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Reducing stress while enhancing self-efficacy and knowledge : virtual training for inexperienced nursing students in the operating room

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Abstract—The operating room (OR) is a demanding and high-pressure environment for healthcare professionals. This study aims to use virtual reality (VR) technology to introduce health profession students to the OR environment in a controlled and immersive way. Using a quasi-experimental design with pre-post measures we aim to investigate the effect of a VR OR simulation on students' anxiety, stress, self-efficacy and knowledge acquisition. We recruited 40 second-year nursing students without prior OR experience and divided them into two groups: one experiencing the OR through a VR display and the other through a slideshow presentation of the same environment. We assessed anxiety, stress, self-efficacy and knowledge level before and after intervention. Results indicated a significant increase in self-efficacy for the two groups. The VR group also showed increase in anxiety in association with decrease in stress levels. Knowledge acquisition improved in both groups. This study underlines VR's potential as an effective tool for OR familiarization, significantly enhancing self-efficacy and reducing stress among nursing students.

Keywords—operating room, nursing, self-efficacy, virtual reality, training

I. INTRODUCTION

The operating room (OR) is a demanding and high-pressure environment for healthcare professionals. However, students often have limited exposure to this critical setting during their training, leaving them ill-prepared to handle the stress and anxiety [1] when they finally enter clinical practice [2]. Simulation-based training is commonly used in health profession education to bridge the gap between theory and practice [3]. Virtual reality (VR) technology offers a promising solution [4] by providing a realistic OR simulation experience, allowing students to gain familiarity with the environment and enhance their confidence before engaging in actual practice.

This study aims to use VR technology to introduce health profession students to the OR environment in a controlled and immersive way. The goal is to investigate the effect of a VR OR simulation on anxiety, stress, self-efficacy and knowledge acquisition of nursing students.

II. METHOD

A. Pedagogical material

We have developed a VR training tool allowing students to immerse in the OR environment. Learners can navigate through the virtual OR, interact with the environment, and get detailed information about aseptic areas, medical staff, and various OR equipment.

B. Participant recruitment

We reached out to several nursing schools in order to recruited second year nursing students who did not have any prior OR experience. The recruitment criteria were designed to ensure participants had no factors that could influence their experience in the VR environment, such as motion sickness, epilepsy, or cardiac issues.

C. Design and procedure

Our study employed a quasi-experimental design with pre-post repeated measures. Participants were assigned to one of the two experimental groups:

- VR operating room environment (n=24)
- Slideshow operating room environment (n=16)

The VR group experienced the OR through a head-mounted VR display (HTV VIVE pro), providing a fully immersive experience while the slideshow group viewed a slideshow presentation depicting the same OR environment shown in the VR simulation.

D. Measures

Participants completed the same four questionnaires both before and after their experience with the virtual OR. We assessed:

- Anxiety, measured with a six-item version of the State-Trait Anxiety Inventory (STAI) [5]
- Stress, using a visual analog scale ranging from 0 to 10. This scale allowed participants to indicate their

level of stress at the idea of being an intern in the OR for the first time.

- Knowledge about OR equipment, medical staff and aseptic areas. Knowledge was assessed using a 9-item quiz (e.g. 'Who is the professional who manages the instrument table?')
- Self-efficacy, measured with a 9-item visual analog scale ranging from 0 to 100 (e.g. 'I feel confident recognizing some of the instruments used by the surgeon during knee surgery')

Furthermore, to measure the sense of presence, participants completed the Slater-Usuh-Steed Presence Questionnaire [6] after the intervention.

III. RESULTS

A. Participants

A total of 40 second-year nursing students were recruited. They were divided into two groups, with 24 participants in the VR group and 16 in the slideshow group.

B. Immersion experience

An independent samples t-test was conducted to compare the immersion score between the VR group and the slideshow group. The VR group ($M = 30.30$, $SD = 5.57$) reported significantly higher level of immersion compared to the slideshow group ($M = 16.1$, $SD = 7.87$). $t(38) = -6.69$, $p < 0.001$.

C. Anxiety

Due to non-parametric nature of the data, a Wilcoxon signed-rank test was conducted to assess changes in anxiety levels within the VR group before and after the intervention. Analysis revealed a significant increase in anxiety from pre ($M = 50.4$, $SD = 6.83$) to post-intervention ($M = 53.8$, $SD = 3.72$) within the VR group, $Z = 42.5$, $p = 0.02$. This suggests that the VR intervention led to a statistically significant increase in anxiety levels among VR group participants.

D. Stress

Conversely, the VR group experienced a significant reduction in stress level post-intervention compared to before intervention as shown by a paired samples t-test, $t(23) = 4.14$, $p < 0.001$.

E. Self-efficacy

Both the VR and slideshow groups showed an increase in self-efficacy following the intervention. A Wilcoxon signed-rank test conducted to investigate differences within the VR group showed a significant increase in self efficacy scores following the intervention, $Z = 300$, $p < 0.001$. For the slideshow group, a paired samples t-test was used and showed a significant improvement in self-efficacy, $t(15) = 5.80$, $p < 0.001$.

Upon further analysis using difference scores and conducting a Mann-Whitney test on these differences, it was found that VR was more effective than slideshow presentations in enhancing self-efficacy among nursing students. $U = 65.5$, $p < 0.001$.

F. Knowledge acquisition

Regarding knowledge acquisition, both groups exhibited improvements with no significant difference between the VR

and slideshow group. Paired samples t-test were performed. The analysis revealed a significant improvement in knowledge scores, $t(15) = 4.25$, $p < 0.001$, with mean scores increasing from pre-intervention ($X = 3.13$, $SD = 1.29$) to post-intervention ($X = 5.05$, $SD = 1.71$) for the slideshow group. We also found a significant improvement in knowledge scores, $t(23) = 7.27$, $p < 0.001$, with mean scores increasing from pre-intervention ($X = 2.97$, $SD = 1.29$) to post-intervention ($X = 5.26$, $SD = 1.17$) for the VR group.

IV. DISCUSSION

The findings from this study underscore the significant potential of virtual reality technology for familiarizing nursing students with the high-pressure OR environment. The immersive VR simulation was associated with enhanced self-efficacy among participants, which is a critical factor for students preparing to enter clinical settings. The increase in anxiety within the VR group, associated with the reduction in stress, offers a nuanced perspective on the immersive experience's impact. While the heightened realism may initially elevate anxiety, the exposure appears to ultimately foster a more profound adaptability to clinical stressors.

The significant improvement in self-efficacy, particularly noted in the VR group compared to the slideshow group, highlights VR's unique capacity to engage students actively, enhancing their confidence in OR-related tasks. However, the increase in knowledge acquisition, showing no significant difference between VR and slideshow presentations, suggests that while VR offers a more engaging and immersive learning experience, the effectiveness in conveying factual information might be comparable to more traditional educational tools.

Future research could explore impacts of VR training on clinical performance, associated with more interaction of learners with the VR environment further delineating the specific aspects of VR simulations that most effectively contribute to student learning and confidence.

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