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Immersive Virtual Reality Simulation as a Tool for Enhancing Clinical Confidence and Sustaining Skill Retention in Undergraduate Nursing Students

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Abstract

Background: Simulation-based learning is being cited as one of the most important andragogical approaches to use in nursing, as it helps to develop clinical skills and confidence in a controlled and safe setting. Although it has been proven to be effective in the world, there is little research that has examined its effects on clinical confidence and skill retention in nursing students in the local setting.

Aim: This study aimed to determine the effectiveness of the simulated interventions on the clinical confidence in nursing students and the retention of the skills, and to examine the connection between the confidence and practical competence.

Methods: A quasi-experimental pre-test/ post-test was conducted on 54 nursing students in the 2nd, 3rd and 4th academic years. The nursing participants were evaluated in terms of clinical confidence and skill retention prior to and after a designed simulation intervention with validated instruments. The use of SPSS version 27 resulted in descriptive statistics, paired t-tests, and Pearson correlation analysis.

Results: Post-intervention analysis revealed a significant improvement in clinical confidence (pre-test mean ± SD: 2.45 ± 0.52; post-test: 3.68 ± 0.47; p = 0.001) and skill retention (pre-test: 6.82 ± 1.21; post-test: 9.54 ± 0.96; p = 0.001). A strong positive correlation (r = 0.68, p = 0.001) was observed between clinical confidence and skill retention, indicating that higher confidence levels were associated with better practical competence.

Conclusion: Simulation education is applicable in promoting clinical confidence, as well as skill retention among nursing students. The correlation between confidence and competence is also positive which highlights the significance of combining structured, reflective and repetitive simulation activities in the nursing curriculum to equip students with skills to practice safe and efficiently in the clinic.

Introduction

Introduction of modern technologies in health care education has changed the environment of teaching and learning, especially in the field of nursing, where the acquisition of clinical competence, in which the safety and efficient care of the patient becomes indispensable. [1] The most prominent of these innovations is the use of immersive Virtual Reality (VR) simulation as a powerful andragogical tool that can simulate complex clinical settings without putting the patients at risk. Healthcare systems are under rising demands around the world in terms of graduating nursing professionals who are highly skilled and assured enough to perform effectively in high-stress clinical situations. [2] The conventional methods of teaching such as lectures and small clinical exposure have been accused of being insufficient to equip students with practical knowledge. Therefore, simulation-based learning and in particular VR has taken center stage as a viable approach to narrow the gap between theory and practice. [3]

Poor clinical preparedness among the undergraduate nursing students is an issue of real concern in the world. The literature has always recorded that a significant percentage of students of nursing develop low clinical confidence, anxiety, and skill loss, especially when they leave the simulated learning conditions and enter the actual clinical settings. [4] Migration of skills with time is also a major concern as students fail to remain competent in key processes because of the lack of chances to practice repeatedly. [5] Overcrowded clinical environments, lack of access to training materials, and insufficient supervision also contribute to the difficulties in low- and middle-income countries such as Pakistan. These limitations negatively impact the progression of psychomotor skills and clinical decision-making capabilities, which eventually have influence on patient safety and quality of care. [6]

Immersive Virtual Reality simulation is a paradigm shift in nursing education, as it provides the interactive, learner-centered, and experiential learning opportunities. VR enables students to experience real-life clinical situations, repeat the skills, and get direct feedback in a controlled setting. [7] Another construct of importance in this research is clinical confidence which is defined as an attitude by a student towards the perceived capability to carry out clinical procedures efficiently and make the right decisions in situations involving patients. Skill retention, conversely, refers to the capacity to store and recollect acquired clinical skills. [8] The two constructs serve as vital measures of educational efficacy and are inseparably associated with patient outcomes. VR simulation can improve such results, encouraging active learning, critical thinking, and experience.[9]

The conceptual principles that stand behind VR-based learning are the theories of experiential learning, constructivism, and situated learning. The theory of experiential learning underlines the direct experience and reflection of learning that is naturally provided by VR environments. Constructivist theory proposes that learners actively build knowledge by interacting with the surrounding, and situated learning emphasizes the significance of the context in learning skills. [10] VR simulation fits these frameworks by putting students in simulated realistic clinical settings where they are able to apply knowledge, make choices, and learn about the outcomes. These theoretical viewpoints have a solid basis of the analysis of how VR might affect clinical confidence and skill retention in the long term. [11]

Although the use of VR in healthcare education is increasingly becoming common, it is surrounded with numerous debates and controversies over its effectiveness,

accessibility, and cost-efficiency. Although there are studies that reported a massive enhancement in clinical performance and confidence, others claim that VR is incapable of simulating all the complexities of engaging with a real patient. [8] The expensive nature of VR technology, technical restrictions, and the necessity of faculty training have also been mentioned as concerns. Also, how much the skills gained in virtual settings translate to real clinical environments is an issue of research still underway. These discussions point to the necessity of strict empirical studies to estimate the actual effects of VR simulation on the results of education. [12]

The introduction of simulation technologies like VR is still young in the South Asian and Pakistani context. The nursing education in the region is predominantly based on the traditional teaching method with little access to high-fidelity simulation devices. [13] Clinical competence development among students is further challenged by overcrowded clinical placements, limited resources, and inconsistency in teaching quality. In spite of upgrading interest in the implementation of innovative educational strategies, empirical data on the efficiency of VR simulation are limited in this regard. Such a deficit in the number of region-specific studies restricts the opportunities of the educator and policymaker to take an informed step in terms of the VR-based learning implementation. [14]

As such, the current research fills an important literature gap by exploring the effects of immersive Virtual Reality simulation on clinical confidence and skill retention in undergraduate nursing students. This research intends to facilitate the progress of the nursing education system and educate the creation of effective teaching methods by offering empirical evidence in a local setting. It is assumed that the findings will facilitate the adoption of novel, technology-based methods that will improve learning, clinical preparedness, and eventually patient safety. Through this, the study addresses the pressing demand of evidence-based educational interventions that are consistent with the changing requirements of contemporary healthcare systems.

Methodology

The design used in this study was a quantitative quasi-experimental design to test the impact of immersive virtual reality simulation on clinical confidence and skill retention in undergraduate nursing students (G BSN). The research was carried out in Zalan College of Nursing, Swat and Janbar College of Nursing Swat. The sample population was comprised of undergraduate nursing students in clinical courses. A simple random sampling method (lottery method) was adopted, which allowed every eligible participant to stand an equal opportunity to be selected, and this minimized selection bias. The G*Power calculator was used to compute the sample size, which had sufficient statistical power to identify significant differences. In the end, the final sample size was 54 participants, which was deemed to be adequate to carry out a statistical analysis. Nursing students receiving clinical training at the time and who were willing to join were included, and those who had significant exposure to virtual reality simulation or were reluctant to join were excluded. The research was ethically approved by Zalan College of Nursing, Swat, before data were collected.

Data Collection Procedure

Data was gathered systematically and systematically. First, the administration of the nursing college was consulted. The lottery method was used to identify and select eligible participants. Participants were informed about the purpose and procedures of the study, and informed consent was signed written, which made their participation voluntary. Adopted standardized tools were used to gather baseline (pre-test) data, including clinical confidence and skill retention. This was followed by the sessions of immersive virtual reality simulations to simulate real clinical situations under supervision. Post-test data were obtained after the intervention (with the same instruments) to assess the outcomes change. All data were not used outside the

research, and confidentiality and anonymity were ensured by assigning codes to the participants.

Data Analysis Procedure

Collected data were coded and entered into SPSS version 27 to analyze the data. Data on demographic variables and the outcomes of the study were summarized using descriptive statistics such as frequency, percentage, mean, and standard deviation. The effectiveness of the intervention was evaluated using inferential statistics. Paired sample t-test was employed in comparison of pre- and post-intervention scores in clinical confidence and skill retention. The correlation analysis between the variables was conducted using Pearson correlation analysis.

Results and Analysis

The study sample included 54 participants, most of them aged between 21 and 23 years (40.7%), then 1820 years (37.0%) and 2426 years (22.3%). Male participants were dominant with 70.4%, and females with 29.6 %, constituting 100% of the sample. In terms of academic progression, the majority of the participants were in 3rd year (37.0%), 2nd year (33.3%) and 4th year (29.7%). Regarding previous experience with simulation, 44.4% indicated that they had been exposed to simulation in the past, and a higher percentage, 55.6%, indicated that they had not been exposed to simulation. This population sample indicates that the sample is largely composed of young, male individuals with differing academic backgrounds and no prior exposure to simulation.

Table 1: Demographic Characteristics of Participants (n = 54)

Variable	Category	Frequency (n)	Percentage (%)
Age (years)	18–20	20	37.0
	21–23	22	40.7
	24–26	12	22.3
Gender	Female	16	29.6
	Male	38	70.4
Academic Year	2nd Year	18	33.3
	3rd Year	20	37.0
	4th Year	16	29.7
Previous Simulation Exposure	Yes	24	44.4
	No	30	55.6

The results of the analysis of the pre- and post-intervention scores demonstrated that both clinical confidence and skill retention among the participants improved significantly. The average clinical confidence score was found to be greater in the post-test (3.68 ± 0.47) than in the pre-test (2.45 ± 0.52) with a t-value of 12.84 with a p-value of 0.001, which was statistically significant. Likewise, the skill retention phenomenon, where pre-test mean was 6.82 with a standard deviation of 1.21, and the after intervention standard deviation was 9.54 with a t-value of 14.21 and p-value of 0.001, was a highly significant gain in practical skills that occurred after the intervention. The findings indicate that the implemented intervention was successful in enhancing confidence and competency of individuals in clinical environments.

Table 2: Pre- and Post-Intervention Scores of Clinical Confidence and Skill Retention

Variable	Pre-test Mean ± SD	Post-test Mean ± SD	t-value	p-value
Clinical	2.45 ± 0.52	3.68 ± 0.47	12.84	0.001

Confidence				
Skill Retention	6.82 ± 1.21	9.54 ± 0.96	14.21	0.001

The analysis of correlations between clinical confidence and skill retention showed that there is a positive significant relationship with an r-value of 0.68 and a p-value of 0.001. This implies that the attainment levels of clinical confidence were significantly related to the skill retention among the participants and that the attainment of clinical confidence has the potential to directly enhance the acquisition and maintenance of practical clinical skills.

Table 3: Correlation Between Clinical Confidence and Skill Retention (Post-test)

Variables	r-value	p-value
Confidence & Skill Retention	0.68	0.001

Discussion

The current work proves that simulation-based training is an effective tool in the improvement of clinical confidence as well as skill retention of the nursing students, which justifies the use of simulation as a potent learning tool in nursing education. Instead of restating the results, these findings are a sort of rejection of the experiential learning theories, especially the Experience Learning Cycle developed by Kolb, which focuses on the learning process based on the introduction of concrete experience, then reflective observation, and active experimentation. The simulation provides the students with a formal atmosphere to practice with real clinical situations and reflect on their performance and the following internalization of clinical actions, which may explain the high levels of confidence and skill retention posted in this case.
In line with our findings, other recent international studies suggest that simulation facilitates self-confidence in clinical practice. The systematic review by Alrashidi et al. found that the simulation was effective in enhancing the self-belief of nursing students in various clinical activities and interpersonal communication skills, and therefore it can be used as a tool to equip nursing students with the real patient experience [15]. On the same note, a massive study in Denmark found out that even greater exposure to simulation provided significant gains in professional self-confidence especially in technical capacity, and the effects were felt even after the period of direct training was over [12]. These papers are consistent with our results, which places importance on the fact that simulation does not only provoke the short-term improvement, but can as well lead to the long-term professional preparedness, which is probably due to the strengthening of the cognitive and psychomotor integration.
Despite the general congruence with the international evidence, other studies indicate subtle variations. As an example, a BMC Nursing trial also demonstrated a significant improvement in clinical skills but no statistically significant differences in self-confidence between simulation and traditional practices [16]. These differences could be explained by differences in methodology, faithfulness of simulation tools, or the repetition of exposure to simulation. The design of our intervention, possibly involving practice with repetition and instant feedback, must have better facilitated retention and confidence. This interpretation was further corroborated in the integrative review by Al Gharib which demonstrated that repeated simulation experiences result in the greatest learning effects, such as confidence and competence in their skills [17].
The high positive relationship between confidence and skill retention in the current study supports self-efficacy theory by Bandura according to which confidence in abilities determines the level of performance. Students who have higher levels of self-confidence in nursing tend to become more interested in the complex clinical

activities and they will stick to the activities during difficult times and thus will learn and remember the skills better. This hypothetical connection is reflected in the studies on flipped classroom based on simulations which state that greater self-conviction leads to more satisfaction and better clinical results [15], indicating that confidence is both a mediator and a result of learning.

Although the advantages of simulation are mostly emphasized in the international literature, its applicability is also supported by the local facts in the Middle East and North Africa. One of the quasi-experiments conducted in Morocco found that not only did immediate knowledge acquisition and retention increase when simulation was used with standardized patients rather than traditional lectures, but also students' self-efficacy was enhanced [18]. Although the contexts and curricula may be different, these findings are similar to ours and may indicate that the positive effect of simulation on the performance of learners goes beyond geographical location, and that these elements are universal laws of adult learning and cognitive psychology.

The resemblances between international and local research can be explained by the similarities in the components of the simulation pedagogy, e.g., structured debriefing, high-fidelity simulation, and compliance with clinical competencies supported by professional frameworks (e.g., Quality and Safety Education for Nurses standards). Differences in results between studies are likely to be due to the variation in sample size, the period of simulation, and the environment of the educational institution. As an example, programs that have an inbuilt, repeated simulation experience have been found to record stronger gains, which is in concord with the idea of deliberate practice, which is the centerpiece of the former theory of expertise development, to support skill maintenance and confidence in the long run [19,20]

Finally, the proposed research can be added to the existing literature that proves that simulation training has a great impact on enhancing clinical confidence and skill retention of nursing students. The results are in line with international empirical studies and well-known theories of learning and indicate that simulation enhances more profound involvement, self-efficacy, and cognitive mediation between theory and practice.

Conclusion

The research showed that simulated learning led to a great increase in clinical confidence and retention of skills by nursing students. The association between confidence and retention of skills was found to be strong and positively related, which indicates that the higher the self-efficacy, the higher the practical competence. Such results correspond with the experiential learning and self-efficacy theories, and point at the fact that structured, reflective and repetitive simulation experiences can work well to connect theoretical knowledge to clinical practice. On the whole, simulation seems to be an appropriate andragogical tool to equip nursing students with the skills to perform safely, competently, and confidently in the clinic.

Recommendations

Introduction of Simulation in Curriculum: Nursing programs ought to include organized sessions on simulation in all academic levels as a way of enhancing confidence and mastery of skills.

Repeated and Periodic Practice: Simulation exercises are supposed to be repeated in institutions to improve the long-term retention of skills and clinical competence.

Debriefing and Feedback: Simulations should be debriefed immediately after the simulation with the help of a structured debriefing in order to promote reflective learning and solidify the knowledge.

Competency Needs: Simulation scenarios must be based on clinical challenges in the settings of student practice in order to be as relevant and engaging as possible.

Training of Faculty: Faculty needs to be trained in special aspects to facilitate and assess high-fidelity learning through simulation design, facilitation, and assessment.

Future Study: It is suggested that future studies should be conducted over a longer period to determine the long-term effectiveness of simulation on clinical practice after graduation and the relative effects of various simulation modalities.

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