REPLICA: Development and Evaluation of an Immersive First-Person Simulation Platform for Psychiatric Education

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Abstract

Understanding the subjective experience of psychiatric disorders is challenging in clinical education. This study presents REPLICA, a virtual reality application simulating psychiatric symptoms from a first-person perspective. The system was evaluated across two student cohorts using an early prototype and an optimized version. Participants completed measures of usability (SUS), presence (IPQ), and simulator sickness (SSQ). Usability significantly improved in the optimized version, while presence remained stable. Cybersickness decreased, though not significantly. Qualitative responses confirmed that participants recognized key symptoms of the simulated disorders. These findings indicate that system improvements enhanced usability without reducing immersion, supporting VR as an effective tool for experiential psychiatric education.

1. Introduction

Understanding psychiatric disorders requires not only knowledge of symptoms but also insight into patients' subjective experiences, which are often difficult to convey through traditional teaching methods. The phenomenological approach emphasizes this first-person perspective, focusing on how individuals experience and interpret their condition (Jaspers, 1968), and is essential for fostering empathy and effective clinical care (Chandra et al., 2018). Immersive technologies such as virtual reality (VR) offer new possibilities for experiential learning by simulating psychiatric symptoms from a first-person perspective. Previous research has demonstrated that VR simulations, particularly of hallucinations, can enhance understanding and empathy (Ando et al., 2011; Marques et al., 2022), although they may also produce unintended effects if not carefully designed (Kalyanaraman et al., 2010). More recent studies highlight the importance of emotional engagement and narrative structure in improving learning outcomes (Hadjipanayi & Michael-Grigoriou, 2022; Lem et al., 2024).

To address limitations of existing applications, which are often restricted to single disorders, this study introduces REPLICA, a modular VR system designed to simulate a range of psychiatric conditions. Building on principles of perspective-taking (Davis et al., 1996) and prior develop-

ment work (Sharma, 2023), REPLICA enables users to engage with simulated symptoms across multiple conditions from a first-person perspective. This study evaluates its usability, immersive qualities, and experiential impact in psychiatric education.

2. Methods

2.1. Study sample

The sample consisted of 157 university students from health-related disciplines (e.g., medicine, psychology, allied health) at different stages of training. Participants engaged with the REPLICA system as part of educational activities focused on psychiatry. Two cohorts reflected different stages of system development: an earlier group using the initial prototype from April 2023 to September 2024 and a later group using an optimized version with hand gestures and expanded simulation features from October 2024. All participants completed the simulations individually in immersive VR, followed by quantitative and qualitative evaluation.

Characteristic	Total Sample (N = 157)	April 2023 – Sep 2024 (n = 82)	Oct 2024 – April 2026 (n = 75)
Age (years) M (SD)	23.36 (2.51)	23.64 (2.66)	22.99 (2.42)
Range	18–40	19–40	18–36
Gender (n)			
Female	92	50	42
Male	65	32	33
Female/Male ratio	1.42	1.56	1.27

Table 1: Descriptive Characteristics of Study Participants by Study Cohorts (Periods).

2.2. REPLICA software & Apparatus

REPLICA is a modular virtual reality (VR) application designed for psychiatric education through immersive first-person simulation of mental health symptoms within realistic everyday environments. Using a head-mounted display (Meta Quest 2), users experience perceptual, cognitive, and emotional alterations from the perspective of a patient, enabling direct engagement with the subjective aspects of mental disorders. Technically, REPLICA is developed in the Unity engine and is based on a modular architecture, where individual symptoms can be independently configured and combined into presets representing specific disorders (e.g., mania, depression, and psychosis). Across system development, several key modifications were implemented to the original prototype. The virtual environment was scaled down from a large multi-floor house to a compact apartment, allowing better focus on individual rooms, easier navigation, and improved performance. User interaction was also refined: while the early prototype relied on handheld VR controllers for navigation (Sharma, 2023), the optimized version employs intuitive hand gesture-based control. In addition, auditory components were enhanced – moving from purely AI-generated voices to voice-to-voice AI synthesis, enabling more emotionally expressive inner speech and auditory hallucination-like experiences. Simulations combine task-based activities with symptom-driven alterations to illustrate how mental disorders affect daily functioning. Visual effects include changes in contrast and brightness, vignetting, distortions of shapes and space, and the appearance of hallucination-like elements (e.g., silhouettes, particles), which dynamically modify the perceived environment.

2.3. Measures

Usability, presence, and simulator-related discomfort were assessed using three standardized self-report instruments administered after the VR experience. The System Usability Scale (SUS) measured perceived usability, yielding a total score from 0 to 100. The Igroup Presence Questionnaire (IPQ) assessed immersion across general presence, spatial presence, involvement, and realism (mean score range -3 to +3). The Simulator Sickness Questionnaire (SSQ) evaluated cybersickness symptoms, including nausea, oculomotor discomfort, and disorientation (scale 0–3). In addition, participants provided open-ended responses describing experienced symptoms for each simulated condition (mania, depression, psychosis). These qualitative data were analyzed to capture perceived symptomatology and subjective experience of the simulations.

2.4. Statistical and qualitative analysis

Participants were divided into two cohorts based on system version: an early cohort (April 2023 – September 2024) and an optimized cohort (October 2024 – April 2026). For each measure (SUS, IPQ, SSQ), descriptive statistics (mean, standard deviation) were computed. Between-group differences were analyzed using independent samples t-tests. Statistical significance was evaluated at $p < .05$. In addition, to explore participants' subjective experiences, open-ended responses were analyzed using a qualitative frequency-based approach using ChatGPT 5.3. Representative symptom-related terms were extracted, standardized, and grouped into three categories corresponding to the simulated conditions: manic state, depression, and psychotic disorder. The relative frequency of each term was visually represented using proportional bubble sizes in a comparative diagram.

3. Results

3.1. Cohort differences for SUS, IPQ and SSQ

The System Usability Scale (SUS) scores indicated a significant improvement in perceived usability between system versions (see Fig.1). Students evaluating the optimized REPLICA system (October 2024–2026; $n = 75$, $M = 77.00$, $SD = 12.60$) reported significantly higher SUS scores than students evaluating the early system (January 2023–September 2024; $n = 82$, $M = 70.18$, $SD = 15.61$), $t(152.69) = 3.02$, $p = .003$, $d = 0.48$. According to established SUS benchmarks, the early version falls within the "Good" usability range, while the optimized version reaches high "Good" and approaches "Excellent" usability. Importantly, both cohorts exceeded the industry average threshold (68), indicating overall acceptable usability, with the optimized system demonstrating a clear shift toward higher and consistent usability. Analysis of the presence measure by IPQ revealed no significant differences between cohorts across all subscales (all $p > .05$). Descriptively, the optimized cohort reported higher general and spatial presence than the early cohort (general presence: $M = 0.90$, $SD = 1.25$ vs. $M = 0.29$, $SD = 1.59$; spatial presence: $M = 0.82$, $SD = 0.83$ vs. $M = 0.54$, $SD = 0.84$), while involvement and experienced realism were comparable. Overall presence remained stable across system versions (IPQ total: $M = 0.36$, $SD = 0.56$ vs. $M = 0.34$, $SD = 0.53$). SSQ cybersickness scores were lower in the optimized system cohort ($M = 0.47$, $SD = 0.34$, $n = 44$) than in the early cohort ($M = 0.63$, $SD = 0.50$, $n = 26$), although this difference was not statistically significant, $t(42.3) = 1.50$, $p = .141$. This pattern suggests a trend toward improved user comfort in the optimized system. Together with the improved usability scores and stable levels of presence, these findings indicate that the system refinements enhanced the overall user experience without compromising immersion.

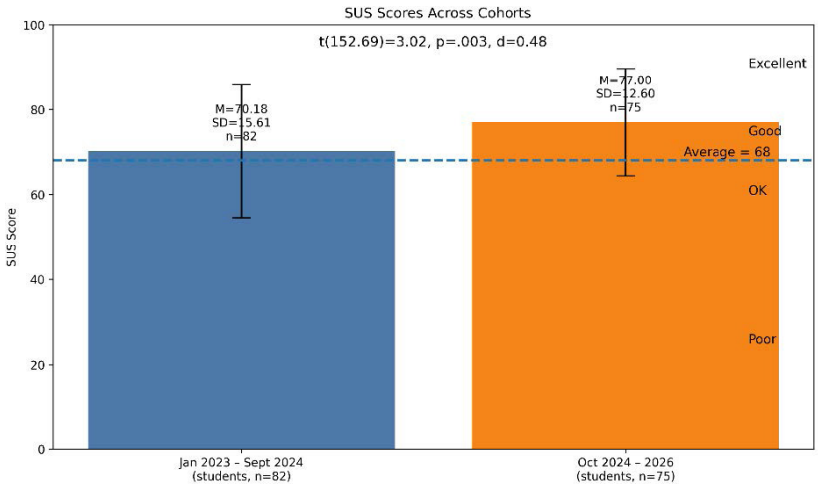

Figure 1: Comparison of SUS scores between student cohorts using the early and optimized versions of the REPLICA system. Error bars represent SD. Right side indicates SUS acceptability ranges and adjective ratings, a dashed line marking the industry average.

3.2. Qualitative Text Analysis of Reported Symptoms Across Simulated Disorders/States

Manic State was characterized by high activation and cognitive acceleration, with dominant features including excitability, increased energy, euphoria, and racing thoughts. Additional symptoms (e.g., impulsivity, irritability, reduced sleep) reflect heightened arousal and reduced behavioral control. **Depression** was defined by low energy and negative affect, with sadness, fatigue, and hopelessness most prominent. Other features (e.g., apathy, isolation, worthlessness) indicate emotional withdrawal and reduced motivation. **Psychotic Disorder** was marked by perceptual disturbances and impaired reality testing, primarily hallucinations and delusions, accompanied by fear, paranoia, and disorganized thinking. In summary, distinct patterns emerged across conditions: mania (high activation), depression (low energy and affect), and psychosis (perceptual distortion). The bubble visualization highlights dominant and condition-specific symptom clusters (see Fig. 2).

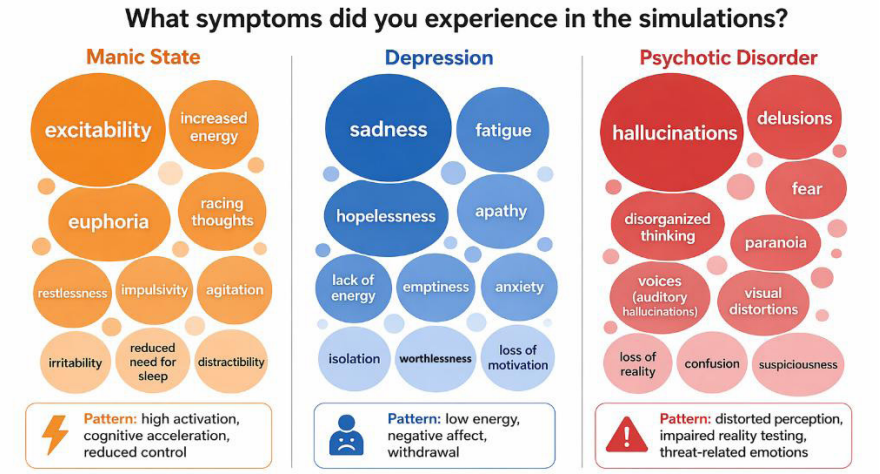

Figure 2: Visualization of the mostly reported symptoms, bubble size representing frequency.

4. Discussion

The comparison of cohorts testing the early prototype and the later optimized version of REPLICA indicates a clear improvement in usability, with the optimized version achieving higher SUS scores. This suggests that iterative refinements – particularly in interaction design and system structure – enhanced overall user experience. In contrast, presence (IPQ) remained stable across cohorts, indicating that the level of immersion was already sufficiently high in the early version, but could be potentially increased by implementation of more interactive tasks. For cybersickness (SSQ), the optimized cohort showed lower scores, indicating improved user comfort; however, this difference did not reach statistical significance. Together, these findings suggest that system development primarily enhanced usability while preserving immersion and contributing to a more comfortable user experience. These findings reinforce the value of iterative development and usability-driven design, particularly in immersive VR systems where interaction complexity can otherwise hinder learning outcomes.

The findings of the qualitative text analyses demonstrate that participants clearly differentiated between simulated mental states, with each condition producing a distinct experiential pattern. Mania was characterized by intensity and activation, with concentrated dominant features. Depression showed a diffuse, multidimensional structure, reflecting the complexity of depressive experience. Psychosis was defined by perceptual distortion and threat-related cognition, with a few highly salient symptoms. Importantly, the patterns align with clinical descriptions, suggesting that the VR simulations successfully conveyed core phenomenological aspects of each disorder. Based on these results REPLICA provides a flexible and scalable platform for experiential, phenomenologically oriented learning in psychiatric education.

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