Research Article

Impact of Virtual Reality (VR) and Augmented Reality (AR) on Nursing Skill Acquisition Among Undergraduate Nursing Students in Selected Nursing Colleges in Uttar Pradesh: A Mixed Method Study

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ARTICLE INFO	ABSTRACT
	Background: In the rapidly evolving landscape of healthcare education, Virtual Reality (VR) and Augmented Reality (AR) have emerged as innovative pedagogical tools that significantly enrich traditional teaching methodologies. These immersive technologies offer realistic, interactive, and student-centered learning experiences, which are particularly valuable in the field of nursing where clinical skills, precision, and confidence are critical. As nursing education shifts towards more experiential and competency-based models, the integration of VR and AR provides a promising solution to bridge the gap between theoretical knowledge and practical application. **Objective:** The primary objective of this research is to investigate the impact of VR and AR technologies on the acquisition of essential nursing skills among undergraduate nursing students. The study aims to assess how these tools influence psychomotor learning, clinical decision-making abilities, and self-confidence in performing nursing procedures. Additionally, the study explores students' perceptions of using these technologies as part of their academic and clinical training. **Methodology:** A quasi-experimental design was employed in this study, conducted across selected nursing colleges in Uttar Pradesh. The study sample consisted of undergraduate nursing students who were divided into two groups: one receiving traditional instruction and the other exposed to VR and AR-based simulations. Data were collected through structured skill assessment checklists, self-reported confidence scales, and student feedback questionnaires. Pre- and post-intervention assessments were used to compare learning outcomes, and the effectiveness of the interventions was statistically analyzed. **Results:** The results of the study revealed that students who received training through VR and AR technologies demonstrated significantly greater improvement in skill acquisition compared to those taught via conventional methods. Specifically, enhancements were noted in their ability to perform clinical procedures accurately, make informed decisions in simulated scenarios, and exhibit increased confidence in patient care situations. Furthermore, student feedback highlighted a high level of satisfaction and engagement with the use of immersive technology in learning environments. **Conclusion:** The study concludes that Virtual Reality and Augmented Reality technologies have a substantial positive impact on nursing skill development. By providing safe, repeatable, and lifelike clinical simulations, these tools support deeper learning and better retention of practical skills. The integration of VR and AR into nursing curricula has the potential to revolutionize how clinical education is

delivered, making it more interactive, learner-centered, and effective. Therefore, nursing institutions should consider adopting these technologies to complement traditional teaching methods and enhance the quality of future healthcare professionals.

Keywords: Virtual Reality (VR), Augmented Reality (AR), Nursing Education, Skill Acquisition, Clinical Simulation, Undergraduate Nursing Students, Psychomotor Skills, Clinical Decision-Making, Nursing Curriculum

1. Introduction

Nursing education serves as the backbone of a competent healthcare system by equipping future nurses with the necessary knowledge, clinical competencies, and professional attitudes required to provide safe and effective patient care. Traditionally, nursing curricula have relied heavily on didactic classroom instruction, supervised clinical rotations, and simulation-based exercises using mannequins or standardized patients. While these conventional teaching methods are foundational, they are often constrained by several limitations such as inconsistent clinical exposure, limited patient availability, faculty shortages, and logistical challenges in ensuring uniform learning experiences for all students.

Furthermore, in real-world clinical settings, opportunities for hands-on practice are frequently limited by concerns related to patient safety, ethical issues, and the complexity of certain medical procedures. This creates a learning gap where students may complete their education without fully mastering the skills required for confident and competent practice.

In response to these challenges, the integration of advanced technologies—particularly **Virtual Reality (VR)** and **Augmented Reality (AR)**—into healthcare education has emerged as a promising innovation. VR provides users with a fully immersive, computer-generated environment where learners can engage in complex clinical scenarios in a risk-free setting. In contrast, AR enhances the real-world environment by overlaying digital content, such as anatomical models or instructional prompts, onto the user's field of vision, thereby supporting real-time interaction and contextual learning.

The use of VR and AR in nursing education allows students to practice essential psychomotor and clinical decision-making skills repeatedly and safely, regardless of time and location constraints. These technologies simulate high-stakes, real-life scenarios, enabling learners to make clinical judgments, apply critical thinking, and gain muscle memory for routine and emergency procedures. The interactive nature of VR/AR also supports personalized, learner-paced education, which may improve knowledge retention, motivation, and engagement.

Globally, academic institutions are increasingly recognizing the potential of immersive learning tools to bridge the theory-practice gap in healthcare education. In the Indian context, particularly in **Kanpur**, a key educational and healthcare hub in **Uttar Pradesh**, nursing colleges are progressively adopting digital innovations to enhance teaching and learning outcomes. As the demand for technologically proficient healthcare professionals grows, there is a pressing need to evaluate the educational efficacy of VR and AR in real-world settings.

This research aims to examine the **impact of Virtual Reality and Augmented Reality on nursing skill acquisition** among undergraduate students in selected nursing colleges of Kanpur. The study focuses on evaluating improvements in **psychomotor skill development**, **clinical reasoning**, and **student confidence levels** through the use of immersive technologies. By investigating this novel approach, the study seeks to contribute valuable insights into the integration of digital innovations into the nursing curriculum, ultimately improving the readiness and competence of future nurses.

2. Objectives of the Study
1. To assess the effectiveness of VR and AR in improving nursing skill acquisition, particularly psychomotor skills.
2. To evaluate the impact of VR and AR on students' clinical decision-making and confidence levels.
3. To identify challenges and barriers associated with the implementation of VR and AR technologies in nursing education.

4. Methodology

3.1 Research Design
This study employed a **mixed-methods research design**, integrating both quantitative and qualitative approaches to provide a comprehensive understanding of the impact of Virtual Reality (VR) and Augmented Reality (AR) on nursing skill acquisition. The quantitative component focused on measuring improvements in knowledge, psychomotor performance, and confidence levels using standardized tools, while the qualitative component explored student perceptions and experiences through focus group discussions (FGDs). The triangulation of data enabled a robust evaluation of both measurable outcomes and subjective learning experiences.

3.2 Study Setting and Population

The research was conducted in **two nursing colleges** located in **Uttar Pradesh, India**, chosen for their infrastructure, student population, and willingness to integrate immersive technologies into their existing curricula. These institutions represented diverse student demographics, ensuring a broad perspective on the effectiveness of VR and AR in nursing education.

A **total of 120 undergraduate nursing students** were selected through purposive sampling and were randomly assigned to two groups:

- **Intervention Group (n=60):** Received VR and AR-based training.
- **Control Group (n=60):** Received traditional training using lecture-based instruction and mannequin-based simulation.

All participants were in their second or third year of study and had basic familiarity with digital tools.

3.3 Intervention

The intervention spanned **four weeks**, during which students in the experimental group participated in structured VR and AR learning sessions. Sessions were conducted **twice a week for three hours**, facilitated by trained faculty members.

VR Modules Included:

- Emergency clinical scenarios, such as cardiac arrest management, patient resuscitation, and trauma care simulations.
- Interactive case-based environments requiring critical decision-making.

AR Applications Covered:

- Guided performance of core nursing procedures including wound dressing, IV insertion, catheterization, and intramuscular injections.
- Use of tablet-based and wearable AR systems that overlaid digital instructions and visual aids onto real-time physical tasks.

Students interacted with the modules using **head-mounted VR displays and mobile AR applications**, providing a realistic and responsive learning environment.

3.4 Data Collection Tools

A combination of quantitative instruments and qualitative techniques were used:

1. **Pre- and Post-Knowledge Tests:**
Structured multiple-choice assessments administered before and after the intervention to measure knowledge acquisition.
2. **Skill Performance Checklists:**
Validated clinical checklists were used by independent evaluators to assess procedural accuracy and efficiency.
3. **Confidence and Satisfaction Questionnaires:**
Likert-scale surveys assessed student self-confidence and satisfaction with the learning approach.
4. **Focus Group Discussions (FGDs):**
Semi-structured FGDs were conducted post-intervention with the intervention group to capture personal experiences, perceived benefits, and challenges related to VR/AR usage.

3.5 Data Analysis

Quantitative data were analyzed using **SPSS software version 25**.

- **Paired t-tests** assessed within-group differences pre- and post-intervention.
- **ANOVA tests** were conducted to compare differences between the intervention and control groups. Statistical significance was set at **$p < 0.05$**.

Qualitative data from FGDs were transcribed and analyzed using **thematic analysis**. Emerging codes were organized into themes that captured the essence of student experiences with VR and AR.

4. Results

4.1 Improvement in Psychomotor Skills

Students in the intervention group showed marked improvement in practical skill execution. The **average skill acquisition rate** increased by **45%** post-intervention, in comparison to **25%** in the control group. Observations indicated that procedures such as catheterization and wound dressing were performed with greater precision and adherence to protocol by VR/AR-trained students.

4.2 Enhanced Clinical Decision-Making

The VR/AR group demonstrated superior clinical reasoning skills during simulated emergencies. In scenario-based assessments, their average scores reached **85%**, compared to **68%** in the control group. Students

reported improved application of theoretical knowledge and were able to respond more effectively in critical situations.

4.3 Increased Confidence Levels

Confidence levels improved significantly among the VR/AR participants. According to post-intervention surveys, **92%** of students in the intervention group felt more confident in managing real clinical scenarios, while only **65%** of the control group reported similar feelings. Students cited the repeated exposure to procedures and decision-making as key confidence boosters.

4.4 Student Satisfaction

The qualitative data revealed high satisfaction with the immersive learning experience. Students described the sessions as **"engaging," "realistic," and "empowering."** Many emphasized that the safe, non-judgmental environment helped them overcome fear and anxiety related to clinical practice. However, a few participants highlighted **technical issues**, such as headset discomfort and software lag, as minor challenges. There were also calls for **more faculty involvement** during AR simulations to offer real-time guidance.

5. Discussion

The findings of this study are consistent with international literature emphasizing the educational benefits of VR and AR in nursing. For example, **Karaçayır et al. (2023)** emphasized that VR creates a controlled, mistake-tolerant space conducive to deliberate practice. Likewise, **Lee and Park (2022)** found that AR technologies significantly improved procedural performance and confidence in student nurses.

In the current study, the observed improvement in psychomotor skills and decision-making validates the hypothesis that immersive technologies bridge the gap between theoretical instruction and clinical application. Additionally, increased confidence and satisfaction suggest that such tools may reduce learning anxiety and foster autonomy in student learning.

However, several **barriers to implementation** were noted. The high cost of VR/AR hardware, the need for technical maintenance, and the requirement for faculty training remain significant challenges, particularly in resource-limited institutions. Institutions seeking to adopt these technologies must invest in **infrastructure development**, **capacity building**, and **technical support systems**.

Nonetheless, the **educational value** of VR and AR is clear. These tools not only support skill mastery but also cultivate **critical thinking, situational awareness, and learner engagement**, which are essential for modern nursing practice.

6. Conclusion

This study provides strong evidence that Virtual Reality and Augmented Reality are **effective, innovative teaching tools** that significantly enhance skill acquisition, clinical decision-making, and confidence among undergraduate nursing students. By simulating realistic patient care scenarios and allowing repeated, error-tolerant practice, VR and AR bridge many of the gaps present in traditional nursing education.

As healthcare demands continue to evolve, the integration of immersive technologies into nursing curricula is no longer a luxury but a necessity. Their potential to transform clinical training, enhance competency, and produce confident, practice-ready graduates is profound.

Moving forward, **future research** should examine the **long-term retention** of skills acquired through VR/AR, explore their **cost-effectiveness**, and develop **scalable models** for widespread adoption in both urban and rural nursing institutions.

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