

**THE DESIGN AND EVALUATION OF A VIRTUAL
STAGE FOR AMATEUR ACTORS TO PRACTICE
THEIR PERFORMANCE SKILLS**



ALİ LEYLEKOĞLU

**ÖZYEĞİN UNIVERSITY
OCTOBER, 2025**

THE DESIGN AND EVALUATION OF A VIRTUAL STAGE FOR AMATEUR ACTORS TO PRACTICE THEIR PERFORMANCE SKILLS

by
Ali Leylekoğlu

Thesis
Submitted in Partial Fulfillment of the
Requirements for the Degree of

Master of Science

in
Design, Technology, and Society

Advisor: Asst. Prof. Gökçe Elif Baykal

Graduate School of Social Sciences
Özyeğin University
İstanbul

October, 2025

THE DESIGN AND EVALUATION OF A VIRTUAL STAGE FOR AMATEUR ACTORS TO PRACTICE THEIR PERFORMANCE SKILLS

Approved by:

Asst. Prof. Gökçe Elif Baykal, Advisor
Department of Communication and Design
Özyeğin University

Asst. Prof. Metin Çavuş
Department of Communication and Design
Özyeğin University

Assoc. Prof. Asım Evren Yantaç
Department of Media and Visual Arts
Koç University

Approval Date: October 30, 2025

To my family & my friends their support and encouragement...



DECLARATION OF ORIGINALITY

I hereby declare that I am the sole author of this thesis and that this is the true copy of my thesis, including the final revisions, approved by my thesis committee. All data and information have been obtained, produced, and presented in accordance with the rules of research ethics and principles of academic honesty. As required by these rules, to the best of my knowledge I have acknowledged ideas, thoughts, and any copyrighted material in accordance with the standard referencing rules. I certify that any part of this thesis has not been submitted for a degree or diploma in another educational institution.

Ali Leylekoğlu

ABSTRACT

This thesis explores how virtual reality technology can help amateur actors overcome the physical limits they meet during rehearsals, such as the lack of steady rehearsal spaces, limited chances to build spatial awareness, and difficulty keeping character continuity. The research was carried out with Özyeğin University's Chamber Theatre group and follows a three-stage process focused on text work and memorization. In the first phase, the researchers examined actors' rehearsal processes through their rehearsal diaries. From these findings they designed a VR rehearsal tool that was integrated into the play and tested it with users in two rounds. Interview data were examined with thematic analysis which revealed six themes that reflect actors' insights into rehearsing in VR. In the second phase, the six themes were turned into a questionnaire and given, through the Özü Chamber Theatre club, to amateur actors who met the study criteria. The actors ranked the themes online from most to least important. The themes' importance rankings were analyzed using the Borda Count method, and the interactive environment emerged as the top priority. In the third phase is designed a three session test and design cycle process around this interactive environment theme and improved the existing rehearsal tool with feedback from participants. Interview data were again analyzed with thematic analysis, producing five new themes. The findings from all three stages give important insights into how VR can enhance text work and memorization, and they outline the design elements and possible tools needed for VR-based script work and memorization.

Keywords: Virtual reality, amateur actor, rehearsal processes, virtual stage, theater

ÖZET

Bu tez, sanal gerçeklik teknolojisinin amatör oyuncuların prova sırasında karşılaştıkları düzenli prova mekânı eksikliği, mekânsal farkındalık geliştirme fırsatlarının sınırlı olması ve karakter sürekliliğini sürdürme zorluğu gibi fiziksel sınırlamaları nasıl aşmalarına yardımcı olabileceğini araştırmaktadır. Araştırma, Özyeğin Üniversitesi Oda Tiyatrosu grubuyla yürütülmüş olup metin çalışması ve ezberlemeye odaklanan üç aşamalı bir süreci izlemektedir. Birinci aşamada araştırmacılar, oyuncuların prova süreçlerini prova günlükleri aracılığıyla incelemiştir. Bu bulgulardan yola çıkarak oyuna entegre edilen ve iki tur kullanıcı testinde değerlendirilen bir sanal gerçeklik prova aracı tasarlanmıştır. Görüşme verileri tematik analizle incelenmiş ve sanal gerçeklikte prova yapmaya ilişkin oyuncu içgörülerini yansıtan altı tema ortaya koymuştur. İkinci aşamada bu altı tema, Özü Oda Tiyatro kulübü aracılığıyla çalışma kriterlerini karşılayan amatör oyunculara sunulan bir anket formuna dönüştürülmüştür. Oyuncular temaları çevrim içi olarak en önemli olandan en önemsiz olana doğru sıralamıştır. Tema önem sıralamaları Borda Sayımı yöntemi kullanılarak analiz edilmiş ve etkileşimli ortam en öncelikli tema olarak ortaya çıkmıştır. Üçüncü aşamada, bu etkileşimli ortam teması etrafında üç oturumluk bir test ve tasarım döngüsü süreci tasarlanmış ve katılımcılardan gelen geri bildirimlerle mevcut prova aracı iyileştirilmiştir. Görüşme verileri yeniden tematik analizle incelenmiş ve beş yeni tema ortaya çıkmıştır. Üç aşamadan elde edilen bulgular, VR'ın metin çalışması ve ezberleme süreçlerini nasıl geliştirebileceğine dair önemli içgörüler sunmakta ve VR tabanlı metin ve ezber çalışmaları için gerekli tasarım öğeleri ile potansiyel araçları ortaya koymaktadır.

Anahtar Kelimeler: Sanal gerçeklik, amatör oyuncu, prova süreci, sanal sahne, tiyatro

ACKNOWLEDGMENTS

I would like to express my profound gratitude to my parents, Belgüzar Leylekoğlu and Veysel Leylekoğlu, whose unwavering love and support sustained me throughout every stage of this thesis. I am especially grateful to Gökçe Elif Baykal, whose support and encouragement were indispensable throughout my thesis journey. I am also deeply indebted to the Özü Oda Community for their collective support, and invaluable assistance during the experimental process. In particular, I would like special to thank the following members for their contributions, throughout this journey: Ahmet Tekbaş, Ali Erkin Eyüboğlu, Alp Aksungur, Asım Öztürk, Asya Özdemirci, Ayşe Elif Kaya, Berkay Eroğlu, Berkay Karagözoğlu, Berci Öykü Kılıç, Beliz Çiner, Cansu Akverdi, Cennet Bağrıyanık, Dila Gülen, Doruk Kaya, Doğa Oba, Ece Adıyaman, Ege Ünal, Elif Oğuz, Elif Göksu Doğan, Elinur Özyurt, Enes Demir, Ezgi Duman, Fırat Karakurt, Furkan İbiş, Görkem Çolak, Hasan Mertcan Saka, İlayda Karaca, İlteriş Berkalp Soysal, İrem Arda, İsmail Torun, Kaan Gönenli, Kemalcan Şener, Kerem Yıldırım, Meral Aika Eren, Mert Bostancı, Mert Ceylan, Merve Kaya, Nehir Altuğer, Nisa Emer, Oguzhan Elma, Oğuzalp Erkovan, Rabia Sude Altıok, Selda Sekban, Sena Çavuş, Sude Yılmaz, Tolga Gümüştan, Umut Tellioğlu, Yağmur Kaya, Yaren Gümüş, Yeşim Talya Kanca, Yiğit Taşdemir, Yiğitcan Tumri.

TABLE OF CONTENTS

DECLARATION OF ORIGINALITY	iv
ABSTRACT.....	v
ÖZET	vi
ACKNOWLEDGMENTS	vii
LIST OF TABLES.....	xi
LIST OF FIGURES	xii
LIST OF ACRONYMS AND ABBREVIATIONS	xiii
1. INTRODUCTION	1
1.1 Background.....	6
1.1.1 VR in Performing Arts: Memorization, Script Work & Practice	6
1.1.2 From Virtual Rehearsal to Live Performance: Integrating VR Into Theatre...	9
1.1.3 Staging AI: LLM-Driven Characters in Virtual Theatre	11
1.1.4 Design Considerations for Virtual Environments.....	13
1.2 Aims and Objectives	15
1.3 Scope of the Thesis	16
2. METHOD	18
2.1 Data Collection	20
2.1.1 Phase 1: Understanding of Virtual Rehearsal Process: Insight Gathering Through Observation, Diaries and Interviews in Real Life Context.	21
2.1.1.1 Recruitment of Participants	22
2.1.1.2 Understanding the Rehearsal Experience in VR Theater for Amateur Actors.....	22
2.1.1.3 Rehearsal Diary.....	25
2.1.1.4 Observation Notes.....	25
2.1.1.5 Interview	27
2.1.2 Phase 2: Identifying Prioritization of Actors' Needs: Online Survey	29
2.1.2.1 Recruitment of Participants	30
2.1.2.2 Survey	32
2.1.3 Phase 3: Iterative VR Rehearsal Trials: Prototype Development.....	32
2.1.3.1 Recruitment of Participants	33

2.1.3.2 Interview	34
2.1.3.3 Technical Details of Setups	35
2.1.3.4 NPC Configuration	36
2.1.3.5 Iterative Prototyping Progress	37
2.1.3.5.1 Orientation and Exploring Interactive Environment Features	37
2.1.3.5.2 Developing Interactive Environment Features in Rehearsal	39
2.1.3.5.3 Testing Interactive Environment	41
2.2 Data Analysis	43
2.2.1 Phase 1: Understanding of Virtual Rehearsal Process	44
2.2.2 Phase 2: Identifying Prioritization of Actors' Needs: Online Survey	46
2.2.3 Phase 3: Iterative VR Rehearsal Trials: Prototype Development	47
3. RESULTS	49
3.1 Phase 1: Understanding of Virtual Rehearsal Process: Insight Gathering Through Observation, Diaries and Interviews in Real Life Context	50
3.1.1 Theme 1: Environment Setting	51
3.1.2 Theme 2: Interactive Environment	53
3.1.3 Theme 3: Advanced Script Management	54
3.1.4 Theme 4: Set Design and Prop Integration	56
3.1.5 Theme 5: Interactive and Adaptive Digital Tools	57
3.1.6 Theme 6: Rehearsal Challenges and Issues for Performers	59
3.2 Phase 2: Identifying Prioritization of Actors' Needs: Online Survey	61
3.2.1 Overview of Borda Count Outcomes	61
3.2.2 Interactive Environment	62
3.2.3 Set Design and Prop Integration	63
3.2.4 Advanced Script Management	63
3.2.5 Rehearsal Challenges and Issues.	64
3.2.6 Environment Setting	65
3.2.7 Interactive and Adaptive Digital Tools	65
3.3 Phase 3: Iterative VR Rehearsal Trials: Prototype Development	66
3.3.1 In-Session Findings: Design-Related Insights About a VR-Based Prototype	69
3.3.1.1 Session 1: Player Preferences for VR-Based Rehearsal Techniques	69
3.3.1.2 Session 2: Refinements for Developing the Interactive Environment	71

3.3.1.3 Session 3: Testing Interactive Environment	73
3.3.2 Post-Session Interview Findings: Themes Emerged From VR-Based Rehearsal Sessions.....	74
3.3.2.1 Theme 1: Design Elements for Rehearsal in Virtual Reality Environments	75
3.3.2.2 Theme 2: AI-Driven Non-Player Character Experience in Virtual Rehearsal.....	76
3.3.2.3 Theme 3: Transforming Conventional Rehearsal Through Virtual Rehearsal.....	79
3.3.2.4 Theme 4: Virtual Rehearsal Boundaries and Technological Limitations.....	81
3.3.2.5 Theme 5: The Potential of VR Technology for Individual Practice Opportunities	83
4. DISCUSSION	85
4.1 Phase 1: Defining Themes of Virtual Rehearsal.....	85
4.1.1 Environment Setting	86
4.1.2 Interactive Environment	87
4.1.3 Advanced Script Management Rehearsals in Virtual Scene	88
4.1.4 Set Design and Prop Integration	89
4.1.5 Interactive and Adaptive Digital Tools.....	90
4.1.6 Rehearsal Challenges and Issues for Performers.....	91
4.2 Phase 2: Interactive Environments as the Foundation for VR Rehearsal	91
4.3 Phase 3: Toward Comprehensive VR Rehearsal Systems.....	94
4.3.1 Design Elements for Rehearsal in Virtual Reality Environments	95
4.3.2 AI-Driven Non-Player Character Experience in Virtual Rehearsal.....	97
4.3.3 Transforming Conventional Rehearsal Through Virtual Rehearsal	98
4.3.4 The Limitations of VR Technology for Virtual Rehearsal	100
4.3.5 The Potential of VR Technology for Rehearsal.....	102
4.3.6 Scalability and Accessibility of VR Prototypes for Amateur Theatre Groups	103
5. LIMITATIONS.....	105
6. CONCLUSION.....	106
REFERENCES	109

LIST OF TABLES

Table 2.1 Participant Demographics & VR Experience	30
Table 3.1 Memorization Techniques and Tools Used by Amateur Actors.....	50
Table 3.2 Borda Counts Summary of Rehearsal Feature Priorities	61
Table 3.3 Conventional Memorization Methods and Tools by Participant	66
Table 3.4 Session 1: Participants' Improvement Suggestions Categorized by Subject.	70
Table 3.5 Session 2: Participants' Improvement Suggestions Categorized by Subject.	72
Table 3.6 Session 3 Participants' Improvement Suggestions Grouped by Subject	74



LIST OF FIGURES

Figure 2.1 Method: Data Collection, Analysis, and Prototype Evaluation.....	18
Figure 2.2 VR Theatre Rehearsal: Observation, Design, and Evaluation	22
Figure 2.3 VR Rehearsal Tool	24
Figure 2.4 NPC Configuration Overview	36
Figure 2.5 Session 1: Participant Testing Interactive Environment Features.....	38
Figure 2.6 Session 1: Game View of Interactive Environment Features.....	38
Figure 2.7 Session 2: Stage Design and Practicing With AI-Driven NPC	40
Figure 2.8 Session 2: Game View of Stage Design & AI-Driven NPC Interactions.....	40
Figure 2.9 Session 3: Testing New Implementations With AI-Driven NPC	41
Figure 2.10 Session 3: Game View of New Implementation Interactions	43

LIST OF ACRONYMS AND ABBREVIATIONS

AI: Artificial Intelligence

API: Application Programming Interface

BC: Borda Count

BS: Borda Score

GPT-4o: Generative Pre-trained Transformer 4 omni

HCI: Human-Computer Interaction

LLM: Large-Language Model

MR: Mixed Reality

NPC: Non-Player Character

NVE: Networked Virtual Environment

PDF: Portable Document Format

SVE: Shared Virtual Environment

UI: User Interface

VFX: Visual Effects

VRML: Virtual Reality Modeling Language

VRISE: VR-Induced Symptoms and Effects

XR: Extended Reality

1. INTRODUCTION

Since the early 1990s, numerous artists have utilized virtual reality (VR) to create scenes and experiences that evoke a sense of nostalgia, simplicity, and tradition. This highlights a unique aspect of how VR functions in art: it allows creators to engage with history and tradition rather than focusing only on virtual environments (Dixon, 2006). Giannachi (2004) further notes that there is not just a single "virtual theatre" but multiple interpretations. This variety arises because VR facilitates diverse forms of art with theatrical elements. In addition, the VR environment serves as a lens through which we perceive reality, thereby creating numerous virtual stages.

An increasing number of researchers are using virtual reality (VR) to explore the boundaries of what we consider *real* (Giannachi, 2004). Slater et al. (2000) demonstrated that actors could conduct their initial rehearsals within a shared desktop-VR environment: collaborating with avatars fosters a strong sensation of togetherness and enhances their ability to cooperate, and the movements and emotions they rehearse online transition effectively to the physical stage. Such virtual rehearsal initiatives aim to transport performers into varied environments and provide enhanced training resources. The combination of theater and technology, especially VR, is rapidly becoming a prominent field in the performing arts.

While this study focuses on virtual reality, it is important to acknowledge the emerging role of mixed reality (MR) and pass-through VR in theatre and performance. Unlike fully immersive VR, which situates actors in purely synthetic environments, MR overlays digital props, sets, and avatars directly onto physical rehearsal spaces. This approach allows amateur actors to remain in familiar rooms while still benefiting from digital augmentation, thus offering a gentler and more accessible pathway into

technologically enhanced rehearsal practices. Recent work in Mixed Reality Theatre highlights how MR productions can merge live performance with immersive layers of digital staging without sacrificing the liveness of theatre (Triebe et al., 2023). Similarly, MR rehearsal systems such as CoMR-MoCap demonstrate how mocap data and virtual props can be integrated into real environments to support spatial awareness and natural interaction (Cannavò et al., 2024). These examples suggest that MR complements VR by enhancing rather than replacing the shared physical and social presence that is central to theatre. However, This study did not integrate MR or pass-through VR for two reasons. First, the available hardware and software resources at the time of the research primarily supported fully immersive VR, and developing an MR prototype would have required additional technical infrastructure (e.g., mocap integration, spatial anchoring) beyond the project's scope. Second, the research design focused on exploring actors' rehearsal practices in controlled, fully virtual environments to establish a baseline understanding of how VR alone can support script work and memorization. By first clarifying VR's affordances and limitations, subsequent studies can build more effectively toward MR systems that combine the advantages of physical presence and digital augmentation.

Integrating VR technology into theatre and other performing arts has created various new and beneficial opportunities for the industry. Nevertheless, researchers highlight the need for further investigation into how this tool aligns with the unique techniques employed in theatre and performance (Bonyadi & Summet, 2018; Bouville et al., 2016; Levordashka et al., 2023; McKendrick et al., 2023; Pittarello et al., 2020; Wales et al., 2024). Recent studies show that virtual reality (VR) can improve theatre rehearsals by giving actors and directors new ways to prepare for performances (Bonyadi & Summet, 2018; Levordashka et al., 2023; McKendrick et al., 2023; Wales et al., 2024).

VR helps actors practice blocking and movement with realistic scenic designs before the physical set is built, which increases their confidence (Bonyadi & Summet, 2018). It also allows the use of full-body avatars and shared digital spaces, making it possible to rehearse remotely and still feel present with others (Levordashka et al., 2023). Special VR rehearsal systems, such as the Virtual Rehearsal Suite, create a strong sense of immersion and emotional connection by combining acting practice with digital tools (McKendrick et al., 2023). In addition, VR brings creative benefits by linking theatre with interactive design methods, giving more flexibility and new opportunities for rehearsal (Wales et al., 2024).

While previous research on VR application analysis and design (Howard & Gutworth, 2020; Jonas et al., 2019; Lee et al., 2024; Souchet et al., 2023) provides valuable insights, there is still a lack of comprehensive guidance for rehearsal processes, as only a limited number of studies focus on theatre and performance practice specifically. Some studies (Bonyadi & Summet, 2018; Levordashka et al., 2023; McKendrick et al., 2023; Wales et al., 2024) indicate that virtual reality (VR) can enhance rehearsal processes. Within this broader context, amateur theater remains underexplored. It is rarely studied in universities and is often overlooked or even dismissed in professional and popular contexts (Nicholson et al., 2018). Therefore, it remains uncertain how amateur actors can adapt their scripts and memorization techniques within a VR rehearsal setting. This uncertainty presents a chance to investigate how VR may support theater rehearsals, particularly regarding script work and line memorization, which are essential in the initial rehearsal stages and connect early practice with preparation for final performances.

Based on our initial field observations and information from recent literature (Levordashka et al., 2023; McKendrick et al., 2023; Wales et al., 2024), we formulated

phase 1 Research Question (RQ): *How can a virtual-reality environment be designed to help actors practice and memorize their scripts work during the rehearsal process?* In Phase 2, the preliminary themes of phase 1 are used to shape our second RQ, *which themes do amateur actors regard as most important to their rehearsal experience in VR environments?* In Phase 3, because participant feedback highlighted the importance of an interactive environment, which motivated the formulation of the following RQ, *How do interactive environment features within VR support amateur actors' script work and line memorization, enabling engaging solo practice when partners are unavailable?* This study utilizes three-phase research using qualitative and quantitative methods to analyse and translate amateur actors' rehearsal needs into concrete design choices for virtual reality-based tools.

In Phase 1, insight gathering through prototype testing in a real life context was carried out in collaboration with the Özü Chamber Theatre Club at Özyeğin University during a rehearsal process that spanned over a month. Actors explored an early VR prototype twice during their regular rehearsals, and semi-structured interviews captured their usability feedback and reflections on script memorization in VR. Participants were briefed on headset use and reminded that they could discontinue at any sign of discomfort. Interview data were transcribed and analyzed using thematic analysis (Braun & Clarke, 2019) procedure, revealing recurrent challenges in conventional rehearsal and the perceived opportunities of VR.

In Phase 2, we investigated the relative salience of the Phase 1 themes. Club members completed an online survey that collected demographic and experience data before asking them to rank the themes and justify their choices. Rankings were scored with the Borda count (Emerson, 2013), allowing themes that were frequently placed

second or third to surface as overall priorities. The findings from Phase 1 revealed six main themes that reflect the priorities for rehearsal features: *interactive environment*, *set design and prop integration*, *advanced script management*, *rehearsal challenges and issues*, *environment settings*, and *interactive and adaptive digital tools*. Combining the ranking scores with the open-ended explanations strengthened the reliability of the results and highlighted that *interactive environment* was the most important design focus for future development, followed by the other five themes in order of priority.

In Phase 3, we implemented a three-stage design-and-test cycle centred on the interactive-environment theme. In Session 1, participants rehearsed the first five pages of Francisco's lines (Hamlet, Act 1, Scene 1) while trialling three interactive features. In Session 2, actors designed a scene in VR, rehearsed ten pages of Bernardo's lines with an AI-driven non-player character, and reviewed the company's dramaturgy report inside the virtual space. In Session 3, after free exploration of the updated interface, participants rehearsed all of Marcellus's lines and compared their VR experience with traditional practice. Interviews from each stage were transcribed and thematically analyzed in qualitative analysis tool (Delve, 2017). Across iterations, the data emphasized the growing importance of credible human representation and a strong sense of presence in VR, both of which enhanced motivation and enjoyment during rehearsal.

Overall, the three phases work together to address the overarching research question of how VR can support amateur actors in script work and rehearsal. Phase 1 generated initial insights and themes from real-world rehearsal experiences, Phase 2 prioritized these themes through actor feedback and ranking, and Phase 3 developed and tested interactive features based on the most important theme. Together, these stages show how combining qualitative insights with quantitative evaluation enables an iterative

design process that produces VR rehearsal tools tailored to the practical needs and expectations of amateur actors.

1.1 Background

This thesis, focusing on recent academic work on virtual reality (VR) rehearsals, organizes the literature into four related topics. First, studies on script work and memorization examine how virtual reality environment settings affect actors' recall, cognitive load, and engagement, arguing that designers must balance sensory richness with mental effort. Second, virtual rehearsal research traces the evolution from early avatar-based set walk through to today's networked, immersive sessions that let geographically dispersed casts collaborate in real time. Third, investigations of AI-driven tools for virtual theatre explore large-language-model avatars and co-creative writing systems that can stand in for scene partners or generate adaptive dialogue, while highlighting challenges such as latency, narrative coherence, and ethical use. Finally, design considerations for virtual environments address social presence, health and safety, and interface choices, offering practical guidance on session duration, avatar fidelity, and interaction supports that promote both script work and performing goals.

1.1.1 VR in Performing Arts: Memorization, Script Work & Practice

Research on virtual reality (VR) in the performing arts today covers a broad spectrum, ranging from prototype design and student engagement to cognitive load and individual differences. The memorization experience inside a VR environment can vary from one person to another. For instance, Noice & Noice (2006) described an "active experiencing" technique that blends verbal, physical, and emotional practice and showed that it increases both immediate and delayed recall in actors (Noice & Noice, 2006).

VR's strong sense of presence may increase cognitive load. Studies in immersive learning contexts have shown that higher interactivity or sensory fidelity does not automatically lead to better recall, as the embodied affordances of VR can introduce extraneous cognitive processing that competes with learning (Khorasani et al., 2023). Similarly, Johnson-Glenberg (2018) emphasized that gestures and motor involvement can strengthen memory traces when they are congruent with learning content, but may hinder retention when the interaction lacks conceptual alignment. Conversely, VR's strong sense of presence may increase cognitive load. Bailey et al. (2012) found that higher presence scores were associated with weaker cued recall, suggesting that rich sensory input can consume working memory resources. Similarly, Mania and Chalmers (2001) reported the highest recall levels in desktop VR conditions, which declined when users used a head-mounted display. Overall, the findings suggest carefully balancing immersive elements and the mental effort required from users.

Individual cognitive differences can also decisively shape the memorization experience. Lawson and Mayer (2025) uncovered a strong relationship between executive function scores and learning outcomes in an immersive study conducted without prior training. However, a brief preparatory tutorial partially reduced this dependence, and participants with high working memory capacity still outperformed others in complex scenes. This result suggests that the multimedia Principle (Mayer, 2024) predicts that the simultaneous presentation of words and images optimizes cognitive processing in interaction with individual capacity limits. Indeed, Kenwright (2017) showed that well-designed video games improve reaction time and coordination, indicating interactive, feedback-driven digital environments.

Studies in actor training provide additional insights into VR's practice potential. Pittarello et al. (2020), for example, developed performance-focused VR prototypes and emphasized that VR-based training tools remain under-explored compared with documentation or sharing platforms. To reinforce this point, Popat (2016) argued that moving from physical to virtual stages may offer unique opportunities for exploring embodiment and creativity. Recent theoretical work also indicates that spatial presence and embodiment are not independent constructs; rather, they shape how users experience creative flow and immersion within performative VR (Halbig & Latoschik, 2025). This conceptual interdependence explains why some actors report deeper creative engagement in VR, while others feel cognitive overload depending on how the system aligns motor and perceptual cues (Halbig & Latoschik, 2025; Khorasani et al., 2023).

Recent studies aimed at accelerating pre-rehearsal preparation address spatial and narrative dimensions together, enabling directors and actors to arrive on stage better equipped. Bonyadi and Summet (2018) used VR-based set walkthroughs that boosted actors' confidence in blocking, eliminating potential staging errors before rehearsal. Likewise, the four reusable drama patterns defined by Vranić and Vranić (2019) early clarify the narrative backbone, reducing the director's dramaturgical interventions.

Overall, these approaches indicate that VR technology can improve rehearsal processes by simultaneously optimizing physical layout and dramatic structure, provided that the sense of presence and embodiment are balanced to avoid overloading learners' cognitive resources (Halbig & Latoschik, 2025; Johnson-Glenberg, 2018).

Tele-immersive research shows that remote performing arts can create co-presence not only among actors but also between actors and audiences. Virtual Director, for example, allows performers to enter a shared 3-D flow state (Branch et al., 2021),

while VR projects such as Theatre 360° carry the same sense of liveness to geographically distant spectators, preserving the overall flow of the performance (Iudova-Romanova et al., 2023). Thus, the boundary between remote rehearsal and production blurs, and mutual interaction functions as a bridge that enriches both the creative process and the stage experience in real-time. Technology-oriented studies further broaden the picture. Wu et al. (2010) combine immersive peripherals with motion recognition to capture the spontaneity of live performance. In contrast, Jung et al. (2006) explore action capture and imitation learning, linking VR research to questions in cognitive science and robotics.

Overall, the above literature portrays virtual reality as a versatile yet potentially demanding medium when poorly designed. Current evidence highlights opportunities in actor training, rehearsal support, remote production, and creative exploration while raising questions about practical constraints, cognitive load, and interdisciplinary relevance.

1.1.2 From Virtual Rehearsal to Live Performance: Integrating VR Into Theatre

In performing arts, especially during theatre rehearsals, virtual reality (VR) studies indicate a significant shift from conventional methods to technology-supported ones. The pioneering work of Reeve and Palmer (1999) utilized virtual reality modeling language (VRML) and avatar systems to transcend the limitations of physical space and set design, thus facilitating this transition. Their approach introduced a dynamic aspect to rehearsals and established the foundation for subsequent research regarding the impact of VR on production effectiveness and actor performance. Expanding on this groundwork, Slater et al. (2000) explored the role of virtual reality in enhancing actors' skills, combining virtual and traditional rehearsals while evaluating VR's capacity to prepare performers for live performances. In summary, these studies illustrate a growing

integration of VR technology and theatre practice, emphasizing both the possibilities and the challenges involved in incorporating VR into the rehearsal process.

Advancements in technology have expanded the possibilities of research to investigate how virtual reality (VR) functions within networked virtual environments (NVEs) and contexts that utilize visual effects (VFX). Normand et al. (2012) made a notable impact by demonstrating that people in different locations can work together remotely and capture full-body movements in a shared virtual space. By using shared virtual environments (SVEs), the system allowed performers to rehearse full-body acts while being in different locations. Their research sparked new conversations about the capabilities of immersive VR for theatre rehearsals, especially concerning collaborative interactions and practical application.

Bouville et al. (2016) investigated the specific difficulties actors encounter in green-screen settings and proposed a virtual reality system to help them prepare for scenes that rely heavily on visual effects. This move toward technology-enhanced rehearsal points to a wider shift in the acting community, which increasingly favours VR-based training. Similarly, Fulton et al. (2022) describe an online platform that allows theatre groups to practice blocking remotely. The system shares an overhead stage layout: directors trigger cues, while performers guide color-coded avatars with a keyboard, mouse, or motion-capture input. Performers can adjust positions to suggest new movements, and the entire layout may project onto the floor to strengthen spatial awareness.

Research indicates that virtual reality (VR) tools are transforming the performing arts, particularly following worldwide social-distancing measures (Levordashka et al., 2023; McKendrick et al., 2023). McKendrick et al. (2023) frame the ongoing digital

evolution of the live arts and entertainment industry and explore how performance training is adjusting to VR technologies. Levordashka et al. (2023) offer a practical assessment of VR in theatre rehearsals, demonstrating that even basic VR setups can improve spatial planning. However, they still face challenges in accurately representing subtle facial expressions and gestures. By examining the live VR production “*You Should Have Stayed Home*”, Wales et al. (2024) analyzed how the processes of theatre-making evolve when the stage turns into a shared virtual space. Their findings suggest that compelling VR theatre requires teams to review existing VR productions, collaborate seamlessly through VRChat, Zoom, and Slack platforms, iterate scripts and sets, and design bespoke lighting, sound, and staging solutions. Nevertheless, headset fatigue continues to limit rehearsal duration.

Those studies highlight a clear meeting point between digital innovation and stage practice, emphasizing the continual development of rehearsal and performance practices in the digital era.

1.1.3 Staging AI: LLM-Driven Characters in Virtual Theatre

Large-language-model (LLM) integrations are reshaping how users interact with non-player characters (NPCs), virtual agents, and co-creative writing tools in immersive media. In a VR murder mystery, Christiansen et al. (2024) compared free-speech input with classic dialogue menus. Both interfaces supported similar social presence, yet voice interaction increased immersion and cognitive load. At the same time, the slow response times of current LLMs disrupted conversational flow, pointing to a need for faster generation or more effective masking strategies (Christiansen et al., 2024). Extending this work, Yin and Xiao (2024) show that VR introduces additional “interaction triggers”

(e.g., proximity and gesture), prompting players to expect greater NPC realism, explicit feedback, and meaningful agency (Yin & Xiao, 2024).

Research by Senanayake (2025) describes a hybrid reinforcement-learning pipeline that outperformed rule-based finite-state machines, surpassing a 75 percent action-prediction benchmark and increasing engagement in a prototype game (Senanayake, 2025). Both in theatre and education, virtual characters appear to foster deeper engagement and learning: Pietroszek et al. (2018) showed that amateur actors rehearsing Hamlet with AI-driven performers responded positively to the experience, while Gamage and Ennis (2018) found that comparable virtual agents heightened participation and improved outcomes in a classroom setting.

Social factors also shape perceived believability. Synthesizing prior studies, Kyriltsias and Michael-Grigoriou (2022) identify four variables: social presence, realism, transportation, and medium-as-actor effects that influence interaction with agents and avatars in immersive spaces. Their review suggests that avatars (user-controlled) and agents (AI-controlled) can evoke parasocial responses when they behave contingently and remain contextually plausible. Building on this foundation, Wu et al. (2025) propose a playwriting-guided hierarchical pipeline: an LLM first outlines dramatic structure, then iteratively refines scenes through plot-based reflection, an approach that early tests link to higher immersion and player agency (Wu et al., 2025). A comparable layer-by-layer strategy underpins Dramatron, where Mirowski et al. (2023) progress from a user logline to titles, characters, story beats, settings, and dialogue. Professional writers in their study viewed the tool as applicable for idea generation and rapid drafting yet emphasized the need for human revision to maintain coherence and authorial voice (Mirowski et al., 2023).

Educational and ethical questions are gaining prominence. A practice-based auto-ethnography by Cake (2025) notes that generative AI offers rapid structural feedback but raises concerns about dataset bias, copyright provenance, and an over-analytical focus that may reduce emotional depth; the author recommends fostering creative self-awareness before widespread classroom adoption. Therapeutic applications show similar promises and caveats. Zisquit et al. (2025) embedded an LLM-driven avatar into a VR self-talk protocol: participants rated usefulness at 6.9 out of 10 and expressed a high willingness to repeat the experience, provided advice quality and avatar credibility remain strong (Zisquit et al., 2025). Finally, Votintseva and Johnson (2024) demonstrate that AI avatars with distinct personalities, real-time emotion recognition, and tailored feedback can broaden access to soft-skills training by bridging the gap between theoretical instruction and live role-play (Votintseva & Johnson, 2024).

Overall, these studies illustrate the opportunities and the challenges of incorporating LLM-driven agents into immersive environments.

1.1.4 Design Considerations for Virtual Environments

Lee et al. (2024) developed a social-VR lobby to support post-performance interaction among remote opera audiences. Evaluation results show that both solo and paired viewers reported high engagement and a strong sense of presence. Paired participants also stayed longer in shared areas and maintained appropriate interpersonal distances, confirming the lobby's effectiveness and hinting at future enhancements such as cooperative tasks that could deepen audience involvement.

Presence in VR can be heightened by embodied representation of the self, and learners with stronger multisensory integration may experience deeper immersion. However, whether this leads to greater cognitive strain depends on the correspondence

and design of embodied interactions (Forster et al., 2022). Extending this interest in social interaction to structured learning, Howard and Gutworth (2020) conducted a meta-analysis of 22 studies with 1,530 participants to test whether VR can improve social skills. On average, VR groups outperformed comparison groups by 0.69 standard deviations, with the largest gains observed in programmes that delivered explicit social-knowledge instruction. In contrast, interventions focused only on emotion regulation or mixed methods produced limited benefits. The study also notes that immersive displays and game elements did not reliably outperform standard monitors or basic controls, highlighting the importance of instructional design over technical novelty.

These observations fit well within the three-layer taxonomy proposed by Jonas et al. (2019), who reviewed 29 multi-user VR systems. Their framework separates design decisions into *Self* (avatar fidelity, gesture tracking, locomotion), *Social Interaction* (communication channels, activity scaffolds), and *Environment* (public versus private spaces, spawn-point strategies, scene editing). Mapping developments from early collaborative environments to platforms such as VRChat, the taxonomy uncovers underused features such as editable stages or private lobbies that could strengthen rehearsal contexts and support the social and pedagogical goals identified in the studies above.

While these studies show VR's social and training potential, health and safety considerations remain important. Souchet et al. (2023a) catalog over 90 individual, hardware, and software factors linked to five virtual reality-induced symptoms and effects (VRISE): cybersickness, visual and muscle fatigue, acute stress, and mental overload. They recommend limiting sessions to 20–30 minutes, inserting breaks, and providing extra ergonomic support for neurodiverse or older users, emphasizing that continuous

health monitoring is still necessary. Complementing this workplace focus, Cossio et al. (2025) review 25 educational studies and find that Simulator Sickness Questionnaire scores are usually low. The most common complaints are oculomotor strain and disorientation, while headset discomfort is mild and inconsistently reported. They advise briefing learners about temporary blurred vision or dizziness and discouraging tasks that demand complete sensorimotor stability, such as driving, immediately after VR use. Finally, Souchet et al. (2023b) analyzed 386 publications and showed how the same five VRSE interact. Their synthesis lists roughly 50 cybersickness factors and 15–20 factors for each remaining category, calling for refined optics and motion paradigms. that reduce sensory conflict, task-appropriate breaks, and continuous psychophysiological monitoring in both workplace and educational deployments.

1.2 Aims and Objectives

This thesis aims to build a virtual reality practice tool for amateur actors to help them rehearse and remember their lines and to keep improving the tool by creating and testing new versions. The investigation is revealed in three phases. In Phase 1, a design and development study of an early prototype within conventional stage rehearsals illuminated both prevailing challenges and the affordances of VR; a thematic analysis distilled six core themes. Phase 2 prioritized these themes via an online survey and the Borda count method, establishing an “interactive environment” as the principal design focus. Phase 3 centered on this priority through a three cycle design test loop: participants initially selected one of three interactive features for examination, their feedback directed successive iterations, and a subsequent thematic analysis yielded five additional themes. The findings derived from qualitative and quantitative analysis guided the progressive

enhancement of the VR tool and furnished evidence-based design insights applicable to amateur theatre ensembles.

1.3 Scope of the Thesis

This study aims to explore the potential contributions of virtual reality (VR) technology to the script work and memorization processes of amateur theatre actors. The research is deliberately limited to the early rehearsal stage, focusing on fundamental acting practices such as discovering tools that can support the recall of lines, achieving integration with the script, and maintaining character continuity. Within this scope, the rehearsal experiences of amateur actors were documented through diaries, observations, and interviews. The findings guided the evaluation of a VR prototype, which was developed and tested through a three-stage iterative design process. In this way, the study seeks to propose applicable design insights that can address the needs of amateur theatre groups.

The research has been intentionally restricted by excluding certain areas. Professional theatre groups and other performing arts (such as opera or dance) were not included, as they operate under different production conditions and resources. Due to the time frame and methodological design of the study, only short-term rehearsal experiences were examined, while long-term learning outcomes and audience experience were left outside the scope. The research was carried out using a Quest 3 VR headset, and the prototype was developed and tested in the Unity environment. Other VR hardware and software platforms were not employed; therefore, no comparative evaluation was made.

In conclusion, these limitations were deliberately applied to increase the focus of the research. By concentrating on the needs of amateur theatre actors during the early

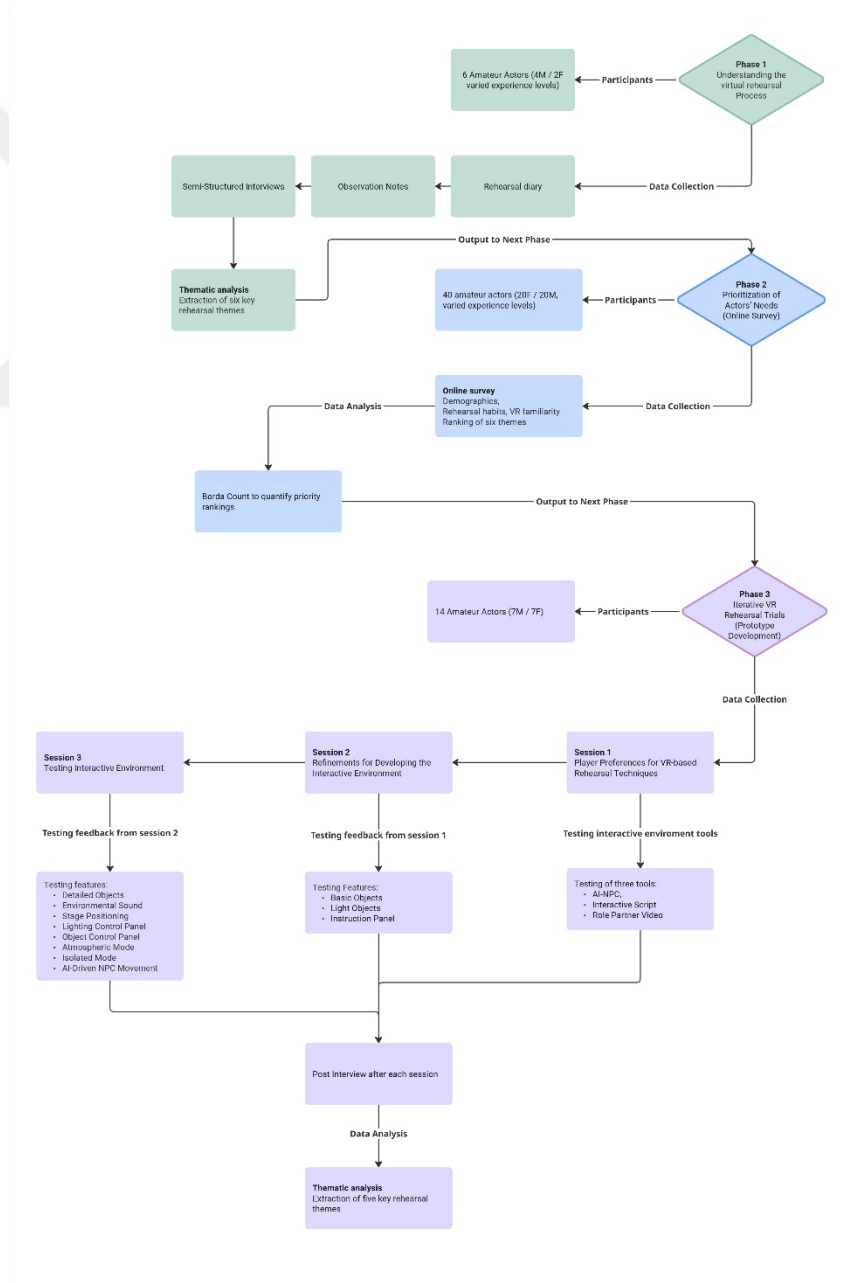
stages of rehearsal, the study aims to generate both in-depth and practically applicable results, rather than addressing broad and diverse topics.



2. METHOD

This study comprises three phases (see Figure 2.1). In phase 1, a qualitative study reports over month collaboration with Ozyegin University Chamber Theatre Club during rehearsals for a drama play to gain in-depth insights about rehearsal practices of amateur players and their opinions on a virtual reality experience for memorization.

Figure 2.1 Method: Data Collection, Analysis, and Prototype Evaluation



In phase 2, identified themes in phase 1 were presented to participants via a survey to determine their main areas of focus to inform the prototyping design. In phase 3, the virtual reality environment was iteratively developed based on amateur actors' preferences and feedback, guiding the design process. Details of each phase are described below. In phases 1 and 3, informal ethics procedures were followed. Amateur actors were fully informed on the study's aims, gave both verbal consent and signed a written consent form before any data were collected, and were reminded that they could withdraw at any time. Phase 2 (online survey). Before the questionnaire, participants saw a brief digital informal consent screen. They read the study information, gave informed consent by clicking "Submit," and could exit the survey at any time. The project received ethical approval from Ozyegin University's Research Ethics Committee (approval number: 2025/13/01)

Phase 1 – Understanding of virtual rehearsal process. This qualitative study was carried out over several months in partnership with a theatre club during its rehearsal phase. In identifying the research problem, we leveraged data from academic studies (Bonyadi & Summet, 2018; Bouville et al., 2016; Levordashka et al., 2023; McKendrick et al., 2023; Wales et al., 2024), observation notes, rehearsal notes and virtual rehearsal experience to discover the challenges actors face during script practice and line memorization. During rehearsals, participants engaged with a virtual reality-based prototype that demonstrated the operation of diverse tools within a virtual environment and their relevance to drama practice. The prototype was tested twice. In the first session, participants became familiar with the system, grasped the procedure, and supplied technical feedback. The second session allowed for a deeper examination of the application and produced suggestions for improving the prototype.

Phase 2 – Identifying the prioritization themes for Virtual Rehearsal. Building on the findings of the previous qualitative study phase 1, an online survey was conducted to clarify and prioritize the design focus areas. 40 amateur actors (20 female, 20 male) with varied stage and rehearsal experience ranked a predefined set of rehearsal needs by importance and explained their choices in free-text form. These explanations revealed the criteria that informed subsequent design decisions.

Phase 3 – Testing Interactive Environment based Virtual Rehearsal. Considering the Phase 1 findings, three iterative design-and-test cycles were carried out with 14 new participants (7 female and 7 male). Each participant completed a scripted rehearsal task in a virtual reality (VR) environment, and experiential feedback was collected after every session through semi-structured interviews. Following each iteration, the interview results were consolidated, the prototype was refined, and the revised version was tested again. This process enabled the emerging needs of amateur actors to influence both the interaction methods and the rehearsal support features. In the following sections, the data collection process, participant selection, iterative prototyping strategy, and the analysis procedure in each phase are presented in detail.

2.1 Data Collection

The study employed a three-phase data collection strategy. In phase 1, this study documented how amateur actors move from conventional rehearsal to an initial VR encounter through direct observations notes, rehearsal diary entries, and semi-structured interviews. In phase 2, this study surveyed 40 actors online, recording demographics and VR familiarity, then used a forced-ranking task to prioritise six design themes and gathered open-ended justifications to enrich the quantitative rankings. In phase 3, this study involved three iterative VR-rehearsal sessions with 14 actors over one month; after

each session, face-to-face interviews were conducted individually to extract reflections on features such as AI-driven NPCs, scene-building tools, and lighting/sound panels. This approach yielded both numeric priorities and rich thematic insights to steer subsequent design decisions.

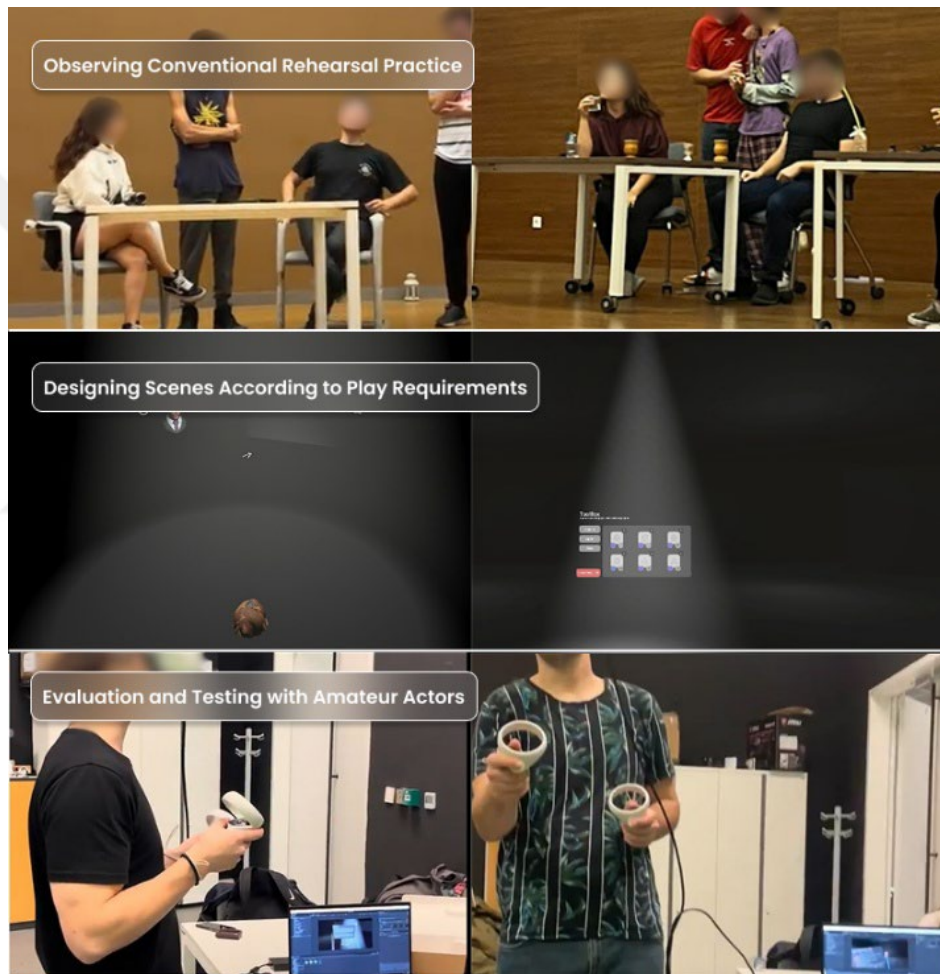
2.1.1 Phase 1: Understanding of Virtual Rehearsal Process: Insight Gathering Through Observation, Diaries and Interviews in Real Life Context.

Data collection process consisted of four main procedures. Participants were recruited from the Özyeğin University Chamber Theatre Club, all with amateur acting experience who volunteered to participate in the study, after the research aim and procedure were clearly explained to them. First, the virtual reality (VR) rehearsal experience tested a prototype that reproduced physical rehearsal tools in a digital environment; actors explored the system freely and then took part in two structured sessions, stage design and scene performance, where they practised avatar choice, set building, lighting adjustment, and placing text cues. Second, the rehearsal diary served as a qualitative source for in-depth insights because the directing team systematically recorded daily notes on task distribution, challenges, and solutions. Third, observation notes provided an additional perspective, as researchers watched both traditional rehearsals and VR sessions on site and documented contextual behaviour patterns. Finally, semi-structured interviews lasting ten to twenty minutes examined actors' script work and memorization strategies, the tools they used and their views on integrating VR into this process, following a three-part protocol. Overall, these procedures offer a methods solid base for understanding conventional rehearsal preparation with VR-supported tools and for discussing technology integration in the performing arts.

2.1.1.1 Recruitment of Participants

Data were collected in collaboration with the cast of a drama production currently in rehearsal within the university theatre club (Figure 2.2a). All participants had prior experience in amateur theatre and voluntarily contributed their insights to this study.

Figure 2.2 *VR Theatre Rehearsal: Observation, Design, and Evaluation*



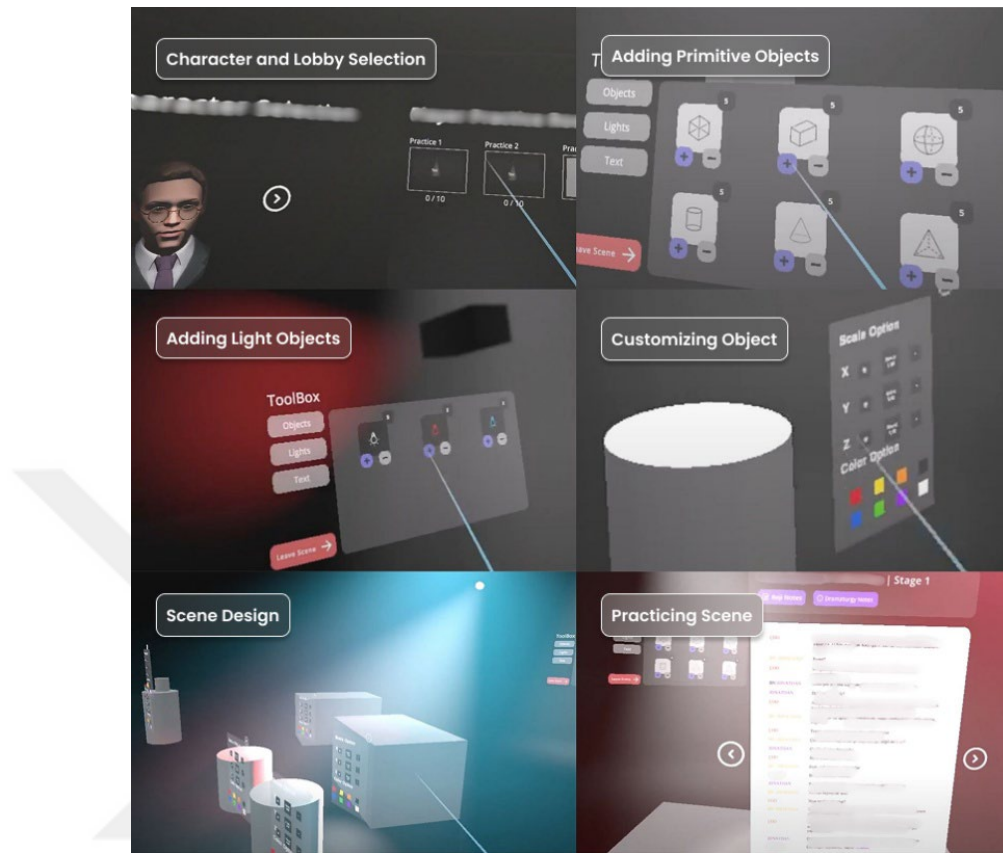
Note. (a) Observing conventional rehearsal practice, (b) Designing the scene according to play requirements, (c) Evaluation and testing with amateur actors.

2.1.1.2 Understanding the Rehearsal Experience in VR Theater for Amateur Actors

In this study we replicated essential physical-rehearsal tools inside a virtual reality (VR) environment so that amateur actors could rehearse in a fully virtual environment

(Figure 2.2b). Based on design insights from studies (Levordashka et al., 2023; McKendrick et al., 2023;) the prototype enabled users to place virtual objects, adjust lighting, and embed text cues directly on stage. This tool gives amateur actors simple features to create and practice scenes in a virtual space. Amateur actors start by choosing a character in the lobby (Figure 2.3a), which gives them an identity and prepares the space for working alone or with others. With a toolbox, they can add basic shapes like cubes, spheres, cylinders, and cones, which work as building blocks for sets or props (Figure 2.3b). Light objects such as spotlights or ambient lights can also be added to change the mood and atmosphere, showing conditions like daylight, stage lighting, or darker settings (Figure 2.3c). These objects can be changed in size and color, which helps actors shape the final look of the set (Figure 2.3d). After placing the objects and lights, amateur actors can design a complete scene that may look like a stage (Figure 2.3e). In the last step, dialogue pieces or script parts can be placed in suitable spots, so the actors can move through the space, rehearse, and practice their lines in a way that matches the environment (Figure 2.3f).

Figure 2.3 *VR Rehearsal Tool*



Note. (a) Character and lobby selection, (b) Adding a primitive object, (c) Adding light objects, (d) Customizing the object, (e) Scene design, (f) Practicing the scene.

Participants interacted with the prototype during two separate sessions. The first session (Figure 2.3c) was an unguided exploration lasting five to ten minutes, allowing participants to familiarise themselves with the VR interface and interaction mechanics. The second session followed a structured two-stage protocol. In stage 1, the time each actor may spend on this stage is limited to 5–10 minutes. Amateur actors selected an avatar and entered a shared rehearsal lobby, thereby establishing personal embodiment and an initial sense of social presence (Figure 2.3a). Actors then used geometric primitives (Figure 2.3b) and lighting assets (Figure 2.3c) to assemble a draft stage layout (Figure 2.3e) while refining their manipulation skills.

In stage 2, the time each actor may spend on this stage was limited to 5–10 minutes. Amateur actors involved in rehearsing a selected scene and informally evaluating individual performance within the VR setting (Figure 2.3f). Finally, semi-structured interviews captured detailed reflections on rehearsing in VR, the challenges encountered, and overall satisfaction with the experience (Figure 2.2c).

2.1.1.3 Rehearsal Diary

The directing team maintains an extensive set of rehearsal notes that serve as a day-by-day chronicle of the production. These documents provide detailed accounts of the tasks carried out, events noted, challenges faced, and assignments allocated to the cast and crew at every phase of the creative process. Beyond functioning as a practical log for the current production, the documents are deliberately preserved as a reference tool so that future ensembles can trace past decisions, anticipate potential difficulties, and benefit from the accumulated experience of earlier teams. For the purposes of this study, the directing team generously granted us unrestricted access to their carefully organized archive. Examining these materials refined the study's focus and strengthened the analysis by highlighting the director's decisions, the actors' challenges, and the spatial limitations of the performance space.

2.1.1.4 Observation Notes

This observation presents a process defining the problems of the rehearsals conducted as part of an ongoing theatre production. Each rehearsal stage has been examined individually in terms of the actors' relationship with the script and stage, emotional expression, memorization status, directorial guidance, and practical staging. Observation notes of conventional rehearsal are described in detail below.

Conventional Rehearsal 1 – Basic Reading and Text Analysis. The rehearsal process began with a basic script reading. In this session, participants engaged in an initial reading aimed at understanding the play's content. The initial reading session was observed to evaluate the participants' effective use of gestures and facial expressions, to evaluate how they interpreted the text and the level of their comprehension of the content, and to enable the actors to gain a basic familiarity with the play's script. During the session, the facilitator took observational notes on how the participants memorized the text.

Conventional Rehearsal 2 – Basic Reading and Text Analysis. At this stage, actors worked on analyzing emotions and situations within scenes through improvisation beyond the script. Observation notes of conventional rehearsal 2 as described in detail below. During the second rehearsal session, observations focused on how the actors differentiated emotional states and the memorization process, which is clear in their exercises. The restricted emotional range was examined, especially in the detail presented by the amateur actors, where emotional expressions overlapped and blended. Throughout the session, the facilitator took notes on the actors' difficulties and their self-reflective practices aimed at increasing individual awareness and strengthening emotional expression within the rehearsal process.

Conventional Rehearsal 3 – Memorization and Directorial Staging. In this rehearsal, actors had not yet fully memorized their lines. Therefore, scene performances were carried out with the aid of prompting. During the third rehearsal, the main focus was to advance the rehearsal process in line with the director's guidance. The director's staging supplied the basic framework that organised scene dynamics and spatial relationships. Because the actors had not fully memorised their lines, the overall flow of

the performance was interrupted, showing the need for continual attention to script memorisation.

Conventional Rehearsal 4 – Memorization and Directorial Staging. This session marked the first attempt to perform the overall flow of the play. During the fourth rehearsal, the focus shifted to working through scene transitions and the overarching structure of the play. A full-stage run-through was conducted to reinforce the rhythm and continuity of the performance, allowing the cast to experience the flow of the production in its entirety and identify areas requiring refinement.

Conventional Rehearsal 5 – Emotional Expression and Detailed Staging. This rehearsal focused specifically on improving the actors' ability to convey emotional transitions within scenes. In the fifth rehearsal, actors focused on enhancing their ability to express emotional transitions more effectively within scenes. The director offered detailed stage directions, addressing both emotional expression and physical staging to support the intended performance dynamics. This phase proved particularly productive, as it enabled the actors to connect their internal emotional experiences with corresponding physical actions, contributing to a more cohesive and embodied performance.

In conclusion, this observational study aimed to identify the challenges inherent in the rehearsal process. Five conventional rehearsals were systematically examined: Sessions 1 and 2 concentrated on script analysis, Sessions 3 and 4 on memorization, and Session 5 on emotional expression.

2.1.1.5 Interview

The interviews aimed to examine how amateur actors prepare and memorise scripts and to assess the potential for transferring these practices into virtual reality environment. Before the single interview session, participants received detailed

information about the study. The question set was developed using insights from virtual rehearsal practice, rehearsal diary, observational notes and relevant literature (McKendrick et al., 2023; Levordashka et al., 2023) to ensure alignment with the primary research objective. The structured interview protocol is organized into three distinct sections, each intended to examine specific facets of actors' approaches and experiences in both conventional and virtual reality based rehearsal.

In questions 1 to 4, the protocol examines the personal significance actors attach to script memorisation and details their individual memorisation routines, including any specialised techniques they employ. This section aims to reveal the value performers assign to memorisation, the step by step strategies they follow, the range of methods they test, and their reasons for preferring certain approaches over others.

Questions 5 and 6 focus on the tools and resources actors use when memorising, ranging from reading the script on paper to practising in front of a mirror; the questions evaluate how well each method aids recall and examine why performers select particular strategies.

Questions 7 to 10 examine the incorporation of virtual reality (VR), investigating its potential impact on actors' memorisation practices, outlining an ideal VR rehearsal setting, identifying VR features that could streamline and support memorisation, and capturing participants' expectations of working with VR in this context.

Those questions has been carefully designed to give a deep understanding of the memorisation process, blending traditional methods with the emerging opportunities and challenges of VR technology to create a comprehensive picture of actors' rehearsal and preparation. The questions were thoughtfully structured to prompt participants to share

their experiences and insights openly, emphasising the practical ‘how’ of their rehearsal routines.

Interview appointments were arranged at times convenient for participants, demonstrating respect for their schedules, and each session lasted approximately 10 to 20 minutes. The interview items aimed to capture a comprehensive picture of current script-preparation practices and to evaluate the potential advantages of incorporating virtual reality into theatre rehearsals. The resulting insights are expected to inform wider discussions about technology’s role in the performing arts, particularly in actor training and performance improvement.

2.1.2 Phase 2: Identifying Prioritization of Actors’ Needs: Online Survey

Data collection process involved a web-based survey conducted with the Özyegin University Chamber Theatre Club capturing both theater background and virtual reality experience (Table 2.1). In total, New 40 amateur actors (20 female, 20 male) participated in the survey. In Section 1, participants reported their gender, years of stage work, frequency of VR use, and familiarity with digital rehearsal tools, which ensured that even actors with limited VR literacy could answer confidently. In Section 2, amateur actors ranked six candidate themes (environment setting, interactive environment, advanced script management, set design and prop integration, interactive and adaptive digital tools, and rehearsal challenges) according to their perceived importance for VR rehearsal; these complete rankings were later aggregated with the Borda count method (Emerson, 2013). The Borda Count method was selected because it provides a structured way to aggregate complete preference ordering across multiple participants, producing a collective priority list that reflects the relative importance of each theme. In Section 3, amateur actors provided open-ended rationales for those rankings, adding qualitative depth to the quantitative

priorities. This qualitative and quantitative arrangement produced a balanced view of current rehearsal practices and expectations for VR support, informing the prototype iterations described in Phase 3.

2.1.2.1 Recruitment of Participants

Table 2.1 presents 40 amateur actors, evenly divided by gender (20 female and 20 male). The actors belonged to the Özyeğin University Chamber Theatre Club, and invitations were sent through the club to members who met the study criteria.

Table 2.1 *Participant Demographics & VR Experience*

Participant No	Gender	Acting Years	VR Experience
SP1	Male	5–10 years	Experienced
SP2	Male	5–10 years	No experience
SP3	Male	5–10 years	Experienced
SP4	Male	10+ years	Experienced
SP5*	Male	5–10 years	Experienced
SP6*	Male	3–5 years	Experienced
SP7	Female	3–5 years	Experienced
SP8	Female	1–3 years	Experienced
SP9	Female	5–10 years	Experienced
SP10*	Men	10+ years	Experienced
SP11	Female	1–3 years	Experienced
SP12	Male	5–10 years	Experienced
SP13	Male	5–10 years	Experienced
SP14	Female	1–6 months	Experienced
SP15	Female	5–10 years	Experienced
SP16	Male	6 months–1 year	No experience
SP17	Female	5–10 years	No experience
SP18*	Female	6 months–1 year	No experience
SP19	Male	3–5 years	No experience

Participant No	Gender	Acting Years	VR Experience
SP20	Female	3–5 years	No experience
SP21	Female	3–5 years	No experience
SP22	Male	10+ years	Experienced
SP23	Male	5–10 years	Experienced
SP24	Male	6 months–1 year	Experienced
SP25	Male	1–3 years	Experienced
SP26	Male	6 months–1 year	Experienced
SP27	Male	5–10 years	No experience
SP28*	Female	3–5 years	No experience
SP29	Female	1–6 months	Experienced
SP30	Female	3–5 years	No experience
SP31*	Female	5–10 years	Experienced
SP32	Male	1–3 years	No experience
SP33	Female	1–6 months	No experience
SP34	Female	3–5 years	No experience
SP35	Male	5–10 years	No experience
SP36	Male	3–5 years	No experience
SP37	Female	3–5 years	Experienced
SP38	Female	1–3 years	No experience
SP39	Female	3–5 years	No experience
SP40*	Female	1–3 years	No experience

Note. SP Participants marked with an asterisk took part in the next phase 3 study.*

Students from the trainee actors were excluded because they had no acting experience; each participant had to have appeared in at least one amateur stage production. To help respondents with limited VR knowledge, the questionnaire included brief explanations of key VR terms.

Acting experience differed widely: 3 participants had 1–6 months, 4 had 6 months–1 year, 6 had 1–3 years, 11 had 3–5 years, 13 had 5–10 years, and 3 had more than 10 years of experience. 22 actors already had some VR experience gained through

design projects, gaming, or earlier rehearsal trials while 18 had never used VR. Seven individuals, marked with an asterisk in the table (Table 2.1), volunteered for the next in-depth phase of the study. Overall, the sample provides a balanced cross-section in terms of age, gender, stage experiences, and VR familiarity, giving a basis for this study.

2.1.2.2 Survey

Data was collected with a web based tool built in Microsoft Forms. Informed by themes that emerged from an earlier exploratory study, the survey comprised three sections. The first section recorded age, gender, years of stage experience, frequency of VR use, and familiarity with digital rehearsal tools. In the forced-ranking task, participants ordered six themes: environment setting, interactive environment, advanced script management, set design and prop integration, interactive and adaptive digital tools, and rehearsal challenges and issues for performers, according to perceived relevance. Finally, the open-ended rationales section invited actors to explain why each theme would best support VR-based rehearsal workflows. This mixed-methods approach yielded both quantitative priority rankings and rich qualitative insights, providing a foundation for subsequent analysis and iterative design.

2.1.3 Phase 3: Iterative VR Rehearsal Trials: Prototype Development

14 amateur actors (7 female, 7 male) completed three consecutive VR rehearsal sessions, and their post session feedback was transcribed verbatim using aTrain (2017) audio transcription tool for thematic analysis. In Session 1, actors received a five-minute orientation on headset controls, rehearsed 3 pages of Francisco's lines from Hamlet, Act I, Scene I with three tools (role-partner video, interactive script, and an AI-driven NPC)

presented in a counterbalanced order for each participants, and then joined interviews about tool preferences and improvement ideas.

In Session 2, based on the phase 1 NPC and the feedback that may be associated with it, new developments were implemented. Participants set up a virtual stage from a dramaturgical brief, rehearsed up to six pages of Bernardo's lines with an updated NPC whose knowledge bank, animation set, and command recognition had been expanded, and completed interviews that focused on dialogue flow, visual representation, and layout controls.

In Session 3, based on the phase 2 NPC and the feedback that may be associated with it, new developments were implemented. Actors tried new functions such as detailed props, lighting and sound panels, atmospheric and isolation modes, stage-position markers, and enhanced NPC movement, then rehearsed to the end of Act I with the Marcellus character; follow-up interviews identified which feature combinations best supported memorization, script work, and rehearsal logistics. This longitudinal test-and-feedback cycle shows how iterative virtual reality progressively reshapes rehearsal practice.

2.1.3.1 Recruitment of Participants

14 amateur actors (7 female, 7 male) from the Ozyegin University Chamber Theatre Club took part. Several of these participants (SP5, SP6, SP10, SP18, SP28, SP31) had already taken part in Phase 2. All performed in at least one real stage production prior to the study. After each session, semi structured individually face-to-face interviews were audio recorded and transcribed verbatim using the aTrain transcription tool (aTrain, 2023).

2.1.3.2 Interview

Data was collected through individually face-to-face interviews held after every session in which participants tried the virtual reality rehearsal tool. After each stage, in which a different version of the system was tested, participants gave spoken feedback in their own words. The interview questions were revised to suit the focus of the current session, considering changes made after earlier sessions and the tool version under test. A full list of the questions asked in every session is presented below.

In the post-Session 1 interview, participants answered five open-ended questions aimed at capturing detailed reflections on the effectiveness of the VR-based rehearsal tool. First, they evaluated the VR environment in the context of script work and rehearsal flow. Second, they named the single feature they felt best supported their memorization and explained why. Third, they described the difficulties they faced while using the current prototype. Fourth, they discussed the benefits they perceived from the features they found most useful. Finally, they offered clear suggestions for improving later iterations. These questions provided a structured yet flexible frame for collecting rich qualitative data on usability, learning support, and future design priorities.

In the post-Session 2 interview, participants again answered five open-ended questions designed to elicit in-depth qualitative data about the rehearsal tool. First, they judged the overall effectiveness of script practice and memorization carried out with the non-player character (NPC). Second, they reflected on the quality of their interaction with the NPC and described how it could be improved. Third, they evaluated the clarity and ease of use of the on-screen instructions. Fourth, they compared the advantages and disadvantages of memorizing lines in VR with those of conventional rehearsal methods.

Finally, they made concrete proposals for enhancing the memorization workflow and script work experience in the virtual environment.

In the post-Session 3 interview, participants answered eight open-ended questions that explored how different parts of the virtual stage and ways of interacting with it shaped line memorization and script work. First, they discussed how added stage elements such as simple props, lighting, and sound supported or hindered their rehearsal, clarifying how placing or altering lights affected memory and focus. Second, they assessed the contribution of background sounds. Third, they compared the use of low-detail versus high-detail virtual objects, giving examples of the pros and cons of each approach. Fourth, they explained their preferences between rich virtual scenes and empty isolated scenes. Fifth, they evaluated the functionality of the AI-driven NPC and compared working with it to working with a real partner in a conventional rehearsal. Sixth, they listed the main strengths of memorizing lines in VR compared with conventional methods. Seventh, they identified the main weaknesses of memorizing lines in VR compared with conventional methods. Finally, they offered clear suggestions for improving the system.

2.1.3.3 Technical Details of Setups

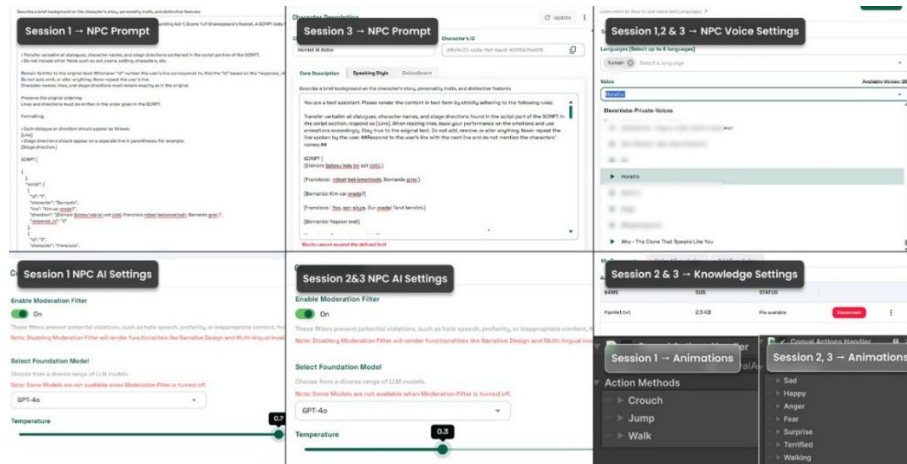
Over three sessions spread across one month, each actor completed a single rehearsal in a Unity 3D virtual reality application running on an Oculus Quest 3 headset. The prototype relied on several Unity Asset Store packages: Convai for the AI-driven non-player character (NPC) (Convai, 2023); Kronnect’s volumetric-lighting toolkit (Kronnect, 2022); the Fantasy Kingdom environment pack (Unity, 2024); Synty’s Polygon Prototype Synty (2019b) and Polygon Knights low-poly assets (Synty, 2019); and the XR Interaction Toolkit framework (Unity, 2024). NPC speech was generated by the ElevenLabs text-to-speech API routed through Convai (2023); ElevenLabs (2025),

while Mixamo (2021) animation clips provided character motion. Each session centred on Act I, Scene I of Shakespeare’s Hamlet (Shakespeare, 2016), and actors rehearsed a different role each session.

2.1.3.4 NPC Configuration

In Session 1, the NPC was initialized with a detailed role prompt (Figure 2.4a) that included the full script excerpt, basic speaking-style instructions, and the default voice profile (Figure 2.4c). AI moderation was enabled, and the foundation model was set to GPT-4o with a temperature of 0.7 (Figure 2.4d). The AI-driven NPC animations held only locomotion states which are crouch, jump, walk (Figure 2.4g), so the character could move but could not yet display emotions. No external knowledge file was attached. In Session 2, early feedback prompted a connection between the Knowledge Bank (Figure 2.4f) and a plain-text Hamlet file, giving the model direct line-by-line context.

Figure 2.4 *NPC Configuration Overview*



Note. (a) Session 1: baseline NPC prompt, (b) Session 3: refined NPC prompt, (c) Sessions 1–3: voice-synthesis settings, (d) Sessions 1: AI-model and temperature parameters, (e) Sessions 2–3: AI-model and temperature parameters (f) Sessions 2–3: knowledge-bank entries, (g) Session 1: initial animation-state set, and (h) Sessions 2–3: expanded animation-state set.

AI moderation was enabled, and the foundation model was set to GPT-4o with a temperature of 0.3 (Figure 2.4e). The same voice and safety settings were retained, while

the animation set expanded to seven expressive states: Sad, Happy, Anger, Fear, Surprise, Terrified, and Walking (Figure 2.4h). These additions allowed the NPC to convey basic effects yet remain faithful to the script. In Session 3, the role prompt was further refined for clarity, stressing strict adherence to the source text and forbidding any mention of character names in responses (Figure 2.4b). All other core AI and voice parameters stayed the same. Combined with the enriched knowledge base and emotional animations introduced in Session 2, this arrangement produced the most stable and context-aware configuration in the study.

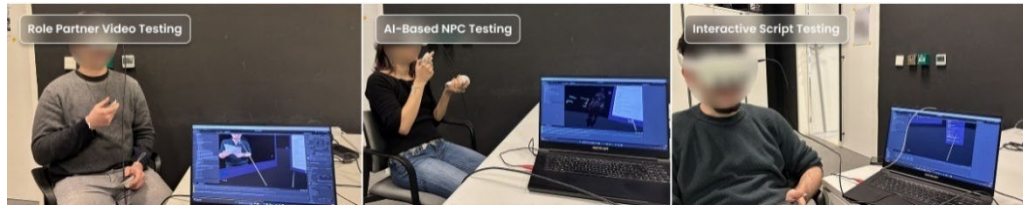
2.1.3.5 Iterative Prototyping Progress

This section delineates the iterative design process underlying the study, beginning with a concise overview of the technical configuration and advancing through three structured sessions.

2.1.3.5.1 Orientation and Exploring Interactive Environment Features

The primary objective of this session was to conduct an in-depth exploration of the interactive environment's features identified in the previous phase and to evaluate the rehearsal process through focused examination of specific functionalities. The session commenced with a standardized five-minute orientation period during which the facilitator introduced participants to fundamental VR controls and explained precautionary measures to prevent potential motion sickness.

Figure 2.5 Session 1: Participant Testing Interactive Environment Features

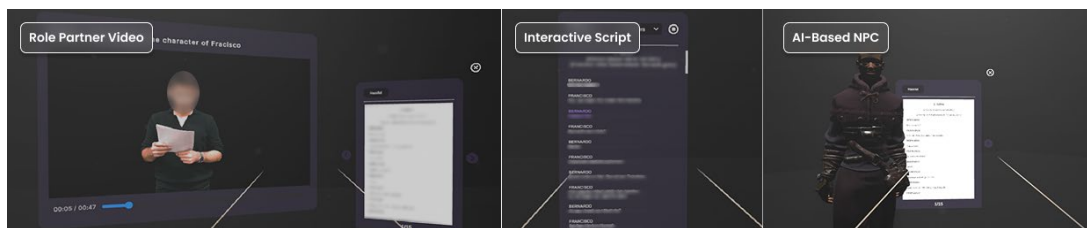


Note. (a) Role Partner Video, (b) AI-driven NPC, and (c) Interactive Script.

Following the orientation, participants engaged in rehearsal of Francisco's lines within the virtual environment using three distinct rehearsal tools:

AI-driven NPC (Figure 2.5b), Interactive Script (Figure 2.5c), and Role Partner Video (Figure 2.5a). To minimize order effects and ensure that exposure to one tool did not influence performance with subsequent tools, the testing sequence was counterbalanced across participants. Upon completion of the rehearsal activities, individual interviews were conducted to capture participant preferences regarding tool selection for further development and to gather recommendations for enhancing the virtual rehearsal process. The three main features evaluated are described below:

Figure 2.6 Session 1: Game View of Interactive Environment Features



Note. (a) Role-Partner Video, (b) Interactive Script, (c) AI-driven NPC.

Virtual rehearsal with role partner interaction (Role Partner Video) enables actors to rehearse within the VR environment either alongside actual scene partners or with realistic virtual representations (Figure 2.6a). This modality provides synchronized visual and auditory cues to facilitate natural dialogue flow. As Phase 1 participant

observed: “It would be great to rehearse with my scene partners, but if I’m practicing alone, it would really help to have tools in the environment that represent them maybe virtual people who deliver their lines.”

Asynchronous interaction with real partners (Interactive Script) incorporates recorded voice samples and delivery patterns from actual scene partners, presenting digital cues that are temporally aligned with dialogue progression to enhance natural conversation flow (Figure 2.6b). Phase 1 participant explained: “If all my scene partners’ voices were recorded together with the tones they use, and I could give my cue in sync with my own speech and receive their response digitally; it would help a lot. You could run your lines much more naturally.”

Interaction with NPCs (AI-driven NPC) features intelligent virtual characters programmed to respond dynamically to actor cues, enabling continuous rehearsal sessions even in the absence of human partners (Figure 2.6c). A Phase 1 participant highlighted this benefit: “Having characters, even NPCs, that I can interact with is a huge plus. If they can actually speak and I can perform as if I were acting with real people instead of listening to recordings, my memorization time could be two or three times faster.”

2.1.3.5.2 Developing Interactive Environment Features in Rehearsal

The objective of this session was to examine actors’ individual scene-rehearsal processes through collaborative interaction with an AI-driven NPC. The focus centered on gathering actor feedback regarding the AI-driven non-player character (NPC) functionality and identifying features most suitable for early-stage rehearsal activities.

Figure 2.7 Session 2: Stage Design and Practicing With AI-Driven NPC



Note. (a) Stage Design, (b) Practice with AI-driven NPC.

Consequently, this session specifically targeted NPC-related issues identified in the previous phase, including enhancing command recognition capabilities, preventing the NPC from vocalizing character names that disrupt dialogue flow, improving the NPC's visual representation (Figure 2.8c), and integrating stage design elements (Figure 2.8a and Figure 2.8b).

Figure 2.8 Session 2: Game View of Stage Design & AI-Driven NPC Interactions



Note. Session 2: Gameview of Stage Design & AI-Driven NPC Interactions. (a) Light Object Controls, (b) Basic Object Controls, (c)Instructions for AI-driven NPC, (d) Control Panel.

Based on participant feedback from Session 1, stage layout and configuration controls were incorporated into the interactive environment prototype. The system now includes Basic Objects, which provide five fundamental elements that participants can use to design and personalize the environment according to their vision. In addition, the Light Object enables participants to adjust ambient illumination, thereby allowing exploration of atmosphere and mood within the virtual space. Finally, the Instruction Panel delivers clear guidance on how participants can interact with the AI-driven non-

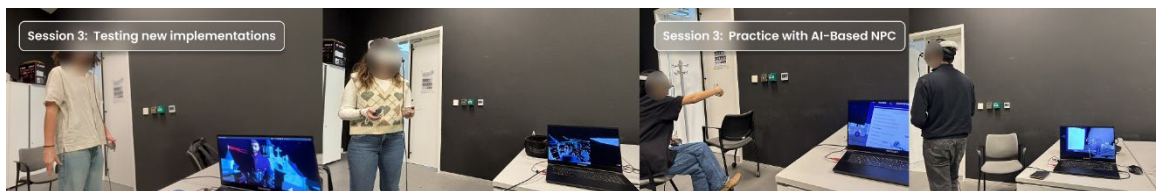
player character (NPC). Collectively, these features enhance the flexibility of the prototype and support participants in articulating and testing their design intentions.

The following protocol was implemented to address each identified issue systematically. To prepare the virtual stage environment, participants initially reviewed a dramaturgical report provided by the collaborating theatre organization, followed by a 15 minute period allocated for environment setup (Figure 2.7a). Subsequently, amateur actors engaged in a 15-minute rehearsal session focusing on the first five pages of Bernardo's character lines while interacting with the enhanced AI-driven NPC (Figure 2.7b). Interviews conducted at the session's conclusion enabled amateur actors to discuss potential system improvements and provide recommendations for optimizing the rehearsal process.

2.1.3.5.3 Testing Interactive Environment

The objective of this session was to identify which rehearsal tools most effectively support line memorization and comprehensive text work. To address this aim, several newly implemented design features were integrated into the system, based on participant feedback from earlier sessions.

Figure 2.9 *Session 3: Testing New Implementations With AI-Driven NPC*



Note. (a) Testing New Implementations, (b) Practice with AI-driven NPC.

These included *Detailed Object* (Figure 2.10d), *Environmental Sound* (Figure 2.10g), *Stage Positioning* (Figure 2.10h), *Light* (Figure 2.10e) and *Object Controls Panel*

(Figure 2.10f), *Atmospheric* (Figure 2.10a) and *Isolation* (Figure 2.10b) *Modes* for practicing choice, and enhanced *NPC Movement Capabilities* (Figure 2.10i).

The Detailed Objects feature introduced scenic elements such as a castle wall, door, or staircase, which were incorporated into rehearsal to approximate the play's physical setting. Environmental Sound provided ambient or background audio to strengthen the sense of atmosphere during practice. Stage Positioning tools allowed performers to rehearse movements and placements relative to the stage layout. Through the Lighting Control Panel, participants could adjust aim, rotation, and color of light sources, as well as duplicate or lock them to preserve a configuration. The Object Control Panel similarly enabled modification of objects' size and rotation, with options to duplicate or lock them for consistency.

In terms of rehearsal modes, Atmospheric Mode offered a fixed scenic treatment with period-appropriate effects, creating immersive conditions for line memorization, while Isolated Mode stripped the stage to a simplified form, supporting focused practice on dialogue and blocking. Finally, the addition of enhanced AI-Driven NPC Movement enabled non-player characters to follow performers and move autonomously, providing a dynamic partner for rehearsal and testing interaction.

Together, these tools were designed to extend the prototype's capacity for rehearsal, balancing immersive contextual support with focused practice modes to facilitate both memorization and deeper engagement with the text.

The experimental protocol consisted of two phases: initially, all features were systematically tested by amateur actors under facilitator guidance to ensure familiarity with the complete system functionality (Figure 2.9a). Subsequently, participants were instructed to rehearse the entire Scene 1 Act 1 with the Marcellus character. During this

phase, actors were encouraged to select and customize tools according to their individual rehearsal preferences and subsequently evaluate the rehearsal process based on their chosen tool configurations (Figure 2.9b).

Figure 2.10 *Session 3: Game View of New Implementation Interactions*



Note. (a) Atmospheric Mode applies fixed, period-appropriate effects such as fog or candlelight. (b) Isolated Mode presents a simplified stage for focused line practice. (c) Primitive Objects provide basic rehearsal shapes. (d) Detailed Objects offer scenic elements like doors or stairs. (e) Light Panel UI controls angle, color, duplication, and locking of lights. (f) Object Panel UI manages scaling, rotation, duplication, and locking of props. (g) Environmental Sound supplies ambient audio to strengthen atmosphere. (h) Stage Positions assist with blocking and movement. (i) AI-Based NPC Movement allows characters to follow performers or move autonomously.

2.2 Data Analysis

Quantitative and qualitative analysis used in three complementary phases that progressively deepened our understanding of amateur actors' rehearsal needs in virtual reality. In Phase 1, rehearsal diaries and the virtual rehearsal experience guided the

development of a semi-structured interview protocol, and the six resulting actor transcripts were subsequently analysed using thematic analysis (Braun & Clarke, 2019; Byrne, 2022). Inductive coding conducted in Miro was followed by axial synthesis, six themes that link actors' memorization practices to actionable VR design opportunities.

In phase 2, we adopted a collective choice perspective, applying the Borda count (Emerson, 2013) to synthesise forty participants' complete rankings of the six design themes. The resulting scores produced an ordered list of priority features, which we subsequently enriched by integrating participants' open-ended rationales.

In Phase 3, 14 actors worked with three successive VR prototype versions. This study re-analysed their post-session interviews, identified by longitudinal tags such as "P2S1" and "P2S3", using the same thematic procedure. This analysis generated five themes that clarify how successive VR sessions influence script work, memorization strategies, and rehearsal logistics.

Throughout the study, we cycled between the data and our research questions, checking internal coherence, refining theme names, and foregrounding participants' own words to minimise interpretive bias. The subsections that follow describe the procedures, coding choices, and thematic structures for each phase, showing how insights from diaries and interviews, quantitative prioritisation, and longitudinal VR trials converge to inform our design implications.

2.2.1 Phase 1: Understanding of Virtual Rehearsal Process

In this study, the rehearsal diary and observation notes helped us understand and explore the problem, while the literature guided the design of the virtual-rehearsal experience. Insights obtained from the diary, observation notes, and literature informed the interview questions posed after participants completed the virtual rehearsal. The diary

and notes yielded insights into the actors' script work and memorization processes. Meanwhile, the virtual-rehearsal section provided an actor centred perspective on integrating virtual reality (VR) experiences into rehearsals. This study used Braun and Clarke's thematic-analysis method (Braun & Clarke 2019; Byrne 2022). This method was selected to gain insights into actors' experiences, enabling close examination of their engagement with both the script and the virtual-reality environment. The approach accords with qualitative research principles and supports a rigorous treatment of qualitative data.

This study conducted a thematic analysis (Braun & Clarke 2019; Byrne 2022) of the interview transcripts. First, we imported the transcript data into Miro (2011) to organise and label the material, ensuring the documents remained easy to access. A preliminary reading stage identified essential ideas and observations, providing a foundation for the later, more comprehensive analysis. Using an inductive approach, each segment of data was categorized with a unique code representing its meaning. At the conclusion of analysis, axial coding organised similar codes into wider, integrated themes. The procedure was carried out iteratively, ensuring the categories were polished and the coding remained consistent. Each theme was reviewed in relation to the complete data set, with particular care given to how the codes combined to portray the actors' experiences and views. Ensuring that the themes accurately mirrored the data and aligned with the research questions made this step essential. During theme development, the questions were continually reviewed to maintain relevance and clarity. Through repeated cycles, the study gained deeper insight into the themes and their implications.

2.2.2 Phase 2: Identifying Prioritization of Actors' Needs: Online Survey

The Borda Count (BC) uses all preference information because each participant must rank every theme from first to sixth (Emerson, 2013). By giving a fixed score to every position, it includes all votes and prevents one single “best” choice from dominating, so the result is based on group consensus. Two weight vectors are common in the literature: the original rule, $(n, n - 1, \dots, 1)$, and the version more often used today, $(n - 1, n - 2, \dots, 0)$. Emerson (2013) points out that when voters give complete rankings, both vectors lead to the same social order, because adding the same constant to every score does not change the ranking. This makes small differences in importance, visible and fair.

In this study, the classic BC with the $(n - 1, n - 2, \dots, 0)$ vector was applied to find the relative importance of six rehearsal-related themes. 40 amateur actors ranked the themes from most to least important (1–6). We then assigned fixed weights (1st = 5, 2nd = 4, 3rd = 3, 4th = 2, 5th = 1, 6th = 0). For each theme, the Borda Score (BS) equals the sum of the number of votes in each rank multiplied by the weight of that rank. Because full rankings were used, switching to $(n, n - 1, \dots, 1)$ would add the same constant to every BS and would not change the final order.

This straightforward aggregation captures not only which features were most often chosen first but also how strongly they were preferred relative to all other options, in line with de Borda method Emerson (2013). To deepen our understanding of why amateur actors made these choices, we then asked each participant an open-ended follow-up: *“How do you think the theme you consider most important contributes to your rehearsal process?”*, *“Could you please explain why this contribution is important to you?”* Analyzing their narrative responses allowed us to link each theme’s numeric

ranking to the practical, experiential reasons actors and directors value it, thus enriching the quantitative Borda results with qualitative insights.

2.2.3 Phase 3: Iterative VR Rehearsal Trials: Prototype Development

In this study, the data were examined with Braun and Clarke's thematic analysis (2019). This method was chosen to understand and explore patterns in depth how amateur actors experience an interactive virtual reality setting and how they work with the script and memorise their lines. We conducted three sessions with a total of 14 participants. The audio recordings from these sessions were transcribed into text with the aTrain software (2023), which lets us work offline and protects participants' privacy. The transcripts were then uploaded to Delve (2017), a web-based platform for qualitative analysis. aTrain (2023) was selected for its capacity to safeguard data confidentiality (Haberl et al., 2024), whereas Delve (2017) was chosen for its intuitive interface that facilitates data coding and interpretation during the thematic analysis process.

This study followed an inductive approach, allowing patterns to emerge from the data rather than fitting them to predefined theories. Interview recordings from the three sessions underwent thematic analysis. First, the raw data were organised to ensure easy access. An initial reading highlighted key ideas and observations that guided subsequent, more detailed steps. During inductive coding, each data segment was assigned a unique code that captured its meaning; these broad initial codes were later refined into more specific thematic categories. To track changes over time while preserving anonymity, systematic identifiers combined participant and session information (e.g., "P2S1", "P2S3" for Participant 2, Session 1 or 3).

Relationships between codes were examined, producing five candidate themes. These themes were reviewed for internal coherence and for clear distinctions from one

another. Each theme was evaluated within the wider data set, with close attention to how individual codes combined to create a coherent account of the actors' experiences and views. Throughout theme development, the research question was revisited repeatedly to keep the analysis focused; this iterative loop deepened understanding of the themes and their implications. Short, clear labels were assigned and links between themes clarified. Finally, the five themes were related back to the research question, and participant quotations supported the findings to provide an objective account of how these themes illuminate virtual reality based rehearsal. To reduce interpretive bias, the analysis avoided searching for hidden meanings and instead presented a data-driven portrayal of participants' direct experiences and perceptions of VR technology.

3. RESULTS

The results highlight across three sequential phases that trace the path from exploratory understanding to prioritisation and iterative refinement of VR-supported rehearsal. Phase 1 analyses interviews with six experienced amateur actors, first describing their varied memorization practices and then identifying six design-relevant themes: environment setting, interactive environments, advanced script management, set design and prop integration, interactive and adaptive digital tools, and rehearsal challenges and issues for performers. Briefly, these themes demonstrate how core elements of conventional theatre can migrate into virtual space.

In phase 2, This study quantifies the relative importance of these themes with a Borda Count (Emerson, 2013) results of 40 amateur actors, showing a clear ordering in which an interactive environment and set design and prop integration dominate, while tool-level supports are valued but less critical (Table 3.2).

In Phase 3, the study conducted three VR-rehearsal design-and-test cycles with 14 amateur actors and, drawing on the thematic-analysis results, highlighted five themes: (1) Design elements for rehearsal in virtual reality environments; (2) AI-driven non-player-character experience in virtual rehearsal; (3) Transforming conventional rehearsal through virtual rehearsal; (4) Virtual-rehearsal boundaries and technological limitations; and (5) The potential of VR technology for individual practice opportunities. Overall, the themes reveal opportunities such as virtual-rehearsal design, responsive AI-Driven NPC, flow-based multisensory memorization, and flexible solo practice, as well as constraints such as technical glitches and increased mental effort within the prototype system. The study first describes what actors currently do and need, then sets shared priorities, and

finally demonstrates in practice how those priorities function during rehearsals. This sequence provides solid evidence for the design recommendations that follow.

3.1 Phase 1: Understanding of Virtual Rehearsal Process: Insight Gathering Through Observation, Diaries and Interviews in Real Life Context

The interview data from Questions 1 to 6 shed light on the strategies, resources, and practices employed by actors in their on-site rehearsal environments. Table 3.1 details the six participants' memorisation approaches and theatre experience, which ranges from two to twelve years, and notes that four have never used VR, whereas two men have some limited experience.

Table 3.1 *Memorization Techniques and Tools Used by Amateur Actors*

Pno	Gender	Theatre Exp.	VR Exp.	Memorization Approach	Techniques	Tools
P1	Male	1-3 years	No	Understanding the text before memorizing it	Line by line memorization	Mirror
P2	Female	1-3 years	No	Memorizing by interpreting characters' intentions	Memorizing with writing	Writing; Mirror; Video Recording
P3	Female	4-6 years	No	Using emotions to memorize	Line by line memorization	Reading aloud; Mirror; Against people
P4	Male	10+ years	Yes (limited)	Focusing on the character's and the author's intent	Script analysis then record and playback	Audio; Mirror
P5	Male	7-9 years	No	After understanding the text and character, work on the lines	Rote repetition; Active experiencing	Audio; Mirror; Against people

Pno	Gender	Theatre Exp.	VR Exp.	Memorization Approach	Techniques	Tools
P6	Male	10+ years	Yes	Memorizing by thinking how characters would say it	Associative memory technique	Writing; Audio

Memorisation methods differ widely, ranging from close study of the script and the character's motivation to establishing an affective link and rehearsing from the character's point of view, with several participants highlighting the need to first understand the intentions of both character and author. Memorisation techniques extend from structured step-by-step practices, transcription, and iterative repetition to creating associations, while many performers highlight the role of acting exercises and emotional immersion in improving recall. Common rehearsal tools include mirrors, writing implements, video-recording devices, and partner run-throughs, with mirrors and recordings frequently used for personal performance review. This overview indicates an extensive spectrum of personal tactics adopted by actors to retain lines, uniting conventional rehearsal routines with unique alterations to enhance character immersion.

An in-depth examination of actors' replies in Questions 6 to 10 revealed six main themes that offer early insights into the study's main question and guide the discussion on designing VR-based rehearsals. The first five themes concern how script work and memorization and script work can shift from conventional rehearsal to virtual rehearsal, whereas the sixth theme explores ways to solve the challenges that arise in conventional environment through virtual reality.

3.1.1 Theme 1: Environment Setting

This theme identifies the main elements for enhancing user experience in virtual settings, with attention to comfort, engagement, and immersion. The importance of

creating a visually comfortable environment is highlighted; this involves designing visual elements and spatial layouts that reduce eye strain and support user comfort. It is asserted that optimal illumination requires environments to be well lit but not excessively bright or overly dark, thereby preventing eye strain. P2: “*...In virtual environments, sufficient lighting is essential; the space should remain well lit while avoiding both unnecessary darkness and brightness to ensure visual comfort...*”

Appropriate lighting conditions are examined, highlighting the importance of balanced illumination. Maintaining such balance ensures an atmosphere that fosters both user comfort and immersion, while preventing extremes that could impair the experience. P2: “*...It ought to be arranged so that it does not cause eye strain...*”

The concept of freedom of movement is also discussed, highlighting the necessity for expansive surroundings that allow consumers unimpeded mobility. This autonomy is essential for augmenting user engagement and cultivating a sense of presence within the virtual environment. It indicates a desire for minimalist design in spaces devoid of essential decorations to enhance this feeling of freedom. P4: “*...Moreover, a void, defined as a space that permits unrestricted movement, is essential. In situations where there is no decor, I prefer nothing at all...*”

The concept of few distractions is examined. This emphasizes the establishment of an atmosphere that reduces external distractions, allowing users to focus and completely engage in the virtual experience. It recognizes the difficulty of operating in a tranquil atmosphere, proposing an ambient setting that reduces distractions while maybe integrating gaming components to augment participation. P6: “*...I am unable to function effectively in a quiet environment. A balance between minimal distraction and the ability to create a playful atmosphere would be advantageous...*”

These elements define a VR environment that emphasizes user comfort, engagement, and immersion. The discussion explores an approach for the development of user-centered virtual environments that improve the overall user experience by highlighting visual comfort, balanced lighting, spatial freedom, and minimal distractions. Each emphasized element contributes to the design of an ideal virtual environment.

3.1.2 Theme 2: Interactive Environment

This theme investigates the ways in which technology can improve role-playing by increasing both engagement and realism. This theme is centered on three key components: asynchronous interaction with real actors, enhanced memorization through the use of non-player characters (NPC) interaction, and the importance of virtual rehearsals with role partners.

Initially, the concept of asynchronous real role partner interaction is introduced, underscoring the significance of digital asynchronous in role playing. By incorporating the recorded voices and tones of other participants, this method enables more natural and fluid interactions, potentially enhancing the realism of the role-playing experience. It is proposed that the experience could be significantly enhanced by the integration of digital permits that are synchronized with individual lines, thereby enabling a more natural flow of dialogue. P2: *“... If the voices of all my peers, their dialogues, and the tones in which they deliver them were recorded, and I could respond synchronously to their digital replies, it could provide significant contributions.” It could facilitate a more organic memorizing process...*”

Another sub-theme, interaction with non-player characters (NPCs), underscores the value of NPCs in role-playing contexts. NPCs, especially those with verbal capabilities, are regarded as interactive tools that potentially enhance participants’ script

work and line retention. The inclusion of speaking characters, including NPCs, is regarded as an important advantage, possibly improving the memorizing process by two to three times, therefore enriching the depth and interest of playing roles. P4: *“...The presence of characters to engage with, even if they are non-playable, would be a significant advantage.” If those characters were capable of speech, it would confer an even greater benefit. Beyond mere audio recording, if it simulates active engagement, this could substantially accelerate my line memorization process...*”

Finally, the importance of virtual rehearsals with role partners is examined. This feature enables participants to rehearse in a virtual environment, utilizing either actual partners or virtual representations, so providing a flexible setting for rehearsal. This method enhances performance and interaction in role-playing contexts, emphasizing the capacity of virtual worlds to replicate actual practice circumstances. P3: *“...Rehearsing with my role partners would be advantageous; however, even when rehearsing solo, utilizing tools to represent them in the environment, such as virtual humans to deliver their lines, would be highly beneficial...”*

The findings highlight technology’s capacity to enhance the depth, realism, and educational value of play scenarios. Furthermore, they emphasise that both asynchronous and synchronous interactions with real characters, together with engagement-based NPC interaction, can increase presence and interactivity in role-playing contexts.

3.1.3 Theme 3: Advanced Script Management

This theme explores two key sub-themes for enhancement: script interaction and clearly directorial guidance. The initial sub-theme, Integration of Director’s Notes, emphasizes the strategic incorporation of directorial feedback into the rehearsal script to provide actors with interpretive guidance. This is accomplished through innovative

techniques like color coding or textual adjustments to indicate emotional emphasis, assisting actors in grasping the emotional depth necessary for each line. P6: *“...Specifically regarding emotions, changing the color of text on a word-by-word basis may convey the intended emotion.”*

The integration of director's instructions, whether in written or auditory form, potentially improves accessibility, enabling actors to receive guidance while interacting with their lines. P3: *“...Inclusion of director's notes within the text or the integration of visible commands could probably provide significant benefits. I desire to access those lines at any moment of my choosing. However, receiving directions simultaneously would be advantageous.”*

The careful positioning of these notes next to relevant script text is essential, allowing actors to easily associate the guidance with specific dialogues or scenes without diverting from their current script location. P1: *“...The inclusion of director's notes is essential; however, their positioning on the same page is significant.”* The placement of director's notes several pages away complicates the understanding of the context surrounding the dialogue or text that precedes them, so highlighting the importance of proximity to the scene. “

The second sub-theme, script Customization and Interaction, examines the flexibility and engagement of digital scripts. This includes features that enable actors to adjust text placement within the script for personal comfort, thereby improving overall usability. P1: *“...You can position the text wherever you prefer...”*

The system includes interactive annotations that facilitate dynamic engagement with the script, allowing users to sketch or emphasize directly on the digital document. P6: *“...I am able to sketch on the script...”*

Digital directions enables quick access to various parts of a script, replicating the traditional page-turning experience in a digital context. P5: “...*Similar to navigating through a physical printed text, this process may involve zooming in or out on a page, thereby exposing various elements related to those found in a word processor or PDF format...* ”.

User-controlled adjustments of the script's appearance, including text size and layout, are highlighted, P4: “ *...Having a text that I can manipulate related to positioning and size would be adequate...* ”, as well as reducing distractions during memorization can be achieved by hiding elements of the script, thereby directing focus towards particular lines.. P3: “*...Having visibility of my lines while performing, without the necessity of referring to the script, my task would be much easier...* ”.

Furthermore, improving the visibility of lines eliminates the necessity for a physical script, allowing actors to rehearse with greater freedom. P4: “*...If the section that contains my lines were made more distinct, whether by using color, a heavier stroke, or some other method, it would help me a great deal. In addition, as I mentioned before, having full control over the text so I can move it wherever I need and resize it at will would be extremely useful...* ”

Sub-themes present visions for a rehearsal environment that integrates technology and design to enhance the interaction among scripts, directorial guidance, and actor performance, thereby promoting a more efficient and immersive rehearsal experience.

3.1.4 Theme 4: Set Design and Prop Integration

This theme highlights the importance of developing rehearsal environments that improve the theatrical experience by emphasizing on aspects that increase immersion for actors. The initial focus is on the essential purpose for realistic set design. Actors benefit

significantly from sets that accurately represent the play's environment, potentially enhancing their involvement in the scene. “P4: “...*Especially if I'll be inside a set or on place, this is definitely a huge plus...*”.

Furthermore, how fundamental objects can assist novice actors in spatial orientation. Properly placed objects are potentially important for fostering spatial awareness, thereby enhancing the scene's authenticity. P4: “...*I can use simple placeholders. For example, a box or anything shaped like a chair can serve that purpose...*”.

Furthermore, the recurrence of detailed sets is emphasized as a important aspect. A set that accurately describes the realistic play environment allows actors to adjust to their surroundings, enriching their performance. This approach stresses the necessity of precise set design and decor, highlighting their roles in fostering a realistic and supportive environment for actors. P3: “ ...*Having the sets for any performance you are rehearsing is essential. As nearly equivalent to one-to-one as feasible...*”.

These elements highlight the importance of meticulous set design and the deliberate application of decor in creating an environment that both enables and enhances the actor's capacity to deliver an engaging performance.

3.1.5 Theme 5: Interactive and Adaptive Digital Tools

This theme examines the role of digital tools and functions in improving actors' memorization skills, emphasizing the value of a virtual environment that can be customized to individual needs.

Personalizing is emphasized as important, allowing modifications to the virtual environment that fit individual preferences and particular requirements, hence improving

the potentially quality of the learning and practice processes. P2: “...*It is essential that it allows for wide customization...*”.

The potential importance of interactive tools for creativity is highlighted, emphasizing their role in enhancing user involvement in drawing and writing tasks. This engagement enhances retention and promotes creativity, endorsing a minimalist approach emphasizing cognitive processes over virtual environment distractions. P5: “...*I want to draw and write. I don’t think anything else is needed beyond that, because this is mostly a mental process...*”.

The combination of background music and clear text visibility also stands out. This approach seeks to create an engaging learning environment that activates the auditory senses while keeping critical information easily accessible. P6: “...*It would have been nice to have background music along with script I could always see...*”.

Moreover, integrating memorization games is highlighted as an innovative strategy to improve learning. Digital puzzles and interactive games can reinforce memorization in an enjoyable and effective way by offering content that might not be possible in a conventional stage. P1: “...*A wide variety of games can be introduced in a digital environment, providing rich content. Puzzle games, for example, can strengthen memorization an advantage we may not yet achieve in real life...*”.

Self observation serves as a key tool for personal growth, giving individuals the chance to review and improve their performance through reflection. P3: “...*It could be helpful if I were able to watch myself later...*”.

Overall, these features shape an environment that is both flexible and engaging. Adjustable settings, creative tools, background music, memory games, and opportunities

for self-review turn the platform into a valuable elements for actors as amateur actors can learn their lines and rehearse.

3.1.6 Theme 6: Rehearsal Challenges and Issues for Performers

This theme explores the diverse obstacles faced by performers during their rehearsal sessions. It is organized around three sub-themes, each exploring separate facets of rehearsal complexity: the subtleties of text and director's annotations, the limitations of conventional rehearsal spaces, and the procedural challenges inherent in scheduling and ensemble alignment. This study sets out in detail the common challenges faced in rehearsal practices and offers practical recommendations to help and improve them.

This sub-theme explores the difficulties actors face in memorizing their lines and following the director's instructions. P3: "... *Director's notes are the part people skip most often...*". It highlights obstacles, particularly the direction of actors to miss subtle directorial instructions and the physical stress that comes with conventional memorization techniques. P3: "...*the conventional method of frequently referring to a script, which requires leaning down, glancing up to gain a sense of direction, or managing the text, often distracts from the core experience of performing...*".

Moreover, it emphasizes the challenge of maintaining character consistency during the transition from memorizing the script to live performing, suggesting a break in the smooth representation of the character. P1: "...*For example, individual memorization, without any cues, requires a brief break from one's emotional state, unlike situations where cues support a continuous and uninterrupted portrayal of a character...*".

This sub-theme concerning environmental limitations on rehearsal focuses on the restrictions created by insufficient physical rehearsal environments, emphasizing how

inadequate conditions can restrict an actor's capacity to completely connect with their role character. P1: *"...I have repeatedly highlighted my approach to embodying the moment as natural, regularly rehearsing in front of a mirror in the dressing room. However, such settings rarely create a supportive atmosphere or allow for the true embodiment of character as I desire..."*.

It suggests that virtual reality (VR) technologies hold innovative possibilities as a practical choice that can overcome limitations of physical spaces by providing more immersive and flexible rehearsal environments. P5: *"...The limited characteristics of real-life environments contrasted with the limitless imaginative possibilities of virtual reality (VR) implies that VR has the potential to greatly enhance the rehearsal process by making the world of the play more tangible..."*.

This sub-theme regarding logistical difficulties in managing time and coordinating teams focuses on the complex logistical details involved in planning and conducting rehearsals, highlighting the challenges of aligning the availability of all group members. P2: *"...the difficulty in reaching an agreement on rehearsal times due to overlapping schedules hampers the chance for consistent rehearsal opportunities..."*

The lengthy duration of rehearsal periods can exhaust amateur actors both physically and mentally. P3: *"...the extensive time dedicated to practice sessions already imposes a substantial requirement on those involved..."*. Additionally, during rehearsals when some participants were missing or not fully present, the actors faced shortcomings in the rehearsal process and this situation makes them complex. P3: *"...Additionally, the occasional need for individual practice sessions, when team members are inevitably missing, adds another level of complexity..."*. Challenges in logistics for effectively coordinating rehearsals of large groups lead to a lengthy process. P2: *"...The need for*

efficient use of time is crucial when overseeing the concurrent presence of many participants on stage...”.

Overall, these sub-themes shed light on the complex and diverse obstacles that performing amateur actors face, encouraging creative solutions to improve rehearsal practices and enrich the creative journey.

3.2 Phase 2: Identifying Prioritization of Actors’ Needs: Online Survey

Using the participant information provided in Table 2.1, we analysed their rankings of six VR-supported rehearsal features with the Borda count method, which assigns progressively more points to higher-ranked items; Table 3.2 reports each feature’s Borda score alongside its overall rank.

Table 3.2 *Borda Counts Summary of Rehearsal Feature Priorities*

Theme	1st	2nd	3rd	4th	5th	6th	BScore
Interactive Environment	15	4	7	8	4	2	132
Set Design and Prop Integration	10	9	2	5	7	7	109
Advanced Script Management	3	6	10	10	7	4	96
Rehearsal Challenges and Issues	6	8	5	7	4	10	95
Environment Settings	2	7	9	6	8	8	85
Interactive & Adaptive Digital Tools	4	6	7	4	10	9	83

3.2.1 Overview of Borda Count Outcomes

The Borda count results indicated clear priorities among the six themes. Interactive Environment emerged as the top-ranked theme with the highest total score (132 points). This was followed by Set Design and Prop Integration (109 points) as the second-highest priority, and Advanced Script Management (96 points) in third place. The next two themes were close in overall score: Rehearsal Challenges and Issues (95 points)

ranked fourth and Environment Settings (85 points) fifth. Finally, Interactive and Adaptive Digital Tools received the lowest total score (83 points), making it the sixth-ranked theme. This ranking suggests that participants placed the greatest emphasis on the immersive, interactive aspects of the VR rehearsal platform and staging elements, while tool support for memorization and adaptation, although still valued, was a relatively lower priority.

3.2.2 Interactive Environment

Participants highly prioritized an interactive rehearsal environment, emphasizing that real-time communication and co-presence in the virtual space are fundamental for effective theater practice. This theme was often described as the foundation for an immersive and realistic rehearsal, enabling actors to engage with others (NPC) as they would on a real stage. As one participant explained, SP39: *“Without ensemble communication, no production lands clean.”*, highlighting that the collaborative interaction afforded by the VR environment was seen as crucial for a successful rehearsal process. Participants noted that a highly interactive virtual environment could streamline actor coordination, improve engagement, and ultimately enhance performance quality by replicating the social dynamics of in-person rehearsals. SP20: *“I believe the interactive environment is more fundamental than others for making the rehearsal process as realistic as possible. Because primarily, a rehearsal space, especially when scenes involve multiple actors, must enable actors to rehearse those scenes interacting with each other. Thus, instead of memorizing or reciting alone, an actor reacts to the other’s lines/movements within the scene, increasing the play’s believability.”* Similarly, SP26 emphasized the importance of realism in interactivity, observing that *“The most important function is the interactive environment, because in a VR environment, the more it feels*

like the real world, the more realistic the rehearsal process can be. For example, if our NPC characters can make us forget that they are NPCs and convince us that they also have a personality, then we can behave as if there is a real human in front of us. Thanks to this, we can adapt better in a live environment.”

3.2.3 Set Design and Prop Integration

The second-ranked theme, set design and prop integration, was valued for allowing creatives to incorporate stage elements into rehearsals early and often. Participants cited that being able to visualize and experiment with the set in a virtual environment from the outset provides a significant advantage for directing, blocking, and actor orientation. This VR-supported capability addresses a common theatrical challenge: in conventional processes, the physical set often appears late, leaving little time for actors to adapt. By contrast, a virtual set can be present throughout rehearsals, saving time on adjustments and enabling iterative trial-and-error with scenography and props. One participant noted the benefit of early immersion in the stage design: SP23: *“Becoming familiar with the set and being able to test it via virtual reality will save time and help in aesthetic evaluation.”* By integrating props and set virtually, directors and actors can jointly refine spatial interactions and creative decisions well before the actual set is constructed, leading to a more seamless transition to the real stage.

3.2.4 Advanced Script Management

Participants who prioritized advanced script management highlighted its importance for theatrical workflow and performance quality. This theme refers to digital tools for handling scripts, cues, and directors’ notes in an integrated way. Users valued features that support detailed dramaturgical work for instance, linking script annotations,

directorial comments, and actor prompts as these can sharpen the actors' understanding of their roles and the play's direction. The ability to collaboratively manage script changes in real time was seen to polish performances and ensure consistency. As one participant emphasized, SP6: *"The director is the person who shapes and polishes the actor like clay, so detailed work on the script with the director's notes is very important."* This quote reflects the view that a robust script management system in the VR platform would facilitate the meticulous refinement of acting and blocking, ultimately supporting the creative vision and narrative coherence of the production.

3.2.5 Rehearsal Challenges and Issues.

Another theme of concern was the set of logistical challenges inherently present in staging rehearsals. Participants who ranked this theme highly were often focused on overcoming practical barriers such as scheduling conflicts, geographic distance, and limited rehearsal facilities. They noted that a virtual rehearsal environment can mitigate these issues by enabling remote participation and flexible scheduling, thereby saving time and reducing the need for physical space. This reflects a perspective of using technology to remove coordination constraints in collaborative work. One participant explained how a VR platform could directly address these pain points: SP11: *"Difficulty in gathering everyone at the same time for rehearsals and sometimes lack of space for rehearsals. I think VR environments will be beneficial because these physical difficulties won't exist there."* By removing dependency on all actors being co-located and on a physical stage availability, the virtual solution was seen as increasing rehearsal accessibility and efficiency. Participants envisioned that such a system could reduce cancellations and delays in production timelines, thereby streamlining the overall rehearsal process.

3.2.6 Environment Setting

Participants also drew attention to the importance of environment settings the ability to control and customize the virtual rehearsal space's conditions. This theme was prioritized by some because the appropriateness and comfort of the rehearsal environment were seen as foundational for all other activities. Providing a user customization, ergonomically comfortable virtual space that can adapt to the scene's needs (for example, adjusting visual ambiance, acoustics, or incorporating background elements). Several participants commented that if the virtual environment is not set up correctly or feels off, it can negatively impact actor focus and the effectiveness of practice. One participant captured this sentiment, noting that SP29: "*A comfortable environment can enable more efficient rehearsals.*" The implication is that by fine-tuning environment settings making the virtual space realistic, appropriate to the play's context, and comfortable the system can improve immersion and ensure that other rehearsal components (like acting, blocking, and interaction) proceed optimally without distraction or mismatch in setting.

3.2.7 Interactive and Adaptive Digital Tools.

Interactive and adaptive digital tools were the lowest-ranked theme overall, but those who did prioritize this aspect stressed its value in supporting individual rehearsal tasks. This theme encompasses features such as intelligent prompting systems, adaptive feedback, and gamified exercises for memorization and practice. Participants appreciated these tools as personal aids that could streamline learning lines, cues, and other routine tasks. For example, memory aids and on-demand prompts embedded in the VR system were seen as ways to reduce disruptions when an actor forgets a line or needs guidance. One participant focused on the benefit to memorization, explaining that such tools SP14: "*Enable memorization to be much faster and more memorable, especially during*

preparation for physical rehearsals.” This illustrates how digital support tools can augment the rehearsal process: by accelerating line retention, providing adaptive feedback (such as allowing actors to watch their own performance or receive reminders), and thereby freeing actors and directors to spend more time on creative development rather than rote practice. Although this theme ranked last, it was still regarded as a meaningful enhancement by the participants who championed it, particularly for improving individual efficiency and confidence in the rehearsal workflow.

3.3 Phase 3: Iterative VR Rehearsal Trials: Prototype Development

14 amateur actors in Table 3.3 indicates that conventional script work and memorization depends on a multimodal blend of low-cost, readily accessible practices.

Table 3.3 *Conventional Memorization Methods and Tools by Participant*

PNO	Gender	Years Acting	Productions Participated	Conventional Memorization Method	Tools Used
P1	Female	4-6	1-3	Reads the text silently, then aloud; highlights character names and first words with colored markers to recall visual flow	Colored markers
P2	Male	1-3	1-3	Works by writing the text out and creating visual associations	Pen—paper or tablet
P3	Male	1-3	1-3	Records all lines, leaves own lines blank, pauses playback to repeat	Phone (voice recording)
P4	Male	4-6	4-6	Practises script during rehearsals; also records and listens to own voice	Phone (voice recording)

PNO	Gender	Years Acting	Productions Participated	Conventional Memorization Method	Tools Used
P5	Female	7-9	10+	Prints text, annotates, reads aloud; rehearses as if with a tutor	Pen, paper, colored markers
P6	Female	1-3	1-3	Reads repeatedly for retention; visualises the page while recalling	Paper
P7	Male	1-3	1-3	Composes tunes for lines, rereads, practises interactively with friends	Guitar (music)
P8*	Female	1-3	1-3	Studies alone like memorising poetry; practises again with director	PDF or printed text
P9*	Male	4-6	1-3	Analyses context, reads; records audio and rehearses with movement	voice recording
P10*	Female	4-6	1-3	Tracks cue order; memorises preceding and following lines	Text
P11*	Female	1-3	1-3	Reads repeatedly for story flow; practises with a friend	Text (paper/digital), friend
P12*	Male	10+	7-9	Reads script; listens to recordings of other roles, fills gaps with own lines	Text, voice recorder
P13*	Male	7-9	1-3	Visualises script; “embodies” character, speaks preceding cue lines	Text
P14*	Female	7-9	7-9	Reads aloud/silently; sets rhythm and melody, uses colours for emphasis	Phone (voice recording), pen

Most participants start by reading their lines silently and then aloud, marking key cues and rhythms with coloured pens or digital highlighters; several reinforce this visual encoding by rewriting the text, which helps fix the sequence in memory. Roughly one-third augment these text-centred methods with audio rehearsal, recording the entire script on a phone but muting their own lines to practise call-and-response timing, while others incorporate kinesthetic or affective scaffolds such as composing melodies, pacing the stage while listening to recordings, or staging self-directed dialogues that mimic a tutor. Colour coding and mental imagery extend study into the spatial domain, and occasional pair-practice sessions provide social feedback loops that enrich recall. Actors with more than five years of experience typically combine two or more techniques; for instance, they print annotation with audio playback, indicating that expertise encourages methodological hybridity. Collectively, these patterns establish baseline requirements for VR rehearsal tools: they must preserve familiar script-markup affordances, enable in-world audio capture and playback for cue-based rehearsal, and support embodied or rhythmic prompts that translate physical and musical mnemonics into virtual space, thereby maintaining cognitive continuity as actors move from page to performance.

The thematic analysis of participant experiences across three sessions of VR-based theatre rehearsal revealed five major themes that characterize how virtual reality interactive environments transform conventional script work and line retention for amateur theatre actors. These themes emerged through systematic analysis of 14 participants' experiences and provided comprehensive insight into both the opportunities and challenges presented by VR technology in theatre practice.

3.3.1 In-Session Findings: Design-Related Insights About a VR-Based Prototype

This section describes the iterative design process and the improvements developed through three sessions informed by participants' feedback and suggestions.

3.3.1.1 Session 1: Player Preferences for VR-Based Rehearsal Techniques

Participants' reflections on the three rehearsal methods indicated different areas of focus.

Role Partner Video was described as static. Suggestions included making the experience more interactive, adding flexible playback options such as rewind and fast-forward, and allowing for larger display settings.

Interactive Script was seen as useful but in need of refinement. Participants emphasized clearer presentation, easier control, and better alignment with users' pacing.

AI-driven NPC was the most frequently chosen technique. Participants highlighted the importance of supporting more natural interactions, options for customization, and greater adaptability.

In addition, participants pointed out aspects relevant to VR-based rehearsal environments, such as mobility, realistic stage layouts, intuitive controls, and integration of VR-specific features. Across all rehearsal techniques, participants suggested ways to create a more smooth and engaging rehearsal experience, including improved speech recognition, multiple voice options, dynamic timing features, and interfaces designed to help sustain attention.

Table 3.4 *Session 1: Participants' Improvement Suggestions Categorized by Subject.*

Subject	Suggestion	Participants
AI-Driven NPC*	Should understand commands better, give lines directly without saying names	SP1, SP7, SP8
AI-Driven NPC*	Needs to feel more realistic: add emotions, facial expressions, and adapt to user's pace	SP1, SP4, SP12, SP11
AI-Driven NPC	Should be customizable: multiple characters and stage props possible	SP7, SP11, SP12
AI-Driven NPC*	Improve lighting on face, position/size adjustments	SP8, SP14
AI-Driven NPC	Add voice analysis: NPC/text should react to tone and speed	SP12
Subject	Suggestion	Participants
AI-Driven NPC*	More accurate speech recognition	SP10
AI-Driven NPC	Add multiple voice options	SP10
Interactive Script	Character lines can be color-coded	SP2
Interactive Script	Play/pause and control buttons should be simpler	SP8
Interactive Script	Dialogue flow shouldn't be fixed, adapt to user's pace	SP14, SP11
Interactive Script	Dynamic timer for each line, auto-pause on mistakes	SP12
Role Partner Video	Shouldn't feel like a plain YouTube video, needs to be more interactive	SP5
Role Partner Video	Allow adjusting pauses between lines	SP13, SP10
Video Scene Partner	Easier stop-resume and rewind/forward functions	SP8, SP10, SP14
Role Partner Video	Larger video window for better visibility	SP8
Role Partner Video*	Enable standing, Wireless rehearsal (PC-headset)	SP2
General VR Experience*	Should provide a realistic stage feeling	SP5, SP12
General VR Experience*	Stage design and props should simulate real rehearsals	SP4, SP7, SP12
General VR Experience	Eye-tracking and intuitive controls (e.g., gaze or voice commands)	SP6

*Note. Suggestions marked with * were chosen for implementation in Session 2.*

The selection of the virtual rehearsal techniques for further development was based on participants' feedback and their alignment with the research questions. Two criteria guided the refinement of the prototype: (1) the expected contribution to players'

overall perceived quality of experience, and (2) short-term feasibility in terms of time, technical resources, and manageability. Accordingly, we focused on improvements that directly enhance fluency and usability. Examples include suggestions such as better NPC command comprehension and response realism, simplifying control and flow in the interactive scenario, improving video playback controls, and increasing scene realism. Features prioritized under these criteria are indicated with a check in the Table 3.4.

The suggestions not selected were those that required greater technical maturity, posed higher design complexity, or showed weaker relevance to the research questions (e.g., eye-tracking and intuitive control integration, extensive scene and prop customization, advanced video/audio analysis). These design decisions reflected a scope-management strategy aimed at maximizing user impact within the available time and resources.

3.3.1.2 Session 2: Refinements for Developing the Interactive Environment

The participants' suggestions mainly focused on enhancing realism and usability across different aspects of the system. For NPCs, they emphasized more natural behaviors, emotional cues, improved command recognition, and the ability to portray multiple characters in Table 3.5. In terms of interactive text, participants requested clearer visual distinctions such as color coding, highlights, and step by step line displays to support memorization and tracking. Stage and environment feedback included demands for themed designs, better object management, and more spacious, user friendly settings. Suggestions for animations highlighted the need for role specific movements, stage actions, and faster NPC reaction times. Finally, on the technical side, participants sought improved tools for text editing such as annotation, AI recognition, and device adjustments to ensure smoother interaction.

Table 3.5 *Session 2: Participants' Improvement Suggestions Categorized by Subject.*

Subject	Suggestion	Participants
AI-Driven NPC*	More realistic NPC: improved command recognition, emotional responses, natural reactions	SP1, SP7, SP8
AI-Driven NPC*	The NPC should provide the user's next line after delivering its own, either on screen or through spoken output.	SP1, SP4, SP12, SP11
AI-Driven NPC	Emotional cues in dialogue can be supported through parentheses, dramaturgical notes, or user-defined emotion tags.	P7, P11, P12
AI-Driven NPC*	Multiple NPC characters should be available	SP8, S P14
AI-Driven NPC	NPC reaction time should be shorter	SP12
AI-Driven NPC*	NPC should move realistically	SP10
AI-Driven NPC	Improve AI command recognition accuracy	SP10
AI-Driven NPC	Lines can be highlighted or color-coded, with character names clearly distinguished in the NPC's user interface panel	SP2
AI-Driven NPC	Reduce "Push to Talk" button waiting time	SP8
Script	Step-by-step text display, only current line visible	SP14, SP11
Script	Easier line tracking with colored highlights per character	SP12
Script	Export text output; allow editing, annotating	SP5
Environmental Design	Themed stage design and props (e.g., Hamlet castle), ready-made packages like Sims	SP13, SP10
Environmental Design	Object management: select, copy, duplicate, nest; finer light/object manipulation	SP8, SP10, SP14
Environmental Design	Environment less dark and cramped, more spacious/pleasant design	SP8
Technical*	Adjustable lens or clarity independent of headset	SP2

*Note. Suggestions marked with * were chosen for implementation in Session 2.*

The aspects of refinement of the virtual rehearsal technique (Table 3.5) were selected based on participant needs and their direct relevance to the research question. Priority was given to suggestions that increase the naturalness and speed of player-NPC interaction (e.g., command recognition accuracy, affective and natural responses, realistic motion), maintain rehearsal flow without interruptions (e.g., step-by-step line display, character-specific color highlighting), and improve the practicality of scenes and props (e.g., basic prop management, a more spacious stage layout). This approach aims to prioritize developments with high short-term user impact and strong technical feasibility (rows with a check mark).

Suggestions not selected were those with heavier scope and cost, or limited relevance to the current prototype. For example, themed scene and prop libraries, multiple NPCs, extensive animation and ambient-sound expansions, toolchain modifications (e.g., export and annotation), or hardware-dependent improvements (e.g., lens or optical adjustments). These were excluded at this stage because they require additional infrastructure and asset creation, pose performance and integration risks, or contribute only indirectly to the research question.

3.3.1.3 Session 3: Testing Interactive Environment

Most participants emphasized AI-Driven NPC improvements, such as clearer command recognition, more natural and emotional delivery of lines, and the ability to select or add multiple NPCs (see Table 3.6). A few participants highlighted the need for better text and line tracking, suggesting features like a highlighted cursor or showing only the relevant lines. Others focused on sound and atmosphere, recommending more variety and adjustable volume levels. Finally, one participant suggested optimizing lighting and resource usage to improve performance. The primary reason for suspending development

in this session was the set of features and limitations of the AI-Driven NPC platform we used Convai, which restricted our ability to implement changes at the required level. Nevertheless, we documented the feedback and designated it as future directions; our roadmap includes evaluating alternatives to reduce platform dependence and planning further studies on additional components.

Table 3.6 *Session 3 Participants' Improvement Suggestions Grouped by Subject*

Subject	Suggestion	Participants
AI-Driven NPC	Should understand commands more clearly; continuous and natural interaction like a human	SP1, SP7, SP8
AI-Driven NPC	Should deliver lines with emotions and consistently; movements should be more natural and human-like	SP1, SP4, SP12, SP11
AI-Driven NPC	Character selection via start menu; support for multiple NPCs	SP7, SP11, SP12
Script	A highlighted cursor or marker to follow long lines	SP8, SP14
Script / Line Tracking	Line tracking should be clearer; only necessary parts shown	SP12
Sound and Atmosphere	Increase sound variety (birds, people, nature, etc.); adjustable volume levels	SP10

3.3.2 Post-Session Interview Findings: Themes Emerged From VR-Based Rehearsal Sessions

The post-session interviews indicated that VR-based rehearsals facilitate memorization, engagement, and creative exploration through immersive environmental design, AI-driven non-player character interaction, and multi-sensory learning processes, while also revealing technological and cognitive constraints that underscore the need for continued refinement.

3.3.2.1 Theme 1: Design Elements for Rehearsal in Virtual Reality Environments

This theme examines how design elements for rehearsal in virtual reality environments, including visual aesthetics, spatial configuration, lighting, sound, and objects, transform the sense of presence and text work. The theme reveals that environmental design plays a main role in creating convincing theatrical spaces that support both memorization and character development. Participants consistently reported that VR environments provide a qualitatively different experience from conventional rehearsal spaces, with the immersive features of virtual environments facilitating deeper interaction with theatrical material and creating favorable conditions for effective text work.

The environmental design elements of VR environments, particularly set design, lighting, and NPC integration, indicate that those elements can indirectly contribute to the memorization process by supporting space construction and sense of belonging. P3S2: “...After creating the set, adjusting the lighting, and approaching the NPC (non-player character), I felt much better. In the first session, the space was unclear; I stayed distant, and the lack of set design reduced environmental clarity.” As participants emphasized, the gradual addition of environmental elements has the potential to improve experience quality; the contribution of set design to memorization performance appears more evident particularly in scenes conducted with NPCs. P6S2: “Set design makes an important contribution to the memorization process; when you get used to space, you can deliver a more convincing performance.” This finding suggests that environmental design can become a functional component that supports actor performance, going beyond being merely a visual element. Additionally, the ability to customize lighting and set objects

appears to have reinforced feelings of motivation and ownership among participants. P10S2: “Being able to adjust lighting and create new objects enriches the rehearsal process.”

The atmosphere presented in VR environments indicates that it can support emotional participation that remains limited in conventional methods and thus creates a transformation in perception regarding text work. P7S3: “...but mainly that interaction and atmosphere make my memorization quite enjoyable.” This atmosphere, combined with interaction, has the potential to make the memorization process both efficient and enjoyable for some participants. The same feedback suggests that the VR environment awakens a sense of seriousness about the scene and can help develop a more professional approach to work. P2S2: “Actually, I thought I was having a more serious, more realistic experience.” In addition, it is also mentioned that the excitement created by technology and dramaturgical support increase motivation and facilitates remembering. P9S2: “The excitement of VR and bringing the dramaturgy report in front of me increased memorability.” These observations show that VR atmosphere has the potential to offer multi-faceted contributions to memorization and script work processes. Therefore, the flexible use of environmental design elements appears to hold potential for deepening the rehearsal experience and increasing subjective participation.

3.3.2.2 Theme 2: AI-Driven Non-Player Character Experience in Virtual Rehearsal

This theme explores how AI-driven NPC characters function as rehearsal partners, examining their capacities for understanding commands, providing meaningful interaction, and supporting the memorization process. The theme reveals both the potential and current limitations of AI technology in simulating human rehearsal partners

for amateur theater actors. Participants' experiences show that AI partners can usefully solve a fundamental challenge like finding partners in amateur theater while providing adaptive, responsive interaction that supports text work. However, the theme also highlights current technological constraints that limit the full realization of AI's potential as a rehearsal partner.

The capacity of AI-driven NPCs to understand and implement commands appears to hold a prominent place in session experiences and this capacity can show development as sessions progress. P2S3: "I think it understands 80-90% of everything I say. It especially understands basic things or average things." This rate, which the participant describes as high, draws attention to AI's potential to function as a rehearsal partner. The ability to fulfill emotional commands creates the impression among participants that AI can go beyond being merely a technical tool. P2S3: "I said fear and it did it, I said excitement and it did that too." This view provides a clue that AI can perceive and reflect emotional nuances. Cross-session comparisons support participant perception that there is an increase in AI performance. P2S2: "In the second session, I think the accuracy and percentage of the NPC's response to the commands we gave was higher." These observations suggest that AI's learning capacity may reveal its reflections in practical use.

The interaction established with AI indicates that it can approach conventional rehearsal partner experience and has the potential to adapt to users' personal work dynamics. P2S3: "At the same time, it was close to my own dynamics and tempo, so it becomes like a travel companion with me." This observation suggests that AI can be perceived as a partner that can understand and support the participant's work rhythm, beyond being a system that merely executes commands. It is also emphasized that the quality of communication sometimes gains an emotional dimension. P7S3: "In that

respect, it listens sweetly and responds.” This expression provides clues that interaction can gain a more human quality rather than being purely a technical process. Finally, the development perceived by participants in artificial intelligence’s capacity to show human-like characteristics may reflect progress in human-machine interaction. P11S2: “More human-like and easy to communicate with.” Such feedback can be evaluated as qualitative data supporting technology’s potential to improve its way of communicating with users over time.

The contribution of NPCs as rehearsal partners indicates that they can offer a potential solution to the partner shortage problem frequently encountered by amateur theater actors. P12S3: “Putting someone who reacts to me in front of me, an object, a material is useful for my memorization. Because I’ve always said and will say again, acting and play are entirely about action and reaction.” Beyond this functional role, participants also evaluated the NPC’s performance qualities, particularly its ability to generate presence and atmosphere. For some, this was experienced as a heightened sense of realism: P10S3: “I felt as if there was a real person in front of me; it read my lines back and added emotion.” Others highlighted that while delivery could at times feel artificial, the interaction still enhanced the rehearsal process. P7S3: “For example, it performed fear well... but its voice was a bit like reading poetry. Still, that interaction and atmosphere made memorization quite enjoyable for me.” Similarly, the atmosphere created by the NPC was described as central to engagement and learning. P8S3: “I think it was precisely that interaction and atmosphere that made the memorization process very enjoyable.” These reflections suggest that the NPC was perceived not only as a technical aid but as a rehearsal partner capable of contributing to believability and emotional presence, even if its performance occasionally lacked naturalness. At the same time, participants

emphasized the practical advantages of working with AI. P14S3: “It served as if I was memorizing with a partner.” Additionally, the opportunity for independent work was valued. P6S3: “You don’t have to be dependent on another person, as if there is someone in front of you.” Taken together, these accounts indicate that AI-driven NPCs can partially simulate an authentic rehearsal partner experience, providing both functional support and affective engagement that enrich the rehearsal process.

3.3.2.3 Theme 3: Transforming Conventional Rehearsal through Virtual Rehearsal

This theme addresses the potential of VR environments to transform conventional memorization approaches into flow-based and interaction-focused memorization processes. The possible advantages of multi-sensory learning and the potential contributions of individual practice opportunities offered by VR technology are also discussed. Participant data indicates that VR-supported memorization can go beyond conventional reading-based methods by incorporating visual, auditory, and interactive components into a memorization experience. Additionally, feedback suggests that this transformation can help some challenges frequently encountered in conventional script work by making the process more engaging and enjoyable while increasing memorization efficiency.

VR environments suggest that they can provide a possible alternative for people who struggle with conventional text-based memorization methods by offering opportunities for memorizing within flow. P4S1: “...speaking for myself, for example, I am a person who cannot memorize by reading. I cannot memorize directly by reading from script. Even if I read it 50 times, I forget it on the 51st.” The same participant stated that working with script in a flow context could alleviate this difficulty. P4S1: “I

memorize a flow and within that flow I can continuously memorize dialogues. I can also memorize in general rehearsal processes.” VR environments’ simulation of this rehearsal process has the potential to create an interactive and continuous memorizing experience. P4S1: “...for me, for example, having artificial intelligence that flows replicas to me is very useful.” Thus, memorization can transform from an isolated activity into a process where interaction is central.

The multi-sensory memorizing experience offered by VR environments indicates that it can provide additional advantages compared to conventional memorization approaches. P3S1: “...compared to other tools, in terms of reading, seeing by reading from the side, having someone speak in front of you is much more advantageous than doing this from an audio recording.” The simultaneous presentation of visual and auditory stimuli emphasized here can create potential synergy in the memorizing process. Participants report experiencing a reinforcing effect from multi-sensory engagement, noting that simultaneously reading and hearing the text appears to facilitate line retention. P2S2: “...Both hearing the text from the NPC and reading it reinforces memorizing.” Thus, the needs of participants with different memorizing styles are met and the process can gain a more inclusive quality.

VR-based memorization processes suggest that they can offer potential advantages in motivation and interaction dimensions compared to conventional approaches. P5S3: “When I compare it with conventional methods, VR is more fun and interactive. It breaks the monotony.” This evaluation provides a clue about the motivational contributions of VR environments to the memorizing process. The limitations of conventional memorization methods also become visible through participant experiences. P8S3: “Reading alone at home becomes boring, here there is

mutual conversation.” It can be suggested that interaction-based VR experience can reduce the monotony of individual work. Additionally, some participants stated that they felt a positive difference in memorizing speed. P11S3: “Memorization happens faster in VR because I see, hear, and get reactions.” While these observations imply that multi-sensory inputs and instant feedback can support the memorization process, they also recall that more comprehensive research is needed to confirm causal relationships.

3.3.2.4 Theme 4: Virtual Rehearsal Boundaries and Technological Limitations

This theme draws attention to the potential of VR-based rehearsal systems to transform conventional rehearsal while also pointing to various factors that may limit the applicability of these technologies. Technical malfunctions, users’ difficulties in adapting to the system, and limitations affecting overall experience quality have been among the elements that occasionally stand out in participants’ experiences. The fact that these limitations encompass technical, physical, and cognitive dimensions suggests that there is a need for user-centered design approaches as well as continuous technological improvements. In this framework, for VR infrastructures to be used effectively, it may be important for both technology development teams and practitioners to develop stakeholder-focused strategies to identify and address emerging challenges at an early stage.

The current limitations of AI-driven systems indicate that they can bring various challenges to the implementation process. P5S3: “I think the NPC character has problems with commands.” It is stated that such challenges become more evident especially when complex instructions are involved. The need for specific instructions also emerges as another highlighted constraint. P12S3: “You need to give incredibly specific

instructions.” This observation implies that interaction with AI can sometimes turn into a technical process rather than a natural dialogue. Limitations regarding character management have also been expressed by participants. P9S3: “It doesn’t fully understand which characters it should read and which character it should leave to me.” This statement about AI potentially struggling to correctly interpret role distribution, especially in multi-character scenes suggests that the usage experience may be limited in certain contexts.

The technical limits of VR systems indicate that they can be reflected in user experience. P8S2: “Due to the delay/quality problem experienced in sound, I don’t think I can fully interact.” Such audio delays have the potential to reduce the naturalness of interaction. Similarly, inconsistencies in response times have also been noted. P3S2: “The

The only problem is that sometimes it cannot respond instantly to every word.” These delays are thought to be able to interrupt dialogue flow. Additionally, system performance being perceived as inconsistent from time to time appears as a factor that can affect the credibility of conversation simulation. P5S3: “Sometimes it paused, and sentence endings were a bit artificial.” These findings suggest that focusing especially on audio processing and real-time response generation topics in the development of VR and AI-driven rehearsal infrastructures could be beneficial.

Some challenges related to the physical use of VR technology suggest that they can become evident especially in long-term sessions. P2S1: “Spending long hours can currently create health problems.” This statement indicates that current hardware may be open to improvement in ergonomic terms. Additionally, increased cognitive loads have also been mentioned as an important constraint. P4S3: “While training artificial intelligence, I was planning the next step on one hand and trying to make sure it understood my sentences correctly on the other. When my mind was so full, I couldn’t

focus on either the text or its meaning.” This situation shows that interaction with artificial intelligence can require additional mental effort and that considering this factor in developing user-centered design principles could be beneficial.

3.3.2.5 Theme 5: The Potential of VR Technology for Individual Practice Opportunities

This theme addresses the potential of VR technology to increase temporal and spatial flexibility in theater practice by relating it to individual work opportunities for practical challenges frequently faced by amateur actors. Participant data indicates that VR infrastructure can partially overcome conventional temporal and spatial limitations and thus offer new opportunities for personalized practicing and professional development. Additionally, views reveal various insights about future applications of VR but also suggest that the full capacity of technology has not yet been fully realized.

The temporal flexibility offered by VR technology suggests that it can adapt to the individual work needs of amateur theater actors. P10S1: “When people are alone or when their schedules don’t match with another person, they can work individually to improve themselves, I found it useful.” Such flexibility can alleviate time constraints in conventional rehearsal systems and allow actors to work according to their own availability. Personal pace control is also a possible advantage emphasized by participants. P7S2: “I can work at my own pace; I don’t have to wait for anyone.” This feature can provide significant convenience especially for actors with different learning speeds and work rhythms.

The spatial independence provided by virtual environments indicates that it can offer solutions to location-based limitations frequently encountered in amateur theater. P6S1: “You can rehearse anywhere without needing physical space.” This advantage can

be particularly valuable for amateur theater groups that have difficulty accessing rehearsal spaces. Additionally, the ability to create customized environments appears to offer creative possibilities that go beyond conventional rehearsal spaces. P9S1: “Being able to create different stage designs and atmospheres is very inspiring.” This flexibility can support both the creative process and technical preparation.

Participants’ views on the future potential of VR technology suggest that current applications represent only the beginning of possible developments. P11S1: “I think this technology will become much more advanced and widespread in the future.” Such expectations indicate that VR-based theater education tools may gain broader acceptance and functionality over time. However, some participants also emphasize that technology needs further development to reach its full potential. P4S1: “It’s a good start, but there’s still room for improvement in many areas.” This balanced perspective suggests that while current VR applications show promise, they require continuous development and refinement to fully meet user needs.

4. DISCUSSION

This discussion summarizes the three phases of the study and, in order to reveal design lessons for VR-supported theatre rehearsal, presents the findings theme by theme. First, in Phase 1, we return to six themes (*Environment Setting, Interactive Environment, Advanced Script Management Rehearsals in Virtual Scene, Set Design and Prop Integration, Interactive and Adaptive Digital Tools and, Rehearsal Challenges and Issues for Performers*) and show how these overlap with actors' routine practices and unmet needs. Next, we link these themes to the Borda-count preferences from Phase 2 and explain why Interactive Environments and Set and Prop Integration lie at the center of the group's shared priorities. In Phase 3, we addressed virtual reality, the transformation of traditional methods, and the rehearsal process through six themes: *Design Elements for Rehearsal in Virtual Reality Environments, AI-Driven Non-Player Character Experience in Virtual Rehearsal, Transforming Conventional Rehearsal through Virtual Rehearsal, The Limitations of VR Technology for Virtual Rehearsal, The Potential of VR Technology for Rehearsal, and Scalability and Accessibility of VR Prototypes for Amateur Theatre Groups*.

4.1 Phase 1: Defining Themes of Virtual Rehearsal

The integration of Virtual Reality (VR) in theater rehearsals represents a shift in acting training and rehearsal practices, as evidenced by the themes identified in this research and their alignment with existing literature. This section examines what the findings mean and considers how VR technology can both transform and challenge traditional theatre practice.

4.1.1 Environment Setting

Designing script work experience and line retention in virtual reality (VR) environments involves an evolving process. Despite this, several consistent variables have been identified. Previous research highlights key factors such as appropriate stage configuration, sufficient lighting, and freedom of movement. McKendrick et al. (2023) emphasized the importance of these elements, noting that visual discomfort was often caused by the grid layout of the virtual environment. Some users addressed this issue by placing a box on the stage to reduce the discomfort (McKendrick et al., 2023).

Considering these observations, it is evident that the virtual space should be fully customizable by the user. Such customization enables individuals to tailor the environment to their specific needs and preferences, fostering a less distracting and more effective work setting (Levordashka et al., 2023). User feedback plays a crucial role in understanding how customization impacts learning experiences. In this context, the use of evaluation methods such as heuristic evaluation is recommended to assess the influence of the designed experience on user engagement. Techniques like heuristic evaluation (Nielsen and Molich, 1990) and usability testing (Dumas and Redish, 1993) can yield valuable insights into improving usability and overall effectiveness. This process contributes to a deeper understanding of user experiences, preferences, and requirements, thereby enhancing the effectiveness of text study and memorization in virtual reality (VR) environments. Ultimately, incorporating such feedback and evaluation practices can significantly inform and refine the design and development of VR-based learning systems.

4.1.2 Interactive Environment

Participants have highlighted the necessity for hands-on experiences in their memorization and text study methods within virtual reality (VR) settings. They indicated that memorization is more effective when conducted in a staged environment, suggesting that a stage-like atmosphere can elevate their learning experience. Presence and embodiment are closely interrelated rather than distinct constructs. Halbig and Latoschik (2025) demonstrate that design features that reinforce body ownership and agency, which are central components of embodiment, also enhance spatial presence. This theoretical connection helps explain participants' reports of heightened emotional presence when their avatars engaged in physical proximity, such as simulated touch, within the virtual environment.

Furthermore, they mentioned that practicing with fellow players could aid their memorization efforts. This is because, during the memorization phase, players can more vividly visualize and embody their roles on the virtual stage, effectively utilizing the immersive features of virtual reality (VR). Additionally, players acknowledged the advantages of engaging with non-player characters (NPCs) while practicing alone. Such interactions can replicate real-world situations, offering a more stimulating and effective rehearsal experience. This element of virtual reality (VR) provides a flexible and adaptive learning environment, addressing both individual and group learning requirements.

Previous research supports these findings (Gamage & Ennis, 2018; Levordashka et al., 2023; Pittarello et al., 2020; Slater et al., 2000). For example, Levordashka et al. (2023) showed that rehearsal experiences in virtual reality (VR), when applied to a physical context, can enhance player performance. The skills and techniques honed in the virtual environment were proven to be applicable and beneficial in actual settings. This

result highlights the importance of virtual reality (VR) as an effective medium for improving real-world experiences, serving as a link between virtual practice and physical execution. The integration of a simulated environment, engagement with non-playable characters (NPCs), and opportunities for collaborative training in virtual reality (VR) creates a rich and diverse educational experience (Gamage & Ennis, 2018). This approach not only facilitates script work and line retention but also contributes to the development of practical skills that can be utilized in conventional rehearsal process.

As a result, the virtual reality (VR) environment plays a valuable and adaptable role in enhancing and supplementing physical experiences, providing a distinctive and potentially efficient method to improve learning and practice processes.

4.1.3 Advanced Script Management Rehearsals in Virtual Scene

Virtual reality environments for script work offer valuable insights into how this technology can be integrated into theatrical practices involving amateur actors. Actors have highlighted that VR overcomes the physical world's limitations, greatly assisting script memorization. A particularly impressive feature is the ability to display scripts alongside the director's notes, which not only helps actors keep track of the script but also enables them to receive directorial feedback instantly, thus improving the effectiveness of the memorization process. The ability to customize key aspects of the script, including its size, font style, and placement, allows actors to adjust their workspace according to their individual preferences and needs.

Additionally, the evolving characteristics of the director's notes, which can be accessed in real time, play a significant role in speeding up the memorization process during rehearsals. Actors have reported that interactive script features, including color coding, highlighting, and the ability to add annotations, enhance engagement and

contribute to a more enjoyable learning experience. These features help quickly pinpoint important script sections and support a more effective study method. The option to open and close the script in a virtual reality environment is an essential component that enhances both flexibility and user experience (Mckendrick et al., 2023).

The actors have indicated that this feature diminishes distractions and aids in focusing during study sessions. Such innovative characteristics emphasize the potential of VR technology in the realms of theater and performance arts. This study is a reference for future explorations of script work within VR environments.

4.1.4 Set Design and Prop Integration

Amateur actors have emphasized the key role set design and prop integration play in their rehearsal and memorization practices. They have observed that authentically created set pieces and props potentially enhance their ability to internalize scripts. Incorporating these elements, similar to what is seen in the actual performance, significantly supports the memorization process. Even when precise replicas are unavailable, utilizing primitive versions of these props can help actors visualize and engage with their performance settings.

The focus on realism in set design holds notable importance (Mckendrick et al., 2023). Creating a set that closely resembles the intended performance setting not only assists in memorization but also notable roles the actors' performances. This realistic props and set integration allows actors to immerse themselves entirely in the narrative, leading to a more authentic and convincing representation of their characters. Research in this field supports these claims by highlighting the essential role of a prop library (Levordashka et al., 2023). Having a varied and extensive assortment of props enables actors to recreate their performance environments during rehearsals better (Normand et

al., 2012). These props serve as important tools in defining a scene's spatial and contextual elements, allowing actors to engage more organically with their surroundings and one another.

4.1.5 Interactive and Adaptive Digital Tools

Interactive and adaptive digital tools offer a learning environment that can be customized to meet users' needs. Such adaptability presents a considerable benefit, particularly for individuals with varying understanding styles and preferences. For example, some amateur actors can memorize lines more effectively through visual cues, while others prefer written content. These tools enable each learner to tailor the educational journey to suit their approach. Tools that allow users to communicate ideas through drawing and writing play an important role in promoting creativity. Such resources enhance creative thinking and encourage deeper engagement in the learning process. Expressing creativity serves as an essential method for assimilating and comprehending information. Elements like background music and maintaining clear text should be considered when designing an engaging educational environment.

This approach can increase interest in learning materials and help users maintain their attention for extended periods. Music can add dynamism to learning activities that might otherwise be monotonous. Games in education are another key element that makes learning fun and effective. Interactive tools like memory games can reinforce knowledge and make the learning process more interactive. Games can enhance motivation, making learning more appealing (Kenwright, 2017). The integration of such digital tools not only provides an interactive and adaptable environment and makes learning more engaging, creative, and personally meaningful. These insights could be an important guide for the future of digital tool use in education.

4.1.6 Rehearsal Challenges and Issues for Performers

For amateur actors, the difficulties faced in a physical setting start with the challenges in the memorization process. During rehearsals that follow the script and the director's guidance, actors must not only recall their lines but also incorporate direction and sustain the fluidity of their performance. When practicing individually, the constant need to reference the script can complicate matters, resulting in a fragmented emotional connection with the character and disrupting the flow of memorization and script analysis. The second difficulty stems from the constraints of rehearsal environments.

Environments such as rooms or similar spaces frequently cannot provide sufficient support for performers to immerse themselves in their roles, leading to difficulties with memorization. Virtual environments present an ideal alternative to fulfill these spatial requirements. The challenges associated with scheduling rehearsal sessions and organizing team meetings are recognized. Finding appropriate times for group rehearsals can be challenging and requires considerable time. This situation highlights the necessity of individual rehearsal time. A possible solution is a virtual environment where actors can rehearse alone and efficiently without being in the exact location of their conventional stage. Because a virtual environment can simulate their conventional scene.

4.2 Phase 2: Interactive Environments as the Foundation for VR Rehearsal

The Interactive Environment theme scored the highest in the Borda Count because participants valued presence and co-presence technologies during VR rehearsals. They reported that interactive features, such as picking up, moving, and resizing props, increased their sense of being inside the scene and made the virtual space feel authentic (Levordashka et al., 2023). In a related study, Wales et al. (2024) describe an actor who felt an unexpectedly strong sense of physical presence when her avatar moved close to

her teammates' avatars; when the virtual hands touched, the moment was emotionally intense even without real-world contact (Wales et al., 2024). Additionally, Levordashka et al. (2023) report that actors in social VR rehearsals experience spatially embodied co-presence, which facilitates both collaboration and emotional connection. This aligns with Förster's (2022) claim that presence should not be viewed merely as a technological effect but as an outcome of embodied interaction and self-perception within the virtual environment. These findings suggest that successful VR rehearsal systems must prioritize body-based interaction and co-presence rather than graphical fidelity alone.

These experiences show that actors want in-world interaction that mirrors what they do on a physical stage. They prefer realistic avatar representations, yet some forms, such as generic humanoids, can be interpreted in multiple ways. Wales et al. also note that human-to-human interaction differs from the scripted experiences typical of video games, because even a rich game narrative lacks the guiding human element. Nevertheless, actors who cannot rehearse face-to-face view non-player characters (NPCs) as helpful additions rather than replacements for human partners. While an NPC cannot provide the full feedback loop of a live colleague, it can support the early stages of rehearsal when partners are not available.

Therefore, Virtual rehearsal platforms should prioritize smooth, real-time collaboration rather than aiming for advanced graphics or extensive personalization. Branch et al. found that participants felt a strong sense of identification even on Zoom, showing that graphic quality does not determine presence (Branch et al., 2021). VR also lets actors experiment with actions that might feel awkward on a physical stage. A participant in study (Branch et al., 2021) explained that they would not normally kiss during a physical rehearsal, since they had never done so before, but in the virtual setting

the action felt completely acceptable. This example shows that synchronous remote rehearsals give actors the confidence to try behaviours they might avoid in person. VR setting not only offers deep immersion but also helps actors build a coherent mental model of the virtual set and their virtual partners (Bouville et al., 2016). The interactive environment familiarizes them with virtual decor and props, while an interactive scenario lets them practice blocking and dialogue (Bouville et al., 2016). Once presence is established, attention shifts to creative exploration inside the rehearsal space.

Three interlinked themes support interactive scene design: Stage Design and Décor Integration, Rehearsal Challenges and Issues, and Enhanced Text Management. Stage Design and Prop Integration enriches memorization by representing physical scenery in VR and lets actors and designers test visual and spatial ideas without real-world costs. In Levordashka et al., participants said that, while an empty rehearsal room would work, the strong link between interaction and engagement made them want a library of everyday objects. This overlaps with Rehearsal Challenges and Issues because VR can offer an alternative when conventional theatre faces space limits, scheduling conflicts, and blocking problems. Time management and team coordination are inherently complex, as organizing rehearsals and aligning everyone's schedules is difficult (Leylekoğlu and Baykal, 2025)

Advanced Script Management keeps dramaturgy reports and director's notes inside the digital workflow, aligning textual, spatial, and artistic inputs. In Mirowski et al., (2023) the AI-assisted writing tool Dramatron lets playwrights explore, alter, and recreate styles and narrative elements through targeted prompts (Mirowski et al., 2023). When such tools merge with VR scenes, they bring many viewpoints together in one shared immersive space, opening the way for fresh, rich theatre experiences.

Looking at the other themes, environment settings and interactive and adaptive digital tools received lower, yet meaningful support compared with the main components. Although VR eases access by reducing spatial limits, timing clashes, and ergonomic concerns, participants viewed these benefits as secondary. Likewise, AI-driven line memorization and gamified rehearsal exercises gained real value only after the idea of presence was secured.

4.3 Phase 3: Toward Comprehensive VR Rehearsal Systems

This discussion of the thematic analysis results highlights what virtual reality (VR) rehearsal tools should provide. Comprehensive systems may need to offer flexible stage layouts, lighting, and sound that work as clear memory cues for actors rather than simple background decoration. These elements must be tuned to help performers learn their lines without causing too much cognitive load. AI-driven non-player characters also need to improve. They should recognize emotion, keep steady timing, and adapt their behavior through user feedback so that dialogue flows naturally and the sense of shared presence grows. Developers, designers, and researchers must likewise tackle current technical limits. Comfortable hardware, adjustable interface options and clear guidelines on session length are vital for reducing cybersickness, eye strain, and muscle fatigue. An iterative, user-centered approach where prototypes are refined with actors and theatre professionals can make creative freedom and ease of use go hand in hand. By combining stage-specific environmental cues, responsive AI partners, and clear health-focused practices, VR rehearsal platforms can move beyond small-scale trials and become reliable everyday resources for theatre training and production.

4.3.1 Design Elements for Rehearsal in Virtual Reality Environments

In virtual reality (VR)–based rehearsal systems, environmental components do more than serve visual aesthetics; stage layout, light positioning, and sound design can reframe the actor text interaction. When carefully arranged, these elements create reminder cues that support line memorization during rehearsal. A rehearsal environment with interactive components helps actors recall scene-related details more easily (Bouville et al., 2016). Johnson-Glenberg (2018) argues that immersive VR learning is most effective when designed according to embodied principles, where gestures and bodily movements play a direct role in encoding memory. In the context of theatre rehearsals, this suggests that stage layouts, lighting, and interactive props should be developed as embodied cues that strengthen memorization and comprehension. Similarly, Halbig and Latoschik (2025) highlight that embodiment contributes directly to spatial presence, reinforcing the need for rehearsal environments that integrate both environmental and bodily interaction as design criteria. Therefore, treating the conditions under which virtual cues aid memory as a design criterion can guide the creation of rehearsal settings that improve line learning and suit text-comprehension processes. This supports embodied cognition theory: the actor’s bodily interaction with objects including virtual props links memory and performance (Johnson-Glenberg, 2018).

In this context, the study by Bailey et al. (2012) shows that strategies to change attitudes or habits primarily seek to raise motivation. In contrast, in transferring factual knowledge, the learner’s capacity to encode and store information is decisive (Bailey et al., 2012). Thus, it is potentially essential to balance design features that enhance immersion with elements that help memory retention in VR rehearsal. P3S2 participant’s statement: “*After creating the set, adjusting the lighting, and approaching the NPC (non-*

player character), I felt much better. In the first session, the space was unclear; I stayed distant, and the lack of set design reduced environmental clarity.” This remark confirms the direct impact of scene clarity and customizable environmental elements on motivation.

On the other hand, the findings of Dinh et al. (1999) suggest that designers can enhance the sense of presence and spatial memory by adding non-visual sensory stimuli such as tactile feedback or cues (Dinh et al., 1999). This approach allows for the development of alternative representations in the early stages of the rehearsal process when actors cannot access production-specific props and props. In this way, the physical constraints often encountered in traditional rehearsal spaces are overcome, and VR environments allow actors to work on a digital representation of the existing scene. Reinforcing the feeling of “being there” familiarizes them with the script content and can create an immersive script study environment that supports memorization efficiency and character development.

Offering customizable set items in the early rehearsal phase as a pre-prepared library can be tailored to the scenario requirements and embodies this strategy. Indeed, Levordashka et al.'s (2023) study showed that participants requested an accessible object library where daily items, such as a sofa or a mirror, could be easily added to the virtual rehearsal space, which they believed would enhance interaction (Levordashka et al., 2023). In short, when the environment design process is overly complex or poorly structured, the platform becomes difficult to use and may negatively affect memorization and scenario study processes.

4.3.2 AI-Driven Non-Player Character Experience in Virtual Rehearsal

AI-driven non-player characters (NPCs) ease the practical difficulty of finding a rehearsal partner in amateur theatre. Participants described the AI-Driven NPC as “a partner who reacts to me,” noting that it keeps the basic action-reaction loop alive during rehearsal. Amateur actors did not position the NPC as a complete replacement for human collaboration; instead, they framed it as a short-term helper that can fill gaps when schedules or venues make face-to-face rehearsals difficult. Participants argued that rehearsing with a human-like agent is more advantageous than other digital options because the NPC can maintain active dialogue. Förster (2022) notes that embodiment encompasses agency and body ownership, which are key to sustaining a sense of presence in virtual environments. This insight is relevant to VR rehearsals with AI-driven NPCs, as actors valued the NPCs’ ability to maintain responsive dialogue and action–reaction loops that simulate embodied interaction. While NPCs cannot fully replace human partners, their capacity to sustain embodied rehearsal practices illustrates how agency-driven design can support solo practice.

Amateur actors felt the NPC could understand a large share of the directions. Votintseva and Johnson (2024) report that virtual agents showing natural and emotional responses improve negotiation simulation retention, and scenarios enriched with gamification broaden participants’ tactical repertoires (Votintseva & Johnson, 2024).

In virtual reality rehearsals, the NPC could partly recognize emotional cues such as “fear” and “excitement.” Nevertheless, participants valued consistent emotional expression. Their feedback partly overlaps with that of Kán et al. (2023), who argue that realism in VR training should not be limited to visual detail but also strengthen behavioral components of animation, action, dialogue, and emotion that fit the situation (Kán et al.,

2023). Better emotion recognition could deepen the sense of stage realism and enrich actors' practice of emotional expression. According to Yin and Xiao (2024), VR's "life-like" perspective and feedback dynamics raise users' expectations of realism in NPC interactions (Yin & Xiao, 2024). This suggests that participants may build the representation of real life in VR while relying on AI-driven NPCs for human representation.

The NPC was observed to match the actor's flow, almost like a real partner. Similar adaptive mechanisms made characters more engaging and narratives more fluent in a study on the plot-based reflection technique (Wu et al., 2025). This result implies that personalized rehearsal flows are possible but also reveals subjective differences: some users called the interaction "human-like," while others still found it mechanical. Increasing behavioral realism in virtual humans, especially when the agent's behavior shows awareness of the user's presence, leads to a stronger social presence (Kyrilitsias & Michael-Grigoriou, 2022).

Although higher realism strengthens immediate social presence, the rarity of such experiences may weaken the claim that a sustainable relational bond forms with the NPC. Findings show that the NPC's influence is shaped by its answers and design elements such as appearance, voice qualities, and modes of expression. Detailed voice, body language, and avatar design development can enhance overall interaction quality (Zisquit et al., 2024).

4.3.3 Transforming Conventional Rehearsal Through Virtual Rehearsal

Virtual reality technologies are increasingly integrating theatrical aesthetic and dramatic elements, while theatre practitioners are adapting modern VR development techniques for creative productions (Iudova-Romanova et al., 2023). The transformative

potential of VR-based rehearsal settings becomes particularly evident with the emergence of flow-oriented and interaction-centered strategies. Accounts from participants indicate that multimodal experiences, which blend visual, auditory, and interactive elements, can render memorization more engaging and fluid compared to traditional text-reading approaches. Customizing accommodate individual practice need may enhance accessibility by reducing recall errors and improving the line consistency. As participants have pointed out, engaging with AI-driven NPCs that maintain “line flow” can transform memorization from a solitary task into a continuous rehearsal experience. Such interactions enable amateur actors to repetitively hear and respond to the text within its stage context, thus enhancing semantic processing and providing an alternative strategy for memorization, especially for those who find reading-based techniques challenging.

Participant feedback in the present study indicates that multimodal arrangements, where visual and auditory inputs are presented together, can enrich the memorization experience. However, a high density of stimuli may overload some performers’ mental resources, so maintaining an appropriate balance is advisable in VR scene design. (Mayer, 2024) The meaningful learning model argues that durable learning is supported only when learners actively select, organize, and integrate information (Mayer, 2024). Hence, amateur actors should carefully choreograph scene flow, and the effort required to maintain interaction mechanics should not overshadow the rehearsal task. Mayer’s immersion principle shows that fully immersive three-dimensional VR does not consistently outperform a two-dimensional desktop presentation of the same material (Mayer, 2024). The combined information load from spoken dialogue, on-screen text panels, and NPC responses can assist some learners yet impose excessive cognitive demands on others.

Individual differences in executive function and working memory capacity also significantly shape learning experiences in VR settings (Lawson & Mayer, 2025).

4.3.4 The Limitations of VR Technology for Virtual Rehearsal

The study shows that VR rehearsal can improve conventional practice, yet it also uncovers limitations caused by technical faults, interaction gaps, and human factors. These results indicate the need for a user-centered, iterative design process so developers, researchers, and theatre practitioners can find and solve problems early. Participants linked the freedom to customize lights and stage objects with higher motivation and a stronger sense of ownership. This finding supports the value of modular, user-centered design. At the same time, adding too many elements at once may distract actors from the play itself (Levordashka et al., 2023; Leylekoğlu & Baykal, 2025; Mckendrick et al., 2023). Designers should, therefore, let users create stages quickly or personalize them through ready-made assets. Interaction with non-player characters (NPCs) is another challenge. Yin and Xiao (2024) report that most NPCs still rely on “push-button” logic and respond only slightly to body movements, while users expect smooth, free-flowing dialogue (Yin & Xiao, 2024).

Response times can also vary with internet speed or device performance. Participants said they needed very specific commands, especially in scenes with many characters. Such issues break the rehearsal flow and force actors to troubleshoot the system. In line with this, Mania and Chalmers (2001) found that when dialogue becomes technical, command errors rise and memory performance falls (Mania and Chalmers, 2001). Zisquit et al. (2025) study has also been emphasized that design factors such as an NPC’s appearance, voice, body language, and role selection strongly influence the quality

of interaction; improving these elements is therefore expected to enhance the overall user experience (Zisquit et al., 2025).

Rehearsal experiences were not the same for everyone. Some participants improved over time by learning new strategies or because the model was adapted after feedback. Designing human-like AI-driven NPCs requires establishing a balanced interaction between environmental conditions, user actions, and narrative flow. Senanayake (2025) emphasizes that a reliable system must respond appropriately without negatively affecting performance, comply with hardware limitations, manage ethical risks, and undergo rigorous testing processes. However, corrections made by players to the dialogues of AI-driven NPCs can disrupt their concentration. Therefore, AI-based NPCs should be designed to support users in maintaining focus on their rehearsal goals. Surprisingly, occasional wrong lines from an AI-Driven NPC might help memorization. The active experiencing approach of Noice and Noice (2006) shows that when actors focus on meaning instead of single words, recall rises from about 50 % to 60 %. Likewise, Votintseva and Johnson (2024) report that virtual agents with emotional reactions boost learning and that gamified tasks widen actors' repertoires. The occasional delivery of incorrect lines by an AI-driven NPC and the amateur actor's engagement through correcting these errors may contribute positively to memorization practice.

To support diverse users, VR interfaces must stay scalable and adaptable. Options such as adjustable audio volume and resizable text panels enable the system to cater to different rehearsal habits. Integrating individual practice styles early in the design phase is potentially important. Every amateur actor needs a smooth, practical VR rehearsal experience supported by customizable settings (Levordashka et al., 2023; Leylekoğlu & Baykal, 2025; McKendrick et al., 2023; Wales et al., 2024).

Using VR for long periods has raised health risk concerns. Multiple systematic reviews report higher rates of cybersickness, visual fatigue, and musculoskeletal strain as exposure time increases (Cossio et al., 2025; Souchet et al., 2023). Improving hardware ergonomics and providing clear session-planning guidelines is therefore important, a point reinforced by recent ergonomics-focused guideline papers (Cossio et al., 2025).

Finally, VR's flow-oriented and interactive features can make memorization engaging and productive. Reaching this goal requires a firm user-centered design perspective (Gulliksen et al., 2003). Enriched opportunities that support individual practice may be important for the broader and more effective adoption of VR rehearsal tools in theatre.

4.3.5 The Potential of VR Technology for Rehearsal

Virtual reality (VR) offers notable opportunities to enhance temporal and spatial flexibility in amateur actors' rehearsal processes, although these opportunities are still maturing. Participant feedback indicates that the chance to work individually and at one's own pace reduces time pressure and supports line memorization. However, it is premature to claim that VR removes all time-related constraints.

A key benefit of VR environments is that actors can rehearse according to their schedules and personalize their pace. This flexibility shortens waiting times and creates a more efficient workflow, especially for actors with diverse learning rhythms. Still, when intensive group rehearsals are required, temporal misalignment does not disappear entirely; VR provides only incremental improvement.

Spatial independence can also ease common challenges, such as securing rehearsal space and covering rental costs. VR's embodied sense of co-presence enables strong social bonds even in remote interactions, enriching collective rehearsal

experiences (Levordashka et al., 2023). Moreover, drag-and-drop digital set design lets actors experiment with different stage layouts at minimal cost. The practical effect of these gains depends on factors such as hardware quality, the intuitiveness of set-building interfaces, and actors' digital literacy. For example, the study reported that a VR-based rehearsal system could yield acting performances comparable to conventional stage work (Bouville et al., 2016).

Amateur actors express cautious optimism about VR's future. They agree that improvements are still needed in interaction realism, hardware ergonomics, and overall usability. These issues highlight the importance of iterative design methods and development cycles grounded in systematic user feedback if VR tools are to evolve from complementary helps into integrated components of theatre education.

4.3.6 Scalability and Accessibility of VR Prototypes for Amateur Theatre Groups

Studies show that social VR can facilitate remote, immersive rehearsals, enabling actors to practice blocking and spatial awareness without access to physical rehearsal spaces (Levordashka et al., 2023). VR rehearsal tools also help amateur actors address challenges such as inconsistent venues and limited stage time, while supporting memorization and character continuity (Leylekoğlu & Baykal, 2024). In addition, these technologies have been linked to reductions in rehearsal costs and time (Levordashka et al., 2023). Despite these benefits, widespread adoption faces persistent challenges. VR theatre relies on emerging and sometimes unstable technologies, which can complicate production and rehearsal processes (Wales et al., 2024). Large-scale VR systems remain costly and often demand substantial technical infrastructure (McKendrick et al., 2021). Moreover, participation depends on internet-connected headsets (Wales et al., 2024) and digital literacy, yet many theatre students and amateurs report little prior VR experience,

necessitating additional onboarding (Levordashka et al., 2023). While consumer-grade standalone headsets have improved affordability, equitable access for full ensembles is still not assured (Leylekoğlu & Baykal, 2025). Accessibility is further shaped by design and ergonomic considerations. Amateur actors frequently encounter difficulties with character embodiment due to limited motion tracking, restricted gesture support, and avatars lacking expressive capabilities (Levordashka et al., 2023; Leylekoğlu & Baykal, 2025). Research emphasizes the importance of customizable, self-contained rehearsal environments that align with traditional theatre practice and incorporate inclusive technical features (McKendrick et al., 2021; Leylekoğlu & Baykal, 2025). Overall, VR currently functions best as a complementary rehearsal tool rather than a replacement. It offers flexibility for early-stage preparation and location-independent practice but has yet to replicate the creative richness of in-person group rehearsals (Levordashka et al., 2023; Leylekoğlu & Baykal, 2024).

5. LIMITATIONS

This study was carried out within certain boundaries, and therefore the findings have some limitations in terms of interpretation and generalization. First, the research was conducted only with amateur actors from the Özyeğin University Chamber Theatre club. Professional theatre groups and other performing arts (such as opera or dance) were intentionally excluded. This decision helped to focus on the needs of amateur actors in early rehearsal stages, but it also limits the generalizability of the results since professional actors, with their different experience, methods, and resources, were not represented. In terms of time, the study focused on short rehearsal sessions. As a result, long-term learning outcomes, lasting effects on character development, or the audience's experience were not examined. From a technological perspective, the study was limited to the Meta Quest 3 headset and a Unity-based prototype; other VR devices and software platforms were not compared. In addition, augmented reality (AR) and mixed reality (MR) technologies were not included in this research, meaning that hybrid systems combining different layers of reality were outside the scope. The developed VR prototype was also limited in its features, focusing on stage design, lighting, and AI-driven NPCs, while multi-user interaction, cross-platform rehearsal, or advanced animation were not considered. In terms of health and ergonomics, only basic observations were made, and possible long-term effects of VR use were not studied in detail. Finally, since the study focused only on amateur theatre, the findings cannot be directly generalized to groups with different cultural backgrounds, age ranges, or professional production contexts.

6. CONCLUSION

This thesis set out to explore how virtual reality can support amateur actors in script work and line memorization, addressing the recurring challenges of limited rehearsal spaces, irregular partner availability, and difficulties in sustaining character continuity. Through a three-phase mixed-methods design, the research explored actors' lived rehearsal experiences, identified their priorities, and iteratively developed a VR rehearsal prototype that was tested in practice. The study shows that VR, when thoughtfully designed, can provide amateur actors with meaningful rehearsal opportunities that complement and extend conventional stage practice. The study also highlights the added value of AI-driven non-player characters.

Phase 1 revealed six themes: interactive environments, set and prop integration, script management, rehearsal challenges, environment settings, and adaptive digital tools. These themes captured both the difficulties and the aspirations of amateur actors. Phase 2 clarified their relative importance using a Borda-count survey, showing that an interactive rehearsal environment is the foundation upon which other features gain value. Phase 3 deepened these findings by translating them into design elements and iterative testing cycles. Interactive props, lighting and sound controls, adjustable script panels, and AI-driven NPCs were gradually refined to align with actors' feedback. Together, these phases demonstrate how diaries, observations, interviews, surveys, and iterative trials can progressively shape a prototype that reflects the needs of its intended users.

The findings highlight that interactive environments are more than aesthetic enhancements. They create spatial cues that strengthen memorization and offer a sense of co-presence that motivates actors to practice. Script panels, when designed to remain visible yet invisible, balance immersion with cognitive comfort and allow performers to

shift naturally between reading and acting. The integration of stage and prop elements not only accelerated recall but also allowed actors to feel more confident and engaged in their roles. AI-driven NPC filled a potential gap by maintaining dialogue flow in the absence of role partner, offering a more dynamic and motivating alternative to static recordings, even though limitations such as latency and misread lines still persist. These design implications suggest that VR tools can democratize rehearsal opportunities for amateur actors, giving them more frequent, flexible, and effective ways to prepare for live performance. Therefore, this study also highlights health and ergonomic considerations. Participants emphasized the importance of short sessions, regular breaks, and adaptable interfaces to mitigate eyestrain and cybersickness. This shows that immersive technology for performance must balance intensity with sustainability, ensuring that actors remain comfortable and healthy while rehearsing in virtual environments.

This study discusses several design tendencies for virtual reality rehearsal environments from a qualitative perspective. Based on observations and previous research, providing an interactive and embodied environment that supports the feeling of being on stage may contribute positively to the rehearsal process. Allowing interaction with other users or non-player characters can help maintain a sense of shared play dynamics, even when practicing alone. Flexible text management tools, such as adjusting visibility, size, position, color coding, and adding personal notes, may support memorization and script-following. The inclusion of stage layout and props in the virtual environment can help players experience spatial relationships, although an exact replication of the physical stage is not always necessary; adaptable and supportive spatial cues may be more effective. Personalization features and the ability to adjust the system to different working rhythms can support individual learning processes. In addition, a

clear and intuitive interface may reduce cognitive load and help transfer skills from the virtual environment to real performance situations. These observations are not presented as fixed rules but as possible design considerations informed by user experiences.

Further research should test prototypes with larger and more varied communities, extend rehearsal tasks to full plays over longer time spans, and compare different hardware platforms to evaluate cost-effectiveness. Refining AI-driven NPCs through improved speech recognition and emotion detection could also make them more reliable rehearsal partners. Expanding to multi-user VR rehearsals, cross-platform compatibility, and live-streaming features would allow ensembles and directors to collaborate more seamlessly, even across distances. While the current study focused on VR, it is worth noting that mixed reality and pass-through VR could address some of these limitations. By overlaying digital cues, props, or avatars onto real rehearsal rooms, MR maintains the familiarity of the physical environment while introducing technological augmentation. Future designs could therefore explore how MR based re on the lessons identified here.

In conclusion, this thesis demonstrates that virtual reality can act as a transformative rehearsal medium for amateur actors. By integrating interactive environments, adaptable script tools, customizable stage elements, and AI-driven partners, VR bridges the gap between limited physical resources and the creative demands of performance. The research contributes a set of design principles for developing future VR rehearsal systems that support both artistic expression and cognitive effectiveness. Realizing this potential will depend on sustained collaboration between theatre practitioners, human–computer interaction (HCI) researchers, and XR developers, ensuring that virtual reality continues to evolve not only as a technological platform but also as a creative partner in the art and practice of rehearsal.

REFERENCES

- Bailey, J., Bailenson, J., Won, A., Flora, J., & Armel, K. (2012). Presence and memory: immersive virtual reality effects on cued recall. *Proceedings of the International Society for Presence Research Annual Conference*, (pp. 24-26).
- Bonyadi, C., & Summet, V. (2018). A pilot study in using virtual reality during theatre rehearsal. *Journal of Computing Sciences in Colleges*, 34, 164-171.
- Bouville, R., Gouranton, V., & Arnaldi, B. (2016). Virtual reality rehearsals for acting with visual effects. *International Conference on Computer Graphics & Interactive Techniques*, (pp. 1-8).
- Branch, B., Efstratiou, C., Mirowski, P., Mathewson, K., & Allain, P. (2021). Tele-immersive improv: Effects of immersive visualisations on rehearsing and performing theatre online. *Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems*, (pp. 1-13).
- Braun, V., & Clarke, V. (2019). Reflecting on reflexive thematic analysis. *Qualitative research in sport, exercise and health*, 11, 589-597.
- Braun, V., & Clarke, V. (2021). *Thematic Analysis: A Practical Guide*. SAGE Publications Ltd.
- Byrne, D. (2022). A worked example of Braun and Clarke's approach to reflexive thematic analysis. *Quality & quantity*, 56, 1391-1412.
- Cake, S. (2025). Artificial intelligence as a collaborative tool for script development. *Media Practice and Education*, 1-16.
- Cannavò, A., Bottino, F., & Lamberti, F. (2024). Supporting motion-capture acting with collaborative Mixed Reality. *Computers & Graphics*, 124, 104090. <https://doi.org/10.1016/j.cag.2024.104090>

- Christiansen, F. R., Hollensberg, L. N., Jensen, N. B., Julsgaard, K., Jespersen, K. N., & Nikolov, I. (2024). Exploring presence in interactions with llm-driven npcs: A comparative study of speech recognition and dialogue options. *Proceedings of the 30th ACM Symposium on Virtual Reality Software and Technology*, (pp. 1-11).
- Cossio, S., Chiappinotto, S., Dentice, S., Moreal, C., Magro, G., Dussi, G., Palese, A., & Galazzi, A. (2025b). Cybersickness and discomfort from head-mounted displays delivering fully immersive virtual reality: A systematic review. *Nurse Education in Practice*, 85, 104376. <https://doi.org/10.1016/j.nepr.2025.104376>.
- DeLahunta, S. (2002). Virtual reality and performance. *PAJ: A Journal of Performance and Art*, 24, 105-114.
- Delve. (2017). *Qualitative Data Analysis Software*. Retrieved 5 20, 2025, from Delve: <https://app.delvetool.com/>
- Dinh, H., Walker, N., Hodges, L., Song, C., & Kobayashi, A. (1999). Evaluating the importance of multi-sensory input on memory and the sense of presence in virtual environments. *Proceedings IEEE Virtual Reality*, (pp. 222--228). <https://doi.org/10.1109/vr.1999.756955>
- Dixon, S. (2006). A history of virtual reality in performance. *International Journal of Performance Arts & Digital Media*, 2.
- Dumas, J. S. (1993). A practical guide to usability testing. Greenwood Publishing Group Inc.
- ElevenLabs. (2025). Text to Speech & AI Voice Generator ElevenLabs.
- Emerson, P. (2013). The original Borda count and partial voting. *Social Choice and Welfare*, 40, 353-358.

- Forster, P.-P., Karimpur, H., & Fiehler, K. (2022). Why we Should Rethink Our Approach to Embodiment and Presence. *Frontiers in Virtual Reality*, 3, 838369. <https://doi.org/10.3389/frvir.2025.1616662>
- Fulton, S., Aichele, D., Coulon, E., Kizer, M., Conser, A., & Bares, W. (2022). Stage Together: Remote Rehearsal of Theater Blocking. *Proceedings of the 8th International Conference on Movement and Computing*, (pp. 1-5).
- Gamage, V., & Ennis, C. (2018). Examining the effects of a virtual character on learning and engagement in serious games. *Proceedings of the 11th ACM SIGGRAPH Conference on Motion, Interaction and Games*, (pp. 1-9).
- Geiger, C., Triebus, C., & Harth, J. (2024). Mixed Reality Theatre – Towards a Theatre of Extended Realities. In *GI VR/AR Workshop* (pp. 10-18420). Gesellschaft für Informatik e.V. https://doi.org/10.18420/vrar2024_0018
- Giannachi, G. (2004). *Virtual theatres: an introduction*. Routledge.
- Gulliksen, J., Göransson, B., Boivie, I., Blomkvist, S., Persson, J., & Cajander, Å. (2003). Key principles for user-centred systems design. *Behaviour and Information Technology*, 22, 397-409. <https://doi.org/10.1080/01449290310001624329>
- Haberl, A., Fleiß, J., Kowald, D., & Thalmann, S. (2024). Take the aTrain. Introducing an interface for the Accessible Transcription of Interviews. *Journal of Behavioral and Experimental Finance*, 41, 100891.
- Halbig, A., & Latoschik, M. E. (2025). The interwoven nature of spatial presence and virtual embodiment: a comprehensive perspective. *Frontiers in Virtual Reality*, 6, 1616662. <https://doi.org/10.3389/frvir.2025.1616662>
- Howard, M., & Gutworth, M. (2020). A meta-analysis of virtual reality training programs for social skill development. *Computers & Education*, 144, 103707.

- Iudova-Romanova, K., Humenyuk, T., Horevalov, S., Honcharuk, S., & Mykhalov, V. (2023). Virtual reality in contemporary theatre. *Adjunct Proceedings of the 2024 Nordic Conference on Human-Computer Interaction* (pp. 1-11). ACM New York, NY.
- Johnson-Glenberg, M. C. (2018). Immersive VR and Education: Embodied Design Principles That Include Gesture and Hand Controls. *Frontiers in Robotics and AI*, 5, 375272. <https://doi.org/10.3389/frobt.2018.00081>
- Jonas, M., Said, S., Yu, D., Aiello, C., Furlo, N., & Zytka, D. (2019). Towards a taxonomy of social vr application design. *Extended Abstracts of the Annual Symposium on Computer-Human Interaction in Play Companion Extended Abstracts*, (pp. 437-444).
- JuergenFleiss. (2023). *JuergenFleiss/aTrain: A GUI tool for offline transcription of speech recordings, including speaker diarization, utilizing state-of-the-art machine learning models*. Retrieved from GitHub. <https://github.com/JuergenFleiss/aTrain>
- Jung, B., Amor, H., Heumer, G., & Weber, M. (2006). From motion capture to action capture: A review of imitation learning techniques and their application to VR-based character animation. *Proceedings of the ACM symposium on Virtual reality software and technology*, (pp. 145-154).
- Kán, P., Rumpelnik, M., & Kaufmann, H. (2023). Embodied Conversational Agents with Situation Awareness for Training in Virtual Reality. *ICAT-EGVE 2023 - International Conference on Artificial Reality and Telexistence and Eurographics Symposium on Virtual Environments*. The Eurographics Association.

- Kenwright, B. (2017). Brief review of video games in learning & education how far we have come. *SIGGRAPH Asia 2017 Symposium on Education*, (pp. 1--10).
- Kronnect. (2022, 8 15). *Volumetric Lights 2 | VFX Shaders | Unity Asset Store*. Retrieved 01 02, 2025, from Unity Asset Store: <https://assetstore.unity.com/packages/vfx/shaders/volumetric-lights-2-234539>
- Kyrlitsias, C., & Michael-Grigoriou, D. (2022). Social interaction with agents and avatars in immersive virtual environments: A survey. *Frontiers in Virtual Reality*, 2, 786665.
- Lawson, A., & Mayer, R. (2025). Effect of pre-training and role of working memory characteristics in learning with immersive virtual reality. *International Journal of Human-Computer Interaction*, 41, 2523-2540.
- Lee, S., Viola, I., Rossi, S., Guo, Z., Reimat, I., Ławicka, K., Striner, A., & Cesar, P. (2024a). Designing and evaluating a VR lobby for a socially enriching remote opera watching experience. *IEEE Transactions on Visualization and Computer Graphics*, 30(5), 2055–2065. <https://doi.org/10.1109/tvcg.2024.3372081>
- Levordashka, A., Eastman, J., Skoulikari, E., Salagean, A., Cosker, D., & Stanton Fraser, D. (2023). An Exploration of Theatre Rehearsals in Social Virtual Reality. *Extended Abstracts of the 2023 CHI Conference on Human Factors in Computing Systems*, (pp. 1-7).
- Leylekoğlu, A., & Baykal, G. E. (2025). Towards the design of a VR-based rehearsal tool: Exploring amateur actors' individual and collective needs. *Adjunct Proceedings of the 4th Annual Symposium on Human-Computer Interaction for Work (CHIWORK '25 Adjunct)* (pp. 1–5). Association for Computing Machinery. <https://doi.org/10.1145/3707640.3731914>

- Mania, K., & Chalmers, A. (2001). The effects of levels of immersion on memory and presence in virtual environments: A reality centered approach. *Cyberpsychology & behavior*, 4, 247-264.
- Markowitz, D., & Bailenson, J. (2021). Virtual Reality and Emotion: A 5-Year Systematic Review of Empirical Research (2015-2019).
- Mayer, R. (2024). The past, present, and future of the cognitive theory of multimedia learning. *Educational Psychology Review*, 36, 8. <https://doi.org/10.1007/s10648-023-09842-1>
- Mckendrick, Z., Somin, L., Finn, P., & Sharlin, E. (2023). Virtual Rehearsal Suite: An Environment and Framework for Virtual Performance Practice. *Proceedings of the 2023 ACM International Conference on Interactive Media Experiences*, (pp. 27-39).
- MIRO. (2011). *MIRO | The Innovation Workspace*. Retrieved 2024, from MIRO: <https://miro.com/>
- Mirowski, P., Mathewson, K., Pittman, J., & Evans, R. (2023). Co-writing screenplays and theatre scripts with language models: Evaluation by industry professionals. *Proceedings of the 2023 CHI conference on human factors in computing systems*, (pp. 1-34).
- Mixamo, A. (2021). *Animate 3D characters for games, film, and more*. Retrieved 2 25, 2025, from Adobe: <https://www.mixamo.com/>
- Nicholson, H., Holdsworth, N., & Milling, J. (2018). *The Ecologies of Amateur Theatre*. Palgrave Macmillan London. <https://doi.org/10.1057/978-1-137-50810-2>
- Nielsen, J., & Molich, R. (1990). Heuristic evaluation of user interfaces. *Proceedings of the SIGCHI conference on Human factors in computing systems* (pp. 249-256).

New York: Association for Computing Machinery.

<https://doi.org/10.1145/97243.97281>

Noice, H., & Noice, T. (2006). What studies of actors and acting can tell us about memory and cognitive functioning. *Current directions in psychological science*, 15, 14-18.

Normand, J.-M., Spanlang, B., Tecchia, F., Carrozzino, M., Swapp, D., & Slater, M. (2012). Full body acting rehearsal in a networked virtual environment—A case study. *Presence*, 21, 229-243.

Pietroszek, K., Eckhardt, C., & Tahai, L. (2018). Hamlet: directing virtual actors in computational live theater. *Proceedings of the 24th ACM Symposium on Virtual Reality Software and Technology*, (pp. 1-2).

Pittarello, F., Pagini, V., & Zuffellato, L. (2020). Design and evaluation of an educational virtual reality application for learning how to perform on a stage. *Proceedings of the 2020 International Conference on Advanced Visual Interfaces*, (pp. 1-8).

Polydorou, D. (2024). Immersive storytelling experiences: a design methodology. *Digital Creativity*, 35, 301-320.

Popat, S. (2016). Missing in action: embodied experience and virtual reality. *Theatre Journal*, 357-378.

Senanayake, C. (2025). Dynamic NPC AI Using Reinforcement Learning for an Enhanced Gaming Experience. *Zenodo*.
<https://doi.org/10.5281/zenodo.15024259>

Shakespeare, W. (2016). *Hamlet*. (S. Eyüboğlu, Trans.) Türkiye İş Bankası Kültür Yayınları.

Slater, M., Howell, J., Steed, A., Pertaub, D.-P., & Garau, M. (2000). Acting in virtual reality. 103-110. <https://doi.org/10.1145/351006.351020>

- Souchet, A., Lourdeaux, D., Burkhardt, J.-M., & Hancock, P. (2023). Design guidelines for limiting and eliminating virtual reality-induced symptoms and effects at work: a comprehensive, factor-oriented review. *Frontiers in psychology*, 14.
- Souchet, A., Lourdeaux, D., Pagani, A., & Rebenitsch, L. (2023). A narrative review of immersive virtual reality's ergonomics and risks at the workplace: cybersickness, visual fatigue, muscular fatigue, acute stress, and mental overload. *Virtual Reality*, 27, 19-50.
- Synty. (2019). *POLYGON Knights - Low Poly 3D Art by Synty | 3D Fantasy | Unity Asset Store*. Retrieved from Unity Asset Store: <https://assetstore.unity.com/packages/3d/environments/fantasy/polygon-knights-low-poly-3d-art-by-synty-83694>
- Synty. (2019). *POLYGON Prototype - Low Poly 3D Art by Synty | Tutorial Projects | Unity Asset Store*. Retrieved from Unity Asset Store: <https://assetstore.unity.com/packages/essentials/tutorial-projects/polygon-prototype-low-poly-3d-art-by-synty-137126>
- Unity. (2024). *Fantasy Kingdom in Unity 6 | URP | Tutorial Projects | Unity Asset Store*. Retrieved from Unity Asset Store: <https://assetstore.unity.com/packages/essentials/tutorial-projects/fantasy-kingdom-in-unity-6-urp-298128>
- Votintseva, A., & Johnson, R. (2024). LeMiNo--Let Me Know how to Negotiate: Virtual Simulator for Negotiation Training. *2024 International Conference on Smart Computing, IoT and Machine Learning (SIML)*, (pp. 335-340).

- Vranić, V., & Vranić, A. (2019). Drama patterns: Extracting and reusing the essence of drama. *Proceedings of the 24th European Conference on Pattern Languages of Programs*, (pp. 1-9).
- Wales, M., Wheeler, M., Cimolino, G., Levin, L., Mees, J., & Graham, T. (2024). Process, Roles, Tools, and Team: Understanding the Emerging Medium of Virtual Reality Theatre. *Proceedings of the 2024 CHI Conference on Human Factors in Computing Systems*, (pp. 1-14). <https://doi.org/10.1145/3613904.3642741>
- Wu, H., Wu, W., Xu, T., Zhang, J., & Zhao, H. (2025). Towards Enhanced Immersion and Agency for LLM-based Interactive Drama. *arXiv preprint arXiv:2502.17878*.
- Wu, Q., Boulanger, P., Kazakevich, M., & Taylor, R. (2010). A real-time performance system for virtual theater. *Proceedings of the 2010 ACM workshop on Surreal media and virtual cloning*, (pp. 3-8).
- Yin, M., & Xiao, R. (2024). Press A or Wave: User Expectations for NPC Interactions and Nonverbal Behaviour in Virtual Reality. *Proceedings of the ACM on Human-Computer Interaction*, 8, 1-25. <https://doi.org/10.1145/3677098>
- Zisquit, M., Shoa, A., Oliva, R., Perry, S., Spanlang, B., Klomek, A. B., Slater, M., & Friedman, D. (2025). AI-Enhanced Virtual Reality Self-Talk for Psychological Counseling: Formative Qualitative study. *JMIR Formative Research*, 9, e67782. <https://doi.org/10.2196/67782>