

Artificial Intelligence in Nursing Education: Transforming Learning, Clinical Competency, and Professional Development—A Narrative Review

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ABSTRACT

Artificial intelligence (AI) is rapidly transforming nursing education by introducing innovative approaches to teaching, learning, assessment, and professional development. This narrative review synthesizes current evidence on the applications, benefits, challenges, and future directions of AI in nursing education. A comprehensive literature search was conducted across PubMed, Scopus, Web of Science, CINAHL, ERIC, IEEE Xplore, and Google Scholar to identify relevant studies published between 2019 and 2026. The reviewed literature demonstrates that AI-powered technologies, including adaptive learning systems, intelligent tutoring platforms, virtual simulation, augmented and virtual reality, learning analytics, natural language processing, and generative AI, have significantly enhanced personalized learning, clinical reasoning, competency development, and learner engagement. AI-assisted assessment methods provide objective evaluation and early identification of students requiring academic support, while AI-driven simulation offers safe, realistic environments for developing clinical skills and decision-making abilities. Furthermore, AI supports lifelong learning and continuing professional development by delivering individualized educational resources and competency-based training. Despite these advantages, challenges related to ethical considerations, algorithmic bias, academic integrity, faculty preparedness, technological infrastructure, data privacy, and equitable access remain significant barriers to implementation. The evidence suggests that AI should be integrated as a complementary educational tool rather than a replacement for nurse educators, preserving the humanistic values of nursing practice. Incorporating AI literacy, digital health competencies, and ethical AI principles into nursing curricula, together with institutional support and evidence-based governance, will prepare future nurses for technology-enabled healthcare systems and contribute to high-quality, safe, and patient-centered nursing practice.

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INTRODUCTION

Artificial intelligence (AI) has emerged as one of the most transformative technological innovations in healthcare, fundamentally reshaping clinical practice, healthcare management, biomedical research, and professional education. AI encompasses computational systems capable of performing tasks that traditionally require human intelligence, including pattern recognition, predictive analytics, natural language processing (NLP), computer vision, machine learning (ML), deep learning, and generative AI. Within nursing education, these technologies are increasingly integrated into teaching, learning, assessment, simulation, and competency evaluation, enabling educators to create personalized, data-driven, and competency-oriented learning environments. As nursing education evolves to meet the demands of increasingly complex healthcare systems, AI provides unprecedented opportunities to improve educational quality, clinical preparedness, and lifelong professional development while supporting evidence-based practice and patient safety[1–3].

The rapid digital transformation of healthcare has significantly altered the competencies expected of contemporary nurses. Modern nursing professionals must demonstrate proficiency not only in clinical reasoning and psychomotor skills but also in health informatics, digital literacy, clinical decision support systems, telehealth, and AI-enabled technologies. Consequently, nursing education is transitioning from conventional lecture-based instruction toward technology-enhanced, learner-centered educational models that emphasize experiential learning, critical thinking, collaborative problem-solving and competency-based assessment. AI-powered educational platforms can analyze individual learning patterns, identify knowledge gaps, recommend personalized learning resources, and provide real-time adaptive feedback, thereby facilitating more efficient and individualized educational experiences compared with traditional instructional methods[4–6].

One of the most promising applications of AI in nursing education is intelligent adaptive learning. Adaptive learning systems continuously monitor learner performance and dynamically adjust educational content according to individual strengths, weaknesses, pace of learning, and preferred learning styles. These systems enable nursing students to receive personalized educational pathways, targeted remediation, and continuous formative assessment. Unlike traditional standardized teaching approaches, AI-driven adaptive

learning promotes self-directed learning, enhances learner engagement, and improves knowledge retention by ensuring that educational content aligns with each student's evolving competency profile. Such individualized educational strategies are particularly valuable in nursing curricula, where learners often exhibit substantial variability in prior knowledge, clinical exposure, and practical skills acquisition [7–9].

Simulation-based education has become a cornerstone of nursing training, and AI is substantially expanding its educational potential. Intelligent virtual patients, conversational chatbots, augmented reality (AR), virtual reality (VR), mixed reality (MR), and AI-enhanced simulation environments provide immersive opportunities for students to practice clinical decision-making in realistic but risk-free settings. These technologies facilitate repeated practice, immediate performance feedback, and objective evaluation of psychomotor and cognitive competencies without compromising patient safety. AI-powered simulation systems can also generate dynamic clinical scenarios that respond to learner decisions, thereby promoting higher-order clinical reasoning, diagnostic accuracy, teamwork, communication, and emergency preparedness. Such innovations are particularly valuable for preparing nursing students to manage high-risk clinical situations, including intensive care, emergency medicine, maternal health, neonatal care, and community-based practice[10–13].

Assessment and evaluation are also undergoing significant transformation through AI integration. Traditional nursing assessments often rely on written examinations and subjective faculty observations, which may not comprehensively evaluate clinical competence. AI-supported assessment tools utilize automated scoring systems, computer vision technologies, speech recognition, learning analytics, and predictive modeling to provide objective, continuous, and multidimensional evaluation of learner performance. These technologies can assess clinical reasoning, communication skills, procedural competency, documentation quality, and adherence to evidence-based guidelines while simultaneously generating individualized feedback for learners and educators. Furthermore, predictive analytics can identify students at risk of academic underperformance or attrition, enabling early educational interventions that improve retention and academic success[14–17].

Generative AI has recently introduced additional opportunities and challenges for nursing education. Large

language models can assist students in literature synthesis, clinical case analysis, concept clarification, academic writing, reflective practice, and examination preparation. Faculty members increasingly employ generative AI to develop learning materials, case scenarios, quizzes, and educational content, thereby improving teaching efficiency and curriculum development. However, concerns regarding academic integrity, misinformation, algorithmic bias, data privacy, transparency, and excessive learner dependence have generated important ethical debates. Responsible AI implementation therefore requires robust institutional policies, digital literacy education, faculty development programs, and ethical governance frameworks that ensure AI complements rather than replaces human judgment and professional accountability [18–22].

Beyond undergraduate education, AI also supports continuing professional development, competency maintenance, and lifelong learning among practicing nurses. Intelligent learning management systems, personalized continuing education modules, virtual mentors, and AI-assisted competency tracking facilitate continuous skill enhancement in rapidly evolving healthcare environments. AI can recommend educational resources based on clinical practice patterns, certification requirements, and identified competency gaps, thereby promoting evidence-based practice and career progression. These capabilities are increasingly important as healthcare systems adopt digital health technologies, precision medicine, remote patient monitoring, and AI-assisted clinical decision support, all of which require nurses to continuously update their knowledge and technical competencies throughout their professional careers [23–26].

Despite these considerable advantages, AI implementation in nursing education is accompanied by several challenges. Limited technological infrastructure, financial constraints, inadequate faculty preparedness, digital inequality, concerns regarding algorithmic transparency, cybersecurity risks, and variability in regulatory guidance may hinder successful adoption. Furthermore, educational institutions must ensure that AI technologies enhance rather than diminish essential humanistic aspects of nursing, including empathy, communication, ethical reasoning, cultural competence, and patient-centered care. Addressing these challenges requires interdisciplinary collaboration among nurse educators, healthcare organizations, policymakers, computer scientists, and educational technology developers to establish evidence-informed standards for AI integration into nursing curricula [27–30].

Given the accelerating adoption of AI technologies across nursing education worldwide, a comprehensive narrative synthesis of contemporary evidence is essential to understand their educational applications, effectiveness, implementation challenges, ethical implications, and future directions. This narrative review therefore aims to critically examine current evidence regarding the role of artificial intelligence in transforming nursing education, with particular emphasis on teaching and learning strategies, clinical competency development, learner assessment, simulation-based education, professional development, and implications for future nursing curricula in the era of digital healthcare [31–34].

METHODOLOGY

Study Design

This study was conducted as a narrative review to comprehensively synthesize contemporary evidence regarding the applications of artificial intelligence (AI) in nursing education, with particular emphasis on teaching and learning strategies, clinical competency development, simulation-based education, learner assessment, and continuing professional development. A narrative review methodology was selected because it enables the integration of diverse evidence from quantitative, qualitative, mixed-methods, educational intervention, and implementation studies, thereby providing a broad understanding of emerging technologies and educational innovations. Unlike systematic reviews that focus on narrowly defined clinical questions, a narrative review facilitates critical interpretation of heterogeneous literature and identification of current trends, opportunities, challenges, and future research priorities in AI-enabled nursing education [35].

Search Strategy

A comprehensive literature search was performed across multiple electronic databases, including PubMed/MEDLINE, Scopus, Web of Science, CINAHL, ERIC, IEEE Xplore, and Google Scholar. The search aimed to identify peer-reviewed studies published between January 2019 and June 2026, reflecting the rapid evolution of AI technologies in healthcare education. Additional manual searches of the reference lists of eligible articles were undertaken to identify potentially relevant publications not captured through database searching. Grey literature, conference proceedings with insufficient methodological detail, editorials, commentaries, and duplicate publications were excluded to ensure methodological rigor and evidence quality [36]. The literature search combined Medical Subject Headings (MeSH) and free-text keywords using Boolean operators ("AND" and "OR") to maximize search sensitivity and specificity shown in table 1.

Table 1. MeSH Terms and Search Strategy

Search Concept	MeSH Terms / Keywords	Boolean Operator
Artificial Intelligence	"Artificial Intelligence", "Machine Learning", "Deep Learning", "Generative Artificial Intelligence", "Large Language Models", "Natural Language Processing"	OR
Nursing Education	"Education, Nursing", "Nursing Students", "Nursing Curriculum", "Competency-Based Education", "Clinical Education"	OR
Learning Technologies	"Adaptive Learning", "Digital Learning", "E-learning", "Virtual Learning", "Learning Analytics", "Educational Technology"	OR
Simulation	"Simulation Training", "Virtual Reality", "Augmented Reality", "Mixed Reality", "Virtual Patients", "Clinical Simulation"	OR
Competency	"Clinical Competence", "Clinical Skills", "Clinical Decision-Making", "Critical Thinking", "Professional Competence"	OR
Assessment	"Educational Measurement", "Competency Assessment", "Performance Evaluation", "Feedback", "Objective Structured Clinical Examination"	OR
Professional Development	"Continuing Education", "Professional Development", "Lifelong Learning", "Digital Competency"	OR
Final Search String	("Artificial Intelligence" OR "Machine Learning" OR "Deep Learning") AND ("Education, Nursing" OR "Nursing Students") AND ("Clinical Competence" OR "Simulation Training" OR "Professional Development")	AND

Eligibility Criteria

Studies were included if they: (1) investigated AI applications in undergraduate, postgraduate, or continuing nursing education; (2) evaluated AI-supported teaching strategies, adaptive learning, simulation, competency assessment, or professional development; (3) involved nursing students, nurse educators, or practicing nurses; (4) were published in English between 2019 and 2026; and (5) provided sufficient methodological information and educational outcomes. Quantitative, qualitative, mixed-methods, randomized controlled trials, quasi-experimental studies, observational studies, implementation studies, and high-quality review articles were considered eligible. Publications focusing exclusively on AI applications in direct patient care without an educational component, opinion articles, editorials, letters to the editor, dissertations, and studies lacking full-text availability were excluded[37].

Study Selection

Retrieved citations were imported into reference management software, and duplicate records were removed before screening. Titles and abstracts were independently reviewed to assess their relevance to the review objective. Full-text articles meeting the preliminary eligibility criteria were subsequently evaluated against the predefined inclusion and exclusion criteria. Any discrepancies regarding study eligibility were resolved through discussion and consensus. Studies that met all eligibility requirements were included in the final evidence synthesis. The overall selection process emphasized methodological quality, educational relevance, and applicability to nursing education.

Data Extraction

A standardized data extraction framework was developed to ensure consistency across the included studies. The following information was extracted from each article: author(s), year of publication, country, educational setting, study objectives, research design, participant characteristics, sample size, sampling technique, educational intervention, AI technology employed, data collection instruments, outcome measures, principal findings, and authors' conclusions. Information relating to implementation barriers, ethical considerations, faculty preparedness, learner perceptions, and recommendations for future research was also documented to facilitate thematic synthesis.

Data Synthesis

Given the methodological heterogeneity of the included studies, a quantitative meta-analysis was not appropriate. Therefore, findings were synthesized narratively by grouping studies into major thematic domains. These domains included AI-assisted personalized learning, intelligent tutoring systems, simulation-based education, virtual patients, competency assessment, clinical decision-making education, generative AI in nursing education, faculty perspectives, ethical considerations, digital literacy, and continuing professional development. Similar findings were compared across studies to identify recurring patterns, emerging innovations, implementation challenges, and evidence gaps. Contradictory findings were examined critically to provide a balanced interpretation of the available evidence and to formulate recommendations for future educational practice and research.

Quality Considerations

Although formal risk-of-bias assessment is not mandatory for narrative reviews, preference was given to peer-reviewed studies with clearly described methodologies, adequate sample sizes, validated measurement instruments, and transparent reporting of outcomes. Educational intervention studies, randomized trials, mixed-methods research, and systematic reviews published in reputable nursing, medical education, and healthcare informatics journals were prioritized. This approach enhanced the credibility and reliability of the synthesized evidence while minimizing the influence of low-quality publications.

RESULTS

A total of studies published between 2019 and 2026 were reviewed to examine the role of artificial intelligence (AI) in nursing education. The evidence demonstrated that AI has become an increasingly important educational technology for improving learning experiences, strengthening clinical competency, supporting simulation-based education, enhancing assessment methods, and promoting continuous professional development among nursing students and practicing nurses. Although the included studies varied in design, educational setting, and AI technologies evaluated, a consistent trend emerged indicating that AI has considerable potential to complement traditional nursing education by facilitating personalized learning, objective competency assessment, and data-driven educational decision-making. The findings were synthesized into five major themes: AI-assisted personalized learning, AI-enhanced simulation and clinical competency, intelligent assessment and learning analytics, generative AI in nursing education, and challenges associated with AI implementation.

AI-Assisted Personalized Learning

The majority of studies reported that AI-powered adaptive learning platforms significantly improved students' academic performance by delivering individualized educational content based on learners' strengths, weaknesses, and progress. Machine learning algorithms continuously analyzed students' responses, identified knowledge deficits, and recommended targeted educational resources, allowing learners to progress according to their individual pace rather than following standardized instructional pathways. Several quasi-experimental and mixed-methods studies demonstrated that adaptive learning increased learner engagement, improved examination scores, enhanced knowledge retention, and promoted greater confidence in applying theoretical concepts during clinical practice. Nurse educators also reported that AI-supported learning management systems reduced the time required to monitor learner progress while enabling earlier identification of students requiring academic support. These findings suggest that AI-assisted personalized learning may contribute to more efficient and learner-centered nursing education by supporting self-directed learning and competency-based curriculum delivery [1–6].

AI-Enhanced Simulation and Clinical Competency

Simulation-based education represented one of the most extensively investigated applications of AI in nursing education. Studies consistently demonstrated that AI-powered virtual patients, conversational agents, computer vision systems, and immersive virtual reality simulations enhanced clinical reasoning, psychomotor skill acquisition, communication, and decision-making abilities. Intelligent simulation environments dynamically modified clinical scenarios according to learner performance, allowing students to manage increasingly complex patient conditions while receiving immediate formative feedback. Evidence further indicated that repeated exposure to AI-supported simulations improved clinical confidence, reduced procedural errors, and enhanced preparedness for real-world patient care. Several investigations involving undergraduate nursing students reported significant improvements in Objective Structured Clinical Examination (OSCE) performance following participation in AI-assisted simulation training. Faculty members also emphasized that AI-enabled simulation provided objective and standardized competency evaluation while reducing assessor variability and increasing consistency in clinical skills assessment [7–12].

Intelligent Assessment and Learning Analytics

AI-supported assessment systems have transformed conventional methods of evaluating nursing students by introducing continuous, objective, and data-driven performance monitoring. Numerous studies described the successful implementation of intelligent tutoring systems, automated scoring algorithms, learning analytics dashboards, speech recognition technologies, and computer vision applications for competency assessment. These technologies evaluated learners' clinical reasoning, procedural accuracy, communication skills, documentation quality, and adherence to evidence-based practice guidelines. Predictive analytics further enabled educators to identify students at increased risk of academic failure, poor clinical performance, or programme attrition, facilitating timely academic interventions and individualized mentoring. Several longitudinal studies reported that institutions implementing AI-driven learning analytics experienced improved student retention, enhanced academic progression, and better overall educational outcomes. Importantly, most educators regarded AI as a valuable adjunct rather than a replacement for faculty assessment, emphasizing that human judgment remains essential when evaluating professionalism, empathy, ethical reasoning, and interpersonal communication [13–18].

Generative Artificial Intelligence in Nursing Education

The emergence of generative artificial intelligence (GenAI), particularly large language models (LLMs), has introduced new opportunities for transforming nursing education. Across the reviewed studies, GenAI was increasingly used to support literature appraisal, concept clarification, clinical case analysis, reflective writing, examination preparation, and academic writing assistance.

Nursing students reported that AI-powered conversational systems provided immediate explanations of complex nursing concepts, generated individualized practice questions, and offered interactive feedback that promoted self-directed learning. Faculty members also utilized generative AI to develop case scenarios, simulation scripts, formative quizzes, and teaching materials, thereby reducing the time required for curriculum development and instructional planning. Several educational intervention studies demonstrated that students who incorporated AI-assisted learning tools into structured educational activities showed improvements in critical thinking, problem-solving ability, and confidence when managing complex clinical scenarios. Nevertheless, most investigators emphasized that AI-generated information requires critical evaluation because inaccuracies, fabricated references, and contextual errors may occur. Consequently, educators consistently recommended integrating AI literacy, evidence appraisal, and responsible AI use into undergraduate nursing curricula to ensure that students develop the ability to verify AI-generated information against reliable scientific evidence before applying it in clinical practice [19–23].

Professional Development and Lifelong Learning

Beyond undergraduate education, AI has become an important resource for continuing professional development among registered nurses. Several studies demonstrated that AI-supported learning management systems and digital competency platforms enabled personalized continuing education by recommending educational modules according to nurses' clinical specialties, previous learning achievements, certification requirements, and identified competency gaps. Intelligent tutoring systems provided adaptive educational content that allowed practicing nurses to update their knowledge at their own pace while maintaining clinical responsibilities. In specialty areas such as critical care, emergency nursing, oncology, maternal health, neonatal nursing, and community health, AI-assisted educational platforms facilitated rapid dissemination of current evidence-based guidelines and supported competency maintenance in

rapidly changing healthcare environments. Predictive learning analytics further enabled institutions to monitor workforce educational needs, identify organizational competency gaps, and design targeted educational interventions. Collectively, these findings suggest that AI can support lifelong learning and promote continuous professional growth throughout nurses' careers, thereby strengthening workforce readiness and improving the quality of patient care [24–27].

Challenges and Ethical Considerations

Despite the substantial educational benefits identified across the literature, numerous studies highlighted important challenges associated with AI implementation in nursing education. Limited technological infrastructure, inadequate financial resources, insufficient faculty training, and unequal access to digital technologies remain major barriers, particularly in low- and middle-income countries. Several investigations reported that many nurse educators lacked confidence in selecting, implementing, and evaluating AI-based educational technologies, emphasizing the need for structured faculty development programmes and institutional support [35–40]. Concerns regarding algorithmic bias, transparency, explainability, cybersecurity, confidentiality of learner data, and compliance with data protection regulations were also frequently reported. Ethical concerns extended to issues of academic integrity, as unrestricted use of generative AI may encourage plagiarism, reduce independent critical thinking, or create excessive dependence on automated content generation. Furthermore, several authors cautioned that although AI can effectively enhance cognitive learning and procedural training, it cannot replace essential human attributes of nursing such as empathy, compassion, ethical reasoning, therapeutic communication, cultural sensitivity, and patient-centered care. Accordingly, most studies recommended that AI should function as a supportive educational technology that complements rather than substitutes the expertise of nurse educators and authentic clinical experiences [28–31].

Table 2. Characteristics and Summary of Included Studies on Artificial Intelligence in Nursing Education

Author	Year	Country	Domain	Objective/Aim	Research Methodology (Research Design, Population & Sample, Sampling Technique, Data Collection Tool)	Key Results	Conclusion
O'Connor et al.	2023	Ireland	AI in Nursing Education	To explore AI applications in	Narrative review; published	AI enhanced personalized learning,	AI has significant potential to

				undergraduate nursing education	educational studies; literature search of major databases; data extraction using predefined review framework	simulation, and assessment while improving learner engagement.	modernize nursing education but requires ethical implementation.
Buchanan et al.	2023	United Kingdom	ChatGPT in Nursing Education	To evaluate opportunities and challenges of generative AI in nursing education	Commentary with evidence synthesis; educational literature review	ChatGPT improved learning support and academic productivity but raised concerns regarding plagiarism and misinformation.	AI should supplement—not replace—critical thinking and educator supervision.
Kung et al.	2023	United States	Large Language Models	To evaluate ChatGPT performance in medical and health education	Cross-sectional evaluation using examination questions	Large language models demonstrated promising educational capability but variable clinical accuracy.	Human verification remains essential before applying AI-generated information.
Sallam	2023	Jordan	ChatGPT in Health Professions Education	To summarize evidence regarding ChatGPT in healthcare education	Systematic review; published literature; PRISMA methodology	ChatGPT improved learning efficiency while highlighting concerns about hallucinations and ethical use.	Responsible AI governance and digital literacy are essential for healthcare education.
Lozano et al.	2024	Spain	Virtual Simulation	To investigate AI-supported virtual patient simulation for nursing students	Quasi-experimental study; undergraduate nursing students; convenience sampling; competency	Virtual simulation significantly improved clinical reasoning and decision-making skills.	AI-enhanced simulation effectively complements conventional clinical training.

					assessment checklist		
Chan et al.	2024	Hong Kong	Adaptive Learning	To evaluate adaptive AI learning systems in nursing education	Mixed-methods study; nursing students; purposive sampling; questionnaires and academic performance records	Personalized learning improved knowledge retention, engagement, and learner satisfaction.	Adaptive AI supports individualized competency-based education.
Abd-Alrazeeni et al.	2026	Saudi Arabia	AI in Nursing Education	To synthesize empirical evidence on AI integration in nursing education	Systematic review; 28 empirical studies; CASP appraisal; thematic synthesis	AI improved personalized learning, simulation, automated assessment, and curriculum management.	AI integration enhances educational quality while requiring ethical governance and faculty preparedness.
Nugent et al.	2026	Ireland	AI-Enhanced Pedagogies	To map AI pedagogies used in nursing education	Scoping review; multiple international databases; PRISMA-ScR methodology	AI supported adaptive learning, simulation, assessment, and educator decision-making.	Evidence supports wider implementation alongside educator training and governance.
Kim et al.	2022	South Korea	Intelligent Tutoring Systems	To examine AI-supported intelligent tutoring in nursing education	Randomized educational trial; undergraduate nursing students; structured competency evaluation	Students receiving AI-supported tutoring achieved significantly higher competency scores.	Intelligent tutoring systems improve academic performance and clinical preparedness.
Johnson et al.	2024	Australia	Learning Analytics	To evaluate predictive learning analytics for identifying academically at-risk	Prospective cohort study; nursing students; institutional learning	AI prediction models accurately identified students requiring early	Learning analytics facilitate timely educational support and improve

				nursing students	analytics database	academic intervention.	student retention.
Lifshits & Rosenberg	2024	Israel	AI in Nursing Education	To synthesize evidence on AI applications in nursing education	Scoping review; studies retrieved from multiple databases using PRISMA-ScR methodology	AI enhanced learning, simulation, knowledge acquisition, and competency development, although technical and implementation barriers remained.	AI offers substantial educational benefits when integrated with appropriate pedagogical strategies and faculty support.
Srinivasan et al.	2024	India	AI Chatbots	To explore the pedagogical implications of AI chatbots in nursing education	Narrative review of published literature	AI chatbots supported personalized learning, student engagement, simulation, and educational efficiency while highlighting ethical concerns.	AI should be integrated using clear ethical frameworks and educator oversight.
Summers et al.	2024	Australia	Generative AI	To explore nursing students' perceptions of generative AI	Qualitative descriptive study; nursing students; purposive sampling; semi-structured interviews	Students valued AI for learning support but expressed concerns regarding academic integrity, overreliance, and professional competence.	Institutions should establish responsible AI-use policies and strengthen AI literacy.
Ostlick, Mariani & Lovecchio	2026	United States	Faculty and Student Perspectives	To examine perceptions and adoption of AI chatbots among nursing faculty and students	Mixed-methods cross-sectional survey; BSN students and faculty (N=254); Technology Acceptance Model questionnaire	Participants reported positive perceptions of AI usefulness while emphasizing concerns about ethics, accuracy, and excessive dependence.	Faculty development and AI literacy programmes are essential for successful implementation.

Sallam	2023	Jordan	ChatGPT in Healthcare Education	To systematically review ChatGPT applications in health professions education	Systematic review using PRISMA methodology	ChatGPT improved educational efficiency and learning support but presented challenges related to hallucinations and misinformation.	Human supervision remains essential when using generative AI in education.
Kung et al.	2023	United States	Large Language Models	To evaluate ChatGPT performance in health sciences education	Cross-sectional evaluation using standardized examination questions	ChatGPT demonstrated promising reasoning ability but inconsistent clinical accuracy.	AI should complement rather than replace conventional educational approaches.
Chan et al.	2024	Hong Kong	Adaptive Learning	To assess AI-supported adaptive learning in nursing programmes	Mixed-methods educational evaluation; undergraduate nursing students; questionnaires and academic performance assessment	Personalized AI learning pathways improved learner engagement, academic achievement, and knowledge retention.	Adaptive learning effectively supports competency-based nursing education.
Kim et al.	2022	South Korea	Intelligent Tutoring Systems	To determine the effectiveness of AI-based tutoring for nursing students	Randomized educational intervention; undergraduate nursing students; competency assessment and structured evaluation	Students receiving AI-supported tutoring achieved higher knowledge and competency scores than controls.	Intelligent tutoring systems improve learning outcomes and clinical preparedness.
Johnson et al.	2024	Australia	Learning Analytics	To evaluate AI-based predictive learning analytics for identifying academically at-risk students	Prospective cohort study using institutional learning analytics database	Predictive algorithms successfully identified students requiring early academic intervention,	AI-driven learning analytics support timely educational decision-making and student

						improving retention and progression.	success.
Abd-Alrazeeni et al.	2026	Saudi Arabia	AI Integration in Nursing Education	To review empirical evidence regarding AI implementation in nursing education	Systematic review of empirical studies with critical appraisal and thematic synthesis	AI enhanced adaptive learning, simulation, automated assessment, curriculum development, and educator efficiency while identifying ethical and infrastructural barriers.	Successful implementation requires governance frameworks, faculty preparedness, and responsible integration into nursing curricula.

DISCUSSION

The findings of this narrative review demonstrate that artificial intelligence (AI) is transforming nursing education by facilitating innovative, learner-centered, and competency-based educational approaches. Across the reviewed literature, AI consistently enhanced personalized learning, simulation-based education, learner assessment, clinical reasoning, and continuing professional development. The integration of machine learning, natural language processing, learning analytics, intelligent tutoring systems, virtual patients, and generative AI has expanded educational opportunities beyond traditional classroom instruction, enabling nursing students to engage in adaptive, interactive, and evidence-informed learning experiences. These findings align with the global transition toward digital health and competency-based nursing education, where graduates are expected to possess clinical expertise alongside digital literacy and informatics competencies to function effectively in increasingly technology-enabled healthcare environments [1–4].

One of the most consistent findings across the literature was the effectiveness of AI-supported adaptive learning systems. Unlike conventional educational models that provide uniform instruction for all learners, AI continuously analyzes student performance and individual learning patterns to generate personalized educational pathways. Such individualized learning improves knowledge retention, learner engagement, self-directed learning, and academic performance by allowing students to focus on identified competency gaps. Adaptive educational technologies also provide educators with valuable insights into learner progression, enabling timely remediation and more effective academic support. Consequently, AI-assisted personalized learning represents an important advancement in competency-based nursing education, where mastery of clinical knowledge and skills is prioritized over time-based educational progression [5–8].

Simulation-based education emerged as another major area in which AI substantially contributes to nursing competency development. AI-powered virtual patients, immersive virtual reality environments, augmented reality applications, and intelligent simulation platforms provide realistic clinical experiences without compromising patient safety. These technologies enable students to repeatedly practice complex procedures, emergency management, communication, and clinical decision-making while receiving immediate formative feedback. Evidence synthesized in this review indicates that AI-enhanced simulation improves Objective Structured Clinical Examination (OSCE) performance, clinical confidence, psychomotor skills, and diagnostic reasoning. Importantly, AI-driven simulation allows standardized exposure to rare or high-risk clinical scenarios that may not be consistently encountered during traditional clinical placements, thereby strengthening workforce preparedness for contemporary healthcare practice [9–12].

The review also highlights the growing importance of AI-supported assessment and learning analytics in nursing education. Conventional evaluation methods often depend on written examinations and subjective faculty observations, which may inadequately capture learners' clinical competence. AI introduces objective, continuous, and multidimensional assessment through automated scoring systems, computer vision, speech recognition, and predictive analytics. These technologies provide detailed feedback regarding learner performance while enabling educators to identify students at risk of academic failure or poor clinical performance at an earlier stage. Early intervention facilitated by predictive learning analytics may improve student retention, academic progression, and programme completion. Nevertheless, the literature consistently emphasizes that AI-generated assessments should complement rather than replace professional faculty judgment, particularly when evaluating communication skills, professionalism, ethical reasoning, empathy, and patient-centered care [13–16].

Generative AI has rapidly become one of the most influential innovations in nursing education. Large language models are increasingly used for literature synthesis, academic writing assistance, case-based learning, examination preparation, and concept clarification. Faculty members similarly benefit from AI-assisted development of educational materials, simulation scenarios, formative assessments, and curriculum resources. Despite these advantages, reviewed studies identified important concerns regarding inaccurate AI-generated information, fabricated references, algorithmic bias, academic misconduct, and excessive dependence on automated systems. Consequently, nursing programmes should integrate structured AI literacy training that equips students to critically evaluate AI-generated outputs, verify information using high-quality scientific evidence, and apply ethical principles when utilizing AI technologies in educational and clinical settings [17–20].

Ethical and organizational considerations remain central to successful AI implementation. Although AI enhances educational efficiency, it cannot replicate the humanistic values that define professional nursing practice. Compassion, empathy, therapeutic communication, ethical decision-making, cultural competence, and professional accountability remain essential competencies that require meaningful interaction with educators, patients, families, and multidisciplinary healthcare teams. Furthermore, disparities in technological infrastructure, financial resources, faculty expertise, and institutional readiness continue to limit widespread AI adoption, particularly in resource-constrained educational settings. Addressing these challenges will require investment in digital infrastructure, faculty development programmes, standardized institutional policies, and robust governance frameworks that ensure transparency, fairness, privacy, and responsible AI implementation throughout nursing education [21–24].

The findings of this review have several implications for nursing education, curriculum development, and policy. First, AI competencies should be systematically incorporated into undergraduate and postgraduate nursing curricula, including digital literacy, AI ethics, health informatics, data interpretation, clinical decision support, and responsible use of generative AI. Second, nurse educators require structured professional development to effectively integrate AI technologies into teaching, assessment, and curriculum design. Third, educational institutions should establish evidence-based guidelines governing AI use, academic integrity, data security, and learner privacy while promoting interdisciplinary collaboration among nursing educators, computer scientists, educational technologists, and healthcare organizations. Finally, future research should move beyond descriptive investigations toward large multicenter randomized educational trials that evaluate long-term educational outcomes, competency development, patient safety, cost-effectiveness, and implementation strategies across diverse educational contexts [25–30].

Overall, the current evidence demonstrates that artificial intelligence represents a transformative educational innovation capable of substantially improving nursing education when implemented responsibly. AI enhances personalized learning, strengthens clinical competency, supports objective assessment, facilitates lifelong professional development, and prepares future nurses for digitally enabled healthcare systems. However, its successful integration depends upon balancing technological innovation with human-centered nursing values, ethical governance, faculty preparedness, and evidence-based educational practice. Future nursing education should therefore embrace AI as an enabling educational partner that augments—rather than replaces—the expertise of nurse educators and the compassionate, patient-centered philosophy that underpins the nursing profession [31–35].

Strengths and Limitations

This narrative review provides a comprehensive synthesis of contemporary evidence on the integration of artificial intelligence in nursing education, encompassing personalized learning, simulation, competency assessment, and professional development. It includes recent literature from diverse educational settings and highlights both technological advancements and ethical considerations. However, the review is limited by its narrative design, which may be subject to selection bias and does not provide quantitative effect estimates. Additionally, the heterogeneity of study designs, AI technologies, and outcome measures limits direct comparison and generalizability of findings.

Recommendations

Future research should prioritize multicenter randomized controlled trials and longitudinal studies to evaluate the long-term effectiveness of AI in nursing education and its impact on clinical competency and patient outcomes. Nursing curricula should incorporate AI literacy, digital health, ethical AI use, and health informatics as core competencies. Institutions should invest in faculty development, technological infrastructure, and standardized governance frameworks to ensure responsible AI implementation. Collaborative efforts among educators, healthcare organizations, policymakers, and technology developers are essential for sustainable integration.

CONCLUSION

Artificial intelligence is transforming nursing education by creating personalized, adaptive, and competency-based learning environments that enhance knowledge acquisition, clinical reasoning, simulation-based training, learner assessment, and lifelong professional development. The evidence reviewed indicates that AI-powered technologies—including adaptive learning systems, virtual simulations, intelligent tutoring platforms, learning analytics, and generative AI—can significantly improve educational efficiency, learner engagement, and clinical competency when integrated appropriately. Nevertheless, successful implementation requires robust technological

infrastructure, faculty preparedness, ethical governance, and institutional policies that safeguard academic integrity, data privacy, and equitable access. Importantly, AI should complement rather than replace the essential human dimensions of nursing education, including empathy, ethical decision-making, communication, and patient-centered care. Integrating AI literacy into nursing curricula and promoting interdisciplinary collaboration will prepare future nurses to work effectively in increasingly digital healthcare systems. Continued high-quality research is needed to establish best practices, evaluate long-term educational outcomes, and ensure that AI contributes to safe, evidence-based, and compassionate nursing practice while strengthening the future nursing workforce.

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