experience. Three participants had experienced VR before, two had experience on one occasion only, while the third participant had experienced VR multiple times and has access to a VR HMD on a regular basis. One participant indicated that they played computer games regularly in the past, but of late, their usage was minimal.

Students: This group consisted of 14 individuals, identifying as female (9) and male (5). All were taking part in or had recently completed a microteaching module. Eleven students had experienced VR before, with seven indicating on one occasion only. Two had experienced VR between two and five times, while two participants had experienced VR multiple times and stated they have access to a VR HMD on a regular basis and play VR games. Two students' indicated that they regularly played traditional computer games.

4.3 Presentation of Findings, Themes and Subthemes

This section presents the key findings, structured around four overarching themes that emerged from the qualitative interview analysis: (**1**) Bridging the Gap between Theory and Practice, (**2**) MiTeachVR as a Tool for Self-Directed Active Learning and Reflection, (**3**) Evaluating Adoption of the MiTeachVR system: Feasibility, Challenges and User Perspectives, and (**4**) Supports to Promote the Use of the MiTeachVR System. Subthemes were grouped under these overarching themes to highlight both their uniqueness and areas of overlap where relevant. Themes are supported by illustrative quotes and contextual commentary. Where appropriate, insights from questionnaires and observation data are integrated to provide clarity, context and a more nuanced understanding.

The main themes and subthemes from both groups are presented in (**Table 4.1**).

Table 4.1 Themes and Subthemes

Theme 01 – Bridging the Gap Between Theory and Practice
Subthemes 01 – Linking Theory and Practice 02 – Skills Development and Opportunities to Practice - The Skill of Public Speaking - Movement and Classroom Circulation - Avatars possibly are easier to teach than Peers - Safe Supportive Practice for Building Confidence 03 – Is MiTeachVR Complementary or an Alternative to Traditional Microteaching
Theme 02 – A Tool for Self-Directed Active Learning and Reflection
Subthemes 01 - Independent Practice Tool for Self-Directed Learning 02 - MT Home Practice Opportunity 03 - Self Reflection using the Record and Playback Function
Theme 03 – Evaluating Adoption of the MiTeachVR system: Feasibility, Challenges and User Perspectives
Subthemes 01 - Perceived Usefulness and Feasibility 02 - Factors influencing Intentions to Adopt or Reject the MiTeachVR system 03 - Potential Use of the MiTeachVR system beyond Microteaching
Theme 04 – Supports to Promote the Use of the MiTeachVR System
Subthemes 01 - Technical Support 02 - Training, Support and Continuing Professional Development (CPD)

Although I present the themes and their associated subthemes in a linear format, this does not suggest weighting in order of importance. The nature of the data set is shrouded in complexity, because of the overlap, nuances and the interconnectivity of the subject matter. The participants' voices and views are not in isolation, but represent a holistic view of the complex intersected domains of microteaching, both traditional and in IVR. The following sections present the four main themes and their associated subthemes.

4.4 Theme 01: Bridging the Gap between Theory and Practice

This theme portrays the views of lecturers and students relating to the utility of the MiTeachVR system to help bridge the gap between theory and practice. It considers how abstract ideas, theory and student knowledge are connected to real-world microteaching. Bridging the gap between theory and practice requires a combination of knowledge, experimentation and practical application, where abstract concepts and theory learned in class, are grounded through practical hands-on experience in a real-life scenario, such as teaching in a live classroom (Ferguson & Sutphin, 2022; Ledger & Fischetti, 2019), or in this research the MiTeachVR classroom. Prior studies have noted, VR when combined with the principles of traditional microteaching has been shown to be a suitable tool to bridge the gap between theory and practice (Ferguson & Sutphin, 2022; Ledger & Fischetti, 2019). MiTeachVR is a virtual classroom designed to help bridge that gap before students proceed to the live classroom. This theme consists of four subthemes (1) Linking Theory and Practice, (2) Skills Development and Repeated Practice, (3) Enhancing-Teaching Skills through Repeated Practice, (4) Is MiTeachVR Complementary or an Alternative to Traditional Microteaching. The following sections examine the identified subthemes.

4.4.1 Linking Theory and Practice

Lecturers spoke about the importance of linking theory and practice to bridge the gap between knowledge and action, making teaching theoretical concepts more relevant and applicable. Linking theory and practice ensures that theories are not just concepts residing with the student, but knowledge applied in a practical way, effectively enhancing student teaching skills and practice, equipping them for their future roles (Allen & Ryan, 1969; Bakır, 2014; Ferguson & Sutphin, 2022). Lecturers spoke about the potential of the MiTeachVR system as a platform for microteaching practice within the IoE, represented in the following extracts:

> I think its suitability is that it allows you to kind of connect that kind of theory practice aspect of learning…VR is now becoming a kind of the practice place, rather than it being a hybrid place, that it's kind of bridging what they're learning in their coursework and out in the workplace (**Lecturer 102**).

> I think it [MiTeachVR] would absolutely bridge that gap between the theory and practice…I think that would be really, really beneficial…because theory is theory. Now, you can read about teaching all day long, but until you go through it, you just don't know (**Lecturer 105**).

Lecturers articulated the need to move beyond classroom theory and apply learning principles directly to the practical aspects of teaching real-world contexts. Lecturers also indicate students do not understand the practical concepts of teaching until they experience it first-hand. In addition, lecturer (**105**) drew parallels from their own personal experience when they were training, as they encountered obstacles that they were not prepared for, explaining "I think that something like a VR headset would have really got me over those first few weeks". The narratives show that lecturers' perceive the MiTeachVR system to be a suitable device to help students' bridge the gap between theory and practice, indicating it could lead to deeper student comprehension. This finding is similar findings of other researchers in the area investigating microteaching in VR (e.g., Ferguson & Sutphin, 2022; Ledger & Fischetti, 2019), who also reported that VR simulation has the ability to help link theory to the practical application of skills development for PSTs to use in real-world contexts.

Students expressed similar views to lecturers. They spoke about the connection between the theoretical knowledge learned in class and its practical application not just for microteaching practice, but also when they qualify as teachers entering the workplace, as indicated in the following student representative extracts:

> Everything that you would learn in the classroom environment about the science of teaching can be done here [in the MiTeachVR system] (**Student 010**).

> It [MiTeachVR] kind of got me back into the knack of teaching the class. Because you do spend a lot of time in lectures and stuff as a student teacher. So I definitely think it was positive in that way that you're kind of practicing the skills that you're going to be enacting when you're qualified. I think that was definitely a positive part of it (**Student 009**).

The data illustrates that students consider the MiTeachVR classroom to be a platform where they can apply theory to practice. Students further revealed that the MiTeachVR system has potential to be a valuable tool for refining microteaching skills before they move to a live classroom environment. Student (**004**) indicated that it would enhance teaching practice "because I feel like it allows you to improve where you need to improve, before you actually go out and teach in the real world". Student (**012**) spoke about enhancing practice as "It helps you develop skills and qualities that you might not know that you had", which suggests that the discovery of new or hidden skills can lead to personal and professional growth. These findings reveal that students see the beneficial value of the MiTeachVR system to contribute to their microteaching and communication skills development. These insights and findings show similarities to other researchers using VR simulation for microteaching (Ledger & Fischetti, 2019; Mariana et al., 2023), with Ferguson and Sutphin, indicating VR helped prepare PSTs personally and professionally for their teaching experience because they had opportunities to practice and "improve their lesson materials, and practice their classroom management strategies" (2022, p. 445). Importantly, the data further highlights how MiTeachVR as a bespoke IVR system may facilitate the discovery and development of latent skills and qualities, extending our knowledge and understanding as to how VR can be used in communication skills development.

From the comments, it would appear lecturers and students recognise the value and usefulness of the MiTeachVR system as a hands-on practical tool to link theory to practice, enabling students to internalise, process and practice their microteaching skills in a manner comparable to a live microteaching classroom session. This study's analysis of lecturer and student perspectives provides empirical insights to the IVR literature as it shows similar findings by other researchers (e.g., Delamarre et al., 2021; Ferguson & Sutphin, 2022). The observed efficacy of the MiTeachVR system may indicate its role as a tool which could be useful as part of a constructivist pedagogy. This finding suggests that the MiTeachVR system may be able to facilitate active and experiential learning necessary for students to build understanding through direct engagement, as "VR allows a learner to learn by doing, a constructivist approach" (Pantelidis, 2009, p. 64).

Lecturer (**105**) discussed secondary school students entering ITE have no teaching experience, and the usefulness of the MiTeachVR system would help them practice their skills, especially since it would be their first teaching experience. Student (**009**) had a similar view as they felt the MiTeachVR system would be helpful in applying theory to practice "especially for younger students that are only getting used to teaching…and being gradually taught how to teach". Clearly, novice PSTs are going to face a number of challenges to switch from the role of being a 'secondary school student' to the role as a teacher (PST). These findings indicate that lecturers and students consider the MiTeachVR classroom as a suitable initial step into teaching practice. These insights may contribute to the findings reported by Ferguson and Sutphin (2022) in which they explain that for some PSTs in their study, the first encounter of teaching a class was using a VR simulation as "some of the participants were freshmen who had just left high school" (p. 441). They explained that the MXR simulation experience helped them feel better prepared for the real classroom experience and to begin to think professionally. The MiTeachVR environment is designed to extend beyond the MXR experiences of some simulation systems. As a bespoke fully IVR environment, it provides PSTs with a sense of presence and immersion as they are afforded the ability to stand in a full sized 360^{O} realistic classroom environment. This ability not only helps link theory to practice, but further bridges the classroom experience by mimicking a life-sized classroom thereby, creating and connecting PSTs to a realistic teaching context. This has the potential to extend our knowledge and understandings of how IVR environments may be used to enhance the PSTs experience through VR classroom presence.

The comments from lecturers and students demonstrate that they recognise the design of the MiTeachVR system may be a useful innovative tool for microteaching, to link theory and practice. Elsewhere, the practicality of the MiTeachVR system to link theory to practice is further evidenced in the questionnaire responses, Q12 asked, “To what extent do you believe the MiTeachVR is a practical tool in microteaching?” On a 10 point Likert scale, the scores were high with lecturers (8.17) and students (9.07), demonstrating that they perceive the MiTeachVR system to be a practical tool for microteaching practice. MiTeachVR is a novel IVR prototype system and the empirical data suggests that it may have practical value in its capacity to facilitate the application of theoretical knowledge while students practice their communication skills in an IVR classroom environment. Lecturers and students perceived that the fully immersive nature of the MiTeachVR system could help enhance PST preparedness for real-world classroom contexts, and effectively bridge the gap between theory and classroom practice. This study used a fully IVR system, and the data shows similarities to the findings of Ledger and Fischetti (2019) who reported that PSTs felt that VR simulations enhanced their preparedness for real classroom environments, effectively connecting theoretical learning with practical experience to enter the workforce. The data reveals that lecturers also recognise the value of VR for preparing PSTs for real-world classrooms, which is similar to the findings reported by Ferguson and Sutphin (2022) revealing that PSTs instructors noticed improvements in students’ readiness to teach. Participants suggest that the MiTeachVR system has a role to play in linking theory to practice, which is crucial for effective communication skills development because it provides a context and meaning to learned concepts. VR may allow a deeper understanding and skill development through practice, as learners actively construct meaningful knowledge from their individual experiences (Huang et al., 2010). It can also contribute to extending and nurturing PSTs hidden potential, skills and qualities. The data broadly adds to other

VR simulation literature (e.g., Ferguson & Sutphin, 2022; Fischetti et al., 2022; Ledger & Fischetti, 2019; Mariana et al., 2023), by expanding our understanding of how IVR similar to the MiTeachVR system can be utilised to link theory to microteaching practice to build teaching and communications skills.

In summary, the findings demonstrate that participants expressed favourable views on the possible effectiveness of the MiTeachVR system's ability to help bridge the gap between theory and practice by enabling the practical implementation of teaching theories within an IVR classroom. They recognise the potential of the MiTeachVR classroom for PSTs to move beyond theory and experience teaching in a classroom environment. Further indicating the skills they practice in IVR microteaching are the skills they will enact in a live classroom when they qualify.

4.4.2 Skills Development and Opportunities to Practice

The successful application of linking theory to skills development in teaching practice creates a sense of accomplishment and increases positivity, as students develop and refine their skills and teaching ability, which ultimately contributes to building student confidence (Bakır, 2014; Ledger & Fischetti, 2019). Confidence permeated in a number of areas under different guises throughout the interviews, but was largely associated with skills development. Lecturers spoke about skills building as a crucial aspect of professional development in ITE. There is a general sense from lecturers and PSTs that the MiTeachVR system may be a suitable tool for students to practice and develop their skills, structure their teaching (lesson plans), practice communication skills, public speaking, and movement and classroom circulation. The findings suggest that skills development in IVR may build self-efficacy and resilience, thereby increasing student confidence in their own ability as teachers, as evidenced in the following lecturer extracts:

> I think certainly for those first levels of microteaching where it's around that **confidence building in presenting**, getting used to the actual **skill and structure of teaching** and how it works. It [MiTeachVR] is very good for their **confidence and self-efficacy**…it's become like a cliché, but that resilience piece is really, really, important for students that they can trust

> themselves that they know they can do it and that they can demonstrate to themselves that they can do it (**Lecturer 106**).
>
> This [MiTeachVR] gives them a chance to actually build their confidence as a person at the top of the room who is a facilitator **moving around a room and allowing them to develop that themselves**. I think it will enhance their experience (**Lecturer 105**).

These sentiments highlight the possibility of MiTeachVR to increase teaching competencies, confidence and self-efficacy, similar to findings reported by Ledger and Fischetti (2019) whose participants expressed support for Microteaching 2.0 VR technology and its capacity to improve their confidence and readiness for real classroom contexts. In general, lecturers considered the MiTeachVR system to be a suitable useful tool to help build student teaching skills, especially in the early stages of ITE, also evidenced earlier in 4.4.1. These current findings are similar to the pedagogical rationale advanced by Dawson and Lignugaris-Kraft (2017), regarding the necessity of developing foundational teaching skills in novice teachers. Their work highlighted the potential of virtual classroom simulation for accelerated improvement in targeted skills compared to real-world classroom practice. This research shows similar findings indicating that IVR simulation may be an effective method for skills acquisition. Consequently, this study's empirical results may contribute to existing knowledge by underscoring that simulated environments like the MiTeachVR system may be of strategic importance for providing the scaffolding required to advance PSTs toward subsequent, more complex skills development.

Students expressed similar views to lecturers about the potential of the MiTeachVR system, as they understood it to be a useful tool to help build their teaching skills, with the following representative extracts. Student (**006**) stated, "You could use it to try out different teaching strategies and skills…before you actually do it with students". In addition, "it would instil even more confidence in me to go forward with my teaching practice or a lesson plan or my methodology or the structure of my class" (Student **010**).

These participant comments indicate the possible potential of the MiTeachVR system to help towards developing foundational skills and strategies while increasing PST confidence. These insights are similar to other researchers (e.g., Dawson & Lignugaris-Kraft, 2017; Ferguson & Sutphin, 2022; Ledger & Fischetti, 2019; Zhang et al., 2024) who also found that practicing teaching and skills development in safe low-risk virtual simulations helped build PSTs' confidence and efficacy. Simulation offers a low-risk opportunity for students to practice with virtual students (avatars), providing an authentic teaching experience promoting growth, personal and professional, en-route to becoming a teacher (Ferguson & Sutphin, 2022). The findings show that lecturers and PSTs see the utility of the MiTeachVR classroom for PSTs to develop their skills, trial new teaching strategies, movement and classroom circulation, which are obviously important for PST development.

As a cross-reference the questionnaire responses further evidence the belief of lecturers and students the MiTeachVR system's usefulness to develop and enhance pre-service student teaching skills. Q11 asked, "To what extent do you believe the MiTeachVR system would be useful to improve student (your) teaching skills?" On a 10 point Likert scale, the scores were high with lecturers (8.00) and PSTs (9.14), indicating a strong belief that the MiTeachVR system has potential to help to enhance and improve student teaching skills. Written comments included "I think the MiTeachVR System is a great tool for students, as future teachers, to practice teaching skills in a controlled environment" (**Student Q009**), with lecturer (**Q102**) commenting that it was a good way for students to "engage in practical experiences and support the opportunities for professional learning for students".

The findings reveal that students spoke about the usefulness of the MiTeachVR system for repeated practice and self-correction, as they could practice skills, make errors and self-correct, while also practicing their skills and trying out their teaching material, as exemplified in the following representative student extracts:

> You can only make it better by doing it once, twice, three times. It's going to get better… learning it and repeating, learning, repeating. If I had that space, that space is positive (**Student 002**).

> You can just pop it on and do it [practice microteaching in IVR], and you can trial and error all the time. If it's not going well, you can go back and start again (**Student 008**).

> It allows me to make mistakes, but I can self-correct those mistakes as I go along (**Student 010**).

These findings also tie closely to the concept of personalised learning, allowing learners to tailor their learning to their own unique needs, interests, what matters to them and their learning style (Smith, 2017). Kavanagh et al. (2017) report that VR has the potential to provide self-paced learning where students can potentially repeat lessons multiple times without requiring an instructor. VR is a promising tool for providing repeated practice and feedback for foundational skills (Dawson & Lignugaris-Kraft, 2017)

From the comments repeated practice and self-correction of errors are clearly important to PSTs. VR allows PSTs to make mistakes in a less pressurised environment without the fear of negative repercussions (McGarr, 2021). Students further explained, opportunities for repeated practice and self-correction would help develop and improve their skills, and increase their confidence, because "it makes you feel more confident in your teaching" (**Student 003**). With another student stating, "It does build up your skills and your confidence, not just for assignments, but for your future, when you enter a teaching role" (**Student 012**). The findings demonstrate that the students can see the possible benefit and usefulness of the MiTeachVR system for skills practice. Clearly, students consider developing skills and error correction as part of microteaching practice and continuous professional development is crucial as it improves mastery, with stronger, more reliable performance. The ability to repeatedly practice in a safe environment is clear benefit of IVR technologies (Hamilton et al., 2020). According to Ersozlu et al (2021) virtual simulation can provide repeatable experiential learning opportunities for PSTs to practice, furthermore it can provide opportunities for immediate feedback from an experienced tutor. The MiTeachVR system can record the microteaching session, allowing PSTs to review their performance in multiple cycles of practice and review.

The following exemplar from (**Student 015**) who used their participation in this research as a vehicle to practice their microteaching skill and class material in preparation for a traditional microteaching session later that week as part of their microteaching module. They also spoke about the limited opportunity to practice before a traditional microteaching session and could see the usefulness of the MiTeachVR system for practicing their microteaching skills, commenting:

> I would say it's a very useful tool for practicing your microteaching. I know in my own experience when I've done microteaching. I've just had to practice it in my room [at home] and you can imagine that it's quite hard to do on your own. So, it was very useful to practice [in the MiTeachVR classroom] and I know for my course and probably a lot of teaching courses, you don't get a whole lot of practice before you actually are put in the classroom (**Student 015**).

This extract from student (**015**) revealed the importance of repeated practice for skills based learning, before students go into the traditional live classroom. This student has clearly demonstrated part of the microteaching cycle by Allen and Ryan (1969) as they (1) planned their lesson, (2) taught the lesson using their microteaching skill in IVR, (3) reviewed the recorded session to self-reflect and evaluate. At the end of the session, the student was able to re-plan their session and complete further practice, before going into the traditional live microteaching classroom.

In summary, the data presented here is based on empirical evidence demonstrating that lecturers and students believe that the MiTeachVR system has utility to help students develop their teaching skills in IRV. Through trial and error, self-correction and repeated practice, MiTeachVR may be able to contribute to students' professional development and confidence. They also consider that skills practiced in IVR can transfer to the live classroom.

As part of this subtheme, four tertiary themes will be discussed under four headings (**1**) The Skill of Public Speaking, (**2**) Movement around the Classroom, (**3**) Avatars are easier to teach than Peers, and (**4**) A Safe Space to reduce Fear and Anxiety.

4.4.2.1 The Skill of Public Speaking

Lecturers spoke about the importance of public speaking, paralanguage and the need for students to hear their own voice as part of skills development, especially in the early stages of ITE. Paralanguage refers to the non-verbal elements of communication that accompany speech and help convey meaning (Padilla Cruz, 2023). One lecturer explained for students new to teaching it is important to get them comfortable speaking and using their own voice. They need to:

> hear how they speak, their own tone, or you know, the volume of the voice, because there is a huge negativity around public speaking, and students say I was terrible at doing it (**Lecturer 104**).

Lecturer (**103**) indicated that a large part of being a teacher is about speaking in public as "most tasks all have an element of speaking". Lecturer (**105**) further expanded PSTs will be working "in environments where they will have to speak up". Speaking is a fundamental communication skill because it has a direct impact on PSTs' ability to teach, engage, and encourage students, ultimately shaping the learning experience for their students (Allen & Ryan, 1969; Bakır, 2014; Remesh, 2013).

There is a general sense from lecturers that the MiTeachVR classroom has potential for students to practice their speech and the art of public speaking. Lecturer (**101**) stated the MiTeachVR system would be useful for students "as a device to get comfortable with speaking to a possible audience". These views align with Ferguson and Sutphin (2022) and Ledger & Fischetti (2019), who reported that VR was a practical tool for improving communication skills, public speaking, developing language skills and increasing confidence.

The skill of public speaking was a concern for several students, indicating that they and other students can sometimes find it difficult to speak in front of a class, which can impede their progression and confidence. Many students believed that practicing in the MiTeachVR classroom before moving to a live classroom environment would enhance their presentation and public speaking skills. They felt by practicing in IVR would improve their abilities, reduce anxiety, and boost their confidence, making them more prepared for public speaking in real-world classroom environments, as represented in the following student extracts:

> I think it [MiTeachVR] would help a lot of people with their confidence, or people who might struggle speaking in front of a group. It may help build them up (**Student 004**).
>
> So I feel like for lots of students, it [MiTeachVR] would help in getting over the fear of presenting in front of people…once they go into the actual classroom, [em] they'll be much more comfortable doing the actual sessions (**Student 006**).

Expanding on this another student gave a more in-depth explanation:

> When the student teacher that doesn't have the confidence to openly, freely speak in a live classroom. Its human nature and this tool [MiTeachVR] would help alleviate the problems of those elements of human nature or it could **<u>enhance and instil that bit more confidence.</u>** Take the student teacher who can't project their voice that well or they're very soft spoken. If they had maybe a little bit of time with this [MiTeachVR], it would build up that confidence and get them going with, voice projection or their clarity, as they are moving around the classroom (**Student 010**).

As this student quote demonstrates, participants also believed that improving their presentation and public speaking skills would directly enhance their teaching effectiveness when they transitioned to either traditional microteaching or a live classroom. Ferguson and Sutphin (2022) reported similar findings, indicating that when PSTs practiced their lesson and public speaking skills in a virtual simulation prior to live teaching, they felt less nervous, built confidence, and improved their public speaking. This reduction in nervousness also boosted their confidence in lesson delivery.

It is clear that speech and use of paralanguage is an important skill. To provide a more comprehensive and nuanced understanding of participants speech and paralanguage in the MiTeachVR classroom, I employed observations and review of the playback data using two codes related to the participant's use of their voice (**E11** Voice (pitch, tone, and clarity) and **E02** Hesitancy) to obtain a richer understanding of the phenomenon. In summary, the majority of participants used their voice well during the session. They did not display any level of hesitancy beyond what could be considered normal in a traditional lesson delivery. All spoke with a clear voice and changed tone throughout the session. From the playback data, it was clear that the participants were speaking with a very clear voice and had a good flow.

The combined empirical evidence from the three data sources adds to current knowledge by demonstrating the MiTeachVR classroom may have capacity to function as a supportive and useful tool for the development of PST public speaking skills as part of microteaching. These findings reinforce the work of Zhang et al. (2024), who reported that IVR microteaching training yields measurable improvements in PST efficacy and targeted teaching competencies in some areas including questioning, posture, and language skills, over traditional microteaching training. The data from this study may indicate that virtual simulation could be an effective platform for fostering skill acquisition and transferability across a range of essential instructional domains. The data reveals that both lecturers' and students' perceive a benefit in practicing public spearing in the MiTeachVR system. A key benefit of VR in education is in the area of soft skill learning and enhancement by affording students the opportunity to learn through experience, with one application 'Virtual Speech' designed for practicing public speaking showing positive results and is in use in some HEI's for the purpose of improving student communication skills (Palmas et al., 2019; Thompson, 2024).

4.4.2.2 Movement and Classroom Circulation

The combined influence of proxemics (how people use space and distance) and kinesics (body language, movement and gestures) is highly important during teacher-student interaction, particularly the teachers physical movement and position within the classroom environment (Asún-Dieste et al., 2020). A teacher's appropriate utilisation of nonverbal communications skills, in particular kinesics, can play a crucial role in student success, as these strategies significantly influence both student learning outcomes and foster a conducive learning environment (Sajjad et al., 2023). Lecturer (**103**) highlighted the importance of classroom movement, by problematising the static nature of some teachers within the classroom:

> It's one of the biggest problems for teachers in schools anyway, locking themselves to the whiteboard and the desk particularly, and movement is such a key communicator [em] to students for empathy, for helping students relax, for classroom management purposes. Moving towards a student, maybe who's troublesome and talking too much usually does the trick (**Lecturer 103**).

Further comments from lecturers and students spoke about the importance and opportunities for movement in the classroom, as represented in the following extracts:

> It is a space where a student can explore and understand their own challenges within it. And they can get feedback around movement…It could enhance their experience by moving around the [virtual] room as they would in a [real] classroom (**Lecturer 106**).

> Because I think, your movement in the class definitely determines what kind of teacher you're going to be. From my experience, that if you're a teacher that just kind of stays where they are, stays stationary the whole class, [and] is only looking to bridge to a certain audience, whereas if you are able to even practice moving around the classroom in MiTeachVR, you're able to get to every student. And if you reach every student, that's a great day's teaching (**Student 009**).

The literature suggests movement and classroom movement and circulation is an important skill for PSTs to master, the empirical evidence from this study adds to the body of knowledge pertaining to classroom movement and circulation. The MiTeachVR environment supports teacher classroom circulation and movement, which play a vital role in shaping teaching practices, student interactions, and student learning. Therefore, it is an essential skill that PSTs should actively utilise in the classroom (Shapiro et al., 2024), as it allows them to monitor student activity, break down barriers, and connect with students (*Classroom Management Skill - Circulation*, 2023).

The MiTeachVR system adds an extra dimension over other classroom VR simulation systems, as it enables users to teleport, navigate and walk naturally within the IVR classroom, further adding to our understanding of VR classroom simulation for development of communication skills. Walking in the real world translates to kinaesthetic movement in the IVR environment, creating a sense of fluid natural movement and realism. Some students walked in the physical world as per the representative extracts:

> It teaches to kind of walk around instead of just standing in one place. To project your voice as well, in the classroom. And to get more comfortable with standing in the classroom (**Student 005**).

> I would lean more towards walking around myself rather than moving myself around, rather than with the controllers (**Student 016**).

Student (**012**) spoke about moving in the MiTeachVR classroom indicating “You could walk around the classroom. [em] You could walk in between students”. Subsequently, they stated “I stayed in the one spot, I didn't walk around [in the physical world], so that's something that I need to improve on”. The observation data confirmed this, indicating the student used the hand controllers to navigate. Crucially, the student’s awareness of this lack of physical movement is important, if they are to use MiTeachVR to help improve their skills of movement and classroom circulation.

Although the real-world physical space was obstacle-free and the VR protection guardian activated inside the HDM, a small of students indicated they felt disoriented and uneasy walking in the physical space while using the VR HMD for fear they would collide with an object in the real-world physical space outside VR. These students preferred to use the controllers to navigate and teleport in the MiTeachVR classroom, further indicating it was a positive experience. Student (**007**) spoke about moving around the VR classroom to move between the aisles, between desks and to the presentation board, but they indicated, “You haven't got the natural walk”. Some students felt nervous, as per the representative extract:

> When you are walking around the room, I think I was a bit nervous. So I think I probably moved a bit more in the physical microteaching rather than in the VR (**Student 008**).

These findings are important as Shapiro et al. (2024) highlighted the significance of understanding that teacher movement is key to effective classroom management.

To provide a more comprehensive and nuanced understanding of participants movements in the MiTeachVR classroom, I employed observations and review of the playback data using two codes related to movement (**E01** Hesitancy and **E02** Confidence) to obtain a richer understanding of the phenomenon. The study data showed the majority of participants did not hesitate to move around, using a large portion of the physical classroom, which translated into movement in the virtual environment. Participants moved up and down the “Aisles”, toward the back of the classroom and then returned to the front “Teacher Desk Area” at the top of the VR classroom. In contrast, a small number of participants did not move around the physical classroom, remaining primarily within a three-meter area. However, playback data revealed that these participants did move around inside the IVR classroom – primarily using the hand controllers rather than physically walking in the full area.

These insights are important to our understanding of how PSTs move around the virtual classroom. Classroom circulation is highly important as it helps establish and maintain a positive classroom culture allowing PSTs to support students and build positive relationships (*Classroom Management Skill - Circulation*, 2023). The ability of the MiTeachVR system to enable PSTs to practice moving naturally within the virtual classroom environment, was considered a key advantage by participants because it increases their awareness, enhances their ability to interact with students and manage the classroom effectively. Other microteaching VR studies (e.g., Ferguson & Sutphin, 2022; Ledger & Fischetti, 2019) used VR simulations that did not require the user to navigate the environment by physically walking in the real-world. In their research Seufert et al. (2022), used a prototype IVR system that employed hand controllers to navigate and teleport in the classroom. Riecke and Zielasko (2021) Describe two methods of navigating in IVR, “teleporting” and “locomotion”. Teleporting is instantaneous, and lacks flow, because there is no time to experience the journey, transition, or mental/spatial switching, however minimal effort is involved to reach the desired target position. Continuous locomotion from real walking or controller-based movement takes time, it allows the user to experience and process the journey, plan the direction, velocity and speed, and it also requires effort and sustained attention. They do not allocated advantages or disadvantages, as they indicate it depends on the goal, desired user experience and individual preferences. This is important to our understanding of how PSTs will perceive movement and classroom circulation in the MiTeachVR classroom and the learning they derive from the experience.

Effective classroom circulation is a classroom management skill that creates and maintains a safe supportive learning environment (*Classroom Management Skill - Circulation*, 2023). The findings from the three sources of data demonstrate novel evidence of the MiTeachVR system's possible capacity to support PSTs in developing practical classroom management skills, specifically the crucial ability to practice classroom movement and effective circulation within IVR. However, while the results establish the MiTeachVR systems utility, there are limitations, which require further investigation.

4.4.2.3 Avatars possibly are easier to teach than Peers

Teaching in front of avatars has been shown to ease PSTs nerves and boost confidence in their teaching ability (Ferguson & Sutphin, 2022). Teaching avatars may be easier than teaching real students, because VR environments provide a controlled safe space for PSTs to practice (Delamarre et al., 2021). In this study, students compared teaching avatars in VR to teaching in a live classroom, indicating that teaching avatars is easier because it removes the complexities of teaching peers, by helping to build confidence, before PSTs face the unpredictability of the real-world classroom.

> I think teaching in it [MiTeachVR] is better because you can always be a bit **more confident** in getting your material out [delivered], because **you know you are not speaking to people who could necessarily criticise** you (**Student 001**).

The above extract portrays the feelings of some students who expressed feeling less confident when teaching and speaking in front of their peers, because they felt uncomfortable and nervous. However, they felt more at ease teaching the avatars in the IVR classroom as opposed to real life teaching with their peers. They felt teaching avatars was less intimidating, reduced fear and anxiety, while increasing confidence, as indicated in the following representative extracts:

> You know in the back of your head it is not real people, so you don't feel as pressured that it needs to be fast or it needs to be a certain way, like. **You don't have a fear that somebody's watching you** (**Student 005**).

> It [the MiTeachVR system] allows you to practice it [teaching] and perfect yourself maybe a lot more than you would have in traditional microteaching, but **also you don't have the**

> **other side of maybe getting nervous as you would with real students sat in front of you** (**Student 004**).

The findings demonstrate that students have a preference to teach avatars over their peers during a microteaching skills session. They expressed that they experienced a sense of nervousness, fear and anxiety when they have to speak publicly or teach in front of a class, especially their peers. The concerns raised by students' are consistent with that of Özonur and Kamish who found that during peer microteaching practice sessions "Pre-service teachers express that they mostly experience fear of making a mistake and being criticized" (2019, p. 1228), and they considered it a negative aspect of microteaching. It has been shown that these negative fears can be reduced, with Bakir (2014) reporting that practicing microteaching skills including tone of voice, speaking correctly and fluently helps PSTs build self-confidence by reducing their fear of making mistakes during practice exercises.

Some students commented about the mismatch between the age of their peers and the target ages of the students they portray in a traditional microteaching session. Students further revealed teaching peers acting as younger students in a live traditional microteaching session was unrealistic as their peers were of a similar age to themselves, and added to increased levels of anxiety, as illustrated in the following extracts:

> [MiTeachVR can] increase your confidence, because when we did microteaching with our peers, it was a little awkward because you have to treat them like 13 and 14 year olds and talk to them like they are children (**Student 015**).
>
> I think a lot of us, we find it nerve-wrecking teaching in front of our peers, more so than it would be in front of kids. (**Student 013**).

Similarly, from a VR perspective, Ferguson and Sutphin (2022) found that some PSTs in their study felt that the avatars did not accurately portray the students they were likely to encounter in a real classroom, making the session seem unrealistic. Interestingly, participants in this current study did not perceive the age of the avatars in the MiTeachVR classroom as an issue. A possible explanation for this outcome might be attributed to the avatars cartoon-like features, which likely rendered them relatively age-neutral in their appearance. This finding warrants further investigation in the development of future classroom VR environments. Echoing the views of students, two lecturers felt that in the early stages of microteaching it would probably be easier for students to teach a class of avatars, before going into a live traditional microteaching classroom with peers acting as students as illustrated in the following extract:

> I think as a student, it will be less intimidating if you are teaching avatars. You know if it is just you in the room and you are teaching to the avatars, if you are delivering a session, so it might be something that would be very useful for you to practice your microteaching (**Lecturer 101**).

Clearly, lecturers based on their experience recognise the challenges faced by PSTs as they begin their teaching journey. The findings presented here are similar to the work of Özonur and Kamish (2019) who reported PSTs expressed that teaching peers created stress and anxiety due to their close relationships, which sometimes reduced motivation. Griffith (2016) describes some of the benefits of peer microteaching, indicating that it offers PSTs opportunities to work collaboratively to solve and learn from a teaching problem, discuss the planning of lessons, while also engaging with theory. The preference to teach avatars in the initial stages of microteaching may relate to fear, anxiety and lack of teaching experience as students may be less confident in their ability to teach to a class of peers. Teaching avatars has been shown to ease student anxiety, diminish fear, and foster confidence and self-efficacy (Ferguson & Sutphin, 2022; Larson et al., 2020; Ledger & Fischetti, 2019). Using avatars instead of human students has ethical advantages, because it allows PSTs to make mistakes without impacting a human student, which promotes learning that is applicable to later performance in a live classroom (Delamarre et al., 2021).

Teaching avatars may be perceived as less complex and easier than teaching real-people, as PSTs can build confidence in lesson delivery and classroom movement with artificial students. However, teaching real people is necessary and the next logical step for the PST. Student (**008**) explained that while teaching avatars feels real in VR, they stated, “it's nothing in comparison to when you're in front of people”. Teaching avatars can be considered as a scaffold towards teaching real people in real classroom environments, with Mariana et al., reporting "Microteaching 2.0 technology offers a teaching practice process that follows actual classroom conditions to develop students' ability to teach before meeting face-to-face with real students" (2023, p. 571). While avatars can simulate some cues, they lack the spontaneity of real human interaction and in some instances avatar "behaviors are scripted by the vignette scenarios" (Delamarre et al., 2021, p. 24). Teaching real people provides an authentic experience for PSTs to practice and build their communication skills. This in turn builds and refines PSTs ability to read and respond to social signals in real people. Communication competence is one of the most important elements of ITE, as the quality of teaching process is determined by the quality of communication and teacher-student social interaction (Zlatić et al., 2014). The MiTeachVR classroom affords PSTs to practice their communication skills while teaching avatars in an IVR environment without the need for external human interaction. MiTeachVR is clearly viewed by both lecturers and students as a novel tool that supports and builds PSTs' confidence while simultaneously reducing the nervousness and anxiety often associated with teaching peers.

In summary, the findings demonstrate that both lecturers and students recognise that some students lack confidence and are uncomfortable teaching peers. Teaching avatars was considered less intimidating. Leveraging the MiTeachVR classroom as a stepping-stone for communication and microteaching practice with avatars has potential to enhance skills and build student confidence needed to transition to teaching real students or peers and reduce feelings of anxiety.

4.4.2.4 Safe Supportive Practice for Building Confidence

PSTs often experience anxiety when they have to teach a class of students as part of their placement or microteaching session (Ferguson & Sutphin, 2022; Matoti & Lekhu, 2016; Theelen et al., 2022). Many students spoke about fear and anxiety when faced with the prospect of having to complete a traditional microteaching session, indicating fears related to classroom management and communication skills. These concerns were also reported by Matoti and Lekhu (2016), highlighting areas that cause PST anxiety included classroom management (e.g.: concerns about class control, lesson preparation, attending to student needs, misbehaviour). Under this theme, the issue of having to stand up in front of peers was also raised, discussed earlier.

Student participants spoke about the MiTeachVR classroom as a 'safe space', with student (**002**) indicating it was "a positive safe place to practice microteaching" and student (**004**) revealing "it builds confidence in people". Other students had similar comments, as represented in the following extract:

> I think it [MiTeachVR] would enhance people to be more comfortable with their teaching, because when you start teaching and you do your first microteaching, it is very nerve wrecking. ***<u>Doing it in virtual reality, I felt ten times more comfortable</u>***. And I do feel for the next time I get up in front of a classroom, a real classroom, I will be a lot more comfortable after practicing in the virtual reality (**Student 012**).

This empirical finding is similar to the work of (Ferguson & Sutphin, 2022), confirming that PSTs felt more comfortable and experienced a reduced levels of anxiety when practicing in a VR environment, particularly if it was there first time to teach in a classroom like setting. In a similar thread, lecturer (**106**) spoke about the MiTeachVR classroom as a safe space for students to practice building their skills and increasing their confidence:

> It is a safe bounded space…that gives them the freedom to express themselves in a way that possibly they don't have when they're nervous coming into microteaching first...I think it could really enhance a student's experience in terms of having that security that they're actually working with the materials they've developed and they're working with their own kind of worries around teaching rather than being in a more live classroom where there's individual people (**Lecturer 106**).

In their VR study Delamarre et al. (2021) indicated a trial-and-error approach in the classroom can lead to uncomfortable classroom negative learning experiences. However, they suggest that structured support can help reduce negative challenges and foster a more positive environment that enhances learning. From the findings, it would appear that the MiTeachVR system is considered a safe environment for PSTs to practice, which might help reduce their levels of fear and anxiety, as they gain confidence by developing their teaching skills before transitioning to a real-live classroom.

Drawing from the data the evidence indicates that having a safe place for PSTs to practice might help reduce their levels of fear and anxiety, as they gain confidence by developing their teaching skills. Lecturer (**105**) spoke about fear and anxiety indicating that the MiTeachVR system was a "safe place that would be beneficial for students who are anxious". The findings show that both students and lecturers believe that the MiTeachVR system would be beneficial for PSTs to practice, in a safe environment, build confidence and reduce their anxiety. These findings are similar to the findings of Ledger and Fischetti (2019) who also reported that VR is a safe space for practicing microteaching as it provides a low-risk environment for PSTs to practice repeatedly, build confidence and teaching efficacy before transitioning to a real-world classroom.

Another area that raised anxiety for PSTs was being assessed during their traditional microteaching sessions. Lecturer (**104**) indicated that some PSTs very often feel they did not do very well in their microteaching session, stating, "Students often have the expectation that they've done terrible". Matoti and Lekhu, reported similar findings indicating "evaluation by lecturers is perceived to be a major source of stress" for PTSs (2016, p. 306).

Extra time to practice was an area that arose. Lecturer (**105**) explained that some students' often ask to do a "practice run" with them before they are assessed in a traditional microteaching session, as a way to avoid mistakes and build confidence. While the lecturer tries to facilitate students with extra practice sessions, they explained "all that external time that I give students, not every lecturer can give it". Similarly, while using VR simulation Ferguson and Sutphin (2022), reported that students often expressed a desire for additional opportunities to practice, while teacher educators found it difficult to orchestrate more time for students to practice and apply learned theory in a safe low-risk space.

Obviously, facilitating students in this way contributes to the lecturer's workload, and may create an expectation that other lecturers should provide similar out-of-hour's commitments. Lecturer (**103**) considers the MiTeachVR system as a stepping-stone, as indicated earlier. Lecturer (**105**) further elaborates, as they considered that the MiTeachVR system as a solution sitting between theory and traditional microteaching, with the benefit of saving lecturer time on practice runs, helping students practice their skills independently and build their confidence. Lecturer (**106**) said, "I think that would save a lot of time. It would also help students". These insights may indicate the possible utility of the MiTeachVR system as a practical tool for skills practice in microteaching and confidence building. These sentiments and insights are reflected in the literature revealing that VR allows PSTs to practice somewhat independently in simulated risk-free environments (e.g., Delamarre et al., 2021; Ferguson & Sutphin, 2022; Fischetti et al., 2022; Ledger & Fischetti, 2019; Mariana et al., 2023).

While not prevalent in the data, some participants suggested that the ability to practice using the MiTeachVR system might reduce the chances of dropping out, as detailed in the following extracts. Lecturer (**105**) spoke about student performance in traditional microteaching sessions and stated, "Students really struggle and it can cause them to drop-out". This insight was not raised in other lecturer interviews. However, one student mentioned the subject of student attrition saying:

> I believe if this [MiTeachVR system] keeps going and kind of keeps growing, it could very well improve the whole experience for students. And maybe it will get more students ***to stick with the course and like stick with what they want to do*** [teaching] (**Student 006**).

I asked if they believed the introduction of the MiTeachVR system would, help to reduce student dropout rates, for which they replied, "I think it kind of would" (**Student 006**). They further expanded if students felt comfortable and had the opportunity to practice before assessment in a live traditional microteaching session that would help their confidence, as seen in the following extract:

> I feel like it would be preparing them that bit more [em] in their own kind of comfortable environment…rather than just {em} saying here you do a little bit with a class and then you go off on placement (**Student 006**).

These insights were unexpected and must be viewed with caution, especially as attrition was not a topic readily revealed in the literature accessed for this research. It would appear that these two participants are suggesting that the MiTeachVR system may be useful to provide more opportunities for students to practice, improve academic success, and confidence, and therefore possibly reduce attrition rates. However, attrition and retention in terms of PST, teacher education has been investigated in an Irish context by Keane et al. (2023), relating to underrepresented groups in ITE, and by Lysaght et al. (2017), relating to PSTs' expectations for teaching as a career. The reasons given by these authors for retention and attrition of PSTs were complex and had no direct connection to microteaching. A study examining academic success among PSTs in ITE programmes highlighted that dropout rates and retention of PSTs was complex and multi-causal, with a combination of factors including PSTs' lack of engagement, lower verbal ability, lack of intrinsic motivation and external factors including financial constraints as well as alternative study choices (Weissenbacher et al., 2024). Some studies (e.g., Ferguson & Sutphin, 2022; Fischetti et al., 2022; Ledger et al., 2018) have shown an increase in PST confidence and self-efficacy resulting from practice in immersive simulation and VR. Practicing microteaching and communication skills in the MiTeachVR system may increase PSTs self-confidence, which may influence retention rates. Attrition, did not feature predominantly in the participant interviews, however it is important to report on it here, as it may warrant further investigation in future research.

This research contributes to the understanding of immersive learning environments by demonstrating a shared belief among lecturers and students in the MiTeachVR system as an introductory training tool for PSTs to practice their microteaching and communication skills. One of the perceived benefits of MiTeachVR centres in ability to provide a safe space that supports PSTs in reducing performance anxiety, enhancing self-efficacy, and building confidence through practice.

In summary, PSTs, when faced with the prospect of completing a traditional microteaching session, often experience heightened anxiety and uncertainty (Matoti & Lekhu, 2016). Lecturers and PSTs indicated that practicing in the MiTeachVR classroom would enable extra practice, which may reduce anxiety and build PSTs confidence before they enter a real classroom. Practicing in IVR may contribute to improved self-confidence (Ledger & Fischetti, 2019); which may contribute to increasing retention and reduce attrition, however this will need further investigation.

4.4.3 Is MiTeachVR Complementary or an Alternative to Traditional Microteaching

Rapid technological evolution and trends in recent years have brought transformational change to educational systems (Stavroulia & Lanitis, 2019). The use of VR in ITE has supplemented PSTs experiences allowing them to experience realistic classroom scenarios, practice teaching and reflect on their teaching actions in a safe place (Delamarre et al., 2021; Ledger & Fischetti, 2019; Stavroulia & Lanitis, 2019).

This subtheme explores lecturers and students views to understand if they consider the MiTeachVR system as a complementary or alternative tool for microteaching practice. VR simulation classroom environments can be used to supplement and enhance traditional teaching (Dawson & Lignugaris-Kraft, 2017). Alternative methods replace or have the potential to substantially change traditional teaching methodologies, for example the flipped classroom (M.-K. Lee, 2018; Reidsema et al., 2017). In general, lecturers and students spoke in positive terms about the MiTeachVR system throughout the interviews, highlighting many of its benefits and usefulness, while alluding to some of the shortcomings. However, they were very specific indicating that the MiTeachVR system was not an alternative or direct replacement for traditional face-to-face microteaching. Traditional microteaching is fundamentally associated with face-to-face in-person interactions (Allen & Cooper, 1972a; Hama & Osam, 2021). Lecturers expressed concerns about the current prototype of the MiTeachVR system. While its capabilities were demonstrated in several areas, it fell short in others. They highlighted the lack of avatar interaction within the IVR, as the avatars are unable to speak or engage interactively, which they considered a potential drawback to the development of students' microteaching skills. Representative comments include, “you're not getting feedback on yourself” Student (**001**) and “in a physical classroom you can interact more with students” (**Student 016**). The findings also revealed, there was no opportunity to adapt to change within the classroom, with lecturer (**105**) indicating that in a live-class you need student "responses so you can adapt and change how you teach or pick up on cues and you can't get that from VR". With Lecturer (**101**) stating, "I think you have to get a response from people. Otherwise, it's not microteaching". In their study Seufert et al. (2022) reported similar findings indicating the lack of avatar interaction and dialogue was a disadvantage reducing natural interaction in the VR environment.

Additionally, there were concerns regarding the PST feedback provided after a MiTeachVR session. Lecturers compared how PSTs receive feedback from a teaching expert after a traditional microteaching session, indicating that the MiTeachVR system was not able to provide detailed feedback, as per the following representative extract, "What they are learning from feedback on their [traditional] microteaching, I don't know whether that [MiTeachVR] would be suitable" (**Lecturer 104**). The lecture indicated that the type of feedback provided after a traditional microteaching was in person with a lecturer or microteaching tutor, and replaying the session would not give actual feedback. However, the MiTeachVR system can allow the lecturer or tutor to review the recorded session and provide feedback. Constructive feedback is important for PSTs after a microteaching session as it helps to provide praise, advice, error correction and contributes to building self-efficacy, and confidence (Allen & Ryan, 1969; Bakır, 2014; Griffiths, 2016), but this would entail adopting how the MiTeachVR system is embedded into microteaching.

Notwithstanding the identified shortcomings, the findings reveal that lecturers consider the MiTeachVR prototype may suitable for use as a complementary microteaching tool, as per the following representative extracts. "I do think it's a very good idea as a supplementary or complementary piece (**Lecturer 106**). With lecturer (**103**) stating, "I think it could be supplementary. I think you need to do both. I don't think it could fully replace it [microteaching] until the technology could catch up". This lecturer is indicating that with advances in technology, that that in the future it may be possible to develop a system that may replace traditional microteaching. In their systematic review of language learning, Dhimolea et al. (2022) conclude that VR technologies should be considered as a supplemental tool.

Students expressed similar views to lecturers, as they felt the MiTeachVR system should not be a direct replacement for traditional microteaching, however, they expressed their desire to see it as a complementary tool, as represented in the following extracts, “I think it is an addition, not an alternative just yet” (**Student 008**). They also indicated its usefulness by alternating it between traditional microteaching sessions, “you could do both. You could have a microteaching live and you could have a microteaching VR session” (**Student 002**), with student (**006**) stating that they would like to see the MiTeachVR system used “together with actual face-to-face, as it would be beneficial for the class as a whole”. Another representative extract indicated, “I don't think you should fully replace it [traditional microteaching] because like I said you don't get that instant feedback (**Student 001**), from peers and lecturers during a traditional microteaching practice session.

Face-to-face communication is important in education as it fosters deeper verbal and paralinguistic engagement, allows for immediate feedback, creates stronger connections, and enhances the overall learning experience (Bagheri & Mohamadi Zenouzagh, 2021; Bakir et al., 2020). It is particularly significant in the context of skill-based courses (Eklund & Isotalus, 2024). In their study, Kemp and Grieve (2014) indicate that their students preferred to engage in face-to-face in class discussions. In this study, if faced with a choice to practice their skills in IVR or in a traditional microteaching classroom, the majority of students clearly indicated they would prefer the face-to-face traditional microteaching. This is in stark contrast to earlier comments when they expressed a preference to practice in IVR, as they felt it would be less intimidating, less anxious and more comfortable in the MiTeachVR classroom, however direct replacement appears not to be an option, as per the following representative extracts:

> I think it is more of an alternative than a substitute. I think, in my personal view, that nothing replaces face-to-face learning…I definitely think the two can go hand-in-hand (**Student 009**).

> If I was offered, you can do all your microteaching classes in VR, or you have to pick either all VR or you have to pick all human. I would pick all human. But, if there was a mix, I would definitely like to enjoy developing my skills in the VR space (**Student 002**).

The findings demonstrate that lecturers and students see the MiTeachVR system not as a direct replacement for microteaching practice, but as a complementary tool. The UNECSO report on 'Technology in education', cautions, that "To help improve learning, digital technology should not be a substitute for but a complement to face-to-face interaction" (GEM Report UNESCO, 2023, p. V). These findings are reflected in the work of Dawson and Lignugaris-Kraft (2017) who indicated in their study that the VR simulation they employed was to supplement traditional didactic instruction and field experiences in ITE. It was utilised to contribute to repeated practice and feedback, and not considered a replacement but as a complementary tool.

In summary, lecturers and students did not see the MiTeachVR system as a replacement for traditional face-to-face microteaching practice. Instead, they see it as a useful tool in conjunction with traditional microteaching. If pressed they would choose traditional face-to-face microteaching over IVR. It is clear that the MiTeachVR system has a role in microteaching education similar to other VR simulation systems described by (e.g., Ersozlu et al., 2021; Ledger & Fischetti, 2019; Mariana et al., 2023), and may have potential for further development, although its use as a direct replacement of traditional microteaching in ITE is unclear.

4.4.4 Summary of Theme 01

The emergent data from this theme demonstrates lecturers and students believe that the MiTeachVR system is a useful tool that may benefit students by allowing them to practice their microteaching communications skills in a safe VE. Students spoke about their fear of public speaking in front of their peers, as they also felt uncomfortable. Students explained that they were more at ease teaching avatars, which they felt would help them when they transitioned to live teaching with real people. There was a similar comment from one lecturer who felt that teaching in the MiTeachVR classroom would be less intimidating for students especially in the early stages of microteaching.

Lecturers and students felt MiTeachVR was a safe space for students to practice microteaching, helping to reduce levels of fear and anxiety, while building student self-efficacy and confidence.

4.5 Theme 02: MiTeachVR a Tool for Self-Directed Active Learning and Reflection

This theme portrays the views of lecturers and students relating to the suitability of the MiTeachVR system as a tool for self-directed learning and reflection through the lenses of usefulness (benefit), challenges, and requirements for technical support, as per the research questions. It is based on lecturers and students' experiences and perceptions of the MiTeachVR systems' suitability as a tool for independent practicing of microteaching skills in IRV. It encompasses four interconnected subthemes (**1**) Independent Practice Tool for Self-Directed Learning, (**2**) MT Home Practice Opportunity, (**3**) Self-Reflection using the Record and Playback Function, and (**4**) The Imperative of Clear Learning Objectives. Lecturers shared their perspectives on the MiTeachVR system, reflecting on its benefits, challenges, and its potential role in helping students develop their microteaching skills and engage in reflective practice. Through hands-on interaction with the MiTeachVR system, students expressed their views, highlighting its value as a tool for practicing their microteaching skills, and as a tool for reflective practice. The subthemes are explored in the following section.

4.5.1 Independent Practice Tool for Active Self-Directed Learning

Self-directed learning and active learning are important aspects of teacher development because it empowers individuals to take ownership of their learning process (Smith, 2017). Self-directed learning "is a process in which a learner assumes responsibility to control their own learning objectives" (Morris, 2019, p. 634). They have a strong desire to learn, which can be formal or informal, placing control with the learner for their own learning in areas they identify, and where they can learn at their own pace (Knowles, 1975; Morris, 2019; Smith, 2017). It works towards the personal goal of self-improvement, through goal setting, planning, active engagement and reflection.

In the transcripts lecturers spoke about the opportunities for repeated student practice, independently away from the structure of a timetabled session, explaining that the MiTeachVR system would contribute to the flexibility as to when and how students engage with their own learning and microteaching practice, as represented in the following extract:

> I think if they had the opportunity to do that [practice microteaching in IVR], that would be a huge resource because the microteaching is limited to the time when other teachers are available…So, if they could actually be in charge of their own teaching and learning in that space, I think it'd be a wonderful resource. I think if they have this resource without having to rely on timetabled microteaching only, I think it would really support them in developing that resilience as a teacher and that confidence that they can do it (**Lecturer 106**).

Students expressed they would welcome the opportunity to use the MiTeachVR system for independent practice and self-directed learning. They referred to autonomy where learners have control and responsibility over their own learning, goal setting, with their intrinsic motivation driving independent learning, as illustrated in Morris (2019), and exemplified in the following extracts:

> I would probably love to see it used where students can avail of it themselves, {like} they can avail of it just independently [referring to borrowing it or as a drip-in resource]. I think that would definitely go towards students that want to learn, and they want to get that experience behind them, that they are able to do it themselves independently…and they are able to practice themselves (**Student 009**).

Students viewed the single user design as a useful benefit, as they could practice independently without the reliance on their peers, as represented in the following extracts:

> I'd use it myself, definitely. Because once you know how to do it [the MiTeachVR system], you don't actually need anybody there (**Student 008**).

> For independent learning, yeah, more so than trying to do it in a classroom environment here [on campus] with some of your fellow students because it gives you that little bit more leeway and freedom (**Student 010**).

Students expressed clear benefits regarding the MiTeachVR system's utility as an independent, single-user system, which distinguishes it from other VR simulations that require humans to control avatars in real-time. These findings are similar to those of Pantelidis, who reported that VR allows leaners to progress over a “broad time period not fixed by a regular class schedule” (2009, p. 64), allowing students to self-select their own learning schedule.

The literature on microteaching informs that traditional microteaching sessions are purposefully shortened in duration to allow PSTs to concentrate on one skill at a time, such as class communication, circulation, questioning techniques or lesson planning. These short sessions typically of 10 to 15 minutes in duration are designed to reduce cognitive load and encourage mastery through repetition and reflection (Ferguson & Sutphin, 2022; O’Flaherty et al., 2023; Remesh, 2013; Zalavra & Makri, 2022). However, because of the shortened duration of traditional microteaching sessions “a thorough study of teaching procedures and techniques might not be possible” (Iliasova et al., 2025, p. 3). Aligning with this view, some students spoke about the shortness of traditional microteaching sessions, indicating they do not have enough time to complete the task, as illustrated in the following comments.

Student (**005**) said, “I think you feel under pressure because of the time and stuff, so you're just trying to panic and get everything in”. Student (**016**) said, in a traditional microteaching session they feel “a little rushed…you are always watching the time”. Also referring to the short time allotted to a traditional microteaching session, student (**009**) indicated that using the MiTeachVR system independently would help them with timing, because “sometimes I can get lost and go on tangents and whatnot”. These extracts suggest that students prefer to have more time to practice during a microteaching session and consider the MiTeachVR system as a potential enabler. Bakir (2014) reported the conceptual importance of time in microteaching, noting that the reduced scale is necessary to for comprehensive student participation. However, students considered the time limitation as a negative, citing the brevity of the microteaching session as a source of anxiety about completing tasks on time. The author emphasises that the short time allocated to microteaching sessions is a design and not a flaw. According to Pantelidis (2009), VR allows students to progress at their own pace, thereby making learning more dynamic and participatory. The data from this study highlights that participants consider the MiTeachVR system suitable for use as a tool for independent practice of communication skills, as it allows for the recording of longer sessions and is not constrained by institutional timetabling. The participants' views and demonstrable functionality of the MiTeachVR system directly addresses the research question regarding the benefits of independent microteaching practice in IVR.

Lecturers revealed that there was an opportunity to make the MiTeachVR system available as a drop-in-resource. This would allow students to self-direct and take ownership of their own learning by engaging with the MiTeachVR system on their own time. Some lecturers suggested it could be used as a preparatory tool before attending a traditional microteaching session, adopting the 'flipped classroom and learning' approach, where the conventional educational process is reversed allowing PSTs complete a VR session in MiTeachVR, so they are prepared before entering a traditional microteaching session (Vitta & Al-Hoorie, 2023), as exemplified in these extracts:

> If they got training on how to use it first, so yes, completely, like I said, if you had a drop-in [drop-in VR space], and they could use it to practice, fantastic, but they'd need to know how to use it first (**Lecturer 104**).
>
> Let's say they used it even before they came in to do microteaching in the real world [traditional microteaching session], I think that would give them a very, very strong foundation … we're also introducing a lot of e-learning and kind of *flipped learning*. So where a student goes home and they learn the material and then they come into the classroom and practice…I do think it could be VR microteaching (**Lecturer 105**).

Lecturers generally perceive the MiTeachVR environment as a tool having utility, as a preparatory learning platform to facilitate students learning prior to engagement in traditional microteaching sessions. Lecturers further spoke about the possibilities of saving time indicating, "If you introduced the VR headsets in the classroom {em} and they [the students] learned the material at home that would save time" (**Lecturer 105**). According to Ramirez (2018) flipping the classroom takes time and effort on behalf of the teacher, in scheduling material and planning, but from a student perspective it is worth it. This flipped method may require more preparation time from the student outside of college. Reidsema et al. (2017) explain that flipped learning is a pedagogical approach part of the flipped classroom. Learners engage in an activity to complete some preliminary learning in preparation for a structurally aligned learning activity on campus with their peers and lecturers. Learners acquire knowledge and skills and use them to address a real problem or opportunity (skills development in IVR). Structural alignment between the two activities is important if learners are to engage and the learning outcomes are to be successful. “Teachers may still provide some scaffolding in this process, particularly in first year of university” (Reidsema et al., 2017, p. 10). Using the MiTeachVR system in this way may bring efficiencies to the classroom for the lecturer and ultimately the student in how they plan their personal microteaching practice. In contrast to the view that technology can save time, Zalavra and Makri (2022), report that teachers who engaged with online teaching indicated that traditional Face-to-Face teaching was less time time-consuming. While the two technologies and delivery methods are different, the value of the VR technology MiTeachVR and its possible contribution to student learning should be considered in conjunction with time (lecturer task preparation, administration etc.); to establish what value MiTeachVR and associated methodological changes bring to student learning.

Lecturers highlighted the need for effective student training which will require support from technical staff to deliver the necessary instruction and guidance for them to use the MiTeachVR system independently (discussed later in this chapter). Some students also raised the idea of having a drop-in space for practicing microteaching in IVR, similar to the current traditional microteaching classrooms available in the IoE. As per the following representative extracts:

> A dedicated room that you could go use it [the MiTeachVR system]. And, then obviously the room laid out for it [referring to the room setup to use the MiTeachVR system – large classroom with clear floor space], that there wouldn’t be anything that you’d be afraid that you’d break or bump into (**Student 008**).
>
> If there was a room available or somewhere you could go and book, say, for example, a room in the library that had the VR system. I feel like people could go there to just even practice in their spare time (**Student 013**).

In contrast, one student was ambivalent to the concept of having the MiTeachVR system available for independent practice, indicating, "I don't know, would they [students] go if it was for an hour every week" (**Student 016**). However, this student later indicated that they would like to see the MiTeachVR system introduced "as an additional element, probably prior to the actual microteaching", referring to including the MiTeachVR system as part of scheduled traditional microteaching practice in class. This student also raised concerns relating to the suitability of the MiTeachVR system for home use, explored in the next subtheme "MT Home Practice Opportunity".

Some students indicated that the MiTeachVR system could be useful for when a student is absent from a traditional microteaching session, as they could catch up by practicing independently, with student (**003**) suggesting if they "miss out on a class or something… they're not missing out on their education". Another student indicated that on some occasions the microteaching skill scheduled for practice in the timetabled class may not take up the full allotted time "So maybe before that you could use it [the MiTeachVR System] as a way of practicing the skill first" (**Student 005**). Many students spoke about the prospect for them to borrow the MiTeachVR System, suggesting it should be possible to borrow it from the library in a similar way they borrow a textbook, as per the representative extracts:

> If it was available to me to borrow from the library system, I could take it for two or three days and then you would have to bring it back, and <u>*if there were supports behind that*</u>, I think that would be a goer (**Student 002**).
>
> If it could be available to {em} kind of borrow or use at a certain time in kind of different rooms, {em} that would help students…practice beforehand just to make themselves comfortable as well going to the actual session [traditional microteaching class] (**Student 006**).

The findings demonstrate the potential for the MiTeachVR system as a standalone tool for independent student practice and self-directed learning, considered a fundamental competence in education and for living in our modern world (Morris, 2019). Lecturers and students would like to see the MiTeachVR system available as a drop-in resource or to borrow to use on campus or at home. In a virtual or VR blended environment, the design of VR-based educational approaches, such as using the MiTeachVR for independent practice, will move learning from teacher-centred to student-centred learning (P. Wang et al., 2018). Using the MiTeachVR system for independent skill practice shifts the focus of skills learning to the student as an active participant in constructing their own learning and understanding of applying theory to the skills they are practicing.

4.5.2 Microteaching Home Practice Opportunity

La Velle (2022) identified that good practice in teacher education incorporates “connected practicum experiences” which are designed to link theoretical knowledge with practical application. Continuing the narrative of independent learning, off-campus teacher education training is widely considered as highly effective, providing PSTs with real-life experiences and meaningful learning opportunities (Cowden, 2017). Practicing communication skills using the MiTeachVR at home may have similar advantages. Analysis showed that all lecturers’ and most students’ regarded the MiTeachVR system to be a suitable device for PSTs to use at home (off-campus) to practice communication skills. Lecturers indicated that they would encourage students to borrow the MiTeachVR system for home practice, by taking it home they can “engage in the kind of practical application of their work” (**Lecturer 101**). Lecturer (**102**) would recommend and encourage students to borrow the MiTeachVR system, thereby facilitating PSTs to take ownership of their own learning by being active participants as opposed to being passive learners, commenting:

> I think I would be not only giving the student the headset, but I'd be giving them a pat on the back for the agency to take and use the headset [MiTeachVR system] (**Lecturer 102**).

Agency is the learner’s capacity to make choices, take action, set goals in pursuit of their own learning (Deschênes, 2020). It refers to an individuals’ ability to act intentionally and independently to monitor their goals, particularly within an educational context and is intertwined with motivation, agency is “integral to the students’ ability to regulate, control and monitor their own learning” (Code, 2020, p. 3). Intrinsic motivation, is an individual’s internal drive to direct actions towards behaviours that provide excitement, novelty and enjoyment, as opposed to external forces (Howard et al., 2020). Intrinsic motivation is an important part of self-directed learning. Because the learner believes in their capacity, and has a strong desire to take responsibility to plan and pace their personal learning goals (Morris, 2019). The views of lecturers are consistent with that of Pantelidis (2009), who highlights that VR encourages active participation rather than passivity in learning, because VR can motivate students through interaction and engagement.

Both lecturers and students recognised the need for students to practice independently and were cognisant that home practice using the MiTeachVR system would allow the students to practice and reinforce their learning in an environment that simulates the classroom [MiTeachVR] in the comfort of their own home, as represented in the following extracts:

> The strengths of it are…giving you the ability to practice {em} and simulate real life environments [the MiTeachVR classroom] in the comfort of your own home or place and in the comfort of your own time, I think is, really good (**Lecturer 101**).
>
> It gives them [the students] an opportunity to use a platform [MiTeachVR]…in the comfort of their own bedroom at home, where they might not be comfortable doing it in front of their peers (**Lecturer 102**).

Utilising the MiTeachVR system for home practice emerged as a potential solution, to enable PSTs to engage in independent communications skills practice away from the pressure of peers. Making MiTeachVR available for home practice would involve cost and resource implications. The IoE would need to allocate funding and resources to provide access for PSTs, or alternatively, PSTs would need to purchase their own HMDs to use the MiTeachVR environment. However, without adequate training and or capacity for PSTs to self-fund a HMD, could lead to inequities among PST education, for which Mirazchiysky (2024) cautions could exacerbate the digital divide. The extract from Lecturer (**102**) regarding peers refers to students using the VR headset while being observed by peers while using the device in a shared learning space, which contrasts with the traditional microteaching scenario of teaching directly in front of their peers. However, both are linked based on comments from lectures and students at various points throughout the interviews. (Discussed earlier in this chapter). Lecturers expressed that the MiTeachVR system has an advantage over traditional home practice methods, as represented in the following extracts:

> I remember when I was a student teacher, we would be told, stand in front of a mirror, and, you know, present a topic, or listen to your voice, or record yourself (**Lecturer 102**).

> So, in terms of traditional teaching, for example, if you're learning a presentation at home, you know, it's very dull, it's not so engaging. With the VR headset, {em} it's great...making it more interactive, thus, making it more engaging (**Lecturer 105**).

From their experiences, lecturers understand the challenges of home practice faced by PSTs. Student conveyed similar views, as represented in the following extracts:

> For our microteaching, you can't really prepare yourself properly if you're just sitting in your bedroom going through what you're going to read out or whatever. If you're actually in a simulation of a classroom environment with people [avatars]…it feels a bit more realistic than just saying it to yourself (**Student 001**).

> Having a VR headset and doing it at home in a safe space…you can do whatever you want in your own time (**Student 002**).

> I just feel {like} it is a good alternative to practicing at home by yourself. I just feel {like} it's more, it's useful (**Student 013**).

Students also recognise the utility of the MiTeachVR classroom to enable them to practice independently at home; as VR simulation "offers low-stakes training and maximize active learning opportunities" (Delamarre et al., 2021, p. 2). Lecturer (**101**) spoke positively about the MiTeachVR simulated classroom for home practice; however, they also commented that the environment felt somewhat unrealistic. This is not a view expressed by other lecturers. Regardless of this limitation, they concluded the MiTeachVR system was useful, stating:

> It is a little bit, yeah, well quite unrealistic, but at the same time, much more realistic than your bedroom, your kitchen at home. (**Lecturer 101**).

The data reveals that both lecturers and students agree that practicing in the MiTeachVR classroom offers clear advantages over practicing alone (e.g., in a bedroom, kitchen, or in front of a mirror). This preference is attributed to the inherent capacity of IVR environments to generate a sense of presence and immersion, effectively transporting students to a realistic surroundings (Coban et al., 2022; Seufert et al., 2022; M. Slater, 2018), such as a classroom. Using the MiTeachVR classroom as a home practice tool, shifts from teacher-centred to student-centred learning (P. Wang et al., 2018), where training, practice and learning is no longer restricted to the classroom (Hamilton et al., 2020), because to the adaptability and flexibility of VR (Häfner et al., 2018).

In general, students spoke positively regarding the perceived benefits and utility of using the MiTeachVR system for independent microteaching and communication skills practice at home. In addition, one student spoke about the challenges that might be associated with using the MiTeachVR system in their homes. Their concerns related to the setting up the technology at home, especially concerning the space requirements, with student (**002**) questioning, “Setting up at home…how feasible it is to set up the barriers? Is it user friendly?” referring to the guardian safety barriers to prevent users walking into objects in the physical room. In a similar vein concerning physical space requirements, student (**016**) expressed a view that is more positive stating, “Even if you didn't have the space you could just use the controllers to move around and be safe, for example, in the living room at home or something like that”. These are valid concerns by students, and align to the research question about technical support requirements. If introduced into the IOE, the concerns expressed by students could be address by providing specific user instructions and set-up guides, on-line videos, advice and training from technical staff (discussed later in this chapter).

The findings demonstrate that both lecturers and students consider that the MiTeachVR system may be beneficial for PSTs to practice their microteaching and communication skills at home. Noble et al. (2022), indicate that VR is being introduced by some institutes not only as a prescribed learning tool, but also making VR available outside the course context, in labs, libraries and other learning spaces. The empirical evidence of this study and the insights from the literature collectively indicate that the MiTeachVR system may have utility and benefits as an independent home practice device. These findings may add to the growing body of knowledge regarding VR’s role as a tool for communication and microteaching skills practice. While both lecturers and students express clear teaching and learning benefits associated with the MiTeachVR system, they also highlight several challenges that require further consideration.

4.5.3 Self-Reflection using the Record and Playback Function

Reflection is essential in ITE as it empowers PSTs to perfect their teaching and communication skills, resolve challenges, and contribute to professional development (Asregid et al., 2023). It provides PSTs opportunities to deepen their understanding of their practice (Kroeger et al., 2024). Reflection-in-action occurs during teaching, with PSTs thinking and adjusting teaching in real-time, and generally responding to class dynamics. Reflection-on-action takes place on completion of a teaching session, when PSTs analyse their performance, evaluate outcomes and plan future skill improvement (Schön, 1983). Incorporating structured reflection into microteaching contributes to understanding and professional improvement, thereby building student confidence (Donnelly & Fitzmaurice, 2011; Schön, 1983). This study offers further insights similar to the findings of Iliasova et al. (2025) who emphasise the importance of reflection in microteaching. They highlight that reflective practice is central to microteaching, because it enables PSTs to review and modify their teaching, a benefit clearly evident in this study's participant commentary. Analysis of lecturers transcripts revealed the importance of reflection for students to learn from their microteaching experience, as per the following representative extracts:

> Well, the strengths of it [MiTeachVR System] are that you can practice on your own…it simulates a real teaching environment. It records what you've done so you can play it back, watch, listen, and reflect…so that is really important (**Lecturer 101**).
>
> I think as well as a teacher and somebody, who's taught in a range of contexts, higher Ed, and primary. You know, it's good as well to kind of go into a room and teach something and then analyse it. It doesn't have to be the perfect delivery there and then. So you could actually view back that presentation to see what you did. Say, right, <pause> if I self-evaluate and reflect my own practice, where could I have brought in certain questions during that presentation? And what kinds of questions could I have asked? Could I have asked higher order thinking questions? Could I have brought in questions at the introduction? (**Lecturer 102**).

> I think that its big strength is the recording…self-reflection is always within teaching practice. And kind of *giving yourself feedback* and getting feedback from others is something we are always trying to tackle in self-reflection. {Em} *I mean, you can't be a teacher if you don't self-reflect* (**Lecturer 105**).

The lecturers provided valuable insights that emphasise the significance of recording and self-reflection in enhancing student learning, personal growth, and professional development within the context of microteaching, because reflection is an important aspect of teacher professional development (Stavroulia & Lanitis, 2019).

Reflection has been shown to be an important and useful tool for PSTs, but "video allows them to step back 'into the moment' to review their actions as they occurred in real time" (Jakopovic et al., 2024, p. 140). This is an important feature when considering the MiTeachVR for reflection, as it has the capacity to record the microteaching session for immediate or later playback and reflection. Analysis showed that students spoke about the recording function indicating it was useful and could help them improve their teaching practice by reflecting on their performance as "It will allow you to improve and see where you did well and what you could improve on" (**Student 003**). Other commentary highlighted specific areas of performance, including voice projection, tone of voice, eye contact, movement within the VR classroom, and instances where students either struggled with or felt positive about their overall presentation. Lecturers and students identified the MiTeachVR system's ability to record and play back microteaching sessions inside the HMD as a positive learning feature. This functionality indicates its strong potential as a tool for self-reflection through 'reflecting-on-action'. Because PSTs can also reflect-in-action while delivering their teaching session, the MiTeachVR system is a versatile tool that supports multiple modes of reflection, demonstrating its utility as versatile reflective tool for microteaching and communication skills practice. With lecturer (**106**) indicating PSTs can "develop their own skills, as well as reflect…The whole nature of microteaching is around the recording". The following extracts further highlight the importance of the recording function for reflection:

> The option to watch the replay, I think that's very good. You can see if you like your tone of voice, and where you can change it. You know what aspects of your presentation that you struggled with. You can watch it back and then change it in the future (**Student 001**).

> The ability for me to deliver that [MT session] and then actually to sit down at the end of it and put back on the VR headset. I can see where I was moving around the class. I could hear my voice clearly. Was it projecting? Did I interact with the students enough? So again, that part of it for me is the reflective tool. <u>*It's {like} a VR reflective tool that definitely would enhance my teaching skills*</u> (**Student 010**).

These insights further reveal the utility of the MiTeachVR recording and replay feature in facilitating student reflection and encouraging self-improvement.

Student (**010**) spoke about the ability of the MiTeachVR system to instantaneously playback their microteaching session as an advantage, with student (**007**) adding there is a strength in "being able to review your own work, not having to wait for it to be uploaded [to the VLE]…like when you are doing real microteaching". With another student saying:

> Being able to watch it back just to see what it's like. As soon as I finished that [delivered session] I forgot what I even said but then when I listened to it I could see what I was like up there (**Student 013**).

Similar to this student comment, In their study Jakopovic et al. (2024) reported that one of their participants speaking about the recorded video as part of the microteaching session stated "There is no escaping the images of yourself or the sound of your own voice once it is recorded" (p. 153). Clearly recordings of microteaching session are valuable to students. The authors further emphasises the importance of immediate feedback as it allows students to identify their strengths and areas for improvement immediately after the session, avoiding time gaps in self-reflection analysis. In their study Benton-Kupper (2001) report a participant comment stating that "there are so many little things that you can't get from other people without seeing it yourself" (p. 832). Utilising video recording for reflection and feedback, after a microteaching session, enables students to observe their own teaching, identify errors and areas for improvement (Bakır, 2014; Benton-Kupper, 2001). This current study offers an important novel insight for video-recorded microteaching, leveraging the MiTeachVR system's use of recorded 3D video within the HMD. This distinct, 3D VR recording-based approach differentiates the current findings from those of prior studies that utilised 2D VR simulation technologies or standard video recording.

These and previous studies draw attention to the importance of recordings for student reflection and learning. Some students spoke about the playback avatar, which represents the user and their movement and classroom circulation during their recorded microteaching session. Unlike a recorded video with a single static camera perspective of the student teaching, the MiTeachVR system adopts a novel approach using a simple avatar representing the PSTs. This novel approach is further extended by allowing PSTs to move anywhere in the VR classroom during the playback and observe their own teaching from multiple perspectives. Effectively the student is back in the classroom observing their avatar teaching in a life size virtual classroom. The ability of “seeing an actual avatar, to see where your hands went is good” (**Student 002**). And “you can see them so clearly with the hand movements and whether you moved around the room” (**Student 008**). A further comment reveals:

> I think it's a good tool to use. You can see yourself from, let's say, **kind of out-of-body experience** where you look {em} at yourself and see how do you move. And, do you point enough or do you engage with students (**Student 006**).

Following a similar thread, one lecturer commented:

> So I was able to stand back and watch myself on the playback of how I moved around the classroom for the first time in my life. I've never been able to do that because you physically can't be in two places at once (**Lecturer 103**).

The findings reveal that lecturers and students consider the ability to 3D recorded movement and classroom circulation as a clear benefit. The data from this study may contribute to our understanding of the benefits of replay and reflection in 3D immersive video playback. The participant commentary indicates that they see the MiTeachVR recording function as a benefit that may have utility in supporting PSTs to reflect on their teaching skills and plan for improvement. These findings may also contribute to existing knowledge from other researchers including Ledger and Fischetti (2019) who used simulation technologies for microteaching. In which they reported when PSTs have the ability to review recordings of their microteaching sessions, they are able to reflect, identify areas for improvement, and adjust their approaches accordingly. Similar findings were reported by Delamarre et al. (2021) who also conducted VR study indicating value of recording the session, playback, reflection and feedback. By taking this approach, PSTs adopt a self-directed learning approach that may enhance their ability to learn more effectively and refine their professional development. VR simulation provides a safe training opportunity and maximises active learning opportunities including reflection, and feedback (Delamarre et al., 2021), with reflection enabling PSTs to experiment with teaching strategies, incorporate feedback, and implement changes that enhance their learning outcomes (Iliasova et al., 2025).

4.5.4 The Need for Clear Learning Objectives

Learning objectives are the specific, measurable goals that describe what learners should know or be able to do at the end of a lesson or task (Muijs & Reynolds, 2018; Perrott, 1982; Stronge, 2018). They are important in the context of traditional microteaching (and in VR) because they help PSTs practice a specific targeted skill, to enhance their learning (Allen & Eve, 1968; Ledger & Fischetti, 2019), which is important as microteaching sessions are short often just 10 to 15 minutes.

There was positivity towards recommending the MiTeachVR system to students for independent learning, home practice, and self-reflection. However, concerns were raised, indicating that clear learning objectives would need to be in place to ensure students and lecturers have a clear sense of purpose:

> There would have to be *clear parameters on how they might use* it, and what they're using it for. Including a good understanding of the functionality…I think if I would say you can borrow this, it fits into the microteaching module, well, and this is what we're looking for, A, B, C and D, then absolutely experiment. But I think if they just wanted to bring it home and try it, I think it could be a recipe for disaster (**Lecturer 103**).

Linked to the research questions relating to challenges and supports required, the lecturer felt that unless there was good pedagogical planning for using the MiTeachVR system as an independent learning tool, students may not learn the intended module learning outcomes. Students may develop or practice substandard skills without the oversight of a microteaching expert. It also raises the issue of understanding the MiTeachVR system's functionality, linking to training requirements (discussed later in this chapter). Kavanagh et al. (2017) and Marks and Thomas (2021) both raise the issue of lack of specific pedagogy relating to VR and the need for the development of pedagogical guidelines. Based on this lecturers comment, it is clear that careful consideration to the pedagogical outcomes for using the MiTeachVR system will need to be examined and the relevant guidelines and parameters put in place to ensure it meets the required student learning outcomes.

4.5.5 Summary of Theme 02

The findings from this theme demonstrate the possible potential of the MiTeachVR system as a tool for self-directed learning and independent student practice. It is a flexible tool for students to practice on their own without the need to pre-arrange times and dates with their peers, making it a useful tool as a drop-in resource for borrowing on campus or to use at home. Participants recognise the recording function and it's utility in supporting PSTs to reflect on their communication skills, plan for improvement, and advance professional development. While there are clearly some advantages, some of the identified challenges require further consideration; however MiTeachVR is a flexible tool to use beyond the confines of the classroom.

4.6 Theme 03: Evaluating Adoption of the MiTeachVR system: Feasibility, Challenges and User Perspectives

Perceived usefulness is closely linked to perceived ease of use, when combined influences a user's willingness or intention to adopt a new technology, it refers to the degree to which users believe that a technology will improve efficiency, enhance performance or make a task easier (F. D. Davis, 1989). Extending this understanding from the perspective of VR and education Wong et al., defines perceived usefulness as "The extent to which a person believes that VR training will enhance his or her learning effectiveness and the extent to which that person believes that VR training will be free of effort" (2023, p. 2152).

This theme explores participants concerns and intentions towards adoption of the MiTeachVR system and is discussed under three subthemes (**1**) Perceived Usefulness and Feasibility, (**2**) Factors influencing Intentions to Adopt or Reject the MiTeachVR System, finally, I present a brief insight into the (**3**) Potential Use of the MiTeachVR system beyond Microteaching.

4.6.1 Perceived Usefulness and Feasibility

Jiang et al. understands perceived usefulness is the extent which an individual believes a certain technology can effectively support them in enhancing their learning, and "plays a key role in promoting students' actual use of VR" (2025, p. 140). Feasibility and acceptability are important considerations when implementing a new tool (Larson et al., 2020). Feasibility in terms of VR introduction in this study refers to the extent, to which it can be realistically and successfully implemented, based on perceived usefulness, acceptance, and availability of resources. Aligned with this, participant commentary in this study highlighted the potential suitability of the MiTeachVR system, as evidenced both in this section and across other thematic analyses, indicating its potential utility as a tool for PSTs to practice microteaching skills.

The data derived from the questionnaire responses provided preliminary insights as to the MiTeachVR system's possible usefulness as perceived by the participants. Q14 asked, "From your experience of the MiTeachVR system, has it met your expectations in terms of its ability to be a useful learning tool?" The Likert scores ranging from 1 to 10 were high with lecturers (7.50) and students (8.65), indicating a clear tendency that participants believe the MiTeachVR system to be a useful tool for microteaching practice. Written comments included "I think this would be excellent for teacher's confidence in their practice" (**Lecturer 105**), with student (**012**) revealing, "I felt it was very effective for microteaching. It allowed me to practice my microteaching class in a real like classroom".

In the interviews, participants also discussed the effectiveness of the MiTeachVR system to enhance and improve learning outcomes. The following comments encapsulate the views of lecturers as to the usefulness of the MiTeachVR system:

> I think it is suitable to meet some learning needs and definitely as a practice device, as a device to get comfortable with speaking to a possible audience…I think in essence and in principle, it could be very useful (**Lecturer 101**).
>
> Particularly when you're looking at the application of, teaching skills or analysing teaching approaches. In fact, actually, it would enhance their learning needs more by what would probably be currently provided because {em} it would give them the opportunity to go into a room and record and view back and assess their teaching (**Lecturer 102**).

Students also commented on the usefulness of the MiTeachVR system, as evidenced in the following representative extracts:

> It was useful because it lets you practice for what's to come down the line in a few years, like in a proper classroom (**Student 003**).
>
> It’s useful to practice before you do a session with your class or group [and] as a feedback tool to see where you may be going wrong or if you don't interact as much as you think you did (**Student 006**).

In the following extract, the student indicates that the MiTeachVR system is useful, but qualifies their response:

> If you’re just starting out teaching, it would be useful. But as you progress as a teacher…I think it would probably be limited in its usefulness (**Student 009**).

This raises the important point of determining at what point in the PSTs' training the introduction of VR practice yields the greatest benefit, and warrants further investigation.

The data from the interviews and questionnaires align, indicating that both lecturers and students perceive the MiTeachVR system as a potentially useful learning tool for communication skills and microteaching practice. This study findings are similar to other researchers in the area (e.g., Dawson & Lignugaris-Kraft, 2017; Delamarre et al., 2021; Ferguson & Sutphin, 2022; Ledger et al., 2018; Ledger & Fischetti, 2019; Seufert et al., 2022), which has shown IVR and VR simulation for microteaching to be useful for PSTs in ITE. This current study has demonstrated the possible utility of the MiTeachVR system in the following specific areas: (**1**) Skills development – through repeated practice, support, error correction and feedback. (**2**) Safe and realistic environment – MiTeachVR provides realistic life-size classrooms and avatars, creating a sense of presence and immersion in a safe space for PSTs to practice communication skills. (**3**) Movement and Circulation – through the deliberate and strategic use of the classroom space (IVR or real-world). (**4**) Reflection – enabling PSTs to observe and reflect on their actions during and after communication skills practice. (**5**) Confidence and motivation, by linking theory to practice is instrumental in improving PSTs confidence and motivation.

Participants also discussed the feasibility of adopting the system for microteaching within the IoE. Determining factors of a projects feasibility, practicality, and achievability include the availability and accessibility of resources, potential risks, time, costs and impending obstacles (F. D. Davis, 1989; Doğan & Akça, 2025; Noble et al., 2022; Pöhler & Teuteberg, 2024). Participants indicated it was feasible to implement the MiTeachVR system in its current form, as evidenced in the following representative extracts:

> Yes, but I think it takes a bit of planning, but I think you're halfway there, more than halfway there…I think the technology is there (**lecturer 103**).
>
> Yeah, I think it's feasible [to introduce] it's quite common now, so there's a chance that it's always going to be there (**Student 003**).

Lecturer (**105**) revealed they had explored and considered the possibilities of introducing VR as part of microteaching, indicating their enthusiasm, stating they “would introduce it in the morning. It’s something I have been looking at”. Indicating the prevalence of VR in education, student (**003**) stated, “I think it's [VR] feasible [to introduce] it's quite common now”. Lecturer (**104**) felt that it would be feasible to introduce the MiTeachVR system as part of a module, stating:

> I'd need a bit more training with it. And I think it would be good to incorporate, as I said, with the normal standard microteaching as well (**Lecturer 104**).

Expressing a similar view student (**102**) stated "I think it is feasible, not as a module…I think it should be introduced into a microteaching class".

Similar studies have demonstrated the feasibility of using VR simulation as part of ITE (e.g., Dawson & Lignugaris-Kraft, 2017; Delamarre et al., 2021; Ferguson & Sutphin, 2022; Ledger et al., 2018; Ledger & Fischetti, 2019). The HMD used in this research is the Oculus Quest 2, which is a readily available consumer device. Therefore, it should be possible to implement the MiTeachVR system easily, due to low-cost and ease of implementation. These relatively low-barriers-to-entry, may help promote the adoption of VR microteaching in the IoE and similar ITE institutions without requiring specialised hardware. This data is similar to that of (Seufert et al., 2022) who used an IVR system with similar hardware to the MiTeachVR system, and also indicated similar implementation feasibility. This was attributed to the use of standard, commercially available VR hardware, which is relatively low-cost and easy to implement.

Collectively, the cited studies reviewed here conclude that IVR and VR simulations are powerful tools for PST learning, offering realistic practice opportunities that contribute to skills development and reflective practice. The empirical evidence from the participant findings in this study is similar to existing research. It also demonstrates that participants perceive the MiTeachVR system to be a potentially useful and feasible addition to microteaching practice within the IoE. However, they indicate it should not be a direct replacement, but incorporated as a supplementary element of a microteaching module.

4.6.2 Factors influencing Intentions to Adopt or Reject the MiTeachVR system

Adoption of a technology refers to its acceptance and usefulness as perceived by its users. Influencing factors include, intentional behaviour to use or not use the technology, willingness and readiness to accept and use and are tied to the 'perceived usefulness' and 'perceived ease of use' of the technology (F. D. Davis, 1989; Doğan & Akça, 2025; Noble et al., 2022). Acceptance refers to the individuals' willingness and readiness to adopt and use new technologies, while commitment relates to the individuals' participation and interaction in their learning (Doğan & Akça, 2025). Wong et al. (2023) further suggests that individual traits and openness to the technology are important factors influencing user intentions.

Lecturers and students discussed various factors that would influence their decision to either adopt or reject the MiTeachVR system as a learning tool for communication skills in microteaching. Usefulness was a key factor influencing intention, lecturers and students perceive the MiTeachVR system as a useful tool, as discussed earlier and throughout this chapter, influencing their willingness towards adoption. Participants intention to either adopt or reject the MiTeachVR, it is analysed under several headings, which are explored in the next sections.

Ease of Use

In considering influencing factors, ease of use of a technology is key predictor of acceptance and intention to adopt (Doğan & Akça, 2025; Noble et al., 2022; Wong et al., 2023). Ease of use refers to perceived ease of use or effort expectancy, which relates to the psychological cost of using a new system (Noble et al., 2022). Ease of use is influenced by both the positive and the negative aspects of a technology as perceived by the user, if students "perceive technology as useful and easy to use, they are more likely to accept and adopt it" (Doğan & Akça, 2025, p. 144). For example in a VR context a user may consider the immersive nature of VR as a positive with the potential to improve learning outcomes, or they may consider technical difficulties and setup as negative aspects influencing their decision. Users are more likely to accept a new technology, such as the MiTeachVR system, if they feel the effort required to use it will deliver benefits and useful gains (Noble et al., 2022), simply put it refers to how easy, intuitive and efficient a technology is to use.

Lecturers affirmed that the MiTeachVR system was easy to use, commenting on the environment, navigation within the VR classroom, hand controllers and the PowerPoint function. Lecturers considered that the MiTeachVR system was "friendly and intuitive" (**lecturer 105**), with Lecturer (**103**) saying, "I found it really quick to adapt". A representative encompassing comment indicates:

> I think you can actually engage with it quite quickly. I think the controllers are quite easy to use and you can kind of see them in the virtual world and you can feel them. I think that the turning on the buttons and stuff within it is actually quite easy to do. {Em, so}, I think they [students] could get very used to that very quickly. So the navigation, I think works very well. It certainly works well with the presentation. I was able to move through the slides. I think it would be very easy to use it in quite a creative and dynamic way (**Lecturer 106**).

Students articulated how the MiTeachVR system was an easy tool to use, an influencing factor towards adoption. In general, students responded positively to the design and found the MiTeachVR classroom relatively easy to use, as per the representative extracts:

> I found it relatively easy…I think it took me a while to kind of get used to what buttons to use. But I think after about 10 minutes of playing around with it, you kind of get used to it fairly easy (**Student 009**).
>
> It was easy enough to use, I thought. Yeah, it was easy enough. It was my first time using VR, so I didn't know what it would be like. But yeah, I found it easy enough to use and quite helpful (**Student 004**).
>
> I think it is quite simple. Like, you can do a bit of trial and error with it (**Student 008**).

Although there were some challenges:

> Initially, it was problematic, like anything, it has its pros and cons and little glitches in software, etc. But once we got over those little stumbling blocks, I found it very user-friendly, very interactive (**Student 010**)

When asked, "If the MiTeachVR system was available to you now, would you use it?" the majority of students indicated they would use the system in its current version, as represented in the following comment by student (**010**) "I don't see why you wouldn't use it, you know, because it's such a great little tool for all sorts of reasons".

Lecturers and students identified the design elements as key factors enhancing the ease of use of MiTeachVR and influencing their intention to adopt it, as represented in the following extracts:

> It was easy enough. I think once I got the instruction, I think there might be more clarity around what the different buttons do, but there wasn't. I mean, the point and click thing is great (**Lecturer 101**).
>
> yeah, the whole thing is easy enough to navigate once you're in it, so that's good and it's quite clear how to, like the buttons to press and play (**Lecturer 104**).

> The controllers are quite easy to use…using the buttons in the VR environment is very easy…So the navigation, I think it words well (**Lecturer 106**).
>
> I thought the layout was good because it feels like an actual classroom. [em] It doesn't feel like kind of false (**Student 005**).
>
> It felt realistic…rather than moving the joystick to move…you could walk as if you're physically walking between desks (**Student 007**).
>
> I mentioned earlier, but clarity looking out through windows of trees and it's a very realistic classroom setting. You've plenty of room in it. It's big. It's airy. There's plenty of space between the tables and chairs. It's well-lit and you can move around freely (**Student 010**).
>
> I thought it was really good. It felt really real and I liked the way that you could see the PowerPoint up on the screen (**Student 015**).

These comments are significant because according to the early work of Davis (1989) and later work specific to VR by Noble et al. (2022) and Sümer & Vaněček, (2025), higher levels of perceived ease of use, indicates that a technology requires less effort to use it, this combined with higher perceived benefits and usefulness for users, as indicated earlier, is a strong predictor of acceptance and therefore intention to adopt. These comments would indicate that the MiTeachVR system is a useful tool for microteaching communication skills practice, addressing the research question.

Dedicated Space

From the literature accessed for this research, it does not appear that a dedicated open space is strictly necessary or a precursor to implementing VR, as it is not specifically mentioned. This may be attributed to the specific type of VR system (non-immersive or immersive), how it is utilised (user standing still or moving in a defined space), or if the VR system requires dedicated computer systems or a mobile VR HMD. However, it can be gleaned from the description of the VR systems used by some researchers that a dedicated space may be necessary, for example Fergson and Sutphin (2022), utilised the Mursion™ simulation system, they highlight preparation time is required by specialists in the "Mursion Lab". Similarly, ledger et al. (2018) indicated that their VR session using TeachLivE™ was conducted in a dedicated simulation room.

Lecturers and students considered having a “dedicated VR space” for the MiTeachVR system essential. This would ensure easy access to the VR headsets, allowing them to run classes with minimal set-up time and disruption. Lecturer (**104**) considered that a room that is “completely clear from obstruction…a dedicated place that’s the VR room” would be necessary. Representative comments include:

> The way microteaching is done at the moment is in dedicated spaces. I think probably having them [VR Headsets] in those spaces would be a good idea (**Lecturer 101**).
>
> A dedicated VR space…a space you can bring students, I think that would be great…and maybe someone like yourself on hand, that’s just there for support (**Lecturer 105**).

In general, students felt a dedicated space was necessary, as per the representative comments:

> I suppose if there was a room dedicated to it, I think students would use it more often because they could just go whenever they'd like or when they have time available (**Student 016**).
>
> I think it would be very important… if there was a designated section for virtual reality that someone could book that section and just practice (**Student 012**).

The data clearly demonstrates that both lecturers and students feel that a dedicated VR open space is required. A large clear open space would allow PSTs to practice classroom movement and circulation in a natural way. The inclusion of a dedicated space would require support and investment from IoE management, and may need strong justification, including the potential benefits to PSTs’ learning outcomes. Research in the area of microteaching utilising IVR and VR simulation, has shown the positive learning outcomes for PSTs, (e.g., Dawson & Lignugaris-Kraft, 2017; Delamarre et al., 2021; Ferguson & Sutphin, 2022; Ledger & Fischetti, 2019; Seufert et al., 2022). Given these known benefits, investment in a dedicated space may be beneficial for PSTs learning outcomes.

The inclusion of a dedicated space to store the VR HMD and allow students access to it was another factor influencing intention to adopt for both lecturers and students. Two students indicated a dedicated space might not be necessary, if they could borrow the equipment from the library, while this could be a solution, the students would have to locate an empty classroom or other space on campus, which may not always be possible.

System Reliability and Performance Expectancy

Reliability in the context of the MiTeachVR technology relates to performance expectancy. It refers to how a technology performs to the expectations of the user, and is key factor influencing user intentions to adopt or use a technology (F. D. Davis, 1989; Noble et al., 2022), such as the MiTeachVR system.

Reliability was a key factor for lecturers in considering adoption of the MiTeachVR system, as they discussed consistency and reliability in the MiTeachVR system hardware and software. Lectures discussed how they would need some certainty that the system was going to work, because they did not wish to commit to using a technology that was prone to failure, as represented in the following extract:

> You don't want to put all your eggs in one basket and it doesn't work for you…I'm not doing that again because I know the students were annoyed, I know I'm annoyed, I know this has cost me time. So, I think that would be really, really important to ensure that it is robust enough to be able to be used (**Lecturer 102**).
>
> Reliability. If I'm coming in and I spent half the day just trying to do {em} glitches, particularly if you've got a class there who are ready to engage. So the consistency and reliability of the system, both hardware and software, would be important (**Lecturer 103**).

Reliability was less of a concern for students and was only raised by one student, indicating that they would reject MiTeachVR if the technology was not dependable, saying "I would reject it in case the technology failed on us, like if it didn't work" (**Student 003**).

Lecturers, consider reliability as a key factor in determining their intention to adopt or reject the MiTeachVR system. They are conscious that problems with the system will take up valuable time, inside and outside class time, which could cause disruption to student learning. Having a reliable system would depend on the level and type support put in place to ensure the smooth operation of the MiTeachVR system. This may require lecturer training, technical staff availability and regular maintenance and updating of equipment including HMDs.

Access, Availability, Funding and Scalability

The findings presented here add to the findings reported by Cowan and Farrell (2023b), indicating that gaining access to HMDs was considered a barrier to using VR in ITE. Access and Availability was considered an influencing factor by two lecturers in their decision to either adopt or reject the MiTeachVR system. They raised concerns about the quantities of VR HMDs that would be required. With lecturer (**101**) indicating that "accessibility, and equitability, {like} if some people can access and other people can't in the classroom it is a problem". Having access to sufficient quantities of VR HMDs will be an influential factor for lecturers in their decision to adopt or reject the MiTeachVR system. Aligned with this, cost was considered a barrier, with lecturer (**101**) saying, "Cost, I imagine, would be the biggest barrier". Lecturer (**105**) indicated, "I think there would be some barriers in terms of [em] funding I mean, that's a key one". Kavanagh et al. (2017)., in their systematic review reported similar concerns indicating the initial purchase cost of educational VR technologies can be high, leading to many institutions may be unable to justify the expense.

Cost, access and availability is a genuine concern for lecturers if they are to commit to the introduction of VR into microteaching, with lecturer (**102**) saying, "Universities are so underfunded and everybody is fighting for a particular piece of funding…it could be a challenge". The challenge relates to securing future funding for the MiTeachVR system, which is necessary for its introduction to be successful. Lecturer (**102**) further spoke about the longevity, sustainability and scalability to meet growing teaching needs. These concerns are echoed by Kavanagh et al. (2017), who inform us the introduction and utilisation of VR in the classroom not only involves the costs associated with the initial purchase of the VR hardware and software, but on-going costs including maintenance, development, support, and training. However, Delamarre et al. (2021), Wong et al. (2023), and

Seufert et al. (2022), informs that recent developments of low-cost consumer VR technology has made VR more affordable and therefore allowing for wider integration into education environments.

If the IOE were to implement the MiTeachVR system into current microteaching as part of ITE, consideration to the initial investment in the VR technology will be an important consideration, as to will the on-going running costs associated with such a system. If the MiTeachVR system is to be developed, maintained and scaled up to meet future needs, consideration and commitment to funding are essential for success. These topics were not raised by students.

Discomfort and Cybersickness

Cybersickness is a form of discomfort associated with VR usage, resulting from a sensory conflict similar to motion sickness. It occurs when there is a discrepancy between the visual and vestibular systems (spatial orientation, head and body position and movement), caused by a incongruity between what the user experiences in IVR and their physical movements in the real world (Lawson & Stanney, 2021; Tian et al., 2022).

Most of the lecturers to a larger degree did not experience any discomfort or levels of cybersickness. Lecturer (**101**) felt a little discomfort indicating the HMD is “physically a bit cumbersome, it’s a bit heavy”. Lecturer (**106**) felt it was a little blurry, but once the HDM was adjusted, it was fine. However, they did report a slight headache at the end of the session. One student indicated that the HMD was a “bit claustrophobic…I think it would put people off” (**Student 001**). Student (**010**) stated, “I was a little bit woozy”, but indicated it was short lived. This was neither recorded or observed by the researcher during the student’s microteaching session. Zhang et al. (2024), reported that some PSTs experienced dizziness and discomfort due to the weight of the VR device and prolonged usage. These issues are not uncommon, with current or previous VR technologies, and have been reported in the literature by some researchers (Lege & Bonner, 2020; Zhang et al., 2024). However, Kavanagh et al. (2017), in their systematic review of VR in education found the number of reported instances to be low. Using similar IVR equipment to the MiTeachVR system in their research Seufert et al., (2022) indicated no instances of cyber-sickness.

Aligned with discomfort, student (**003**) stated that "sometimes it [HMD] was uncomfortable, but most of the time I didn't notice it" From the observation data this student appeared focused on the task, portraying a high level of engagement, which may have induced a level of immersion resulting in the student being unaware of the uncomfortable feeling. Other students did not report feelings of discomfort, possibly because being able to walk around the physical room may have reduced a phenomenon known as kinaesthetic mismatch, which is a discrepancy between expected and actual sensory feedback, a contributing factor causing cybersickness.

It can be concluded from the data presented that discomfort and cybersickness must be carefully considered before implementing the MiTeachVR system, to mitigate any potential negative PST experiences. These conclusions were reported in other similar studies (e.g., Lawson & Stanney, 2021; Wong et al., 2023) who determined it was crucial to allay factors that might negatively affect user experience associated with discomfort and cybersickness. Tian et al., concludes that "the best way to solve cybersickness is to profile human susceptibility" (2022, p. 1434), therefore screening before PSTs participate in VR microteaching might be an option.

Resource Intensive

The analysis shows that some lecturers considered that the using VR might be operationally complex. Two lecturers felt that setting up the MiTeachVR system could be a little resource intensive, especially if there were large numbers of students in a class, as indicated by lecturer (**105**) "What's not useful, I think, might be the set-up. If that takes a lot of time, or that if I have 30 students… I think that could be time-consuming". Lecturer (**106**) was concerned that the introduction of the MiTeachVR system may lead to additional work for lecturers, stating "we have experience…of new dimensions coming into some of our modules, and we found that the lecturer ends up doing a huge amount of additional work". Taking a different perspective, lecturer (**103**) said, “So I think it is quite resource intensive, but I think the pros outweigh the cons”. These insights add to our understanding relating to potential resourcing requirements. Ferguson and Sutpin (2022) highlighted in their study that the VR simulation (Mursion) requires appropriate preparation time by specialists to setup scenarios before PSTs can engage with the simulation. However in other studies (e.g., Delamarre et al., 2021; Ledger et al., 2018; Mariana et al., 2023) did not explicitly report on resource intensity. Clearly, VR setup and planning for class requires a level of resourcing. If adopted conversations within the IoE relating to the setup type, number of HMDs, and operational elements and resourcing will be required to ensure a smooth successful introduction.

Training and Technical Support

Training and technical support were also discussed by lecturers as an influencing factor in deciding whether to adopt or reject the introduction of the MiTeachVR system, and is discussed in the Theme 04, later in this chapter.

Virtual Reality should not be the only Option

Students discussed having choice. If they had no choice and the only option was microteaching using the MiTeachVR system, they would reject it because they feel that the human factor is important, as per the following representative extract:

> If it was the only option available, if we were to substitute that for real life, I would reject it because…it's a one-way street and the benefits of being in a real classroom, teaching to peers or actual students and other human beings, it can't be substituted (**Student 002**).

A combination of traditional microteaching and IVR microteaching was preferred as discussed earlier in this chapter. However, it is noted again here because if the MiTeachVR system is to be introduced, the student voice should be heard in any policy decisions.

Teaching Experience

One student felt that their decision to adopt or reject the MiTeachVR related to their teaching experience and at what point they were at in their PST training, as per the following extract:

> Probably the biggest factor that would affect my choice on whether to use it or not to use it would be how far I am in my teaching and what experience I have behind me (**Student 009**).

This is an interesting point, which could be a factor in the introduction of the MiTeachVR system to determining when and how it is introduced into microteaching classes. If PSTs feel they have enough relevant teaching experience, for example from traditional microteaching, or live classroom experience could influence their decision to adopt or reject the MiTeachVR system as a relevant learning tool.

The findings exhibit a tendency from both lecturers and students toward adopting the MiTeachVR system. This demonstrates their belief in its potential as a tool for communication skills practice in microteaching. They have raised a number of points which, if addressed, don't appear to be insurmountable.

4.6.3 Potential Use of the MiTeachVR system beyond Microteaching

One of the strengths of VR is its versatility and application beyond gaming and entertainment. Its usage permeates across various sectors including industry, engineering, architecture, health care as detailed in the review of the literature in chapter three. Dalamarre et al. (2021) highlights that over the past two decades VR has been used in a variety of domains utilising simulation-based training, for example: fire-fighter training, army soldier training, procedural training, safety training, and risk environment training. In an education context Sümer and Vaněček, (2025), in their literature review highlight a number of areas VR is used in HE, these include, digital learning environments, scenario-based learning using simulation, field trips, assessment, virtual labs, drama and classroom replication.

In this study most lecturers' discussed the potential of the MiTeachVR system beyond microteaching, as it is useful "not necessarily just for focusing on the microteaching component skills, but on other things" (Lecturer (**103**). With lecturers, indicating it would be useful for practicing the delivery of conference papers, class presentations, and assessment. One lecturer commented:

> Moving away from microteaching, but if you were to practice delivering a paper for a conference or to your peers or whatever. This would be a brilliant device (**Lecturer 101**).

Another lecturer spoke about an interesting opportunity to utilise the MiTeachVR system as a device to assess students outside microteaching, commenting:

> It enables them to present a certain theoretical concept in a kind of scenario that can be recorded. So rather than kind of writing an essay about how I would present a concept, or writing a lesson plan, which AI would produce for you, you actually are going in and you're actually doing that, which AI can't do for you (**Lecturer 102**).

This is an interesting point, as it appears it could be possible to use the MiTeachVR system in other modules or disciples to develop conceptual thinking. It may be useful to record an assessment or an individual presentation, which could be assessed later. Using the MiTeachVR system in this manner clearly indicates its potential beyond simple video recording, enabling nuanced interactions and deeper understanding.

Lecturer (**105**) indicated that it would be useful to help students transition from secondary school to third level, to gain confidence in general public speaking and presentation skills that they may be required to deliver as part of a module.

Further to this, PST language teachers spoke about the usefulness of the MiTeachVR system for language learning, with one student speaking about how practicing in the MiTeachVR classroom can "challenge you to use your target language, number one, to be able to think on your feet, number two" (**Student 009**). Another student commented on the usefulness for language learning stating:

> I would be able to practice teaching a lesson…or practice speaking, because I am doing languages, to practice teaching a lesson through the language that I'm teaching it in (**Student 015**).

These students see the potential and flexibility of the MiTeachVR system, to help them practice their microteaching skills through the medium of their chosen target language. Apart from microteaching skills acquisition and linking theory to practice, using the MiTeachVR system may offer an additional advantage of providing a safe space to practice language learning. VR can provide a hands on contextual learning environment to enhance learning outcomes and strengthen competence (Dhimolea et al., 2022).

According to Smyth, (2017), some approaches to teacher professional development (PD) often assume that they need external training to improve their skills. Using MiTeachVR may offer an alternative to in-school training and PD as teachers can trial and error new material or teaching approaches in IVR, using their contextual knowledge of their school. The MiTeachVR system could be available for teachers to practice in school or at home in their own time. From the lecturer and student comments, it is clear that MiTeachVR is a novel flexible system, which may have utility beyond traditional microteaching and may be beneficial in other disciplines.

4.6.4 Summary of Theme

The findings demonstrate that lecturers and students believe MiTeachVR system may be a useful tool for microteaching. This indicates its feasibility for introduction into an existing microteaching module within the IOE. However, they did not consider it to be a direct replacement for current traditional microteaching. Willingness to adopt the MiTeachVR system is predicated on several key factors. They include, the establishment of a dedicated space, demonstrated system reliability, assurance relating to accessibility and equitability, an adequate number of VR headsets and appropriate funding for to develop and maintain the system. The omission of any of these could be a barrier to adoption and lead to rejection. Highlighting the usefulness of the MiTeachVR system further, lecturers indicated its usefulness beyond microteaching.

4.7 Theme 04: Supports to Promote the Use of the MiTeachVR System

In today’s changing educational environments, the growing use of technology has enhanced the capacity of educators to develop and deliver innovative instructional approaches, creating opportunities to introduce and adopt new technology in HE (Dhimolea et al., 2022; Theodorio, 2024). Participants discussed the supports needed to facilitate the adoption and use of MiTeachVR, highlighting two key areas: (1) Technical Support and (2) Training and Continuing Professional Development (CPD).

4.7.1 Technical Support

Technical support is recognised as an essential factor to support lecturers and students with the use of current and new technologies (Pursan et al., 2023). Both lecturers and students discussed the need for technical support from a number of aspects. For lecturers technical support is an especially important factor in the early stages of new technology introduction, because equipment fails, problems can occur, and they need to be resolved quickly, as per the representative extracts:

> If the server breaks down, is there somebody there on call? Because you planned your session to do this, it's not working, and you're on your own basically. So not only have you to try and fix the system yourself, but you have to try and think, well if I don't fix it, what am I going to do?...You know when you use a digital or technical resource, you will always come up against that. So it's not new (**Lecturer 102**).

Drawing from their past experience and requirements for technical support relating to the introduction of video and audio recording equipment, used for traditional microteaching, along with current microteaching and classroom technologies lecturer (**101**) stated:

> I think it would be essential in the early stages, in the same way that it was essential in the early stages for microteaching. But, you know, all this equipment here still needs technical support. It still breaks down (**Lecturer 101**).

The data highlight the lecturers' concerns for reliable technical support to minimise disruptions during lessons. In line with this Theodorio, (2024) indicates the provision of technical support, both before and during classroom instruction, contributed to a smooth integration of technology and classroom experiences.

Lecturers indicated technical support for the MiTeachVR system should not reside with the institutions central computer support services, with lecturer (**103**) acknowledging the role of the university's central technical support but emphasised the need for local dedicated VR technical support, because:

> I think this is actually a teaching and learning resource, so you need a technological expertise in that, but you also need the pedagogical expertise (**Lecturer 103**).

The data indicates that VR is not a generic one-size-fits-all technology as this lecturer believes a requirement exists for a domain-specific technologist with VR experience, especially as they view VR to be a 'teaching and learning resource'. This finding is reflected in Theodorio (2024) who contents "technology integration in teaching is not a one-size-fits-all proposition, there is a growing recognition that support mechanisms should be interactive and faculty based" (p. 3-4). With Chalkiadakis et al. (2024) indicating the necessity of support structures when considering introducing VR technologies, because without adequate support lecturers may struggle with VR integration.

The data clearly demonstrates the requirement for technical support including pedagogical expertise is important to lecturers based on their experience with other technologies. The ubiquity of technology in education raises the question of how to integrate it with pedagogical and content knowledge. As indicated by H-Y Lee & Chung (2025), supporting lecturers to understand and apply the Technological Pedagogical and Content Knowledge (TPACK) framework offers a valuable guide for technology integration. TPACK emphasises the interconnectedness of technological knowledge, pedagogical knowledge, and content knowledge for effective technology integration to enhance learning outcomes (Bautista et al., 2024; Tschönhens et al., 2024). The data indicated that lecturers are pragmatic and somewhat cautious, as they recognise that technology can fail, they don't always know how to resolve the issue and require technical support. TPACK skills and knowledge may help them to resolve some minor issues, after which they can seek support from technical support (Bautista et al., 2024).

The data shows that lecturers consider technical support is essential in the early stages of a new technology introduction, to ensure the technology works as it should and disruptions to teaching and learning in class and minimised. Lecturers consider lack of appropriate technical support as an obstacle, with lecturer (**102**) saying, "The primary barriers are really tech support and access to support. If the system crashes and you can't use it, {like} what do you do then?" These are genuine concerns the need to be considered if the MiTeachVR system is to be introduced, because it may not be practical to access central computer services. These findings are reflected in the work of Cowan and Farrell (2023b), whose findings reported that technical support for ITE tutors was ranked the number one barrier to using VR in ITE.

Students discussed the need for technical support and how it might influence their decision to use the MiTeachVR system. Their needs diverged slightly from lecturers, as they approached the matter from a learner's perspective. In general, they indicated that they would feel more comfortable knowing technical support was available, as represented in the extract from student (**012**) “you'd feel more comfortable taking and using the device knowing that there's supports”. Analysis of student transcripts indicated the importance of having access to an on-campus helpdesk or having a technical support specialist available in a dedicated VR room or the library. This would encourage students to use the MiTeachVR system on campus, learn and understand it, and effectively use the technology, thereby addressing any misconceptions and enhancing their learning experience. Similar insights regarding supports were indicated by Theodorio (2024) who highlighted the need for pedagogical and technical support, indicating the importance of hands-on technical support for the successful integration of technology in PST ITE. Hands-on technical support may enrich the experience of PSTs by helping to familiarise them in using the MiTeachVR system, and avoid misunderstandings in it functionality and operation.

Students commented on having a remote messaging system, which would allow them to seek support off campus or out of hours, because “if people are trying to fit it in around their day, you want to be able to have access to the supports. Rather than saying, oh, that system doesn't work” (**Student 007**) which would discourage them from using it, especially if students borrow the MiTeachVR system for home practice. Student (**002**) spoke about having access to online resources for trouble shooting, and phone access to a VR technician. Student (**006**) affirmed that having available technical support would “hugely influence” their decision to use the MiTeachVR, otherwise it would deter them from using it. Because, if a technical problem arose without available technical support they felt "you would be going in and not having the proper experience. Then you would just be thinking, why would you even do it then if it is not done properly" (**Student 006**). This student suggests that the implementation of the MiTeachVR system would be incomplete without the inclusion of technical support. They highlighted the importance of technical support for effectively using the MiTeachVR system. It seems that without sufficient support, their willingness to adopt the system could be negatively impacted. In general, while indicating the need to have technical support; students also acknowledge the need for other support resources, online, phone etc. This would appear to be the type of technical and support resources they access for other technologies they use. In a review focusing on the implementation of technology in schools, Fullan and Donnelly (2013) consider that the implementation of new technologies would be incomplete if there is no technological support or if the support lacks coordination and reliability. "Poor implementation support can cause an innovation to crumble" (Fullan & Donnelly, 2013, p. 18). This may result in the erroneous use of the technology, poor troubleshooting, and possible resistance to using the technology.

It is clear from both the lecturer and student data that technical support is vital not only to encourage them to use the MiTeachVR system and support them while using the system, but also to teach them how to use it. This insight is reflected in the work of Wragg et al. (2023) whose article on "Technicians as teachers" concluded that technical staff play a vital role in supporting student learning and in some instances this can extend to teaching of some technical aspects of a subject or a technology itself, traditionally associated with academic staff. This is because of the technical knowledge and expertise of technical staff.

From my professional experience, I am in agreement with the TALENT Commission (2022) who inform that technical and academic staff do not work in isolation. This is true when it comes to student support, as technical staff support students at every level. Technical support does not just fix problems and resolve issues, it should help users to understand how the technology works and how best to use it. It also extends to supporting the users to make them feel comfortable and at easy using the technology. Technical support extends beyond finding solutions to resolve technical problems, according to Wragg et al. (2023) technical staff are performing functions beyond ‘supporting’ teaching, and are actually involved in duties traditionally associated with academic roles. In my experience, technical support builds confidence in users and empowers them in using the technology effectively. In essence, technical support is the link between the technology and the users experience, especially when issues arise or the user needs advice, help or support with a particular technology. When something goes wrong or a technology fails, technicians are problem solvers, “often in ways which require ingenuity and creativity” (Lewis & Gospel, 2015, p. 441). Beyond resolving technical issues, support may entail creating support documentation, user guides and videos, and it can extend to meeting with lecturers and students to guide them in how to use the technology. Noke et al. (2024) understands technicians “by the very nature of their role as agents orchestrating the sharing of know-how” (p. 1607). From my experience, when academic staff work with existing and new technologies, the availability of technical support is highly reassuring.

The findings reveal, lecturers and students consider technical support highly important. They suggested the following supports (**1**) Dedicated technical support with VR and pedagogical expertise, (**2**) On call phone support, (**3**) Direct messaging support system, (**4**) on Campus helpdesk support, (**5**) the creation of a User Guide and Handbook. These supports do not appear beyond what would be expected with the introduction of a new technology such IVR, and the majority could be supported by the existing technical support structures within the university. The insights and commentary from this empirical study clearly demonstrate that lecturers and students see the merit in using the MiTeachVR system, but clearly indicate the need for VR support, including technical and pedagogical knowledge. These insights add to the current VR and simulation literature.

4.7.2 Training, Support and Continuing Professional Development (CPD)

"In any profession, it is important for professionals to keep up with developments in their field of work" (Muijs & Reynolds, 2018, p. 279). Professional development is crucial for equipping educators with the skills and knowledge necessary to integrate technology into their teaching practices (Theodorio, 2024). Chalkiadis et al. (2024), indicates that inadequate training is a challenge, which can obstruct the effective use of technologies. The transcript analysis revealed that training, support and CPD were important to lecturers to ensure they understand how to use the MiTeachVR system and stay updated with the latest technological advancements in microteaching education. Lecturers indicated that they would need more time to engage with the MiTeachVR system to explore its functions and how to incorporate into their teaching, with lecturer (**105**) suggesting they could take it home "I'll bring this [MiTeachVR HDM] home. I'll go away and trial it". Beyond lecturers' own CPD and willingness to learn, this statement further highlights the possible value of the MiTeachVR system as a tool for PST home practice, since lecturers themselves recognise its potential to be used off campus. Lecturers also felt that appropriate training and CPD would prepare them to adapt to relevant changes in their profession. Lecturer (**102**) considered their participation in this research as a form of CPD, commenting:

> Rather than watching technological and pedagogical innovations go ahead of me, I want to be able to keep up with it. By engaging in these kinds of innovations and approaches, it enables me to do that (**Lecturer 102**).

Lecturers considered adequate training and time for training an essential requirement before the MiTeachVR system's introduction into a microteaching module, as per the representative extract:

> Allocating dedicated training time, committing to that time, and that everybody is aware of it…actually, everybody knows how to do this because it is part of teaching and learning… I think there would have to be some, you know, preconditions for it. Like training, dedicated time and space to do that, not just, there you go, you have got to book out the Oculus (**Lecturer 103**).
>
> Well, you would need training first to know how to use it yourself, before you could show a student how to use it (**Lecturer 104**).

> I think the technical piece and the training in the beginning is important (**Lecturer 106**).

These finding demonstrate that lecturers see a need for adequate training to provide them with the resources, knowledge and skills, before they can effectively provide support and assistance to their students in using the MiTeachVR system. Similar findings were reported by Cowan and Farrell (2023b) who reported there was a clear need for CPD and a willingness by ITE tutors to participate in training. In their systematic review Chalkiadakis et al. (2024) concluded that teachers require comprehensive training to effectively integrate VR into their teaching practices, indicating the need for supportive institutional frameworks. Lecturer (**106**) also indicated students would require training "I think they'd need training. They'll have to get a lot of training and perhaps a little bit of supervision". Lecturers and students also indicated there was a need for training materials including manuals, handbooks, online manuals, and training videos, as per this representative extracts:

> By having a handbook or guidelines and being able to use that, and having that comfort of being able to grasp that in the first time you use it, you know, will make you go back and use it again (**Lecturer 102**).
>
> So maybe if there was an introduction video to go on, when you put the headset on you can press play and it will direct you through the usage of it (**Lecturer 104**).
>
> Step-by-step tutorials and YouTube Videos would be useful (**Lecturer 105**)
>
> Probably like if I watch the video on how it works and maybe actually go into and maybe play like some of these like mini games to get used to controls and the sound and stuff like that would be quite helpful (**Student 001**).
>
> You would need videos on how to use it (**Student 003**).
>
> I think maybe like a video on how to use it. So like a video on how to set it up and then a video of what it's like inside of it, the buttons you need to press (**Student 005**).
>
> There could be worksheets, a step-by-step guide, a handbook, on-line videos and a training section on the DCU website (**Student 012**).

The data reveals the importance of having available training resources for both lecturers and students. Having access to training material empowers users to learn at their own pace and troubleshoot common problems without the need for high levels of direct technical support. These findings are reflected in the work of Farrell et al. (2022) who cited the importance for targeted training, follow-up support, and curriculum specific resources. Having training materials available would be important to support and empower students to effectively use the MiTeachVR system. In my professional experience, user training in the use of technology is essential because it spans the gap between innovation and usability. It ensures that users (lecturers and students) receive base-line training, reduces errors, builds confidence, while supporting users at various skill levels. This in turn can reduce the level of technical support required by users as they become self-sufficient as represented in the comment from lecturer (**101**) indicating that "technical support would not be required to use the system after receiving the correct training". The findings emphasises the importance lecturer CPD, technical supports and resourcing for lecturers and students. The data presented here demonstrates the importance of training and support for students and in particular, lecturers before the implementation of the MiTeachVR system in the IoE. According to Taggart et al. (2023) long-term professional learning opportunities, including on-going exposure to emerging technologies, and curriculum integration should be explored to embed VR technologies into ITE. Providing the necessary knowledge and skills for lecturers to effectively integrate technology into their teaching is essential, because appropriate support contributes to ensuring technology is used effectively. Additionally, supporting PSTs can empower them to become confident and competent technology users, driving positive change in education (Taggart et al., 2023).

One lecturer indicated the need for in-person training stating, "I think a dedicated space and someone like yourself on hand, that's just there for support, you know" (**Lecturer 105**). Some students expressed the need to have in-person training to use the VR equipment and the MiTeachVR system. However, for other participants, this was not a concern, which may suggest they felt confident in their ability to use the MiTeachVR system. These insights suggest that these students did not consider in-person training an essential priority, or an area requiring additional support. Contributing to this perspective could be the intuitive design and user-friendly nature of the MiTeachVR system (discussed earlier). Furthermore, the participants' prior experience with gaming and VR outside this research might have influenced their perception, making them less likely to see training as a barrier to using the MiTeachVR system. Prior experience may reflect their level of confidence in their ability to use the technology. However, lecturers and PSTs with limited technical experience and proficiency may require greater levels of support to effectively harness technology including VR for lesson planning, instruction and evaluation (Theodorio, 2024). The demographic data presented at the start of this chapter indicates the 11 students had prior VR experience, with two indicating they regularly played computer games. Some expressed that a training tutorial was important. Students expressed that having training resources was essential, preferring to have training materials including instruction manuals either physical or on-line, and on-line instruction videos, because “some prefer the handbook, the written form, and some prefer the YouTube video” (**Student 010**). One student suggested that a wall poster explain how to use the MiTeachVR system would be useful, especially in a dedicated VR space.

Referring to a recent VR presentation and the recruitment material for this research, this lecturer indicated that viewing two-dimensional images and screen shots of the MiTeachVR classroom do not prepare you for the immersive nature of the IVR environment, commenting:

> I saw the screenshots. I had an idea of it, but I had no idea of it until I put that headset on today. So I think the best way to learn about this is actually to immerse yourself in the technology itself. I think supplementary guides and stuff would definitely help. The more imagery, the better (**Lecturer 103**).

Student (**004**) had a similar view “I feel like it's something you need to, I can't quite explain it. That it's kind of you need to nearly try it to figure it out”. These comments and insights are interesting and understandable, due to the immersive nature of the MiTeachVR system. Participants suggest there is merit in engaging with the MiTeachVR system to fully understand its immersive nature as part of CPD training. Training on the actual technology, in this instance the MiTeachVR system, as opposed to using a generic VR simulation or abstract presentations, and user guides helps create a direct link to the MiTeachVR system through active engagement and learning by doing.

Overall, the data demonstrates a clear need for training and associated training resources. Training resources will help build competence, confidence, and user independence. Making the introduction of new technology, like the MiTeachVR system, much smoother, acceptable, and more sustainable. Professional learning can empower educators confidence and competence with technology, driving positive educational change (Taggart et al., 2023). Theodorio (2024), suggests that educators should actively engage with their colleagues and IT staff to seek the required support and guidance for the integration of technology into their teaching practices.

4.7.3 Summary of Theme

The findings demonstrate a need for technical support, training and CPD. Lecturers believed that technical support is essential if the MiTeachVR system was to be introduced into microteaching in the IoE. The requirement for technical support is crucial to minimise potential teaching disruption in the event of hardware or software problems. Lecturers highlighted VR was a teaching resource, expressing the need for a dedicated VR technologist with pedagogical expertise. Lecturers and students identified technical support as an influencing factor in their decision to use or reject the MiTeachVR system. The availability of training was considered important to support lecturers and students. Additionally, lecturers emphasised that dedicated VR training and CPD are crucial components when introducing the MiTeachVR system into microteaching in the IoE, ensuring that they do not fall behind their colleagues in other institutions.

4.8 Chapter Summary

In summary, this chapter aimed to give voice to the participants by documenting their lived experiences using the MiTeachVR system, by presenting their personal narratives throughout the thematic analysis of the interview, observation and questionnaire data. Firstly, it introduced the main themes and subthemes identified through the data analysis. Followed by exploring the four selected themes and associated subthemes.

Findings from this study illustrate the complexity and varied views participants have towards traditional microteaching and microteaching in IVR. Students practiced and reflected on their communication skills in both real world and IVR microteaching, indicating that they perceived the MiTeachVR system as a valid and useful platform for developing these skills within an IVE. Lecturers held similar views. They also spoke about the challenges, some highlighted areas for further improvement and reasons that may influence their decision to reject the MiTeachVR system. However, participant narratives were predominantly positive regarding the utility of the MiTeachVR system as a tool for PSTs to practice and potentially enhance their communication skills within the context of microteaching. The analysis of technical and support data in this study may contribute to current knowledge revealing that technical and training support is considered a key factor by lecturers and PSTs to effectively integrate the VR in ITE. In the following chapter, I present the conclusions.

Chapter 5.0: Conclusions

5.1 Introduction

This thesis presents a comprehensive research study exploring the experiences of lecturers and pre-service teachers (PSTs) as they practiced microteaching and communication skills in an Immersive Virtual Reality (IVR) environment. The study specifically investigates participants' perceptions of a prototype IVR system, "MiTeachVR," a life-sized virtual classroom environment designed for PSTs to practice their microteaching communication skills, as part of the Initial teacher Education (ITE) within the Institute of Education (IoE), at Dublin City University (DCU). It is hoped that the findings will serve as a practical resource for other researchers, lecturers involved in microteaching, and to assist in shaping policy decisions for microteaching development within the IoE at DCU. This chapter presents an overall summary of the research and the findings. It will acknowledge the limitations and finally present recommendations based on the findings.

The conclusions derived from this study stem from my reflections on the planning, actions, and observations that I made during the study as I engaged with participants (lecturers and students). The conclusions are resultant from the findings based on the experiences of participants as they used and explored the functions and capabilities of the MiTeachVR system for microteaching and communication skills practice.

5.2 Summary of the Work

The integration of digital tools into teacher education has increased in recent years, with the rapid advancement in virtual reality (VR) simulation technologies significantly reshaping how educators and PSTs learn and prepare for working in the classroom. One such area experiencing a transformation is microteaching as part of ITE.

In chapter 01, I outlined how the training of skilled teachers is of societal significance nationally and internationally, as having highly qualified experienced teachers in the classroom is deemed a high priority. Securing school placements can be a challenge for both PSTs and the higher education institutes (HEI) responsible for providing ITE. Microteaching is a well-established teacher training method affording PSTs the opportunity to participate in a scaled down teaching session. Gaining access to additional practice teaching opportunities both inside and outside the HEI can be challenging. The advancement of VR technologies has given rise to the development of purpose-built VR environments that have the potential to give PSTs the opportunity to practice in a simulated virtual classroom. Combining traditional microteaching with VR technologies appears to have potential as a further option as part of ITE. Rather than just being a technology in the classroom, VR allows the technology to become the classroom, termed Microteaching 2.0. Practicing microteaching skills in IVR environments may be a solution and a novel way for PSTs to learn and practice the art of teaching. The availability of affordable consumer targeted VR technologies provided opportunities to examine the possibility of using VR to teach and practice microteaching communication skills as part of ITE.

The overall aim of the study was to more fully understand the usefulness of a prototype IVR system, MiTeachVR, a platform designed to support PSTs' to practice and develop their microteaching and communication skills in an IVR classroom. The objective was to understand both lecturer and student experiences, perceptions, and acceptance of IVR as a tool for PSTs to practice microteaching and communication skills using the MiTeachVR system. Additionally, I wanted to investigate what supports, both technical and otherwise, would be needed to support the introduction and continued use of the MiTeachVR system into ITE within the IoE.

For this work, I had three research questions:

RQ01 – **How do lecturers and students experience and perceive their engagement with MiTeachVR as a tool for microteaching practice within initial teacher education?**

The findings from this study found that that both students and lecturers had mainly positive experiences engaging with the MiTeachVR system. They perceived it to be a potentially useful resource to help PSTs practice their microteaching communication skills. Both groups of participants expressed the design of the MiTeachVR system provided an authentic teaching experience allowing PSTs to comfortably practice their microteaching and communication skills. They perceived the design elements included in virtual classroom to be pleasing and facilitating a connection to a real physical classroom. Their experience of the user interface was positive, describing it as intuitive and easy to use. The students' perceptions further showed that the MiTeachVR classroom provided a comfortable and safe environment for them to practice and deliver their microteaching sessions. Students' reported lower levels of anxiety teaching avatars, which they perceived helped boost, their confidence in their public speaking skills. Students perceived the record and playback function as a positive experience, indicating its potential for feedback and reflection. Lecturers too had similar experiences and could appreciate the value of the recording and playback feature, comparing it to video-recording in traditional microteaching.

While there was a high level of positivity towards the MiTeachVR system based on both groups of participant's engagement, there was a small level of ambivalence towards some aspects and features of the system. Both groups of participants perceived the absence of two-way interaction with the avatars was limiting, however they felt it did not fully detract from their experience. Some participants observed that the HMD was a little cumbersome especially for people wearing glasses. A small number of participants' experienced low levels of nausea or cybersickness, but this did not deter them from engaging with the MiTeachVR system.

RQ02 - How can lectures and students be supported in the introduction of the MiTeachVR system into microteaching practice in the Institute of education?

The study findings revealed the provision of both technical and training support was deemed a necessary requirement for both students and lecturers. In the event of technical issues occurring during class time, both groups of participants expressed a dedicated technician would be required, to minimise any disruption to teaching and learning. Additionally, findings from lecturers indicated that technical support from a dedicated technician with pedagogical expertise should be considered, as they deemed the MiTeachVR system as a pedagogical tool. Findings from students highlighted that a helpdesk, a dedicated support telephone line and the introduction of a direct messaging service for VR support would be useful. They felt that these help and support systems might encourage PSTs to use the MiTeachVR system outside of dedicated microteaching class time. Further findings revealed that students would like to see the creation and introduction of an online 'MiTeachVR specific User Guide' and a Handbook, to avoid or reduce frustration or guesswork on how to use the system, enabling them to get the most out of using the MiTeachVR system. The findings from both groups deemed that a dedicated supported space should be considered, indicating it would encourage more PSTs to trial and experiment in using the MiTeachVR system to practice their microteaching and communication skills. Lecturers emphasised the importance of continued professional development, particularly within the rapidly evolving virtual reality landscape. This they felt would allow them to up skill and remain aligned with peers at other institutions using similar VR technologies.

RQ03 - Based on their experiences, why would lectures and students choose to adopt or reject the MiTeachVR system?

Based on the experiences of both groups of participants the study found that they would choose to adopt the MiTeachVR system if it was available. Participants from both groups determined that the integrated features built into the MiTeachVR system have real potential to help bridge the gap between theory and practice. Therefore, they considered it useful and expressed their desire for it to be adopted into microteaching within the IoE. Students and lecturers could see value in the MiTeachVR system, as it may be able to solve the problem of additional practice time for PSTs, again indicating usefulness and their intention towards adoption. The findings from both groups of participants revealed positivity towards the MiTeachVR as a tool for self-directed learning, both on campus and as a tool for home use. Both groups considered that it would be useful, providing PSTs with the opportunity to practice at times that best fitted with their schedule. Based on their experiences the data from both students and lecturers indicated that they would choose to adopt the MiTeachVR system as part of microteaching practice within the IoE. However, both groups of participants strongly indicated that they would reject the MiTeachVR system if it became or was introduced as a direct replacement for traditional microteaching. The findings revealed that students understood the value of in-person face-to-face teaching, which was also echoed by lecturers.

Technical support permeated throughout the findings from both students and lecturers, as they perceived it necessary. A lack of support would be an influencing factor in their decision to reject the adoption of the MiTeachVR system. Lecturers further highlighted the need for CDP in the area of VR, which may be an influencing factor towards adoption or rejection.

Overall, the findings demonstrated how IVR simulation can contribute to PSTs' opportunities to practice communication microteaching skills, thereby offering new insights and understanding of technology-enhanced microteaching.

In chapter 02, I reviewed educational and technical literature, concentrating on areas relevant to the focus of this thesis. I examined both seminal and current work in the area to understand key aspects of VR, Effective Teaching, Traditional Microteaching, and Microteaching 2.0. Firstly, I presented the history of VR and its place in society, discussing where VR it is situated in HE, by examining case studies using VR. Next, I examined effective teaching as part of ITE to draw out the attributes required for teaching in the classroom. This was followed by discussing the components central to traditional microteaching to understand how they could be mapped to microteaching in VR. Finally, I describe Microteaching 2.0, the convergence of traditional microteaching and VR simulation.

In chapter 03, I provided context to the study by describing the development and functionality of the MiTeachVR system, central to this study. I further outlined the mapping of the microteaching communication skills used in traditional microteaching and how they map in VR to the MiTeachVR system (**Table 3.1**). I also provided an overview of my role in the design and development of the MiTeachVR system. Following on, I presented the research paradigm, as I outlined how through a single-site case study design this thesis would investigate the use of IVR with two groups, students and lecturers to address the research question. Subsequently, I described the research methods, philosophical and methodological approaches used in the thesis that guided the study. Secondly, I outlined, discussed, and provided a rational for the chosen research instruments employed in the study. This was followed by an explanation of the data management and analysis used to examine the data to extract the findings presented in this thesis. Finally, I discussed data quality, ethical considerations and limitation of the methodology.

In chapter 04, I presented the findings derived from a thematic analysis of the data, while presenting the thematic themes. The data was derived from three sources: interview, questionnaire and observation (real-world and in the MiTeachVR classroom). I presented the findings and discussed them in relation to the literature and my interpretations of the participant narratives and associated data. The key conclusions are presented in the following section Contributions to Knowledge.

5.3 Contribution to Knowledge

While VR integration in ITE is not yet widespread and remains generally under-researched in an Irish context, IVR in microteaching is an even more under-researched field. This study contributes to current VR education and microteaching literature by offering insights into how microteaching and communication skills can be practiced using a novel IVR system, thereby contributing to our understanding of existing knowledge in the field. MiTeachVR is a novel custom prototype system, contextualised, and built with a specific purpose in mind as part of cross-faculty collaboration. The collaboration contributed to knowledge by integrating diverse perspectives to create a unique interdisciplinary solution. The insights learned through the development process may inform current understanding and future design elements of IVR classroom environments.

Lecturers and students used the MiTeachVR system to experience delivering and reviewing a virtual microteaching lesson. Through this combination of lecturers and students, the research gathered insights from two difference perspectives associated with practicing microteaching and communication skills in IVR. This knowledge contributes to our understanding of the requirements lecturers and students deem important when deciding on utilising an IVR classroom similar to the MiTeachVR system.

Many of the studies drawn from in this research have used virtual simulation in microteaching to: (1) to address the limited opportunities PSTs have to practice, (2) develop opportunities for reflection (3) reduce nerves and anxiety, (4) build confidence, (5) improve public speaking, and (6) improve classroom strategies. This study may contribute to this knowledge.

This study predominantly collected qualitative data with some ancillary quantitative data, in combination with observation data. This combination provided a more complete, rigorous and nuanced perspective of the phenomenon by taking advantage of the strengths of each. The collection of empirical evidence through observation generated rich descriptive contextual data about how and why participants acted in a particular way while using MiTeachVR in the field. It was also possible to compare this real-world data to the recorded VR session data to gain greater understand of the phenomenon. This approach of comparing observational data with recorded IVR session data appears novel and did not readily appear in the literature accessed for this research. The data generated through this approach adds to knowledge by understanding of how the users interacted with the MiTeachVR environment. It explained the navigation choices and preferences of users while engaging with the MiTeachVR system, for example did users walk in the physical world or use controllers to move in the VR environment. These findings are important and may contribute to existing knowledge for the future development of similar IVR systems for communication and microteaching practice in IVR.

The findings demonstrated the participants' positive attitude towards the MiTeachVR system and their willingness to use it for PSTs to practice microteaching and communication skills in IVR. Additionally, practicing microteaching and communication skills in IVR may lead to improvements in skills for PSTs. This contribution to knowledge is evident in the following sections and may contribute to previous work in the area.

Bridging the Gap - Linking Theory to Practice

A key component of microteaching is linking classroom theory and classroom practice. Bridging this gap was significant to both lecturers and students, as they considered the MiTeachVR system may be a useful tool for this purpose. It is essential that we understand the place of VR in supporting PSTs to link theory to practice. This research has demonstrated that MiTeachVR may be effective in achieving this through experiential learning, as PSTs can actively perform and repeatedly practice their communication skills in IVR. Using MiTeachVR may lead to better skills acquisition and retention through repeated practice, signifying that it is possible to link theory to practice. This, in turn, may allow PSTs to bridge the skills learned in an IVR microteaching session to a live classroom environment. This has significance for the development of ITE programmes, in terms of resources, curriculum and policy development.

A tool for Self-Directed Learning

The findings reveal that participants considered the MiTeachVR system to be beneficial for bridging theory and practice. They also appreciated the autonomy it affords for self-direct learning and independent practice. This is relevant for future insights as to how the MiTeachVR system could be used in for this purpose. Both lecturers' and students' would like to see the MiTeachVR system available as a drop-in resource or to borrow to use on campus or at home. This suggests that participants consider the MiTeachVR system may be a viable learning resource, suitable for independent practice outside the structures of the university timetable. These findings are significant because they demonstrate a desire among students for a space to practice independently. This also supports a personalised learning approach, where lecturers encourage independent practice and PSTs take full ownership of their learning. Providing PSTs with access to the MiTeachVR system gives rise to further opportunities for practice, especially when opportunities to practice are limited because peers may not be available. This has important implications as to how the IoE would resource and manage this type of technology setup to ensure equitable access for all students. It may be possible to have the MiTeachVR system available as a library resource. However, this may require specialist VR and pedagogical knowledge.

Classroom Circulation and Movement

The findings demonstrate that participants considered the ability of the MiTeachVR system to support movement and classroom circulation to be important, as it is a key aspect of classroom management. The findings from both groups of participants showed that they considered the ability to navigate and walk around the MiTeachVR classroom as a useful feature. This has important implications for our understanding of proactive PST behaviour in managing the classroom. The ability to physically walk around the MiTeachVR classroom enables PSTs to practice classroom circulation, movement and positioning themselves in various places within the classroom, rather than standing in the same position. This was considered an advantage, because students indicated that they often stand in the same position when taking part in a traditional microteaching session. This was also seen in the observation data. By moving around the room, a teacher can change classroom dynamics, encourage student engagement, and help build a rapport and trust with students. PSTs can learn to explore the classroom and consider which parts of the classroom would be more advantageous to connect with students. Practicing this skill in VR using the MiTeachVR system may contribute to improvements in classroom movement and circulation.

Fear of Public Speaking

The findings show that students expressed a fear of public speaking, which was confirmed by lecturers. This has significant implications for our comprehension of how to help PSTs, because public speaking is essential in their professional life. Poor performance in this essential skill has implications for their ability to share ideas, transmit knowledge and teach effectively. Furthermore, it can affect PST anxiety levels and confidence. The MiTeachVR system has the potential to provide PSTs with a realistic life-size environment to practice public speaking skills before teaching in a live classroom. The record and replay functionality enables PSTs to listen back to their speech. They can reflect on the volume, pitch, tone, speed and clarity of their voice, where they could learn from the process to improve effective communication skills. Building this essential communication skill may contribute to lower levels of anxiety and increase PST confidence.

Teaching Avatars is considered easier

The findings from students revealed that they felt higher levels of anxiety when faced with teaching their peers for fear of being criticised for their performance. Lecturer findings echoed those of PSTs.

These insights demonstrate that there is a need to consider other options, rather than only practice teaching directly to peers. Many PSTs felt they experienced lower levels of fear and anxiety when teaching in front of avatars in the MiTeachVR classroom as opposed to teaching in front of their peers, as they don't have to worry about making mistakes. This insight should be a consideration when we think about the initial stages of microteaching practice, because teaching avatars may have the potential to be beneficial, especially if it reduces the negative feelings reported by students while teaching a live class with real human students. However, one of the criticisms of teaching avatars was the lack of two way communications as the avatars have limited interactions and do not possess the power to speak. While trying to address fear and anxiety experienced by PSTs, we must also seek to understand the best way to prepare for in-person teaching after practicing with avatars. The findings contribute to our knowledge, indicating practicing teaching in IVR may be a useful tool to build confidence, reduce fear and anxiety for PSTs as they transition to teaching human students.

Useful Tool for reflection

Lecturers and students indicated that the recording and playback function was innovative and very useful as a method to reflect on their performance. Lecturers further indicated that reflection was a key component of microteaching, and the recording function was very helpful, contributing to student development and progression. This has important implications for our understanding of the importance of reflection and how it can be implemented with IVR. The MiTeachVR system provides PSTs with an immediate opportunity to privately reflect on their performance by reviewing their recorded session, while it is fresh in their minds. PSTs can repeat their session while making changes to improve their performance, recording and reviewing multiple times. They can reflect on their decisions, strategies and various communication skills, allowing them to connect the VR experience to pedagogical theory. While learning outcomes through self-reflection is potentially useful, the most valuable learning outcomes may come from reflection and discussion with peers and or lecturers after they review the VR session. This raises the question of how best to structure post-session reflection, which helps solidify the link between theory, practice and PST professional development.

Traditional Microteaching verses IVR Microteaching

The findings and contributions to knowledge presented here indicate that MiTeachVR is a promising tool for microteaching in IVR. While it excels in a range of areas for communication skills, participants in this study did not consider it as a direct replacement for traditional microteaching. This has important implications for our understanding of how the MiTeachVR system can be incorporated into microteaching in the IoE. Firstly, MiTeachVR would be most effective if it were integrated into the curriculum to supplement traditional microteaching, allowing PSTs to bridge the gap between classroom theory and real-world classroom practice in a safe, risk-free VE. Secondly, this research clearly identified that if PSTs and lecturers were presented with a binary choice, they would choose traditional microteaching over IVR microteaching.

Supports to promote the use of the MiTeachVR System

Support was clearly identified in the findings as paramount to the successful adoption and implementation of the MiTeachVR system into microteaching as part of ITE within the IoE. Support must be considered from different perspectives. Firstly, the provision of specialist, dedicated technical support should be considered to ensure that hardware and software are maintained and updated. Consideration should be given to having a dedicated pedagogical VR expert to work with lecturers and PSTs. Secondly, training support, including initial user training, should be provided on how to use the MiTeachVR equipment and environment. This would require learning how to put on the HMD, how to navigate the VE using physical walking movements and the hand controllers, and how to interact with objects and panels within the MiTeachVR VE. Lecturers would need to be trained on how to integrate the MiTeachVR system into their curriculum. Thirdly, on-going CPD would be important to ensure that lecturers know how to use the MiTeachVR system and stay updated with the latest technological advancements in microteaching education.

Having high-quality user resources is deemed important for lecturers and students. The IoE could consider making available a range of training and support materials, including instruction manuals, either physical or digital, and online instructional videos. Instructional posters displayed in the room or library where users can use or borrow the MiTeachVR system may encourage PSTs to use the MiTeachVR system, as would access to a dedicated VR expert who has a pedagogical understanding associated with microteaching.

The insights gained from this study, including recommendations for future work, may contribute to the understanding of IVR as part of microteaching in ITE. The contribution provides lecturers, PSTs, technical staff and policy decision makers a foundation and guide to understand IVR's place in microteaching as part of ITE in the IoE.

5.4 Limitations

While this study offered insights into practicing microteaching communication skills in an IVR simulation, I am conscious that limitations exist within the study, including constraints with the MiTeachVR prototype.

Limited Sample Size

The study was a single-site case design, conducted with two cohorts of students studying on the (BET) and (BEDLAN) programmes, which may have limited the number and range of participants. The sample size is small (14 students and 6 lecturers), may have limited the insights from both groups. Additionally, the sample may not adequately represent the broader population within the IoE.

Prototype Limitations and Constraints

MiTeachVR is a prototype IVR simulation classroom, and some of the elements typically associated with traditional microteaching could not be mapped in VR and were absent from the system. For example, the avatars lacked the ability to speak or interact with the user, beyond showing a status bubble above the avatar's head. Using the hand controllers to point and select some features was a little difficult, and using the hand controllers to pick up and write with the whiteboard marker was cumbersome. A further limitation relates to the novelty of the technology, as participants had not encountered microteaching IVR simulation previously. While novelty is usually celebrated in research, the nature of the MiTeachVR system may have increased participants' sense of innovation which may have influenced their responses.

Limited Exposure Time using the MiTeachVR Classroom

The teaching and mastery of teaching and communication skills is a complex and lengthy process. I recognise that the short exposure times participants had using the MiTeachVR classroom may have impacted their experience. The limited exposure time in engaging with the MiTeachVR system could have reduced participants' full appreciation and understanding of the MiTeachVR system. This may have impacted the interview and questionnaire responses, although not obvious from the findings.

Impact of the Data Collection Time on Participants

The design of the 'practice activity' using the MiTeachVR entailed a lot of time collecting the data, as each session took approximately an hour to an hour and a half. Students had two sessions. Participants also had to complete a task of preparing a PowerPoint outside of the data collection times. The time required by participants to take part in the study may have limited the number of participants willing to participate.

Limitations to the Scope of the Studies Claims

The small sample size, short exposure times and prototype constraints limit the study's claims. A larger number of participants may have provided further insights about the usefulness of the MiTeachVR system for microteaching and communications skills practice. The short exposure times that participants had to use the system for may have limited their experience. Because participants had limited exposure to VR before this study, they may have experienced a novelty effect, which in turn may have impacted their responses. The constraints in the functionality of the MiTeachVR prototype may have impacted the user experience and their ability to fully compare microteaching in IVR to a traditional microteaching experience. This could have impacted on the participants' responses in the interviews and questionnaires. This combination of limitations and constraints limits the scope of the study's claims.

5.5 Recommendations for future work

Extend the current study

This study used a single-site case design. Future qualitative research studies might consider extending the existing study by employing a multiple-case design, which may produce and add further robust knowledge to the findings presented here. Extending this study can offer insights that enhance credibility, transferability, depth, and impact of the findings from this current study. The study could be repeated with a larger sample size taken from a wider heterogeneous group of PSTs. Researchers could consider extending the number of sessions that participants are exposed to in the MiTeachVR classroom. Additionally, extending the study by incorporating multiple cases from different ITE programmes at different institutes of education may be helpful to confirm and extend the findings presented in this study.

Comparative study

This research was conducted using a single-site case study design to understand participants' perceptions and the usefulness of the MiTeachVR system for communication skills development as part of microteaching in ITE within the IoE. Future researchers could consider a comparative study of two groups. The first group could practice their communication skills in a traditional microteaching setting, while the second group practiced in a VR simulation environment. A comparison of the results from such a group may shed further insights to determine the effectiveness of technology-enhanced microteaching.

Technological Enhancements

Given the limitations associated with the MiTeachVR prototype, future research might investigate the incorporation of artificial intelligence to add voice and interactive speech to the avatars. This may improve the system, making it more interactive, while adding an extra level of realism. Another area warranting investigation would be to investigate the effect on PST engagement by replacing the cartoon-like avatars with photorealistic human-like models. Redesigning the control panel functions and reallocating them to buttons on the hand controllers or the ability to touch the buttons on the panels in the VR environment could improve system interaction. The addition of voice commands has the potential to improve functionality, making the system feel somewhat more intuitive, natural, and possibly enhancing the user experience. A more technologically enhanced IVR system may be easier for users to engage with, reducing training time and the need for high levels technical support.

Proxemics and Circulation

As a skill, movement and circulation may be difficult to train in a traditional classroom. Building on the empirical evidence relating to classroom movement within the MiTeachVR classroom using hand controllers and physical walking, future researchers could consider an extension to the observation element of this study, and rigorously measure and train effective teacher movement and use of space within the virtual classroom. This extension could be used to understand how such training translates into movement in real-world classroom contexts. Understanding this movement could have an impact on policy relating to the type and size of room needed for IVR microteaching.

Attrition Rates

Student drop-out rates were revealed in the data, but did not feature prominently. Given the lack of data pertaining to attrition rates and the suggestion that the MiTeachVR system may enhance the student experience, thereby potentially reducing attrition, this is an area that may warrant further investigation. The results of such an investigation may potentially be useful for student retention and policy development.

5.6 Final thoughts

The advancement in VR technologies has evolved from a niche novelty into a transformative technology reshaping education in many areas. Research has indicated that microteaching in VR may have benefits for PSTs. Under the correct circumstances, microteaching in IVR simulation can play a role in supporting PSTs to practice their microteaching communication skills, enabling them to bridge the gap between theory and classroom practice. If the MiTeachVR system were to be adopted into ITE within the IoE, there is a strong likelihood it would bring an extra dimension to the learning possibilities for PSTs as evidenced in this research. It would also expose PSTs to a technology that is multifaceted with potential in many areas of education. The knowledge and practical experience that PSTs gain from exposure as part of ITE could translate to their own classroom. From the perspective of a lecturer, microteaching in VR simulation may offer an innovative pedagogical approach with practical benefits, including a safe, controlled practice environment, immediate feedback, similarity in the teaching scenarios, and the possibility to increase student motivation. If the MiTeachVR system were available to students, the practicum opportunities would be increased, which may lead to improvements in communication skills and learning outcomes.

Finally, while there is a growing number of studies exploring VR simulation for microteaching practice, this research is one of the few to use a fully IVR approach. There is limited evidence of microteaching IVR simulation studies incorporating real-world observation to understand participants' navigation within the VE. This, combined with the findings, demonstrates this study's potential contribution to the field.

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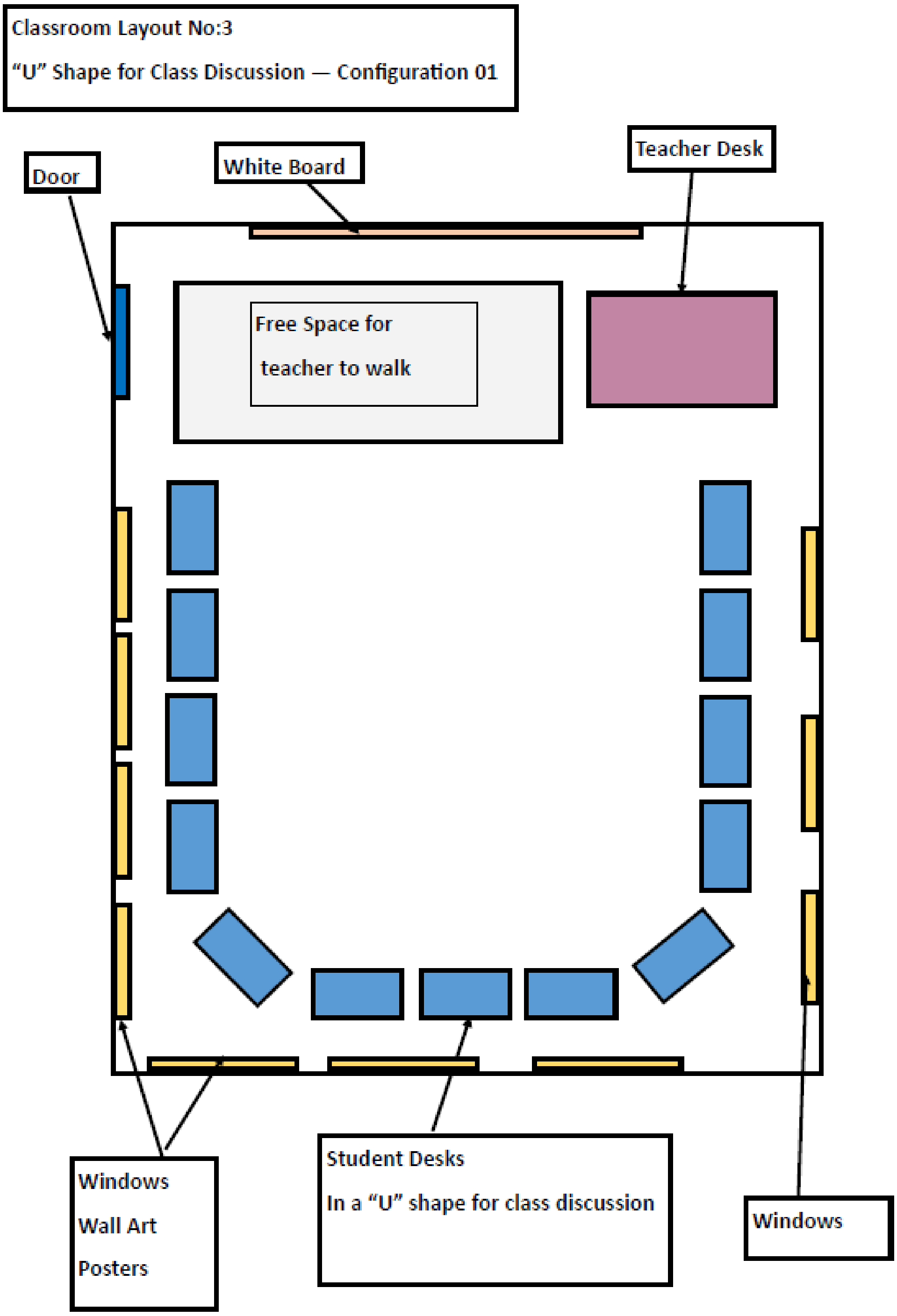
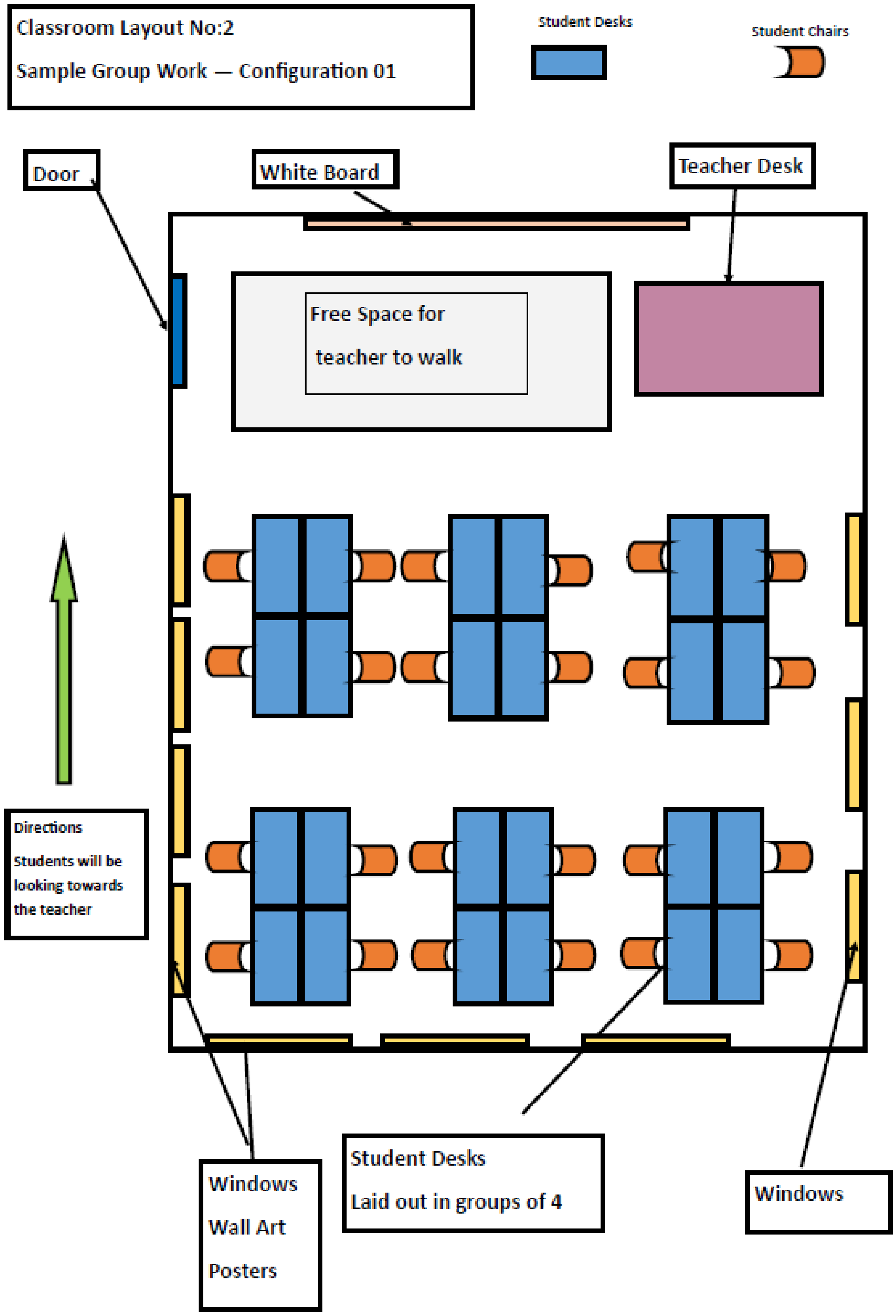
Appendices

Appendix A: MiTeachVR Classroom Layouts

MiTeachVR sample classroom layout 01 – U Shape



MiTeachVR sample classroom layout 02 – Group Work



Appendix B: MiTeachVR Protocol and Operational Instructions

MiTeachVR

Protocol and Operational Instructions

MiTeachVR

Tutor Protocol

Before participant arrives and research session starts

1. Check Virtual Reality (VR) Head Mounted Displays (HMD) are fully charged before the data collection session.
2. Ensure the HMDs are fully clean and sanitised before the data collection session.
3. Ensure the room/area the data collection is taking place in is clean, tidy with no trip hazards.
4. Researcher welcomes the participant and explains the procedures.

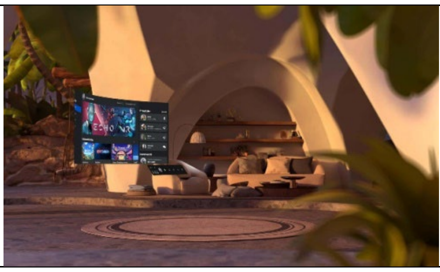
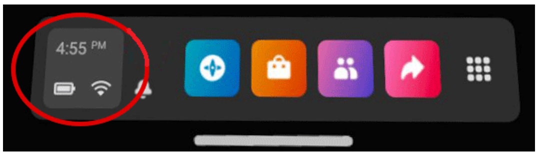
Participant Protocol for using the VR environment

5. Before a participant puts on the HMD the Participant Protocol should be explained.
6. Explain to the participant the Health and Safety issues while using the HMD and engaging in the VR environment:
    a. Do not move outside the safety guard area while using the HMD.
    b. If the participant feels the sick (Cyber Sickness) – they should stop the experiment and notify the researcher. The participant should sit down until they have recovered. If the participant feels able to continue the experiment, the research can restart. If they do not feel up to continuing the session must be stopped.

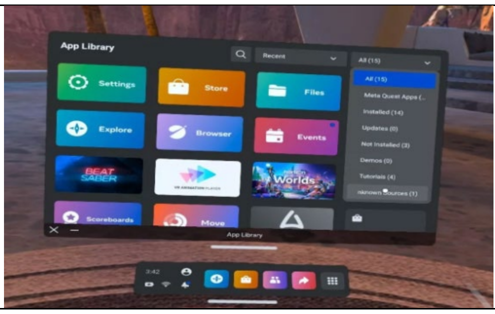
Setting Participant up in the Practice VR Environment

7. Show the participant the headset and explain that the focus of the lens can be adjusted by moving the lens left or right (there are 3 positions) (**Pic 1**). Show the controllers and explain the buttons, and in particular the "Oculus" menu button **(Pic 2)**.
8. The participant puts on the headset and enters the "Oculus Lounge" (**Pic 3)**.
9. The participant checks that the HMD is connected to the DCU Guest WiFi by checking the icon on the control panel (**Pic 4**).

Sample Screen shots to show participants	
	
Pic 1. Oculus HDM Lens adjustment	**Pic 2**. Oculus Controller Menu Button

Sample Screen shots to show participants	
	
Pic 3. Oculus Lounge	**Pic 4**. WiFi Icon on the Control Panel

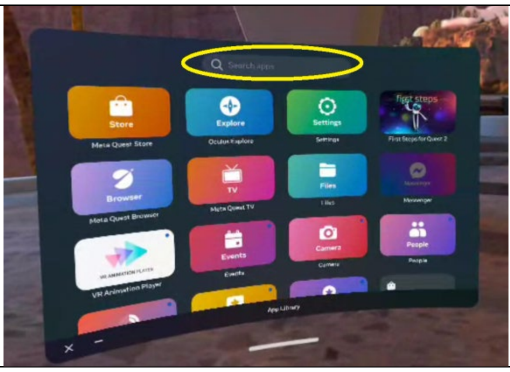
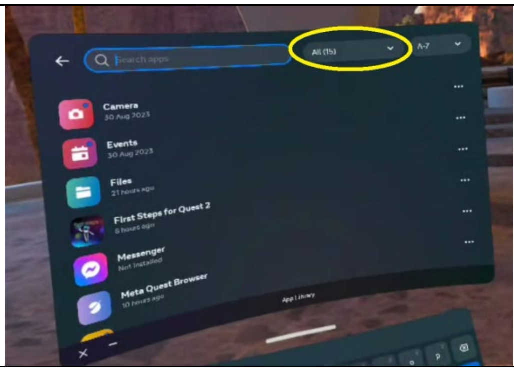
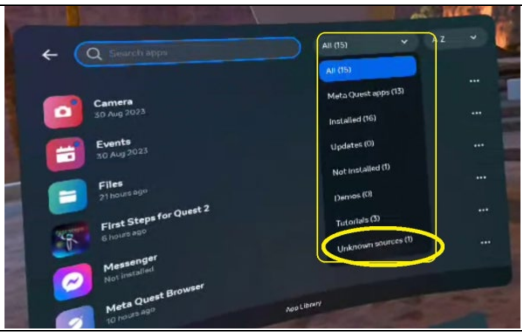
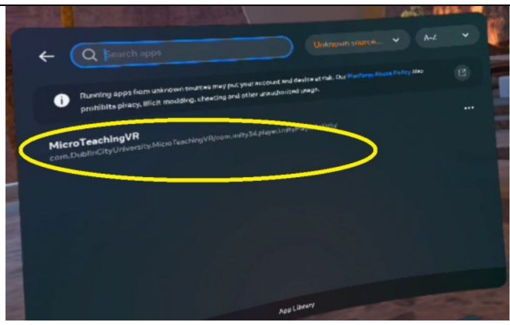
10. The participant navigates to the App Library panel (**Pic 5**) and selects the “Oculus First Steps for Quest 2” (**Pic 6**).
    a. Click the App Library.
    b. Click on the “Oculus First Steps for Quest 2” icon.
    c. Allow participant to complete the initial assimilation using the “Oculus First Steps for Quest 2”. Participants will learn how to: (use controllers, navigate the VR environment etc.)
    d. Allow participant to practice for about 10 minutes.

Sample Screen shots to show participants	
	
Pic 5. App Library	**Pic 6**. Oculus Steps for Quest 2

11. At the end of the “Oculus First Steps for Quest 2” session tell the participant to exit by pressing the Oculus indent button. This will display a menu and the participant can quit.
12. At this point the participant will be back in the Oculus lounge.
13. Allow 5 minutes for the participant to use the hand controllers to move and teleport around the Oculus Lounge. *Explain to the participant that this in conjunction with the learning from the “Oculus First Steps for Quest 2” will be useful when they enter the MiTeachVR Classroom as the movements are similar*.
14. At the end of the session answer any question student may have.
15. Allow the participant to wait 5 minutes before starting the MiTeachVR session.

<u>Guiding/Setting up the Participant in the MiTeachVR Environment</u>

1. The participant puts on the headset and navigates to the "MiTeachVR App".
    a. On the app library panel, <u>click</u> the search bar (**Pic 7**).
    b. Click on the dropdown menu (All 15) (**Pic 8**).
    c. Scroll to the bottom of the list and <u>click</u> "Unknown Sources (1)" (**Pic 9**).
    d. A new panel opens – <u>click</u> on the "MicroTeachingVR" option (**Pic 10**).
    e. The "Made with UNITY" will appear and then the MiTeachVR Classroom will open.

<table>
<tr><th colspan="2">Sample Screen shots to show participants</th></tr>
<tr><td>
</td><td>
</td></tr>
<tr><td>Pic 7 App Library</td><td>Pic 8. App Library Search Panel</td></tr>
<tr><td>
</td><td>
</td></tr>
<tr><td>Pic 9. App Library Drop Down Menu</td><td>Pic 10. MicroTeaching VR Link</td></tr>
</table>

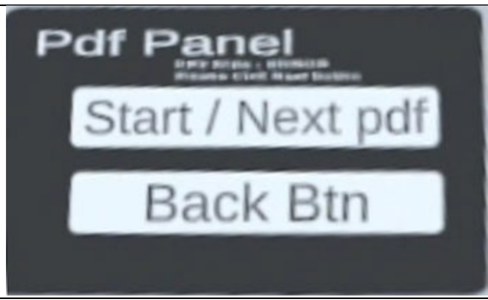
<u>Inside the MiTeachVR Environment</u>

1. At this point, the Participant should be inside the MiTeachVR Classroom environment.
2. Allow the participant 1 minute to assimilate to the MiTeachVR Classroom Environment.
3. Answer any question participant may have.
4. Explain what they can expect to see in the MiTeachVr Classroom.
    a. Admin Panel (**Pic 11**).
    b. PowerPoint Panel (**Pic 12**).

c. Sample Classroom View (**Pic 13**).

d. Sample Classroom View (**Pic 14**).

5. Answer any question student may have.
6. Tutor prepare to start the session.

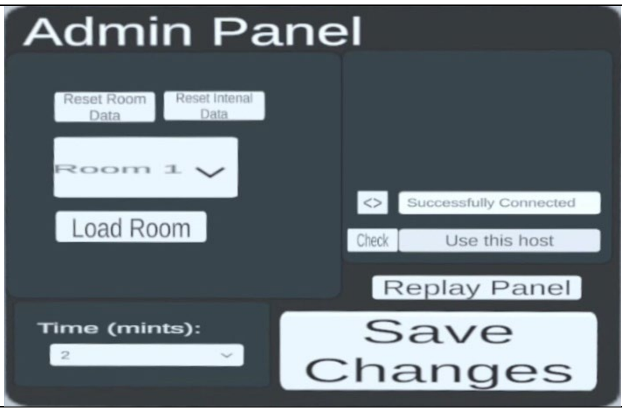
Sample Screen shots to show participants	
	
Pic 11. MiTeachVR Admin Panel	**Pic 12**. MiTeachVR PowerPoint Panel
	
Pic 13. MiTeachVR Sample Classroom View	**Pic 14**. MiTeachVR Sample Classroom View

Tutor Setup

Admin Panel Setup

1. Upon entering the MiTeachVr Classroom environment, press the right controller trigger button to move to the floor area.
2. Click "Check" Button – wait for 3 seconds.
3. Once it indicates "Success" then continue – otherwise exit the software and check the WiFi connection.
4. Once checking is successful.
5. Check if the room is empty – if it is not empty – continue / otherwise click "Reset Room Data" – wait for 10 - 20 seconds and restart the software.
6. Once the room is filled with tables – continue.
7. Set how much time the student session will be – 2, 5, 7, or 10 minutes.
8. Click "Save Changes".
9. ***** The admin panel will disappear and the Student Panel will appear.

Admin Panel



<u>Student Panel Setup</u>

1. When the participant enters the room they should call out the 'Session ID', 'Position ID' and the 'Clip ID'. ***<u>The tutor records the codes.</u>***
2. At this point, any PowerPoint Images should be uploaded to the server before the session recording starts.

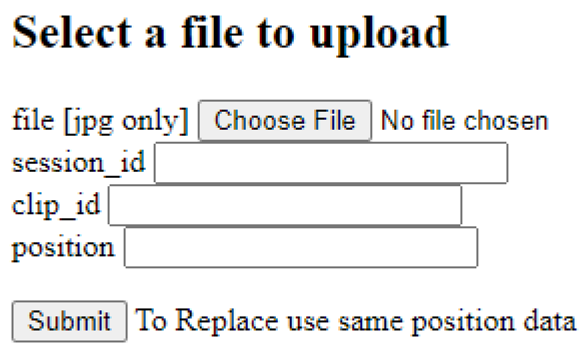
Student Panel

In this example the:

Session Id: 388n
Position: 0
Clip ID: 5qdq

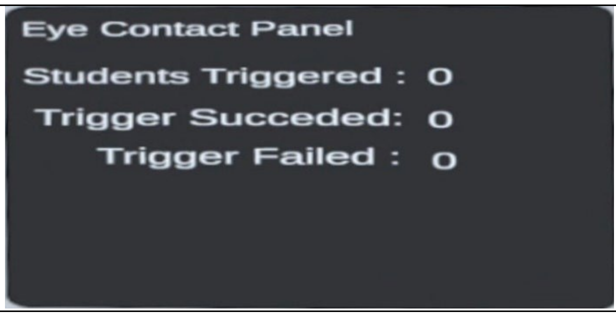
<u>Image Upload</u>

3. Prior to testing session – Tutor uploads the PowerPoint Images.
4. Ask students to send PPT in JPG format. The file needs to have the extension ".jpg" in lowercase.
5. Upload the JPG to the server: http://ec2-34-254-255-35.eu-west-1.compute.amazonaws.com:5000/image_upload



6. After the PowerPoint, images are uploaded.
7. The must check that their PowerPoint Slides are uploaded and ready for use (if they are using slides).
8. Go to '**PPT Panel**' click the start button once only and check the PPT slide:1 appears
9. If slide:2 appears click back button
10. If file not found appears, they should check with the tutor, who will check and or upload the images again.
11. To Check images the tutor opens the image change url - http://ec2-34-254-255-35.eu-west-1.compute.amazonaws.com:5000/image_change/pat/**student-session-id**/jit/**student-clip-id**
12. Confirm the number of image the student uploaded matches the quantity of files on the server.
13. Once the images are uploaded and ready for use, the session can start.

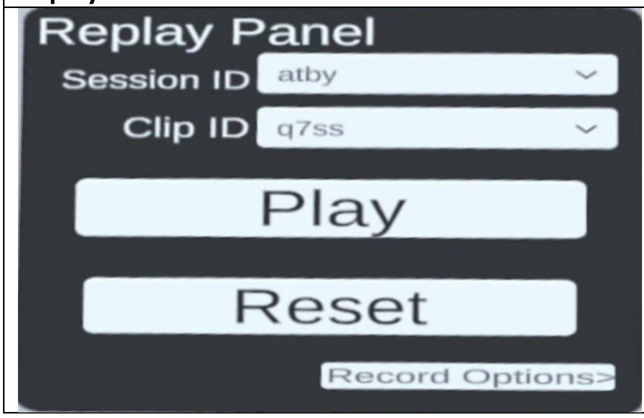
14. The participant presses the '**Start/stop Recording**' button.
15. When the participant starts the recording, they should clearly state their ***name, and the 'Session ID', 'Position ID' and the 'Clip ID' again***.
16. When the practice session is complete, the participant must press the '**Start/Stop Recording**' - The word '**RECORDING**' will disappear.
17. The participant must wait 10 seconds for the recording to upload to the server.
18. While they are waiting the participant can look at the At the end of the session the student can assess the eye-contact panel to check their interaction rate

Eye Contact Panel


19. At the end of the recording session, the participant can remove the headset or click the “Replay Options” to enter replay mode.

<u>Replay Session – Participant ONLY</u>

1. The participant will put back on the headset.
2. In the admin panel, click “**Replay Pane**l” button.
   Student - In the student panel, click “**Replay Options**” button.
3. In “Replay Panel” click “Reset” – wait for 3 seconds.
4. From the drop down menu ‘**Session ID**’ – Select corresponding 4 characters of the participant session data (***The tutor will have a note of it from earlier***).
5. From the drop down menu ‘**Clip ID**’ – Select corresponding 4 characters of the participant session data (***The tutor will have a note of it from earlier***).
6. Click ‘**Play**’ to view the session. **<u>NOTE:</u>** there is no pause or stop – you must wait until the replay is complete.
7. The participant will remove the headset and report their experience of the session and how they feel it went.. *<u>And or feedback can be given based on the replay.</u>*

<table>
<tr><th colspan="2">Replay Panel</th></tr>
<tr><td>
</td><td>In this example the:

Session Id: atby
Clip ID: q7ss</td></tr>
</table>

<u>Replay Session – Tutor and Participant</u>

1. The tutor and the participant can each put on a headset.
2. In the admin panel, click “**Replay Pane**l” button.
   Student - In the student panel, click “**Replay Options**” button.
3. In “Replay Panel” click “Reset” – wait for 3 seconds.
4. From the drop down menu ‘**Session ID**’ – Select corresponding 4 characters of the participant session data (***The tutor will have a note of it from earlier***).
5. From the drop down menu ‘**Clip ID**’ – Select corresponding 4 characters of the participant session data (***The tutor will have a note of it from earlier***).
6. Click ‘**Play**’ to view the session. **<u>NOTE:</u>** there is no pause or stop – you must wait until the replay is complete.
7. The tutor and participant will remove the headsets and a tutor led feedback session can start.

Appendix C: Student Recruitment Flyer

MiTeachVR
DCU

Microteaching in Virtual Reality
Participants Required

We are seeking research participants to test a purpose-built Virtual Reality (VR) classroom designed to allow students teachers practice their teaching skills.

Are you a student on a teaching programme?

Are you willing to learn how to use VR?

Are you willing to practice your teaching in VR?

Location: St. Patrick's Campus, Drumcondra.

What's involved?: Complete two VR sessions and tell us about your experience.

If you are interested contact:

Patrick Boylan

patrick.boylan7@mail.dcu.ie

MiTeachVR
DCU

Appendix D: Student and Lecturer Recruitment Process

Student Recruitment: In class recruitment, with approval from the module lecturer I visited the classes of the BSc in Education and Training (BET) and BEd in Gaeilge and French, German or Spanish (BEDLAN) programmes to present verbally with the accompaniment of a PowerPoint presentation the purpose and nature of the research. Recruitment flyers (**Appendix C**) detailing the research and my email contact details were distributed. I passed around the class a pre-printed sign-up sheet for students who wished to sign-up, so as not to cause undue influence the sheet was left in the class for students sign-up and I collected after class. I emailed potential participants using my DCU student email address outlining the research and what they could expect. They were asked to respond by email if they wished to participate. For those who agreed to participate I emailed them further details including the Plain Language Statement (PLS) and suggested dates and times for them to select that suited their schedule. It was made clear that they could withdraw from the study at any point without providing a reason and there would be no consequences.

Lecturer Recruitment: A number of lecturers were identified meeting the criteria. I emailed them directly using my DCU student email address outlining the research and what they could expect and including a recruitment flyer. They were asked to respond by email if they wished to participate or required any more information. For those who agreed to participate I emailed them further details including the Plain Language Statement (PLS) and suggested dates and times for them to select that suited their schedule. It was made clear that they could withdraw from the study at any point without providing a reason and there would be no consequences

Appendix E: Student and Lecture Testing Protocols

Student Protocol – Session 01

1. **Researcher** - Setup room and test equipment
2. **Researcher** – Health and Safety Check and clean VR equipment
3. **Researcher** – Prepare paperwork (PLC and Consent)

4. Welcome student - thank them for participating.
5. Explain the Session outline – explain what the procedures are and what they can expect at the session. Using VR, Health and Safety
6. Give a copy of the Plain Language Statement to the participant.
7. **Session 01 -** Ask the participant to read and sign the Consent form 01.
   ** Testing cannot start until the participant signs the Consent Form **
8. **Session 01 -** Ask the participant complete Demographics Questionnaire.

9. Start VR Familiarisation – **First Steps.** Initial assimilation using the Oculus test system. (How to use controllers etc.)

10. Break - **5 Minutes must be taken**

11. Start VR Intro to the **MiTeachVR** system – **1 minute.** Understand what the MiTeachVR environment looks like (Look and Feel).

12. Debriefing - Answer any question student may have.
13. Discuss and answer any question on the PowerPoint the participant wishes to use in the Live session (Session 02)

14. Arrange date and time for session 02.
15. Participant leaves the room.

16. **Researcher** – Complete paperwork, tidy up the equipment and the room, Use this time to reflect and take notes.

Student Protocol – Session 02

1. **Researcher** - Setup room and test equipment
2. **Researcher** – Health and Safety Check and clean VR equipment
3. **Researcher** – Prepare paperwork (PLC and Consent)

4. Welcome student - thank them for taken part in Session 02.
5. Thank them for sending their PowerPoint or ask them to give to the researcher on a memory stick.

6. Explain the Session outline – explain what the procedures are and what they can expect at the session. Using VR, Health and Safety
7. Give a copy of the Plain Language Statement to the participant.
8. **Session 01 -** Ask the participant to read and sign the Consent form 01.
   ** Testing cannot start until the participant signs the Consent Form **

9. Start VR Teaching Session in the **MiTeachVR** environment

10. Break - **5 Minutes must be taken**

11. **Session 02 -** Ask the participant complete Main Questionnaire
12. Interview – Confirm it is okay for the researcher to record the session
    State that the session is being recorded at the start of the recording

13. Debriefing - Answer any question student may have.
14. Discuss and answer any question on the PowerPoint the participant wishes to use in the Live session (Session 02)

15. Arrange date and time for session 02.
16. Participant leaves the room.

17. **Researcher** – Complete paperwork, tidy up the equipment and the room, Use this time to reflect and take notes.

Lecturer Protocol – Combined Session

1. **Researcher** - Setup room and test equipment
2. **Researcher** – Health and Safety Check and clean VR equipment
3. **Researcher** – Prepare paperwork (PLC and Consent)

4. Welcome lecturer - thank them for taken part in Session 02.
5. Thank them for sending their PowerPoint or ask them to give to the researcher on a memory stick.

6. Explain the Session outline – explain what the procedures are and what they can expect at the session. Using VR, Health and Safety
7. Give a copy of the Plain Language Statement to the participant.
8. Ask the participant to read and sign the Consent form 01.
   ** Testing cannot start until the participant signs the Consent Form **

9. Start VR Familiarisation – **First Steps.** Initial assimilation using the Oculus test system. (How to use controllers etc.)
10.
11. Break - **5 Minutes must be taken**
12. Start VR Teaching Session in the **MiTeachVR** environment
13. Break - **5 Minutes must be taken**

14. Ask the participant complete Main Questionnaire (Combined Questionnaire)
15. Interview – Confirm it is okay for the researcher to record the session
    State that the session is being recorded at the start of the recording

16. Debriefing - Answer any question student may have.
17. Discuss and answer any question on the PowerPoint the participant wishes to use in the Live session (Session 02)

18. Arrange date and time for session 02.
19. Participant leaves the room.

20. **Researcher** – Complete paperwork, tidy up the equipment and the room, Use this time to reflect and take notes.

Appendix F: Plain Language Statement and Consent Form

DUBLIN CITY UNIVERSITY

Informed Consent Form

Using VR technologies support student teachers in learning to teach

Research Team:

Name	**School/Unit**	**Email**
Dr Alan Gorman	Policy and Practice	alan.gorman@dcu.ie
Dr Peter Tiernan	STEM Education, Innovation and Global Studies	peter.d.tiernan@dcu.ie
Prof Alan Smeaton	FEC/School of Computing/Insight	alan.smeaton@dcu.ie
Dr Shirley Coyle	FEC/School of Electronic Engineering/Insight	shirley.coyle@dcu.ie
Dr Maura Coulter	School of Arts Education and Movement	maura.coulter@dcu.ie
Dr Enda Donlon	STEM Education, Innovation and Global Studies	enda.donlon@dcu.ie
Darran Heaney	DCU Anti-Bullying Centre	darran.heaney@dcu.ie
Suzanne Stone	Teaching Enhancement Unit	suzanne.stone@dcu.ie
Edoardo Celeste	School of Law and Government	edoardo.celeste@dcu.ie
Patrick Boylan	School of Psychology	patrick.boylan7@mail.dcu.ie

Clarification of the purpose of the research

This research study aims to explore how the use of VR technologies can create purpose-built virtual classroom scenarios that will allow you to practice these fundamental skills, alongside presenting opportunities that will require certain actions from you as you engage in classroom-based scenarios.

Confirmation of particular requirements as highlighted in the Plain Language Statement

Participation involves sharing (a) biometric data that specifically focuses on movement, voice, and stress-level and (b) taking part in a one to one interview with a member of the research team that will last for approximately 30 minutes. The interview will be audio recorded. Once the interview is transcribed, I am aware that the audio recording will be deleted and my name will not be used on the transcript. I am also aware that the biometric data will not identify me in any way.

Consent Questions		
Participant – please complete the following by indicating 'Yes' or 'No' to the questions		
	Yes	**No**
I have read the Plain Language Statement (or had it read to me)		
I understand the information provided		
I understand the information provided in relation to data protection		
I have had an opportunity to ask questions and discuss this study		
I have received satisfactory answers to all my questions		
I am aware that my interview will be audiotaped		

Confirmation that involvement in the Research Study is voluntary

If I choose not to take part in this research study, I am aware there will be no consequences. I do not need to provide any reason for choosing not to take part. I can withdraw at any stage if I feel in any way uncomfortable about my participation and any data that I have provided will not be used in this research study. I do not need to provide any reason for withdrawing from the study and I am aware there will be no consequences for withdrawing.

Confirmation of arrangements to be made to protect confidentiality of data, including that confidentiality of information provided is subject to legal limitations
I understand that the data collected will be kept confidential where the data will be anonymised by the research team to ensure that my identity is kept confidential. I understand that there are also exceptional circumstances where confidentiality cannot be maintained due to legal limitations.

Confirmation of arrangements regarding retention/disposal of data
I understand that my data will be stored in a password protected folder on the researchers' DCU Google Drive account. I am aware that the data will be retained for a period of four years and that it will be then permanently deleted by the researchers.

Confirmations relating to any other relevant information as indicated in the PLS
I consent to the use of my data for future studies within the following parameters: to be disseminated at national and international conference presentations and may appear in research publications.

Signature: I have read and understood the information in this form. My questions and concerns have been answered by the researchers, and I have a copy of this consent form. Therefore, I consent to take part in this research project.

Participant's Signature: ______________________________

Name in Block Capitals: ______________________________

Witness: ______________________________

Date: ______________________________

Appendix G: Observation Sheet

MiTeachVR DCU

Participant Observation Recording Sheet

(Live Session)

Participant ID:	**Date:**	**Location:**
Observer:	**Time:**	**Duration:**

Code	Observation	Comments
E01	Participant appears **hesitant** to moving around using the physical space	
E02	Participant appears **confident** to moving around using the physical space	
E03	Participant appears to be having **difficulty using the controllers**	
E04	Participant appears to be **confident using the controllers**	
E05	Participant temporarily removes headset to **re-orientate** to the physical space	
E06	Participant appears **focused** on the task	
E07	Participant appears to be **delivering the lesson with ease**	
E08	Participant uses **hand gestures** beyond using controllers to navigate	
E09	Participant **uses head movements**	
E10	Participant appears **at ease in the VR environment**	
E11	Participant uses their **voice** (pitch, tone and clarity)	
E12	Participant is **hesitant** in speaking	

Observations:

(See reverse)

Observations:
Reflections:

Appendix H: Student and Lecturers Interview Questions - Schedule

Microteaching Session Semi-structured Interview Questions – Students
Consent to Participate Confirmation *These questions <u>must</u> be asked and confirmation received from the participant before the interview can proceed* • Do you consent for the interview to be recorded <<< Start recording the interview >> • You have given your consent for the interview to be recorded • Can you confirm you have read the Plain Language Statement and signed the Consent Form? • Do you have any questions about the Plain Language Statement or the Consent Form before we begin our conversation?

Student and Lecturers Interview Questions – Page 02

Student Interview Questions – Page 01

Microteaching Session Semi-structured Interview Questions – Students - P01

Experience of the MiTeachVR System - (Experience / Behaviour Questions)
 	
• **<u>Q 01</u> - How would you describe your experience of using the MiTeachVR system?**
  • <u>Q01A</u> – Was it easy or difficult for you to learn how to use the MiTeachVR system? - Why?
  • <u>Q01B</u> - What aspects of the MiTeachVR environment/system did you find particularly satisfying or dissatisfying? (*Engaging / Enjoyable / Useful / Poor*).
  • <u>Q01C</u> - Did you encounter any technical issues or challenges while using the MiTeachVR system? -
    o If so, what were they?
  • <u>Q01D</u> - Did you experience any discomfort, motion sickness, or fatigue during the VR experience?
    o If so, what were they?
  • <u>Q01E</u> - Are there aspects of the MiTeachVR system that are user friendly, intuitive, confusing or difficult to use?
    o If so, what were they and how would you rate them?

Comparison of MiTeachVR to Real-world MT Session – (Comparison Questions)
 	
• **<u>Q 02</u> - How would you compare the MiTeachVR environment to a physical classroom?**
  • <u>Q02A</u> - How does your perception (experience) of teaching in the MiTeachVR environment compare to a traditional face-to-face microteaching session?
  • <u>Q02B</u> – Based on your experience does the MiTeachVR environment enhance or detract from teaching in a traditional face-to-face microteaching session? - In what way?
  • <u>Q02C</u> - In what ways does your engagement with the MiTeachVR virtual environment differ from a traditional face-to-face microteaching session?
  • <u>Q02D</u> - Do you feel the MiTeachVR system is a suitable substitute/alternative for face-to-face microteaching? – Why or why not?

Usefulness
 	
• **<u>Q 03</u> - In what ways do you think the MiTeachVR system is useful for microteaching practice? - Why or Why not?**
  • <u>Q03A</u> - In what ways do you think the MiTeachVR system can enhance your teaching practice?
  • <u>Q03B</u> In what ways do you believe the MiTeachVR system would be useful to improve your:
    ▪ Teaching skills
    ▪ Confidence in public speaking in front of a class
    ▪ Presentation skills
  • <u>Q03C</u> - Would you use the MiTeachVR system if it were available to you as a drop-in resource or available to borrow for independent learning/practice?

Student and Lecturers Interview Questions – Page 03

Student Interview Questions – Page 02

Microteaching Session Semi-structured Interview Questions – Students – P02

Strengths or Weakness

- **Q 04 - What are the strengths and weaknesses of the MiTeachVR environment/system?**
  - Can you comment on:
    - Easy to use. Navigation. Control Panels. Environment Design. Navigation Control
    - Ability to record – Voice, movement, head and hand tracking.
    - Playback function / PowerPoint / Whiteboard.
    - Avatars / Room Layout / Furniture / Windows etc.
    - Did the environment feel realistic or unreal?
- **Q 05 - What factors might influence your decision (intention) to adopt or reject the MiTeachVR system as a microteaching practice/learning tool?**
  - Ease of use / Difficulty / Costs

Feasibility / Supports / Barriers

Feasibility

- **Q 06 - What resources or support do you think would facilitate your use of the MiTeachVR system?**
  - **Q06A** - How feasible do you think it would be to include using the MiTechVR system into your microteaching practice?
  - **Q06B** - How would you like to see the MiTeachVR system introduced into your microteaching module? – Why or why not?
  - **Q06C** - Do you think the MiTeachVR system is practical/feasible to use as an independent learning tool? - Why or why not?

Supports

- **Q 07 - What resources or supports would facilitate you in using the MiTeachVR system?**
  - Videos / On-line Resources / Handbook / In-class-training / peer-to-peer
  - Separate dedicated VR space / Storage
  - Technical support.
  - **Q07A** - To what extent do factors, such as technical support influence your decision to use the MiTeachVR system?
  - **Q07B** - What supports (*other than technical support)* would you consider should be in place to facilitate students who may wish to use the MiTeachVR system outside of class?

Barriers

- **Q 08 - Are there any barriers that might prevent you from using the MiTeachVR system?**
    - Such as: Confidence / Motivation / Time / Disabilities / Low technical ability

Student and Lecturers Interview Questions – Page 04

Student Interview Questions – Page 03

Microteaching Session Semi-structured Interview Questions – Students – P03

Future Recommendations/Expectations
 	
• Q 09 - **What recommendations or suggestions do you have that would help improve the MiTeachVR system?**
  • **Q09A** - What aspects of the MiTeachVR system would you like to see improved or developed in the future?
  • **Q09B** - Is there anything specific you would change or improve about the MiTeachVR system?
  • **Q09C** - Would you like to see multiuser interaction incorporated into future versions of the MiTeachVR system?
  • **Q09D** - Would you like to see more interaction / feedback from the avatars (speaking etc).
  • **Q09E** - What are your expectations for using Virtual Reality for microteaching?

Final / Closing Questions • **Q 10** - Based on your overall experience of the MiTeachVR system would you describe your experience as positive or negative? • **Q11** – If the MiTeachVR system was fully available to you now would you use it? • **Q 12** - Do you have any other comments that you would like to share as part of the research?

Student and Lecturers Interview Questions – Page 05

Microteaching Session Semi-structured Interview Questions – Lecturers
Consent to Participate Confirmation *These questions <u>must</u> be asked and confirmation received from the participant before the interview can proceed* • Do you consent for the interview to be recorded <<< Start recording the interview >> • You have given your consent for the interview to be recorded • Can you confirm you have read the Plain Language Statement and signed the Consent Form? • Do you have any questions about the Plain Language Statement or the Consent Form before we begin our conversation?

Microteaching Session Semi-structured Interview Questions - Lecturer – P01

Experience of the MiTeachVR System - (Experience / Behaviour Questions)
• **Q L01 - How would you describe your experience of using the MiTeachVR system?**
  • **QL01A** - Was it easy or difficult for you to learn how to use the MiTeachVR system? – Why?
  • **QL01B** - What aspects of the MiTeachVR environment/system did you find particularly satisfying or dissatisfying? (*Engaging / Enjoyable / Useful / Poor*).
  • **QL01C** - Did you encounter any technical issues or challenges while using the MiTeachVR system?
    o If so, what were they?
  • **QL01D** - Did you experience any discomfort, motion sickness, or fatigue during the VR experience?
    o If so, what were they?
  • **QL01E** - Are there aspects of the MiTeachVR system that are user friendly, intuitive confusing or difficult to use?
    o If so, what were they and how would you rate them?

Comparison of MiTeachVR to Real-world MT Session – (Comparison Questions)
• **Q L02 - How would you compare the MiTeachVR environment to physical classroom?**
  • **QL02A** - How does your perception (experience) of teaching in the MiTeachVR environment compare to a traditional face-to-face microteaching session?
  • **QL02B** – Based on your experience does the MiTeachVR environment enhance or detract from teaching in a traditional face-to-face microteaching session? - In what way?
  • **QL02C** - In what ways does your engagement with the MiTeachVR virtual environment differ from a traditional face-to-face microteaching session?
  • **QL02D** - Do you feel the MiTeachVR system to be a suitable substitute/alternative for face-to-face microteaching? - Why or Why not?

Usefulness
• **Q L03 - In what ways do you think the MiTeachVR system is useful or not useful for microteaching practice? - Why or Why not?**
  • **QL03A** - In what ways do you think the MiTeachVR system can enhance student teaching practice?
  • **QL03B** In what ways do you believe the MiTeachVR system would be useful to improve student:
    ▪ Teaching skills
    ▪ Confidence in public speaking in front of a class
    ▪ Presentation skills
  • **QL03C** – If the MiTeachVR system was available to students as a drop-in resource or available to borrow for independent learning would you recommend students to avail of it? – Why or why not?

Microteaching Session Semi-structured Interview Questions - Lecturer – P02

Strengths or Weakness

- **Q L04 - What are the strengths and weaknesses of the MiTeachVR environment/system?**
- Can you comment on:
    - Easy to use. Navigation. Control Panels. Environment Design. Navigation Control
    - Ability to record – Voice, movement, head and hand tracking.
    - Playback function / PowerPoint / Whiteboard.
    - Avatars / Room Layout / Furniture / Windows etc.
    - Did the environment feel realistic or unreal?
- What barriers or opportunities might be associated with the implementation of the MiTeachVR system?

Feasibility

- **Q L05 - Do you think the MiTeachVR system is a useful resource for microteaching practice for students? - Why or Why not?**
    - QL05A – Do you think that the MiTeahVR environment/system is suitable to meet student-learning needs?
    - QL05B - In what ways do you think the MiTeachVR system can enhance student teaching practice?
    - QL05C - Do you believe that using the MiTeachVR system would improve student teaching skills?
    - QL05D - Do you think it would be feasible to introduce and implement the MiTeachVR system into your current microteaching module? - Why or why not?
    - QL05E - Do you think the MiTeachVR system is practical/feasible to use as an independent learning tool? - Why or why not?
- QL05F - Would it be difficult to introduce and implement the MiTeachVR system into your current microteaching module?

Supports for students

- **Q 06 - What resources or support do you think would facilitate students to use the MiTeachVR system?**
    - Videos / On-line Resources / Handbook / In-class-training / peer-to-peer
    - Separate dedicated VR space / Storage
    - Technical support.
- QL06A - To what extent do factors, such as technical support influence student's decisions to use technology including the MiTeachVR system?

Support in Class

- QL06B - Do you feel that the necessary technical expertise is available to support the implementation of the MiTeachVR system?
- QL06C - What supports and resources (*other than technical support*) would you as a lecturer deem necessary to support you in implementing and using the MiTeachVR system in class?

Student and Lecturers Interview Questions – Page 08

Microteaching Session Semi-structured Interview Questions - Lecturer – P03

Barriers to Adoption
• **<u>QL07</u> - What factors might influence your decision (intention) to adopt or reject implementing the MiTeachVR system into your microteaching class?**
  o Ease of use / Difficulty / Time Recourses / Costs in time / Extra work required
  o Matching or meeting pedagogical outcomes
  o Resource constraints that need to be considered
  o Financial constraints
  o Technical factors including maintenance
  o Lack of suitable infrastructure (Dedicated VR Space / Secure Storage / WiFi
  o Hygiene / Health and Safety
  o Suitability as a learning tool
  o Institution support
  o Scalability of the system
• **<u>QL07A</u>** - What concerns or reservations do you have about adopting the MiTeachVR system in microteaching?
• **<u>QL07B</u>** - Is the necessary technical expertise available to support the implementation of the MiTeachVR system?
• **<u>QL07C</u>** - Is the necessary pedagogical expertise available to support the implementation of the MiTeachVR system?

Future Recommendations/Expectations
• **Q 08 - What recommendations or suggestions do you have that would help improve the MiTeachVR system?**
  • **<u>Q08A</u>** - What aspects of the MiTeachVR system would you like to see improved or developed in the future?
  • **<u>Q08B</u>** - Is there anything specific you would change or improve about the MiTeachVR system?
  • **<u>Q08C</u>** - Would you like to see multiuser interaction incorporated into future versions of the MiTeachVR system?
  • **<u>Q08D</u>** - Would you like to see more interaction / feedback from the avatars (speaking etc).
  • **<u>Q08E</u>** - What are your expectations for using Virtual Reality for microteaching?

Final / Closing Questions • **<u>Q L09</u>** - Based on your overall experience of the MiTeachVR system would you describe your experience as positive or negative? • **<u>Q L10</u>** – Would you support the introduction of MiTeachVR at institutional level? • **<u>Q L11</u>** - If the MiTeachVR system was fully available to you now or in the near future would you use it in your microteaching module? - Why or why not? • **<u>Q L12</u>** - Do you have any other comments that you would like to share as part of the research?

Appendix I: Types of Interview Questions

Table 4.2 Types of Interview Questions	
Question Type	**Description**
Background/Demographic	To find out the identifying characteristics of the participant being interviewed. Direct straightforward questions including (age, gender, status, etc.)
Experience/Behaviour	To find out what a participant does or has done. Specific and overt questions.
Opinion/Values	To understand the cognitive and interpretive process of participants. What are their thoughts, values, intentions and so on, about the phenomenon being studied.
Feeling Questions	To understand the emotional responses of participants to their experiences and thoughts. Emotional experiences and emotional response questions. How do they feel about the phenomenon.
Knowledge Questions	Questions exploring information of a factual nature that the participant holds.
Sensory Questions	Questions asking what the participant saw, heard, touched, and tasted, and so on.

Note. Adapted from Patton, M, Q, (1990), *Qualitative evaluation and research methods* (2nd ed.). Newbury Park, CA: Sage, pp. 290-292.

Appendix J: Student and Lecturers Questionnaires

MiTeachVR - Participant Questionnaire – (Training Session) - Students

Research Study – Using VR Technologies to support student teachers in learning to teach.

** Thank you for participating in this research study, your experience, comments and opinions are extremely important to the study. Please answer all questions.

1. What is your age in years: [ ] Prefer not to say [ ]

2. What gender do you identify as: Male [ ] Female [ ] Prefer not to say [ ]
Other (*Please specify*)________________________________

3. Have you used Virtual Reality before today's research session? **Yes** [ ] **No** [ ]

3a. If Yes, how often have you used it?
One time only [ ] Two to five times [ ] Six time or more [ ]

A Virtual Reality (VR) headset is any device that allows users to interact with fully immersive simulated environments while experiencing a first person view. For example, Oculus Quest, HTC VIVE, PSVR 2 or similar devices.

4. Do you own or have access to a virtual reality headset on a regular basis?
Yes – I own a VR headset [ ]
Yes – I have regular access to a VR headset [ ]
No – I do not own or have access to a VR headset [ ]

5. Do you regularly play computer games (PC, X-Box, PlayStation etc)? **Yes** [ ] **No** [ ]

6. Did you feel comfortable using the VR technologies today? **Yes** [ ] **No** [ ]

Can you explain why: ____

____

7. Was the training session a useful introduction to the VR Technologies? **Yes** [ ] **No** [ ]

Can you explain why: ____

____

MiTeachVR - Participant Questionnaire – (Live Session) - Students

Research Study – Using VR Technologies to support student teachers in learning to teach.

** Thank you for participating in this research study, your experience, comments and opinions are extremely important to the study. Please answer all questions.

1. To what Extent did you feel immersed in the MiTeachVR environment?

Not Immersed	0	1	2	3	4	5	6	7	8	9	10	Fully Immersed

2. Would you describe the MiTeachVR as a negative or positive experience?

Negative Experience	0	1	2	3	4	5	6	7	8	9	10	Positive Experience

3. How would you rate your overall satisfaction with the MiTeachVR environment/system?

Not Satisfied	0	1	2	3	4	5	6	7	8	9	10	Fully Satisfied

4. To what extent do you believe the MiTeachVR system would be useful to improve your teaching skills?

Not Useful	0	1	2	3	4	5	6	7	8	9	10	Extremely Useful

5. To what extent do you believe the MiTeachVR is a practical tool in microteaching?

Not Practical	0	1	2	3	4	5	6	7	8	9	10	Extremely Practical

6. How would you rate your satisfaction with the performance and features of the MiTeachVR system?

Not Satisfied	0	1	2	3	4	5	6	7	8	9	10	Extremely Satisfied

7. From your experience of the MiTeachVR system, has it met your expectations in terms of its ability to useful as a learning tool?

Expectations Have Not Been Met	0	1	2	3	4	5	6	7	8	9	10	Expectations Have Been Met

8. To what extent do you feel confident in your ability to use the MiTeachVR system effectively?

Not Confident	0	1	2	3	4	5	6	7	8	9	10	Extremely Confident

9. Do you have any other comments that you would like to share as part of the research?

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Thank you for taking part in this research. Your data will be treated confidentially.

MiTeachVR - Participant Questionnaire – (Lecturer Session)

Research Study – Using VR Technologies to support student teachers in learning to teach.

** Thank you for participating in this research study, your experience, comments and opinions are extremely important to the study. Please answer all questions.

1. How many years have you been involved in the practice of Micrteaching? ☐

2. What gender do you identify as: Male ☐ Female ☐ Prefer not to say ☐
Other (*Please specify*)_______________________________

3. Have you used Virtual Reality before today's research session? **Yes** ☐ **No** ☐

3a. If Yes, how often have you used it?
One time only ☐ Two to five times ☐ Six time or more ☐

A Virtual Reality (VR) headset is any device that allows users to interact with fully immersive simulated environments while experiencing a first person view. For example, Oculus Quest, HTC VIVE, PSVR 2 or similar devices.

4. Do you own or have access to a virtual reality headset on a regular basis?
Yes – I own a VR headset ☐
Yes – I have regular access to a VR headset ☐
No – I do not own or have access to a VR headset ☐

5. Do you regularly play computer games (PC, X-Box, PlayStation etc)? **Yes** ☐ **No** ☐

6. Did you feel comfortable using the VR technologies today? **Yes** ☐ **No** ☐

Can you explain why: ____

____

____

____

____

7. Was the training session a useful introduction to the VR Technologies that may have potential for Microteaching? Yes ☐ No ☐

Can you explain why: ____

____

____

____

____

8. To what Extent did you feel immersed in the MiTeachVR environment?

Not Immersed	0	1	2	3	4	5	6	7	8	9	10	Fully Immersed

9. Would you describe the MiTeachVR as a negative or positive experience?

Negative Experience	0	1	2	3	4	5	6	7	8	9	10	Positive Experience

10. How would you rate your overall satisfaction with the MiTeachVR environment/system?

Not Satisfied	0	1	2	3	4	5	6	7	8	9	10	Fully Satisfied

11. To what extent do you believe the MiTeachVR system would be useful to improve your teaching skills?

Not Useful	0	1	2	3	4	5	6	7	8	9	10	Extremely Useful

12. To what extent do you believe the MiTeachVR is a practical tool in microteaching?

Not Practical	0	1	2	3	4	5	6	7	8	9	10	Extremely Practical

13. How would you rate your satisfaction with the performance and features of the MiTeachVR system?

Not Satisfied	0	1	2	3	4	5	6	7	8	9	10	Extremely Satisfied

14. From your experience of the MiTeachVR system, has it met your expectations in terms of its ability to useful as a learning tool?

Expectations Have Not Been Met	0	1	2	3	4	5	6	7	8	9	10	Expectations Have Been Met

15. To what extent do you feel confident in your ability to use the MiTeachVR system effectively?

Not Confident	0	1	2	3	4	5	6	7	8	9	10	Extremely Confident

16. Do you have any other comments that you would like to share as part of the research?

____

____

____

____

____

Thank you for taking part in this research. Your data will be treated confidentially.

Appendix K: MS Word Journal

Project Development – Team Meetings / Decisions / Milestones / Key Events / Reflections			
Month:		**Pages:** 0	**Page:**
Items of Key Importance:	N/A		
Key Issues:	N/A		

Appendix L: Themes and Sub-Themes Table/Map

Themes and Sub-Themes

Theme 00 - General Overview and Experience of Lecturers

Participant	Sub-Themes
L	01 - Innovative Tool for Teaching MT and Beyond
L	02 - Positive Interesting and Enjoyable Experience
S	01 - The MiTeachVR System is Easy to Use
S	02 - Sat - Enjoyable and Beneficial Experience
S	03 - Innovative and New
S	04 - Somewhat Sceptical of VR and its Usefulness for MT

Theme 01 – Supports to Promote the Introduction MiTeachVR System

Participant	Sub-Themes
L&S	01 - Technical Support
L&S	02 - Training Support and CPD
L&S	02 - Training Support
L&S	04 - Dedicated Space to use the MiTeachVR System
S	03 - Supports for use in an MT Module
S	05 - Supports other than Technical and Training Supports

Theme 02 - Self-Directed Active Learning and Reflection

Participant	Sub-Themes
L&S	01 - Independent Practice Tool for Self-Directed Learning
L&S	02 - MT Home Practice Opportunity
L&S	03 - Self Reflection using the Record and Playback Function
L	04 - Recipe for Disaster

Themes and Sub-Themes Table/Map – Page 02

Themes and Sub-Themes	
03 - Bridging the Gap between Theory and Practice	
Participant	**Sub-Themes**
L&S	01 - Linking Theory and Practice
L&S	02 - Confidence Building in Microteaching
L&S	03 - Enhancing Teaching Skills through Repeated Practice
L&S	04 - MT Complement or Alternative
L&S	05 - MiTeachVR vs Face-to-Face MT
L	06 - Unpredictability of Classroom Dynamics
L	07 - Creative Space for Freedom of Expression
L	08 - In the Moment Multitasking
S	01 - Safe Environment to Practice MT
S	02 - MT that is Similar but Different
S	03 - Strength - Translate Skills to a Live MT class
04 - Perceived Usefulness and Intention to Adopt	
Participant	**Sub-Themes**
L&S	01 - Usefulness of the MiTeachVR System for Microteaching Practice
L&S	02 - Intentions to Adopt or Reject the MiTeachVR System
L	03 - Lecturer support for the introduction of the MiTeachVR at institutional level
L	04 - Opportunities for the MiTeachVR System
L	05 - Potential of the MiTeachVR System
S	04 - Preceived Levels of Ease or Difficulty Using the MiTeachVR System
S	05 - Feasibility of including MiTeachVR into your MT Practice
S	06 - Students intentions towards using the MiTeachVR System if it was available now
05 - Describing Lecturers Interaction with the Virtual Environment	
Participant	**Sub-Themes**
L&S	01 - VR Environment Design, Aesthetics, and Layout
L&S	02 - Avatars in the VR Classroom
L&S	04 - Future Design and Development of the MiTeachVR System
L	03 - MiTeachVR Limitations
S	02 - A VR Classroom within a Traditional Classroom
S	04 - PowerPoint and Whiteboard
S	05 - Navigation
S	06 - VR Immersion and Real-world connections

Themes and Sub-Themes Table/Map – Page 03

Themes and Sub-Themes	
06 - Concerns relating to the introduction of MiTeachVR	
Participant	**Sub-Themes**
L&S	01 - Accessibility and Availability of VR Equipment
L&S	02 - Accessibility and Equity for all students
L&S	03 - Ocular Concerns and Additional Needs
L	01 - Funding and Resourcing Concerns
L	05 - Reliability and Consistency with Hardware and Software
L	06 - Possibility of a Workload Increase
S	03 - Experiences of Cybersickness or Discomfort
S	04 - Time Constraints - Students don't have enough time in their schedule
07 - Reduction in course Drop Out Rates	
Participant	**Sub-Themes**
S	No Sub-themes
10 – General Codes - Unused	
Participant	**No Sub-themes. List of eight miscellaneous codes of interest.**
L	01 - Leadership - Leaders in Initial Teacher Education
L	02 - Positively Inclusive
L	03 - Comfort in Practicing Together
L	04 - What are the Corners
L	05 - Preference for the Physical Environment and Real People
S	01 - Minor Issues at the start of the MiTeachVR Session
S	02 - General Comments on the MiTeach System
S	03 - Digital Literate and Familiar with Similar Technology

Appendix M: Guide to Addressing Ethical Issues in Qualitative Research

Where in the Process of Research the Ethical Issue Occurs	Type of Ethical Issue	How to Address the Issue
Prior to conducting the study	• Examine professional association standards. • Seek college/university approval on campus through an institutional review board (IRB). • Gain local permission from site and participants. • Select a site without a vested interest in outcome of study. • Negotiate authorship for publication.	• Consult the code of ethics for professional association in your area. • Submit proposal for IRB approval. • Identify and go through local approvals; find gatekeepers or key personnel to help. • Select sites that will not raise power issues with researchers. • Give credit for work done on the project; decide on author order in future publication.
Beginning the study	• Identify a research problem that will benefit participants. • Disclose purpose of the study. • Do not pressure participants into signing consent forms. • Respect norms and charters of indigenous societies. • Be sensitive to needs of vulnerable populations (e.g., children).	• Conduct a needs assessment or informal conversation with participants about their needs. • Contact participants, and inform them of the general purpose of the study. • Tell participants that they do not have to sign form. • Find out about cultural, religious, gender, and other differences that need to be respected. • Obtain appropriate consent (e.g., parents, as well as children).
Collecting data	• Respect the site, and disrupt as little as possible. • Make certain that all participants receive the same treatment. • Avoid deceiving participants.	• Build trust, and convey extent of anticipated disruption in gaining access. • Put into place wait list provisions for treatment for controls. • Discuss purpose of the study and how data will be used.
	• Respect potential power imbalances and exploitation of participants (e.g., interviewing, observing). • Do not "use" participants by gathering data and leaving site. • Avoid collecting harmful information.	• Avoid leading questions. Withhold sharing personal impressions. Avoid disclosing sensitive information. Involve participants as collaborators. • Provide rewards for participating. • Stay to questions stated in an interview protocol.
Analyzing data	• Avoid siding with participants (going native). • Avoid disclosing only positive results. • Respect the privacy and anonymity of participants.	• Report multiple perspectives. • Report contrary findings. • Assign fictitious names or aliases; develop composite profiles of participants.
Reporting, sharing, and storing data	• Avoid falsifying authorship, evidence, data, findings, and conclusions. • Do not plagiarize. • Avoid disclosing information that would harm participants. • Communicate in clear, straightforward, appropriate language. • Share data with others. • Keep raw data and other materials (e.g., details of procedures, instruments). • Do not duplicate or piecemeal publications. • Provide complete proof of compliance with ethical issues and lack of conflict of interest, if requested. • State who owns the data from a study.	• Report honestly. • See APA (2010) guidelines for permissions needed to reprint or adapt work of others. • Use composite stories so that individuals cannot be identified. • Use unbiased language appropriate for audiences of the research. • Provide copies of report to participants and stakeholders. Share results with other researchers. Consider website distribution. Consider publishing in different languages. • Store data and materials for 5 years (APA, 2010). • Refrain from using the same material for more than one publication. • Disclose funders for research. Disclose who will profit from the research. • Give credit for ownership to researcher, participants, and advisers.

SOURCES: Adapted from APA (2010); Creswell (2013); Lincoln (2009); Mertens and Ginsberg (2009); and Salmons (2010).

(Creswell, 2014, pp. 93–94).

Appendix N: Ethical Approval

The study received research ethics approval from Dublin City University (DCU) Research Ethic Committee, DCU REC Reference (**DCUREC/2023/006**).

Ollscoil Chathair Bhaile Átha Cliath
Dublin City University

DCU

Dr Alan Gorman
School of Policy and Practice

20th April 2023

REC Reference: DCUREC/2023/066

Proposal Title: **Using VR technologies support student teachers in learning to teach**

Applicant(s): **Dr Alan Gorman, Dr Peter Tiernan, Prof Alan Smeaton, Dr Shirley Coyle, Dr Maura Coulter, Dr Enda Donlon, Mr Darran Heaney, Ms Suzanne Stone, Dr Edoardo Celeste, Mr Patrick Boylan**

Dear Colleagues,

Thank you for your application to DCU Research Ethics Committee (REC). Further to notification review, DCU REC is pleased to issue approval for this research proposal.

DCU REC's consideration of all ethics applications is dependent upon the information supplied by the researcher. This information is expected to be truthful and accurate. Researchers are responsible for ensuring that their research is carried out in accordance with the information provided in their ethics application.

Materials used to recruit participants should note that ethical approval for this project has been obtained from the Dublin City University Research Ethics Committee. Should substantial modifications to the research protocol be required at a later stage, a further amendment submission should be made to the REC.

Yours sincerely,

Dr. Melrona Kirrane

Dr. Melrona Kirrane
Chairperson
DCU Research Ethics Committee

DCU Research & Innovation

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Note: Please retain this approval letter for future publication purposes (for research students, this includes incorporating the letter within their thesis appendices).

Appendix O: Key Ethical Points for Participants

Key ethical points for participants

Communication and Recruitment by email: The use of email created distance between researcher and the participants, reducing undue influence or pressure to participate, and also served as record.

Consent and right to Withdraw: All participants (students and lecturers) were verbally informed of the research purpose, requirements and right to withdraw. Each participant was given a printed copy of the plain language statement and a consent form to read and sign (**Appendix F**). In the session I followed the research protocol.

Thank you and Debriefing: After the Data Collection Sessions, each participant was thanked and a debriefing conversation took answering any question participant had and explaining the development of the MiTeachVR system. Participants were email the day following their session to thank them for participating.

Confidentially and Anonymity: I was very conscious about participant anonymity and confidentially, while every effort was made to provide anonymity, the very nature of in-person research diminishes anonymity at the point of testing, however any data collected was anonymised using participant three digit ID's.

Appendix P: Project Time Line

Project Stage 01	
Development of the MiTeachVR System	
<u>Phase 01:</u> MiTeachVR System Development	January – December, 2023
<u>Phase 02:</u> MiTeachVR System Testing Alpha Version Beta Version	 June – August, 2023 September - October, 2023
<u>Phase 03:</u> Prototype Pilot Testing of MiTeachVR System	November - December, 2023
<u>Phase 04:</u> Questionnaire, Interview Questions, and Protocols development and refinement	December, 2023 - January, 2024
Project Stage 02	
Recruitment and Data Collection	
<u>Phase 05:</u> Student Recruitment	Late January - Early February, 2024
<u>Phase 06:</u> Student Data Collection	February – April, 2024
<u>Phase 07:</u> Lecturer Recruitment	Late April – Early May, 2024
<u>Phase 08:</u> Lecturer Data Collection	May – June, 2024

Note: MiTeachVR Project Implementation and Data Collection Timeline