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Emerging Role of AI-Enhanced Simulation in Nursing Education

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Abstract

Background: Artificial intelligence (AI) is transforming simulation-based learning by enabling adaptive, data-driven, and personalized clinical scenarios.

Purpose: This narrative review synthesizes evidence on the applications, benefits, and challenges of AI-enhanced simulation in nursing education.

Methods: A narrative review approach was used to summarize literature published between 2018 and 2025 on AI-enabled simulation technologies in undergraduate nursing programs.

Findings: Key themes include AI-enabled scenario personalization, virtual patients, automated assessment, intelligent debriefing, and faculty readiness.

Conclusion: AI-enhanced simulation strengthens clinical reasoning and competency development; however, successful implementation requires faculty training and institutional support.

Keywords: artificial intelligence, simulation, nursing education, virtual patients, clinical reasoning

1. Introduction

Simulation is a critical component of nursing education, allowing students to practice clinical skills, develop clinical reasoning, and gain confidence in a controlled learning environment. Recent technological advancements have introduced artificial intelligence (AI) as an emerging enhancement to simulation-based learning. AI enables dynamic, responsive, and personalized simulation experiences beyond traditional high-fidelity manikins or static virtual scenarios.

The purpose of this narrative review is to synthesize current evidence and conceptual developments regarding AI-enhanced simulation in nursing education, focusing on undergraduate nursing programs.

2. Background

AI technologies—including machine learning, natural language processing, and predictive analytics—are increasingly used in healthcare training. AI-driven systems can adapt scenarios based on learner performance, evaluate clinical decision-making, reproduce physiological responses, and support automated debriefing. Nursing literature demonstrates growing interest in AI-supported virtual patients and data-driven performance assessment.

3. Key Themes

3.1 AI-Enabled Scenario Personalization

AI modifies simulation parameters dynamically based on learner actions, previous performance, and competency gaps.

3.2 Virtual Patients and Conversational Agents

AI-powered virtual patients communicate through natural language, respond logically, and simulate complex emotions, supporting communication and assessment practice.

3.3 Automated Performance Assessment

AI evaluates prioritization, decision accuracy, response times, and safety adherence, reducing faculty workload.

3.4 AI-Supported Debriefing

Intelligent debriefing provides structured, consistent, data-driven feedback.

3.5 Strengthening Clinical Reasoning

AI-enhanced simulations expose students to diverse scenarios, enabling deliberate practice and real-time feedback.

3.6 Challenges and Limitations

Challenges include limited educator digital literacy, cost, ethical concerns, and lack of institutional guidelines.

4. Implications

AI-enhanced simulation promotes learner-centered environments. Successful integration requires faculty development, alignment with curricular outcomes, robust data governance, and institutional investment. AI can support competency-based curricula and reduce educator workload, but institutions must invest in training and infrastructure.

5. Future Directions

Future research should address scenario accuracy validation, learning outcome measurement, ethical guidelines, culturally contextualized AI modules, and interdisciplinary collaboration.

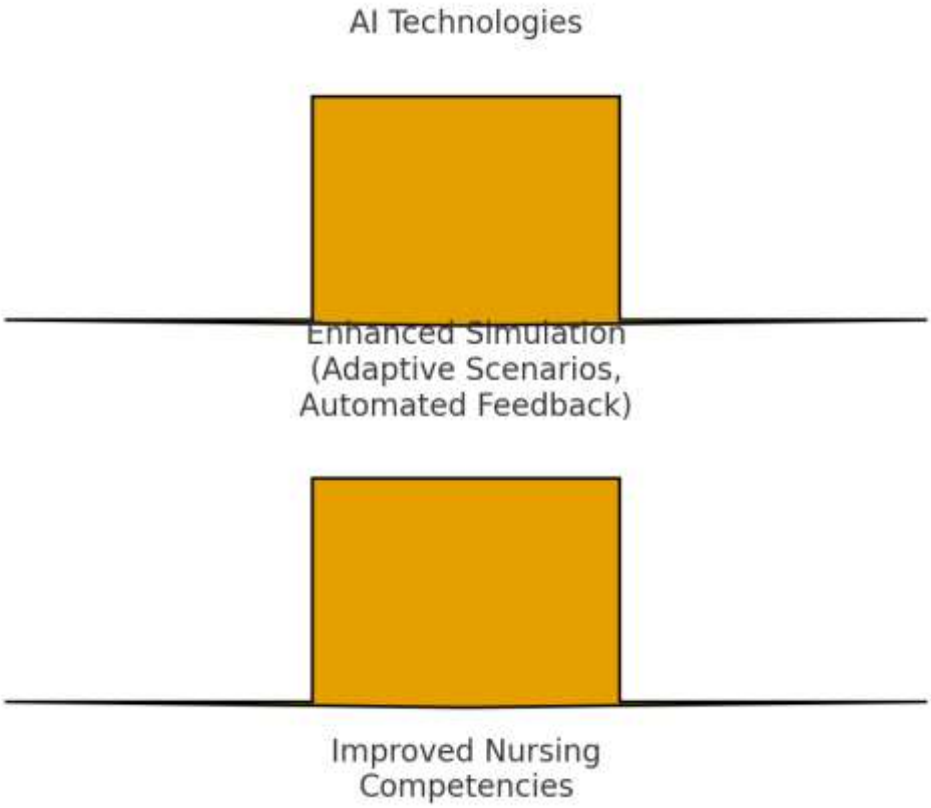
6. Conclusion

AI-enhanced simulation offers adaptable and immersive learning experiences that improve clinical reasoning and competency development. With adequate faculty readiness and institutional support, AI technologies will play a central role in modern nursing education.

Table 1. Applications of AI in Simulation-Based Nursing Education

AI Function	Simulation Application	Educational Benefit
Natural Language Processing	Virtual patients	Enhances communication skill practice
Machine Learning	Performance analytics	Objective competency evaluation
Predictive Algorithms	Adaptive scenarios	Personalized learning pathways

Figure 1. Conceptual Model of AI-Enhanced Simulation



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