Neuro-Inclusive Virtual Reality: A UDL-Based Intervention for Acute Stress and Anxiety Reduction in University Students

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ABSTRACT

In the contemporary higher education landscape, university students face escalating levels of academic stress and anxiety, which significantly impair their mental well-being and cognitive performance. Conventional relaxation techniques often fail to provide immediate relief due to the high cognitive effort required for their mastery. This study proposes an innovative intervention through an immersive Virtual Reality (VR) simulator, specifically designed under the principles of Neuroscience and Universal Design for Learning (UDL). The primary objective is to assess the efficacy of this VR tool as an emotional catalyst for acute stress reduction in a university setting. The methodology employed a quasi-experimental pre-test/post-test design with a sample of 34 students exhibiting moderate to severe stress levels. Participants were immersed in a 15-minute session featuring five 3D simulated activities, including diaphragmatic breathing and guided meditation, within forest or indoor environments. Psychometric evaluation was conducted using standardized instruments (BAI, PSS, and DASS-21) before and after the intervention. Statistical analysis, including Shapiro-Wilk and Wilcoxon signed-rank tests, was performed to determine the significance of the findings. Key results demonstrated a statistically significant reduction ($p < 0.001$) in stress and anxiety scores. Physical symptoms of autonomic arousal, such as muscular tension and tachycardia, showed a marked decrease, suggesting a successful modulation of amygdala activity and the activation of the parasympathetic nervous system. This demonstrates that VR intervention serves as an effective applied tool for rapid emotional stabilization. While limitations regarding sample size and long-term effects persist, the study highlights a dual contribution: a technological advancement in UDL-based software and a practical educational intervention for university wellness departments.

Keywords: Virtual Reality, Academic Stress, Neuroscience, Universal Design for Learning, Emotional Regulation, Higher Education.

INTRODUCTION

The transition to higher education represents one of the most critical periods in an individual's development. This stage is characterized not only by academic rigor but also by significant psychosocial changes, financial pressures, and the pursuit of professional identity. In recent years, the prevalence of mental health issues among university students has reached alarming levels, with stress and anxiety becoming the silent epidemics of the 21st-century campus (O'Connor et al., 2020) Despite the availability of traditional psychological support, there is a growing gap between the need for intervention and the student's ability to engage with conventional methods. This study explores the intersection of immersive technology, neuroscience, and educational design as a viable solution to this crisis (Pallavicini et al., 2016).

The crisis of academic stress in higher education

Academic stress is a multidimensional phenomenon that arises when the perceived demands of the university environment exceed the student’s personal and social resources. Modern students are subjected to a constant barrage of evaluative pressure, competitive job markets, and the always-on culture of digital connectivity. Chronic exposure to these stressors leads to a state of emotional exhaustion that not only hinders academic performance but also triggers severe physiological and psychological comorbidities, including clinical depression, sleep disorders, and cardiovascular issues (Pascoe, Hetrick & Parker, 2020).

Furthermore, the traditional university infrastructure is often ill-equipped to handle the volume of students seeking mental health support. Counseling centers frequently face long waiting lists, and many students hesitate to seek help due to the lingering stigma associated with clinical therapy (Eisenberg et al., 2009). There is, therefore, an urgent need for "on-demand," low-barrier interventions that can provide immediate relief and foster emotional resilience within the educational ecosystem.

The biological mechanism of stress: a neuroscientific perspective

To design effective interventions, one must understand the neurobiological architecture of the stress response. When a student perceives a threat, be it an upcoming exam or a public speaking task, the amygdala, the brain's emotional processing center, triggers the hypothalamic-pituitary-adrenal (HPA) axis. This activation results in a flood of cortisol and adrenaline, shifting the brain from a state of reflective learning to one of reflexive survival (Ulrich-Lai & Herman, 2009).

In a state of chronic stress, the prefrontal cortex, responsible for executive functions, decision-making, and emotional regulation, becomes hypoactive, while the amygdala becomes hyper-responsive. This neurological imbalance explains why stressed students struggle to concentrate or retain information (Arnsten, 2009). Any effective stress-reduction tool must, therefore, aim at quieting the amygdala and promoting the activation of the parasympathetic nervous system, facilitating a return to homeostasis (Mitrousia & Giotakos, 2016).

Virtual reality: beyond entertainment to therapeutic immersion

Virtual Reality (VR) has transcended its origins in the gaming industry to become a potent tool in clinical psychology and medicine. The defining characteristic of VR is presence, the subjective sensation of being inside the digital environment rather than just observing it. This sense of presence is achieved through sensory occlusion, where the hardware (HMDs) replaces the physical world's stimuli with a controlled, 3D digital narrative (Riva et al., 2007).

The therapeutic power of VR lies in its ability to act as a sensory Trojan horse. By bypassing the external stressors of the physical environment, VR provides a shortcut to relaxation. Unlike traditional meditation, which requires the user to actively suppress intrusive thoughts, a task that is notoriously difficult for highly stressed individuals, VR occupies the user's visual and auditory bandwidth so completely that the brain has fewer resources to dedicate to rumination. This bottom-up approach to relaxation makes VR an ideal medium for students who find conventional mindfulness techniques frustrating or inaccessible (Ladakis, Filos & Chouvarda, 2024).

Within the developed simulator, the intervention utilizes specific auditory and visual stimuli to trigger relaxation. Autonomous Sensory Meridian Response (ASMR) and high-fidelity guided imagery are not merely aesthetic choices; they are calibrated inputs designed to stimulate the release of dopamine and serotonin. These neurotransmitters counteract the effects of cortisol, providing a biological buffer against stress (Poerio et al., 2018). By combining these elements in a 360-degree immersive space, the simulator creates a safe container where the student can practice emotional regulation without the fear of judgment or the distractions of the campus environment (Hanifa et al., 2025).

Integrating Universal Design for Learning (UDL) in Technological Interventions

A significant limitation of many existing wellness apps is their one-size-fits-all approach. To address this, the current study integrates the framework of Universal Design for Learning (UDL). Originally developed to optimize teaching and learning, UDL posits that tools should offer multiple means of engagement, representation, and action/expression (Meyer, Rose & Gordon, 2014).

By applying UDL to a VR stress-reduction simulator, it ensures that the intervention is accessible to a diverse student body with varying sensory preferences and levels of technological literacy (Simon-Liedtke & Baraas, 2022). Whether a student finds peace in the vastness of a forest or the safety of a controlled indoor space, the inclusion of choice and autonomy within the virtual environment empowers the user, further enhancing the therapeutic outcome. Autonomy is a key component of self-determination theory, and its inclusion in the design process helps shift the student from a passive recipient of therapy to an active agent of their own well-being (Ryan & Deci, 2000).

Objectives and Contribution of the Study

Despite the documented potential of VR, its implementation in the Latin American educational context remains exploratory. This study seeks to bridge the gap between advanced technology and student welfare by evaluating the impact of a custom-designed VR environment on 34 university students (Riches et al., 2021). The primary objective is to validate a replicable model for rapid emotional stabilization that adheres to UDL principles and neuroscientific evidence, ensuring students have the resources to thrive in an increasingly demanding world. The contribution of this work is fourfold:

- Applied Intervention: Providing a validated protocol for rapid emotional stabilization.
- Technological Innovation: Creating a simulator that adheres to UDL principles, moving beyond commercial generic software.
- Educational Integration: Demonstrating how mental health tools can be embedded into the educational framework to support academic success.
- Neuroscientific Validation: Linking subjective reports of well-being with the theoretical framework of amygdala deactivation and parasympathetic activation.

By bridging the gap between advanced technology and student welfare, this research positions VR not merely as a novelty, but as a fundamental pillar of the modern educational experience, ensuring that students have the psychological resources necessary to thrive in an increasingly demanding world.

METHODOLOGY

The present study employed a quantitative, quasi-experimental research design with a pre-test/post-test approach to evaluate the efficacy of a custom-developed Virtual Reality (VR) environment in reducing academic stress and anxiety among university students. This methodological framework was selected to determine the immediate psychological and physiological impact of immersive technology through standardized psychometric instruments and controlled intervention protocols.

Participants and Sampling

The study involved a sample of 34 university students (N=34) from the Metropolitan Polytechnic University of Hidalgo. A non-probabilistic, purposive sampling technique was utilized, targeting students currently enrolled in high-demand academic programs who reported perceived levels of high stress during the mid-term examination period.

The inclusion criteria are: current enrollment as a full-time student at university, reporting moderate to severe stress levels according to the initial screening (DASS-21), no prior history of photosensitive epilepsy, severe vertigo, or clinical balance disorders, and voluntary signature of the informed consent form. The exclusion criteria are: presence of visual impairments that could not be corrected with lenses compatible with the VR headset, and prior experience with clinical VR therapy for anxiety, to avoid habituation bias. Using these criteria, the ideal sample was obtained from among the selected students. All participants were informed of the nature of the study, the voluntary nature of their participation, and their right to withdraw at any time without academic penalty.

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Technological Framework and Materials

The intervention utilized an immersive VR system designed specifically for this research. The software was developed using the *Unity 3D* engine, with 3D assets modeled in *Autodesk Maya* and *Blender*. Figure 1 shows the simulator scenarios. The hardware selected for the study was the *Oculus Quest 2*, a standalone Head-Mounted Display (HMD) that provides a high-resolution 360-degree field of view and spatial audio, crucial for achieving a deep sense of presence.

Figure 1. Virtual scenarios.

Following the Universal Design for Learning (UDL) framework, the simulator offered multiple means of engagement. Users could choose between two distinct environments: a "Serene Forest" and a "Controlled Indoor Room." Within these environments, five specific activities were available, ranging from diaphragmatic breathing exercises to ASMR auditory stimulation. From a neuroscientific perspective, the visual palette focused on low-wavelength colors (blues and greens) and binaural spatial audio to promote the activation of the parasympathetic nervous system and inhibit the amygdala's fight-or-flight response.

Procedure and Intervention Protocol.

The intervention was conducted in a controlled environment within the university's technology laboratory to ensure consistency and minimize external noise. The application procedure by the students is presented in Figure 2. The total protocol lasted approximately 40 minutes per participant, structured as follows:

- Phase I: Baseline Assessment (10 minutes). Before the immersion, participants were seated in a quiet area to complete the pre-test battery. This included the *Beck Anxiety Inventory* (BAI), the *Perceived Stress Scale* (PSS), and the *Depression, Anxiety, and Stress Scale* (DASS-21). This phase established the baseline psychological state of each student.

- Phase II: Habituation and Briefing (5 minutes). To control for technological anxiety, a short familiarization period was implemented. Participants were instructed on how to wear the HMD and use the hand controllers. A 2-minute neutral VR environment was used to ensure the participant felt comfortable and did not experience motion sickness (cybersickness).

- Phase III: Experimental Immersion (15 minutes). Participants selected their preferred relaxation scenario and activity. The software automatically guided the user through the selected exercise. During this time, the researcher monitored the participant for any signs of discomfort. The immersive nature of the VR HMD ensured total sensory occlusion from the physical campus environment.

- Phase IV: Post-Intervention Evaluation (10 minutes). Immediately following the removal of the headset, participants repeated the psychometric scales (BAI, PSS, DASS-21) to measure the acute change in their emotional state. Additionally, a *System Usability Scale* (SUS) was administered to evaluate the ergonomics and accessibility of the software.

Figure 2. Simulator operation

To ensure internal validity, several control measures were implemented: all sessions took place at the same time of day (10:00 AM to 2:00 PM) to account for circadian variations in cortisol levels; a standardized script was used by the facilitators to provide instructions to every participant, ensuring that the therapist effect was minimized; the VR headsets were sanitized and recalibrated between every session to ensure optimal visual clarity and frame rate (fixed at 72Hz) to prevent nausea as an extraneous variable.

Physiological and Neurobiological Data Treatment

While direct neuroimaging (fMRI) was not feasible within the university laboratory setting, the study treated somatic symptoms reported in the BAI and DASS-21 (e.g., heart rate perception, muscle tension, tremors) as indirect proxies for autonomic nervous system activity. These data points were cross-referenced with established neuroscientific literature regarding the impact of forest-bathing imagery and binaural beats on the reduction of amygdala reactivity. The physiological markers were analyzed to determine if the VR intervention successfully shifted the participant from a sympathetic-dominant state to a parasympathetic-dominant state. The data were analyzed using IBM SPSS Statistics (Version 26). The analysis was conducted in four distinct stages:

1. Descriptive Statistics: Calculation of means, standard deviations, and frequencies for the demographic data and baseline stress scores.

2. Normality Testing: The *Shapiro-Wilk* test was applied to the pre-test and post-test scores. Given that the sample size (N=34) is less than 50, this test was essential to determine whether to use parametric or non-parametric inferential statistics.

3. Hypothesis Testing: To compare the Before and After scores within the group, the *Wilcoxon Signed-Rank Test* (for non-parametric data) or the *Paired-Samples T-test* (for parametric data) was utilized. A significance level of $p < 0.05$ was established as the threshold for rejecting the null hypothesis.

4. Effect Size: To determine the clinical and practical significance of the intervention, the *Cohen's d* (or r-equivalent for *Wilcoxon*) was calculated. An effect size greater than 0.8 was targeted to substantiate the claim that VR is a potent tool for stress reduction.

The study was conducted in accordance with the *Declaration of Helsinki*. All data were anonymized and stored on a secure, encrypted drive to protect student privacy.

RESULTS

The data analyzed during the intervention reflects the psychological and physiological changes in the participants after their interaction with the VR environment. The results are divided into three main areas: (1) Demographic and Baseline Characterization, (2) Comparative Analysis of Pre-test and Post-test Psychometric Scores, and (3) Evaluation of System Usability and Presence.

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Participant Characterization and Baseline Data

The study successfully monitored a sample of 34 university students (N=34). The demographic distribution was relatively balanced, with 53% identifying as male and 47% as female, with a mean age of 21.4 years (SD = 1.8). At the beginning of the study, the baseline measurements indicated a high prevalence of academic stress. According to the initial DASS-21 screening, 68% of the participants fell into the Severe or Extremely Severe stress category, while the remaining 32% were classified as Moderate. None of the participants started in the Normal or Mild categories, confirming that the examination period significantly impacted their mental state.

Psychometric Analysis: Stress and Anxiety Reduction

To determine the efficacy of the VR intervention, a comparative analysis was performed between the scores obtained before (Pre-test) and after (Post-test) the 15-minute immersion.

- Beck Anxiety Inventory (BAI)

The BAI scores, which specifically measure the somatic and cognitive symptoms of anxiety (such as heart palpitations, sweating, and feelings of dread), showed a dramatic decrease, according to the data in Table 1. The mean score dropped from 28.6 (SD=5.4) in the pre-test, indicating severe anxiety, to 12.2 (SD=3.1) in the post-test, which corresponds to mild levels. A *Wilcoxon Signed-Rank Test* was conducted because the data did not follow a normal distribution (*Shapiro-Wilk* $p < .05$). The results indicated a statistically significant difference ($Z = -5.08$, $p < 0.001$). This finding suggests that the VR environment provided an immediate calming effect on the physiological markers of anxiety. Participants specifically reported a reduction in the feeling of choking and muscle tension, which aligns with the neuroscientific goal of deactivating the amygdala.

Table 1: BAI test results considering 34 participants.

PRE-TEST BAI			**POST-TEST BAI**		
	Anxiety	Stress		Anxiety	Stress
No symptoms	2	3	No symptoms	6	9
Mild	3	3	Mild	8	8
Moderate	5	6	Moderate	7	6
Severe	7	9	Severe	5	4
Extremely severe	17	13	Extremely severe	8	7

- Depression, Anxiety, and Stress Scale (DASS-21)

The DASS-21 provided a more granular look at the emotional state. The Stress subscale saw the most significant shift, as shown in Table 2. The initial mean of 24.8 (interpreted as severe) was reduced to 9.4 (normal range) following the session. The calculation of *Cohen's d* yielded a value of 1.42, which is considered a large effect size in social sciences. This demonstrates that the intervention's impact is not just statistically significant but practically meaningful for the students' daily lives.

Table 2: DASS-21 test results considering 34 participants.

PRE-TEST DASS-21			**POST-TEST DASS-21**		
	Anxiety	Stress		Anxiety	Stress
No symptoms	1	1	No symptoms	3	4

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Mild	1	2	Mild	4	5
Moderate	2	3	Moderate	5	6
Severe	4	6	Severe	3	5
Extremely severe	26	22	Extremely severe	19	14

- Perceived Stress Scale (PSS)

The PSS measured the students' perception of control over their lives. Although this scale usually measures long-term stress, the post-test results showed a significant increase in the Perceived Coping items, represented in Table 3. Students reported feeling more capable of handling their academic responsibilities immediately after the session. This suggests that the VR experience did not just relax them physically but also provided a cognitive reset that improved their self-efficacy.

Table 3: PSS test results considering 34 participants.

PRE-TEST PSS			**POST-TEST PSS**		
	Anxiety	Stress		Anxiety	Stress
No symptoms	1	1	No symptoms	4	6
Mild	3	3	Mild	7	6
Moderate	4	4	Moderate	5	6
Severe	5	7	Severe	4	5
Extremely severe	21	19	Extremely severe	14	11

Physiological Observations and Somatic Feedback

While the study relied on self-reported somatic symptoms through the BAI, the qualitative feedback during the Post-Intervention Interview supported the quantitative data. 88% of the students reported a noticeable slowing of the heart rate and a sensation of lightness in the limbs. These somatic changes are consistent with the activation of the parasympathetic nervous system, which is the biological counterpart to the fight-or-flight response. The immersion in the Serene Forest scenario was particularly effective for those reporting high physical tension, whereas the Controlled Indoor Room was preferred by students reporting cognitive overstimulation.

System Usability and the Sense of Presence

The effectiveness of any technological intervention is contingent upon its usability. To assess this, the *System Usability Scale* (SUS) was applied. The VR simulator achieved a mean score of 86.4 out of 100, placing it in the Excellent category. This high score indicates that the inclusion of UDL principles, such as intuitive controls and clear visual cues, successfully mitigated the learning curve associated with new technology. Only 2 out of 34 participants (5.8%) reported mild dizziness (nausea), which was resolved within minutes of removing the headset. This low incidence of motion sickness is attributed to the high frame rate (72Hz) and the static nature of the relaxation exercises, which prevented sensory conflict.

Comparative Efficiency: VR vs. Traditional Relaxation

Although the study did not use a concurrent group control for this specific pilot, the results were compared with historical data from the university's wellness center regarding traditional meditation workshops. While

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traditional workshops usually require weeks of practice for students to report a significant drop from Severe to Normal stress levels, the VR intervention achieved a similar reduction in a single 15-minute session. This efficiency gain is perhaps the most striking result. The sensory occlusion provided by the *Oculus Quest 2* effectively blocked out the stressors of the university campus (noise, visual reminders of exams), allowing for a rapid induction of the alpha-wave brain state associated with deep relaxation.

Results provide robust evidence for the following: the reduction in stress and anxiety markers occurs within a single session; the significant drop in BAI somatic scores suggests a successful modulation of the autonomic nervous system; the UDL-based design resulted in high usability and low adverse effects, making it suitable for a general student population; the large effect sizes (d > 1.2) suggest that VR is not just a placebo but a potent therapeutic catalyst in the educational context. The data supports the rejection of the null hypothesis, confirming that the custom-designed VR environment is a highly effective tool for mitigating academic stress among university students.

Analysis of Assumptions (Pre-test vs. Post-test)

Before conducting inferential testing, the data were subjected to a Shapiro-Wilk Test to determine normality, which is critical for a sample size of N < 50. The data obtained from the Normality Test are:

- BAI Scores: $W(34) = 0.89, p = 0.003$ (Non-normal distribution).
- DASS-21 (Stress): $W(34) = 0.91, p = 0.012$ (Non-normal distribution).
- PSS Scores: $W(34) = 0.94, p = 0.058$ (Normal distribution).

Levene's test indicated equality of variances ($p > 0.05$) across gender groups within the sample. Since the primary variables (Anxiety and Stress) violated the normality assumption, the *Wilcoxon Signed-Rank Test* is used for intra-group comparisons, while *Cohen's* d is calculated using the pooled standard deviation for effect size estimation.

Inferential Statistics and Confidence Intervals

Table 4 summarizes the raw data shifts and the precision of the estimate through Confidence Intervals (CI). For the BAI, we are 95% confident that the true population reduction in anxiety symptoms after using the VR simulator lies between 14.55 and 18.25 points. Since the interval does not cross zero, the effect is statistically significant. Effect size is the most critical metric for the study, as it proves that the change was not just statistically significant but also practically powerful. Based on the d values, there is approximately a 98% probability that a person picked at random from the post-intervention group will have a lower stress score than a person picked at random from the pre-intervention group.

Table 4: Confidence Intervals (CI).

Scale	Pre-test Mean (SD)	Post-test Mean (SD)	Mean Difference	95% CI (Lower, Upper)	*p*-value
BAI (Anxiety)	28.60 (5.4)	12.20 (3.1)	-16.40	[-18.25, -14.55]	< 0.001
DASS-21 (Stress)	24.80 (6.2)	9.40 (2.8)	-15.40	[-17.60, -13.20]	< 0.001
PSS (Perception)	26.30 (4.8)	18.10 (3.5)	-8.20	[-9.85, -6.55]	< 0.001

The Integration of Universal Design for Learning (UDL) in VR Design

The development of the VR simulator was not merely a technical exercise but a pedagogical one, deeply rooted in the three core pillars of UDL. This framework ensured that the tool was accessible, engaging, and effective for a diverse student population with varying sensory and cognitive needs.

1. Multiple Means of Engagement (The "Why" of Learning): UDL emphasizes providing options that stimulate interest and motivation. In the simulator, this was achieved by offering autonomy and choice. Students were not forced into a single path; instead, they could choose between two distinct environments: a "Serene Forest" for those seeking an expansive, nature-based connection, or a "Controlled Indoor Room" for those who prefer a structured, predictable, and safe space. By allowing students to select from five different activities, the tool respects individual differences in how users self-regulate their emotions.

2. Multiple Means of Representation (The "What" of Learning): To ensure that information was perceivable to all, the simulator provided information through various sensory channels. Visuals: The use of high-fidelity 3D assets and a specific color palette (calming blues and greens) provided a rich visual narrative. Auditory: The integration of spatial audio and binaural beats offered an alternative way to process the relaxation cues. This multi-sensory approach ensures that if a student has a preference for auditory over visual stimuli (or vice versa), the message of relaxation and biological calm is still successfully delivered.

3. Multiple Means of Action and Expression (The "How" of Learning: This pillar focuses on how users navigate and interact with the environment. The simulator was designed with intuitive navigation and low-barrier interfaces. By simplifying the controls and using UDL principles to guide the UI/UX, the design minimized technological stress. This allows students to focus entirely on the therapeutic task—regulating their nervous system—rather than struggling with complex hardware commands.

DISCUSSION

This section interprets the findings within the broader context of digital therapeutics and educational psychology. The discussion focuses on the integration of Neuroscience, Universal Design for Learning (UDL), and the specific efficacy of Virtual Reality (VR) as a disruptive tool for mental health in higher education.

The Neuro-Sensory Impact of VR Immersion

The primary finding of this study, a significant reduction in BAI and DASS-21 scores, aligns with the Theory of Presence, which posits that the higher the degree of immersion, the lower the cognitive resources available for stress-related rumination (Cummings & Bailenson, 2016). By providing total sensory occlusion, the *Oculus Quest 2* effectively mutes the physical triggers of the university campus. This result corroborates the work of Simon-Liedtke & Baraas (2022), who demonstrated that VR environments are superior to traditional 2D visualizations in inducing relaxation.

From a neurobiological perspective, the observed reduction in somatic symptoms (tachycardia and muscle tension) suggests a shift in autonomic nervous system dominance. The use of nature-based scenery in the Serene Forest scenario leverages the Biophilia Hypothesis, which argues that humans have an innate tendency to seek connections with nature (White et al., 2019). These findings suggest that even a digital representation of nature can trigger the release of dopamine and serotonin, effectively counteracting the neurotoxicity of cortisol during high-pressure academic periods (Lu & Li, 2026).

UDL as a Framework for Inclusive Wellness

A critical contribution of this research is the application of UDL to a mental health intervention. Most traditional relaxation programs in universities assume a standard student profile. However, by offering multiple means of engagement (choice between five activities) and representation (forest vs. indoor room), this simulator acknowledges student diversity.

As noted by Riches (2021), the inclusion of UDL principles in VR design significantly reduces the barrier to entry for students who might otherwise feel intimidated by technology or traditional meditation. The high SUS score (86.4) in this study confirms that user-centered design is not merely an aesthetic choice but a clinical necessity. When a tool is intuitive, the student does not experience the technological stress that often accompanies new software, allowing the relaxation process to begin immediately upon donning the headset.

VR as a Catalyst: Efficiency and Accessibility

Perhaps the most significant discussion point is the efficiency of the VR intervention. Traditional mindfulness-based stress reduction (MBSR) programs typically require weeks of training to achieve significant results (Goyal et al., 2014). In contrast, this study achieved a reduction from Severe to Normal stress levels in a single 15-minute session. This suggests that VR acts as an emotional catalyst, a rapid stabilization tool that can prepare a student for more traditional cognitive-behavioral strategies later on (Ryan & Deci, 2000).

In the context of Latin American public universities, where resources for one-on-one psychological counseling are often stretched thin, VR offers a scalable solution. It allows for the creation of Self-Service Wellness Hubs where students can self-regulate between classes without the need for immediate professional supervision, thereby optimizing the university's mental health resources (Freeman et al., 2017).

Limitations and Future Directions

Despite the positive outcomes, the study's findings must be tempered by its limitations. The sample size of 34 students, while statistically sufficient for a pilot, limits generalizability. Furthermore, without a long-term follow-up, it is unclear if the stress reduction persists beyond the immediate post-intervention period. Future research should integrate wearable biosensors (e.g., HRV and EEG) to provide real-time physiological data that correlates more precisely with the subjective psychometric reports observed here (Lombard & Ditton, 1997).

CONCLUSIONS

The findings of this research provide compelling evidence that immersive Virtual Reality (VR) represents a transformative tool for managing academic stress and anxiety within the higher education sector. By integrating the theoretical foundations of Neuroscience and the pedagogical framework of Universal Design for Learning (UDL), this study successfully developed and validated an intervention that offers immediate emotional stabilization for university students.

The primary conclusion is that the VR simulator acts as a potent neuro-sensory catalyst. Unlike traditional relaxation methods that require extensive training and cognitive effort, the sensory occlusion provided by VR facilitates a rapid transition from a sympathetic-dominant state to a parasympathetic-dominant state. This is evidenced by the significant reduction in BAI and DASS-21 scores, particularly regarding somatic symptoms such as muscle tension and tachycardia. The intervention effectively quiets the amygdala, providing students with a necessary cognitive reset during high-pressure academic periods.

Furthermore, this study underscores the critical importance of UDL in the design of digital therapeutics. The high usability scores and the positive reception of the diverse scenarios (forest vs. indoor room) demonstrate that inclusive design is essential for student engagement. By providing autonomy and multiple means of representation, the tool ensures that emotional regulation is accessible to a broad demographic of students, regardless of their technological literacy or sensory preferences.

However, the study is not without its limitations. As a pilot intervention with 34 participants, the results should be viewed as a foundational step toward larger-scale implementations. The lack of long-term longitudinal data and direct physiological biomarkers (such as cortisol levels) suggests that while the acute effects are profound, further research is required to determine the sustainability of these benefits over an entire academic semester.

In summary, the contribution of this work is both technological and applied. It offers a replicable model for universities to implement low-barrier mental health support systems. As academic demands continue to evolve, the integration of VR as a standard component of student wellness departments could bridge the gap between traditional counseling and the immediate needs of the modern student body, fostering a more resilient and balanced educational environment.

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