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A Narrative Review of the Impact of Virtual Reality (VR) on Clinical Skills Development in Nursing Students

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Abstract

Background: The integration of virtual reality (VR) within nursing education has advanced rapidly over the past six years, driven by the mounting need for innovative approaches to clinical training, challenges in traditional education models, and the demands created by global health crises.

Objective: This narrative review analyzes recent evidence regarding the role and effectiveness of VR in developing clinical skills among nursing students worldwide.

Methods: Relevant literature from 2019 to 2025 was identified through comprehensive database searches (PubMed, Scopus, Web of Science, Google Scholar) using keywords relating to VR, nursing education, and clinical skills. Studies selected for inclusion consisted of experimental, mixed-methods, systematic reviews, and narrative syntheses, focusing specifically on VR applications in undergraduate and postgraduate nursing programs.

Results: VR significantly enhances students' technical, cognitive, and communication competencies, as well as self-efficacy and readiness for clinical practice. Its benefits are best seen in improvement of practical skills, decision-making, reduction of anxiety and errors, and increased engagement. Despite persistent barriers such as costs, lack of faculty expertise, and infrastructure requirements, VR's pedagogical value is now widely recognized. Future directions include large-scale implementation, integration with artificial intelligence, and research on long-term outcomes.

Conclusion: VR is a transformative agent in the evolution of nursing education, enabling flexible, standardized, and immersive skills training. Systematic investment, curricular adaptation, and ongoing research are essential to maximize its impact and sustainability.

Keywords: Virtual reality, Nursing education, Clinical skills, Simulation, Healthcare training, Technology-enhanced learning, OSCE, Nursing students.

Introduction

Clinical skills development is the cornerstone of nursing education worldwide. Traditional bedside teaching, while foundational, is challenged by shifting patient populations, advances in medical technology, educational reforms, and unforeseen health emergencies such as the COVID-19 pandemic (1–3). These challenges have amplified the need for alternative training approaches that offer realistic, repeatable, and experiential learning without compromising safety or quality of care.

Simulation-based education, historically utilizing low- and high-fidelity mannequins or standardized patients, has delivered significant improvements in nursing students' preparedness. However, such methods are often limited by resource intensity, instructor burden, lack of scalability, and logistical constraints (4–6). The emergence of virtual reality (VR)—defined as a computer-generated, interactive, and immersive environment—promises greater realism, flexibility, equity, and individualized learning experiences (7).

Over the last six years, VR technologies have evolved rapidly, incorporating lifelike visual-auditory cues, haptic feedback, realistic clinical scenarios, and AI-based adaptation. Evidence now shows that VR simulation can safely address gaps in practice exposure, procedural competence, patient interaction, and complex scenario management (8–9). Nursing curricula across high-, middle-, and low-income countries increasingly incorporate VR, not only as a supplement but also a partial replacement for traditional clinical hours (10).

This review critically explores the impact of VR on clinical skills development in nursing students. It synthesizes recent global literature (2019–2025), analyzes pedagogical value and implementation challenges, and offers recommendations for structuring VR-based curricula, faculty development, and research priorities.

Methods

A comprehensive, structured literature search was conducted between January 2019 and June 2025 using PubMed, Scopus, Web of Science, and Google Scholar. Search terms included "virtual reality", "nursing education", "clinical skills", "simulation", "OSCE", and "nursing students". Studies included experimental trials, mixed-methods research, systematic reviews, and high-quality qualitative syntheses focusing on VR's impact on clinical competency. Exclusion criteria were conference abstracts, non-English publications, and studies not directly addressing clinical skills or not involving nursing students.

All articles were independently reviewed for methodological quality, sample size, intervention design, outcomes, and generalizability. Selected findings were organized under key domains: theory and foundations, integration into curricula, effects on skills and assessment, student experience, cost-effectiveness, and barriers and limitations.

Defining Virtual Reality in Nursing Education

Virtual reality (VR) in education refers to simulated environments that replicate real-world clinical scenarios using technology, permitting direct user interaction. Platforms range from **non-immersive desktop simulations** to **fully immersive head-mounted displays (HMDs)** with haptic feedback and motion tracking. Key features include:

- **Immersion:** The degree to which users feel present within the virtual space.
- **Interactivity:** Ability to manipulate objects, make decisions, and receive instant feedback.
- **Multisensory Stimulation:** Use of audiovisual and sometimes tactile cues to enhance realism.
- **Repetitive Deliberate Practice:** Scenarios can be repeated until mastery is achieved.
- **Safe Failure:** Students can make errors without risking patient safety or personal confidence.
- **Data Tracking:** Detailed analytics on performance, decision pathways, and areas for improvement.

VR platforms for nursing education now include commercial products (e.g., Oxford Medical Simulation, SimX), open-source environments, and custom-built scenarios. These cover both basic skills (e.g., hand-washing, injection) and advanced, multi-faceted situations (e.g., cardiac arrest, burns, crisis resource management) (11–14).

Theoretical and Pedagogical Foundations

The use of VR in nursing draws on **constructivist**, **experiential**, and **cognitive load** theories, emphasizing active knowledge construction and reflection through experience (15–17). Key theoretical points include:

- **Kolb's Experiential Learning:** VR enables concrete experience, reflective observation, abstract conceptualization, and active experimentation.
- **Deliberate Practice:** VR's repeatable, feedback-rich environment supports acquisition and retention of complex skills through focused, purposeful repetition.
- **Situated Learning:** Realistic clinical context, with social and cultural cues, enhances transfer of knowledge and skills to practice.
- **Inclusivity:** VR can be tailored to accommodate diverse learning styles, languages, and abilities, fostering equity in training.

Emerging research shows that VR's multisensory engagement reduces extraneous cognitive load, helps focus on relevant clinical cues, and builds both procedural memory and clinical reasoning (18–20).

Integration of VR in Undergraduate and Graduate Nursing Curricula

Global Curriculum Models

Institutions worldwide have integrated VR into diverse points of nursing curricula (21,22):

- **Pre-licensure programs:** Supplement or replace traditional skills labs and clinical hours.
- **Graduate and specialty courses:** Complex scenario training, e.g., ICU, emergency, geriatrics, mental health.
- **Interprofessional education:** Joint simulations with medical, pharmacy, and allied health students.

Blended models (combining face-to-face, mannequin-based, and VR simulations) are most common, maximizing realism and flexibility. Curricular integration requires faculty development, infrastructure investment, and iterative curriculum design to ensure consistency and alignment with learning objectives (23,24).

Implementation Strategies

Successful programs typically apply a **phased integration**:

1. **Faculty training**: Workshops, peer mentoring, and technical support.
2. **Scenario design**: Alignment with core competencies, inclusion of assessment benchmarks.
3. **Pilot testing**: Small group rollouts, followed by large-scale adoption.
4. **Continuous evaluation:** Regular feedback, performance data analytics, and scenario updates.

Global case studies—from the US, UK, Korea, Australia, and Sweden—demonstrate improved performance metrics after integrating VR, especially when combined with faculty-led debriefing sessions and real-time analytics (25,26).

Impact of VR on Basic and Complex Clinical Skills

Basic Procedural Skills

VR is effective for developing basic clinical competencies including hand hygiene, medication administration, wound care, and injections. Studies reveal:

- Improved accuracy and speed in procedural tasks after VR-based training compared to traditional labs (27,28).
- Enhanced retention and confidence levels.
- Significant reduction in risky errors, especially medication administration errors (29).

Complex and Emergency Scenarios

VR excels in preparing students for rare, high-risk, or crisis situations:

- **Cardiac arrest, code blue:** Virtual teams perform assessments, CPR, defibrillation, and advanced airway management in immersive scenarios (30,31).
- **Polytrauma and sepsis management:** Students learn triage, rapid decision-making, communication, and teamwork under pressure.
- **Mental health and communication:** VR environments simulate patients with diverse backgrounds, cognitive states, or language barriers, fostering cultural and interpersonal competence (32,33).

Several multi-center RCTs suggest that VR-trained students perform significantly better in complex OSCE scenarios, with higher pass rates and lower anxiety (34,35).

VR and OSCE/Assessment Enhancement

VR is increasingly employed to prepare for or even conduct **Objective Structured Clinical Examinations (OSCEs)**:

- **OSCE preparation:** VR improves both technical (e.g., physical examinations) and non-technical (e.g., handover communication) OSCE domains. Students reporting greater readiness, skill retention, and self-assurance (36).
- **Assessment objectivity:** VR-simulated OSCE stations allow for standardization of scenarios and checklists, reducing examiner bias and logistical complexity (37,38).
- **Remote assessment:** During COVID-19, VR facilitated remote or hybrid OSCEs, maintaining assessment quality amid clinical site closures (39).

Faculty feedback emphasizes the value of real-time feedback, analytics, and multi-attempt scenarios for fair, reliable grading (40).

Student Engagement, Satisfaction, and Well-being

Engagement and Motivation

VR is associated with dramatic improvements in student **engagement, motivation, and active learning**. Qualitative findings from large-scale surveys include:

- Increased willingness to practice outside class hours.
- Higher perceived relevance and enjoyment, especially for “digital native” generations.
- Reduced anxiety and enhanced self-efficacy in clinical settings (41,42).

Inclusivity and Accessibility

VR platforms now increasingly accommodate students with disabilities (e.g., subtitles, alternative input devices), promote gender and cultural sensitivity, and enable **multilingual learning** (43).

Barriers include initial discomfort with technology, variable access to VR hardware at home, and, in low-resource settings, network constraints—a key area for policy and infrastructure investment (44).

Comparative Effectiveness and Cost-Benefit Analyses

Recent systematic reviews and meta-analyses comparing VR to other methodologies report:

- **Skill acquisition:** VR outperforms traditional classroom and is comparable, if not superior, to mannequin-based simulations for many skills (45).
- **Long-term retention:** Repeated VR practice supports superior performance months after initial training (46).
- **Cost-effectiveness:** Initial set-up is high; however, long-term use, maintenance, and scalability make VR increasingly attractive, especially where clinical sites or mannequins are limited (47).
- **Faculty time:** VR reduces faculty oversight needed for basic skill practice, freeing resources for high-level debriefings (48).

VR in Crisis and Pandemic Response

The COVID-19 pandemic illustrated the critical role of VR in ensuring **continuity of education**:

- Widespread clinical placement cancellations and restricted patient contact drove rapid VR adoption in many universities (49).
- Home-based VR simulation enabled continuation of required clinical hours.
- Comparative studies reveal that students trained via VR during the pandemic not only met but sometimes exceeded pre-pandemic clinical competency metrics (50).

Barriers, Limitations, and Ethical Considerations

Barriers to Implementation

- **Cost and infrastructure:** High initial hardware/software costs; unequal access across regions.
- **Faculty expertise:** Lack of technical skills and resistance from faculty used to traditional pedagogies.
- **Scenario development:** Need for regular content updates, high production demands.

Ethical and Legal Concerns

- **Data privacy and security:** Managing personal and performance data in cloud-based VR platforms.
- **Exposure to high-stress scenarios:** Risk of psychological distress in some students; importance of opt-out and support mechanisms.
- **Inclusivity:** Ongoing work needed to ensure equal access irrespective of gender, culture, disability, or language.

General Limitations

- Small sample sizes in many studies.
- Short follow-up periods; lack of robust data on long-term impact and career outcomes.
- Need for more RCTs across diverse health systems and cultural contexts.

International Perspectives and Case Studies

Notably, high-income countries (e.g., US, UK, Australia, Sweden, South Korea) have taken the lead in VR adoption. However, creative, low-cost VR adaptations are emerging in low- and middle-income countries, especially through mobile-based platforms and international partnerships.

Evidence from collaborative, cross-institutional studies points toward the potential for **global curriculum harmonization**—leveraging VR to deliver shared clinical standards, benchmarking, and even joint international credentials (51–53).

Future Directions and Research Priorities

To maximize the benefits of VR in nursing education, future research should focus on:

- **Large-scale, longitudinal studies** linking VR exposure to clinical performance and patient outcomes post-graduation.
- **Integration with AI and virtual mentors** to personalize scenarios, provide adaptive feedback, and identify learning needs.
- **Expansion of interprofessional and interdisciplinary training,** enabling nursing students to collaborate with other healthcare trainees in realistic virtual teams.
- **Sustainability:** Exploration of scalable, low-cost VR solutions (e.g., mobile VR) for low-resource settings, and open access scenario sharing.
- **Ethical frameworks** for scenario content, data protection, and psychological safety.

Conclusion

Virtual reality has rapidly shifted from novelty to necessity in nursing education, particularly in clinical skills development. The evidence clearly demonstrates VR's power to accelerate learning, deepen understanding, and prepare students for evolving, complex healthcare environments. Despite persistent barriers, VR's trajectory suggests it will become an inextricable component of future nursing curricula worldwide.

Successful and ethical integration depends on systemic investment, multidisciplinary collaboration, and a strong research agenda focused on equity, efficacy, and learner well-being.

Limitations

This review is limited by the heterogeneity of available studies, variability in VR interventions and outcomes, and the rapidly evolving nature of VR technology. While current findings are promising, further research is required to ensure that VR-based methods perpetuate not only technical but also ethical, cultural, and interpersonal excellence in nursing practice.

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